UNIVERSITY OF CALIFORNIA HEALTH

Connected:

Lessons from the University of California Systemwide COVID-19 Response

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DEDICATION

This report is dedicated to the many staff of UCOP whose lives and labor were committed to sustaining the University of California during a pandemic that generated unprecedented challenges, disruptions, and threats to the well-being of our students, employees, and the organization itself, especially: **Amina Assefa, M.P.H.; Kristie Elton, B.S.P.T., M.S.P.T.; Cheryl Lloyd; Rachael Nava; Zoanne Nelson, MBA; and Rachel Nosowsky, J.D.**

And the authors share their endless gratitude and respect for all the University of California Health employees who risked their own lives to save the lives of others and to protect their communities.

The world asks of us
only the strength we have
and we give it.

Then it asks more
and we give it.

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Setting the Stage and Planning for the Future

CARRIE L. BYINGTON, M.D.

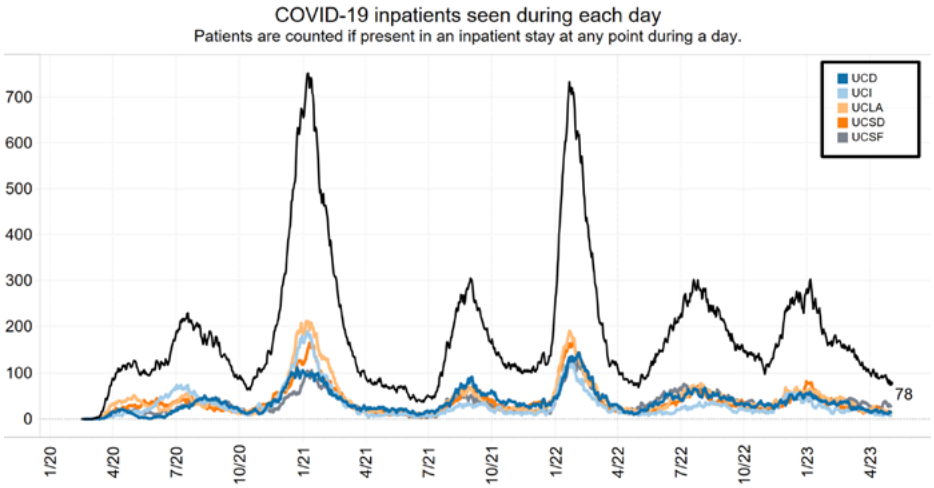
December 31, 2019. New Year's Eve in the United States, and as 2020 began, it was a turning of not only the year, but every aspect of our lives. The date will forever mark for me the periods before and after the global pandemic of severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2). I was listening to a news report about an unknown pneumonia in Wuhan, China. The report generated the same feelings I had at the onset of SARS in 2003 and H1N1 in 2009. The floor sways. Your stomach drops. You hold your breath and try to steel yourself for what you know is coming. At a species level you know what we will see—surges of sickness, suffering, shortages, suspicion, and hopefully survival.

As I write this after-action report, the public health emergency has ended, though SARS-CoV-2 remains a dangerous pathogen that is still a threat in our world. The graphic representation of the surges of disease and hospitalization during the emergency are etched in my memory **(Figure 1)**. I know both what it took to collect and aggregate these data and more importantly that these data represent the daily struggle of health care providers to care for the real people these numbers represented. The UC response to the COVID-19 pandemic claimed the bulk of my time as the new EVP of UC Health, and it was the lens through which I learned about the organization.

FIGURE 1

COVID-19 Data Dashboard

Source: UC Health Center for Data-driven Insights and Innovation



Pandemics challenge organizations, unmask capacities, and reveal true values. In fact, I had talked about how my experience with pandemics had shaped my own values and understanding of the interconnectedness of our world and the need to eliminate health disparities to the UC Board of Regents at my first Health Services Committee meeting on December 10, 2019, just days before we learned a pandemic was brewing.

UC Health (https://health.universityofcalifornia.edu) is the largest academic health center in the U.S. and a significant component of the University of California. As UC Health leadership began to work with the president and chancellors to prepare the UC system for what was coming, I often said, "Please, just assign us one impossible task per day." What I quickly learned was that the there was nothing the system could not do, and do extraordinarily well, if it was a priority. I learned that the UC system, with its human capacities and physical assets, was a powerful platform for public health and health equity.

> *I learned that the many individual parts of the University of California system were deeply connected, one to the other and to the communities of our state.*

When I face a new challenge, I look to the past. What did people who came before me do in a similar situation? I was able to find an article written by a UC Berkeley history doctoral student about the 1918 pandemic that described the situation at UC Berkeley.[1] Reviewing it made it clear that even 100 years on, we would face similar challenges. The paper described three influenza waves on the Berkeley campus, the first and most severe in the fall of 1918. The records of the time show delays in the spring semester and canceled classes due to 25% of the campus falling ill and buildings converted to makeshift hospitals and quarantine facilities. By the end of the year, the president reported influenza had claimed the lives of 20 students and one faculty member.[2] Mask mandates were enacted, and the Daily Californian published a letter on November 11, 1918, that noted, "Since the ordinance requiring that everyone wear a mask has been in force most people have had to obey at least the letter of the law. But many have missed or ignored the spirit and are still evading the law in every possible way as though it were a sign of superiority to disregard it. And so on all sides we see little useless masks the size of a postage stamp, and masks worn on the chin and neck."

I found the article entertaining and the descriptions of campus life during a pandemic interesting and timely, however the article did not offer much practical advice for mitigating the effects of the virus apart from the descriptions of academic buildings used for makeshift hospitals or sites for quarantine and the impossible notion today of the recruitment of women students and the wives of faculty to make gauze masks for the campus population. We did in fact make many masks across the UC campuses, but both men and women joined the efforts.

What I was really looking for was the after-action report for the H1N1 pandemic in 2009–10. I did not find one and realized that essentially all locations acted independently. I could find no memory or evidence of collective action.

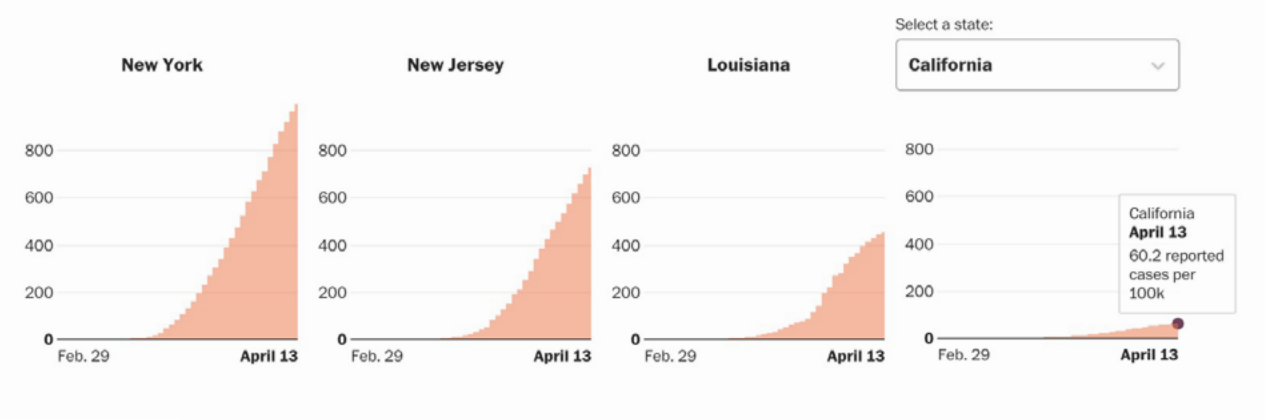
For example, there were no written crisis standards of care for the UC health system. The H1N1 pandemic had been relatively mild, and the UC system had been lucky in 2009. However, we entered this new public health emergency less prepared than we should have been. I write this report for those in the future who will face new threats to public health. As I write, I am watching the more virulent clade I strain of monkeypox virus in the Democratic Republic of the Congo evolve to be transmissible through sexual contact,[3] the spread of Nipah virus from Malaysia to India,[4,5] and in the U.S., the discovery of H5N1 avian influenza circulating widely in dairy cattle and other mammals.[6,7] It is not a question of if, but when the next public health emergency or even pandemic will threaten our well-being.

There are many lessons from the pandemic, and they are included throughout the report. Important lessons were the willingness to act early, starting on January 1, 2020, and to collaborate broadly.

The UC system worked together across all campuses and locations and with the leadership of California to prepare our system and to support the preparations of the state. We sought out guidance internationally from China and Italy, countries that experienced early and overwhelming outbreaks. This work helped us to be better prepared and resulted in better statewide outcomes, especially during the first wave of infection at UC in spring 2020 **(Figure 2)**.

FIGURE 2

Cases of COVID-19 per 100,000 residents in the U.S., reported by state for April 13, 2020



Source: The New York Times

We also learned that combatting pandemics is expensive, from both financial and human perspectives. The work that was required involved major additions to work processes and changes to our usual operations. Despite the new demands, the usual daily work of our hospitals, clinics, and campuses had to continue unimpeded. Data were critical and fragmented across the system. The failure to invest in single systems, or at least interoperable systems, across the UC system meant lots of data collection and aggregation was done manually, which was both labor-intensive and costly. All necessary equipment and supplies for mitigation of infection transmission or diagnosis were both limited and far more expensive than in the years before the pandemic. For example, the cost of N95 masks increased fivefold while our usage increased tenfold. Labor costs were enormous and continue to be higher than pre-pandemic. Investments in interoperable data systems and stockpiling resources may lower costs in the future.

Of all the lessons of the pandemic, the most important for UC, I believe, are those related to leadership and decision-making. The tension between central decision-making and local control across the UC system has existed since at least 1952. This was the year chancellor positions were created for individual campuses, while still maintaining the president's role for the UC system, as described by Dr. Clark Kerr, the first chancellor of UC Berkeley and the 12th president of the University of California, in his memoir.[8] There are advantages and disadvantages to both central and local control, especially in complex organizations. In the U.S., we see this reflected in federal vs. state control and in California, it was evident in the tension between state and local public health authorities. At the time of the pandemic, the balance in the UC system tipped away from central authority and more toward favoring local campus control for important decisions.

Credit: Wayne Tilcock, UC Davis Health

Credit: UCLA Health

Credit: Wayne Tilcock, UC Davis Health

However, there are events so large that they change the course of history and touch every part of existing organizations. The impact of the COVID-19 pandemic was felt broadly and resulted in dramatic changes to the operations of all institutions within the UC system, the state, nation, and world.

> *The response to the pandemic at UC required and benefited from strong central leadership that supported aligned and decisive action combined with the radical inclusion of campuses to inform policy and to direct the implementation of policies and processes locally.*

Central leadership and governance were facilitated by the University of California Office of the President (UCOP) Management Response Team (MRT) and, importantly, by the call to campus locations to send engaged representatives to populate systemwide subject matter expert (SME) groups. The UC system was and is home to deep expertise. The SME groups convened at UC rivaled national and international groups assembled to advise governments and public health agencies such as the Centers for Disease Control and Prevention and the World Health Organization. All locations enthusiastically responded to calls for SME participation. Members of SME groups gave selflessly of their time and expertise, in addition to performing their regular duties, which were made more difficult by the pandemic. **The SME groups served without additional compensation for more than two years during the entirety of the public health emergency.**

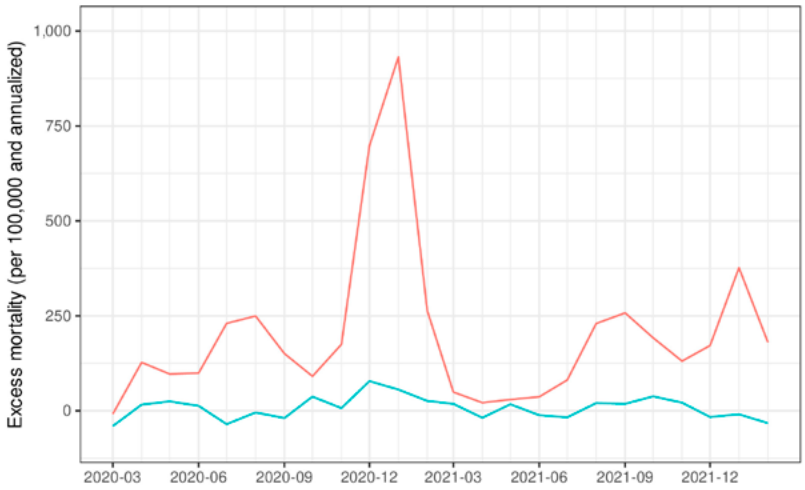
The UCOP MRT provided campuses and locations with a framework for response that included systemwide policies and direction for mitigation that served as the baseline for local action. The campuses then could operationalize the mitigation requirements in ways that best supported their local environments. This resulted in many innovations and the ability to pilot and test interventions at individual locations and to compare outcomes. This capacity enhanced knowledge and performance across the system. Over time best practices were identified and often adopted at additional locations or even systemwide. The combination of strong central decision-making with the robust inclusion of local expertise decreased unproductive variation, delivered a consistent experience across locations, and strengthened the health security of the entire system.

At the end of the public health emergency for SARS-CoV-2, the University of California emerged stronger than ever. The pandemic was expensive, resulting in additional expenses or losses of more than $3.5 billion. These costs, however, were far outweighed by the benefits to UC patients, students, trainees, and employees across the system and to the communities of California. Our hospitals delivered high-quality care with some of the lowest mortality rates in the U.S. Both the academic health centers and campus locations developed capacities for remote health visits and for virtual learning. When more in-person work and education began, UC experienced no outbreaks that required curtailing or closing locations. Our facilities were not superspreaders in the surrounding communities. Research flourished as investigators pivoted to questions related to the pandemic and National Institutes of Health grant funding increased by 25%.

FIGURE 3

Excess mortality in the California resident, employed populations aged 18 and older of the University of California system (blue) and the state of California (red) during the early years of the pandemic

Source: Original data courtesy of Dr. Yea-Hung Chen, UCSF



Importantly, the systemwide policies informed by campus SMEs reduced the variation of experience across all locations and protected UC populations. Figure 3 demonstrates the significantly lower excess mortality seen in the UC employed population compared with the California employed population during the early phases of the public health emergency.

Ultimately, our pandemic response and mitigation activities focused on serving all Californians, especially the most vulnerable. The pandemic was an opportunity to challenge our thinking and to live our public service mission. The UC system proved its commitment not only to the welfare of the people living, studying, and working at UC, but to our patients, the state of California, and the nation.

This report is meant to capture many of the lessons learned during the pandemic and to make them actionable. My hope is that the report will inform and strengthen the decisions made by future employees and students, who will always be the greatest assets of UC.

Fiat Lux.

Dr. Carrie Byington administering some of the first COVID-19 vaccines in January 2021 at the PETCO vaccination supersite staffed by UC San Diego Health

Credit: Erik Jepsen, UC San Diego

Lessons Learned

- The UC system has the capacity to face a challenge as great as the SARS-CoV-2 pandemic and to thrive.
- A public health emergency can refocus the system in ways that prioritize our values, especially the public service mission of UC.
- Leadership matters at both the central and local level.
- The UC system has the expertise to support science-informed decision-making at UCOP.
- Subject matter experts across locations are critical for trust-building collaborations, expanding networks, and providing local guidance to better inform implementation of mitigation efforts.
- Early and decisive action saves lives and leads to better health, education, research, outcomes.
- Labor relations benefited from actions that supported the health and well-being of employees.
- The UC response to the pandemic required and benefited from strong central leadership and the radical inclusion of campus locations to support policy development, innovation, and local implementation of mitigation efforts.
- A new position of Chief Health Security Officer would benefit the UC system by providing coordination of efforts across UC locations and with the state during times of public health emergency and by overseeing activities to enhance readiness and resilience between periods of emergency.[24]

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Presidential Perspectives

JANET NAPOLITANO, J.D., AND MICHAEL V. DRAKE, M.D.

During the period of public health emergency for the SARS-CoV-2 pandemic, from March 11, 2020, to May 11, 2023, the University of California system had two presidents. President Janet Napolitano and President Michael Drake each faced the responsibility of leading one of the largest academic systems in the U.S. during periods of profound uncertainty. Each was faced with significant decisions.

At the start of the pandemic, fear of viral transmission overwhelming health systems led California to lock down all but essential services. The UC system transitioned hundreds of thousands from in-person to remote education and work environments while also providing in-person and virtual health services. The operational challenges were enormous. Later in the pandemic, the decision to return to in-person operations posed different challenges in the face of new expectations for learning and working at UC and across society. We share President Napolitano's and President Drake's perspectives for future leaders.

President Janet Napolitano

Janet Napolitano served the UC system in the role of president from September 30, 2013, through August 1, 2020. Prior to serving as UC president, the Honorable Ms. Napolitano served as the 21st governor of Arizona and as the third United States secretary of homeland security. Both roles prepared her for many of the challenges the UC system faced during the SARS-CoV-2 pandemic.

Credit: University of California

Commentary relevant to January 1, 2020, through August 1, 2020

As the pandemic began, I had four major goals:

1. *Keep UC's 250,000 students and 250,000 faculty and staff **as safe as possible** from a disease for which there were no known effective therapies and no vaccine;*

2. *Enable students to **keep making progress toward their degrees**, while facilitating both the admissions and the graduation processes;*

3. *Convert our teaching hospitals into **COVID hospitals**; and*

4. *Maintain **UC's financial solvency** so that we could be in a position to recover operationally once the pandemic was over.*

Safety

To keep our students, faculty, and staff as safe as possible we decided to immediately curtail classes and depopulate the dorms. Easier said than done. Some students, for example our international students, could not return home. We ended up keeping a small segment of our dorms open for those students, with regular testing protocols put in place. The lack of adequate testing kits was a great hindrance. We had to scavenge, and there were extensive delays at getting test results as everything had to be processed through the Centers for Disease Control and Prevention. This took weeks to work out. The University of California health centers worked together to develop testing for SARS-CoV-2 as soon as this was allowed by the Food and Drug Administration on February 29, 2020.[9]

All UC health centers began to offer COVID testing by polymerase chain reaction (PCR) in March 2020. Ultimately, this experience would help to inform testing on campuses in collaboration with academic laboratories.

By the end of the third week in March, the majority of students had gone and our once-bustling campuses were ghost towns. Even so, some university functions couldn't be shut down. Many of our labs had equipment that needed to continue to operate or, in some cases, live animals that needed daily care and feeding. We worked with lab directors to inventory what lab functions had to continue, then worked out a limited staffing schedule, again with an extensive testing and infection prevention protocol for those who had to continue to work.

Education

We were near spring break for the eight campuses on the quarter system and near mid-semester for our two semester campuses (Berkeley and Merced). So the chancellors and I decided that once students left for break, they would not return. Faculty used the break to convert the remainder of the term to remote learning, primarily by Zoom. This was an amazing feat by our faculty, many of whom had resisted remote learning in the past. We were all determined, however, that UC's educational mission should continue and the circumstances of the pandemic necessitated rapid adjustment to classroom expectations.

While we thought initially that campuses could reopen fully to in-person instruction by fall 2020, that was not to be the case. Although we issued substantive guidance for the fall of 2020 and had some in-person education, it wasn't until fall 2021 that the majority of in-person classes resumed and dorms were once again fully occupied. During this entire period, however, classes continued and students kept making progress toward their degrees. This included the entire 2020-21 school year, when the majority of admitted first-year students spent their initial college experience on Zoom from home. Not ideal, but effective.

Hospitals

UC operates a network of teaching hospitals throughout California. Working with the executive vice president of UC Health, Carrie Byington, M.D., who was in constant communication with the hospital CEOs and incident command centers, the health system addressed myriad issues, including supply chain for masks, personal protective equipment (PPE), and ventilators, an area where the federal government was woefully underprepared, and developed testing, infection prevention, and treatment protocols. We canceled, by order of the governor, all elective procedures, some of which were serious surgeries that had to be delayed. We converted the hospitals into COVID wards and increased hospital bed capacity not knowing what the COVID patient demand would be. Dr. Byington was in constant contact with the State of California Department of Health. We were also in constant communication with the California Nurses Association, the union representing our nursing population. They were frustrated during those initial months by the unreliability of normal supply chains for items such as PPE. Our institutions went out into the market themselves, regularly forced to compete with other hospitals or, indeed, other states for needed supplies. The hospital CEOs had to make difficult decisions on how to distribute the materials they had, and the UC Health Coordinating Committee wrote an ethical and equitable guide for crisis standards of care, which fortunately was never required to be implemented.

Fiscal Health

All the new needs and health and safety requirements identified during the pandemic cost money. The UC system had to refund $350 million in dormitory fees. Canceling elective surgeries meant that our hospitals were hemorrhaging revenue. By June 2020, our hospitals were over $1 billion below their expected revenue forecasts. These losses occurred as we made a commitment to maintain employment and health insurance coverage for UC workers. On April 2, 2020, I wrote to the UC community that there would be no layoffs related to COVID-19 through the end of the fiscal year, June 30, 2020. The memo read in part, **"Providing pay and health and welfare benefits during this period will allow employees to more effectively care for themselves and their families as we all support California and the nation by staying home and doing our part to reduce the spread of this virus."**

The federal dollars were essential here, as they helped plug numerous holes in our budget. We got creative too. While our dining halls were closed, for example, staff helped prepare boxed meals for those students still left on campus and then for first responders and other essential workers in their communities. Nonetheless, without the federal stimulus funds, we may not have survived.

Conclusion

This short summary barely scratches the surface of all the issues involved in essentially shutting down and then reopening UC. The key metric of our success is that there were no COVID outbreaks anywhere in the system. And, having kept our students, faculty, and staff as safe as we could, we were able to continue and maintain the education and research function of the university, albeit at a different level than before. The leadership and cooperation of the campus chancellors was essential, as was the willingness of students, faculty, and staff to do the best we could with what we had. We operated as an integrated system, not 10 individual fiefdoms, and that systemic approach contributed to our successes.

President Michael V. Drake

Michael V. Drake, M.D., is the 21st president of the University of California system and a physician. Prior to serving as UC president, Dr. Drake was a longtime faculty member at UCSF, served as the vice president for health affairs for the UC system (2000–05), was the fifth chancellor of UC Irvine (2005–14), and served as the 15th president of The Ohio State University from June 2014 through June 2020, a period that encompassed the declaration of the SARS-CoV-2 pandemic.

Credit: University of California

Commentary relevant to the public health emergency from March 11, 2020, through May 11, 2023

As a medical doctor, I had experience with the SARS-CoV-1 crisis in 2003 and remember that period well. In January 2020, I heard about a new virus coming out of Asia. I began to model in my mind how this might unfold and tracked the response in China, which was so profound. Based on what happened with SARS the first time, I believed that we would see a rise in infections at the end of January and into early February, and then we'd see infections level off as travel restrictions went into effect.

But it soon became clear that the virus wasn't petering out, and eventually it came to the U.S. Around the end of February 2020, I was hearing more about this, but I wasn't overly concerned. I did, however, notice that information about the virus from the Centers for Disease Control and Prevention (CDC) was being filtered politically.

Eventually, around the first weekend in March, I realized that we were going to have to make our own decisions about how to respond. The information and recommendations coming from the CDC at the time were not sufficient to protect our community in Ohio. Although by the second weekend in March there had been no confirmed cases reported in the state of Ohio, it was clear that COVID-19 would be with us in a matter of days. On the morning of March 9, the first Monday of spring break, our leadership team met. After that meeting, I decided that we would essentially extend spring break by two weeks and instruct our students to remain away from campus until the end of March. I expected that the crisis would have been blunted by then and that they could return to finish out the semester in April and May. That evening saw the beginning of a flurry of activity communicating with students, faculty, staff, families, government officials, and the broader Ohio higher education community, all of whom were taken by surprise at the suddenness of our decision. In several tense meetings, I explained my assessment that we were in essence being invaded, and that every day, every hour we delayed our defensive reaction could lead to an exponential increase in morbidity and mortality.

On Wednesday of that week, we convened an emergency meeting with OSU's governing board. As we went through our action steps, one member asked me, "*Don't you think you're overreacting?*" I said, "***I hope I'm overreacting. What I don't want to do is underreact!*** *I want to do more than what's needed, so that we can get ahead of this, and then we can pull back. Overreacting may be a nuisance, but underreacting could spell disaster.*"

> *The great tragedy of our times is that far too many did, in fact, underreact, at the cost of hundreds of thousands of avoidable fatalities nationally. Then it became my daily job to monitor exactly how the pandemic was unfolding and make decisions based on that information.*

We were four months into the pandemic when I began my job as president of the University of California. By April 2020, things had begun to look better. But then as we relaxed restrictions, we had a summer spike in infections just prior to our scheduled return to fall classes. My new task was to coordinate mitigation of the impact of the mass migration of students, faculty, and staff back to campus in the late summer and early fall. At this point, there was no vaccine and no reliable treatment for COVID-19. We initiated a series of safety requirements, including testing, isolation and retesting, masking, contact tracing, and quarantine that students, staff, faculty, and others had to follow to be able to live or be on our campuses. We had already transitioned to entirely remote instruction except for a few cases.

The UC system was a needed leader nationally in its pandemic response. Our policies affected 10 campuses, our Division of Agriculture and Natural Resources, and our national labs. We have over 240,000 employees and roughly 300,000 students, and we are home to several of the nation's leading academic medical centers. A great many people watch and pay attention to what we do. We ourselves were continually evaluating our effectiveness. Bad decisions could lead to bad clinical outcomes. **Not all of our decisions were popular, but they all reflected our best effort to do what was right for the public health of our campuses and our communities.**

We also had advantages at the University of California. We had wonderful, nationally recognized experts advising us, who were quoted in the media about this topic every day. We welcomed the opportunity to use the expertise of our faculty. Our job was to process the information we got in a way that would keep us safe while allowing us to move forward with our mission of teaching, research, and public service.

Ultimately, we have learned a tremendous amount from the pandemic. There have been silver linings to the dark clouds of the crisis. We were able to re-emphasize the value of collaboration in our health services enterprise. Everyone saw that they were struggling with similar problems. Interventions discovered on one campus could be helpful on another. We shared best practices. Working together as a system helped us do a better job—that was a good thing to illustrate. Our faculty were amazing. They showed resilience, flexibility, and creativity in pivoting on a dime to remote education, and in keeping their research projects moving forward, albeit at a reduced pace in many cases. Our students were amazing as well, changing their learning styles and living circumstances and nevertheless completing the coursework needed to earn their degrees. And our heath care workers were courageous, generous, and spectacular as they risked their lives to keep our health services enterprises open and actively serving our communities throughout the entire period. We also demonstrated again the importance of the University of California to the state, and to the nation. Our experiences, our data, and our experts helped inform decision-making for others.

Lessons Learned

- Bold leadership was required of both presidents.
- The most important decisions were related to protecting the health and safety of our students, employees, and patients.
- The University of California had many assets and resources, including the commitment, creativity, expertise, and knowledge of our faculty and staff that could be leveraged to inform system decisions that led to better health and economic outcomes.
- Overreaction was preferable to underreaction, especially early in the pandemic when there were limited treatments and no vaccines available.
- The UC system was able to provide leadership and guidance to the state and nation.
- The mitigation efforts were costly and yet both presidents were confident in the ability of the UC system to overcome the financial hardships of the pandemic.

3

People First—Human Resources Health-Related Policies

CARRIE L. BYINGTON, M.D.

The University of California recognizes that people are the most important assets of the system. In the decades before the pandemic, the university was known as an organization with exceptional benefits for employees, students, and trainees. Many of these benefits are the result of policies directly related to health and health care, and as became obvious during the pandemic, all policies have impact on the health of populations.

As the pandemic began to unfold, many conversations were taking place in the C-suites across the system and at UCOP. One theme was clear from the start and was expressed by President Janet Napolitano and the 10 UC campus chancellors in a message to the UC community on April 2, 2020, in which they announced collectively a commitment to alleviating concerns about income or job stability during a national emergency by ensuring "there will be no COVID-19 related layoffs for employees through the fiscal year." This guidance also made it possible for employees to retain their health benefits at a time when we were all vulnerable to infection and illness. They ended the letter with the following: **"We cannot predict how the situation will evolve, or what future measures we may need to take to uphold our mission. What we do know is that we will face the future with courage and find our way together."**

A framework for a safer working environment

The UC system is complex, with many locations across California, the Los Alamos National Laboratory in New Mexico, and offices in Washington, D.C. that encompass a variety of educational and work environments. The goal of the COVID-19 response was not to have a one-size-fits-all set of mandates, but rather a framework that could establish a baseline for a safer working environment across all locations. The framework entitled "University of California Consensus Standards for Operations of Campus and Agricultural and Natural Resources" was approved by the UC Board of Regents on May 20, 2020. The document included guidance for all locations that sought to reduce unproductive variation across locations and ensure that students, employees, and trainees across the system had similar environments to study, work, and train. The guidance was broad enough to allow each location to adopt a variety of interventions suitable for their own location, culture, and professional requirements. Each location then served in some ways as an experimental trial. Best practices were identified and shared across locations through the UC Health Coordinating Committee. Examples include infectious disease modeling for campus settings and wastewater surveillance, initially adopted at UC San Diego and then used throughout the UC system for safer resumption of campus activities.[10-12]

The requirements of the board guidance mandated that all location plans for the resumption of on-site activities adhere to 10 points:

1. *Coordination with state and local health departments, including the standard that all UC location plans will comply with state and local orders and directives.*

2. *Phased or staged resumption and scenario planning with each location identifying metrics for prudently increasing (or decreasing) in-person and on-site activities as local conditions dictate. The capacity of local health resources' ability to handle surges in viral infections without resorting to crisis standards of care was a required consideration for all locations.*

3. *Risk assessment and designated point of contact in which every location was expected to perform a detailed risk assessment and to implement site-specific protection plans. All locations were expected to identify a designated official to lead location mitigation activities.*

4. *Health screening, clinical testing capacity, and contact tracing: All locations were required to have plans that included provisions for screening individuals entering university-owned or operated facilities, arranging for clinical tests of any students, faculty, or staff who exhibit symptoms consistent with COVID-19, and investigating any COVID-19 illness to determine if conditions should be altered to further mitigate risks, and identify other university-affiliated people who may have been in close contact. Testing and contact tracing could be performed by the campus, a sister campus, local health officials, or other community resources.*

5. *Housing, case management, and student housing: All location plans were required to address, if applicable, housing density for different types of campus-owned and operated housing and adjustments to common areas, assure appropriate training and personal protective equipment (PPE) for resident assistants and other housing staff, and identify on-site or off-site options for isolation of those students who live in on-campus housing and are diagnosed with COVID-19, as well as quarantine for those who are identified as close contacts of COVID-positive individuals.*

6. *Individual risk reduction measures: This standard required each location to adopt non-pharmaceutical interventions, including at a minimum for fall 2020 hand hygiene, universal face coverings, physical distancing, and compliance with influenza immunization.*

7. *Students, faculty, and staff at increased risk for serious illness: All plans were to include measures to reasonably accommodate students, faculty, and staff who provide documentation of increased risk for severe illness should they contract COVID-19. Options could include virtual learning, remote work, and other accommodations.*

8. *Access limitations: All plans were to address access to campus or to individual facilities by non-affiliates who are not performing essential work.*

9. *Environmental health and safety: All plans were to address any special safety measures necessary to resume operations in buildings that have been shuttered for a prolonged period; and include measures to procure adequate equipment and supplies, including personal protective equipment (PPE), and to retain and properly equip adequate staff to undertake in-person/on-site operations at sites where appropriate adaptations have been made to reduce risk.*

10. *Communication and stakeholder outreach—All plans will be publicly posted. They will include provisions to educate students, faculty, staff, and non-affiliates permitted on site about COVID-19 and how to reduce its spread. Other modes of communication designed to apprise stakeholders—including those with limited English proficiency—of the measures adopted locally and any adjustments as they are made should be considered.*

Health-related benefits prior to the pandemic

At UC, the vast majority of employees are eligible for comprehensive health insurance benefits that include medical, dental, pharmacy, and vision coverage. These employees include faculty and staff with contract, regular or career, limited, academic, partial year, and floater appointments. Postdoctoral scholars are eligible for benefits with employee, fellow, paid direct, non-exempt employee, and interim employee appointments. Resident physicians, house staff, and fellows are offered health benefits through UC Health. Finally, those with casual/restricted (usually students), per diem, or seasonal appointments, graduate students, and those paid by stipend are also eligible for health benefits depending on the appointment percentage and duration. The groups ineligible for benefits include individuals classified as employees on non-university entities, independent contractors, individuals appointed without salary, and individuals who have retired and are eligible for coverage through a UC retiree insurance program.

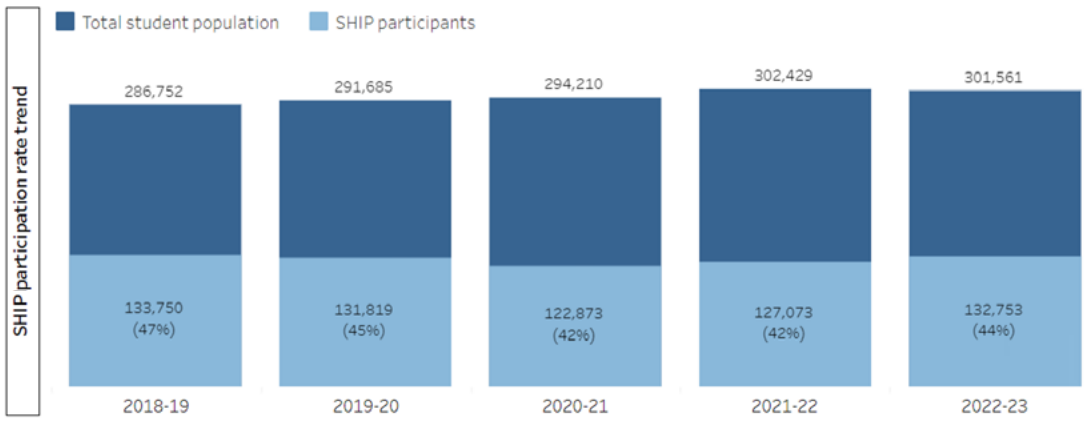
The employee health plans offer a choice of benefits plans. For most plans, the employee portion of the medical plan premium depends on the employee's full-time salary. The employee contribution to the health premium is tiered, with four levels based on salary. Lower paid employees have lower contributions than higher paid employees. The CORE plan is a PPO plan with a high deductible that is paid for entirely by UC and is an option that is free to the employee. Enrollment in UC's employer-sponsored health plans is measured annually in Quarter 4. Enrollment in the medical plan was constant before and after the onset of the pandemic at approximately 88%. Employees who are not enrolled in a UC Health plan most often have coverage through a spouse or partner either at UC or at another organization.

All UC students are required to be enrolled in a qualified health insurance plan to register. Undergraduates are automatically enrolled in the UC Student Health Insurance Program (UC SHIP) unless they waive coverage and provide evidence of alternative coverage such as coverage through a parent's insurance plan, Covered California, or Medi-Cal. UC SHIP is a comprehensive plan that includes medical, dental, vision, and pharmacy coverage. It is an affordable plan tailored to the health needs of students and provides year-round, worldwide coverage. Student participation in UC SHIP dropped modestly after the pandemic, from 47% in 2018–19 to 42%–45% in the years after the pandemic **(Figure 1)**.

FIGURE 1

UC SHIP participants before and after the COVID-19 pandemic

Source: UC SHIP



In addition to health benefits, the majority of UC employees had access to some form of paid sick leave or personal time off prior to the pandemic. Employees also had access to leave related to life events, including unpaid family and medical leave (FML) of up to 12 weeks for a serious health condition in the employee or to care for a family member with a serious health condition. An additional 12 weeks of supplemental FML was also available for regular employees who had exhausted FML benefits. Pay for Family Care and Bonding is also available for eligible employees for up to eight weeks in a calendar year. Leave due to pregnancy, childbirth, or related medical condition (PDL) is also available for up to four months. Paid leave, from vacation, sick, or paid time off, may be substituted for FML or PDL. Finally, leave is available for work-related injury or illness, reproductive loss, and bereavement.

Additional benefits instituted to mitigate effects of the pandemic

Expanded paid administrative leave: On March 16, 2020, concomitantly with the shelter-in-place orders issued by seven Bay Area counties, President Napolitano issued an executive order making all employees eligible for a one-time allotment of up to 128 hours of paid administrative leave. The leave was to be used by December 31, 2020, to address the extraordinary demands being placed on employees and their families due to COVID-19.

Emergency paid sick leave (EPSL): In recognition of the ongoing challenges of the pandemic, the University of California provided 80 hours of emergency paid sick leave in 2021 and again in 2022. All UC employees were eligible if they met at least one of the six qualifying reasons:

1. ***Quarantine or isolation order****—the employee was unable to work or telework because they were subject to an order to quarantine or isolate from the Centers for Disease Control and Prevention, the California Department of Public Health, or a local health authority.*

2. ***Isolation or self-quarantine****—the employee was unable to work or telework because they had been advised to isolate or quarantine by a health care provider because of COVID-19.*

3. ***Testing, diagnosis, and/or vaccination****—the employee was unable to work or telework because they had symptoms of COVID-19 and were seeking medical diagnosis, they had been exposed to COVID-19 and were awaiting diagnostic test results, the university had requested the employee seek testing and the employee was awaiting results, the employee was attending a COVID-19 vaccine appointment for themselves or family member, the employee was experiencing symptoms or caring for a family member with symptoms following a COVID-19 vaccination.*

4. ***Caring for a family member****—the employee was unable to work or telework because they were caring for a family member subject to quarantine or isolation by public health order or under the advice of a health care provider.*

5. ***Closure of school or child care****—the employee was unable to work or telework because they were caring for minor children whose school or usual child care provider was closed or unavailable due to COVID-19.*

6. ***Positive test****—the employee was unable to work or telework because they tested positive for COVID-19 or were caring for a family member with a positive test.*

The use of emergency paid sick leave or COVID-19 leave was an important benefit for many workers and was used from calendar years 2020-2022 **(Table 1)**.

TABLE 1

Use of emergency paid sick leave, calendar years 2020-2022

	Calendar Year 2020		Calendar Year 2021		Calendar Year 2022	
EPSL Total	Hours Used	Amount	Hours Used	Amount	Hours Used	Amount
Systemwide	6,395,634	$217,956,253	2,382,678	$99,958,467	3,749,381	$178,108,339

Source: UC Systemwide Human Resources

> *Systemwide, over three years, more than 12.5 million hours of emergency paid sick leave was used, which was valued at nearly half a billion dollars.*

Use of accrued sick leave for child care: On July 1, 2020, President Napolitano approved a change in the UC Absence for Work Policy to provide relief to parents balancing work and child care responsibilities. Eligible employees were able to use accrued sick leave if they were unable to work or telework because their children were not able to physically attend school or their usual place of care due to COVID-19 restrictions.

COVID relief for flexible spending accounts—March 2021: The 2021 Consolidated Appropriations Act and American Rescue Plan Act made it possible for UC to allow temporary changes to rules that governed health and dependent care flexible spending accounts (FSA). Employees were given extensions and thus more time to use the FSA contributions from 2020 and 2021. Employees were given more time to enroll and make changes to elections in 2021. Employees were also able to increase their elections for dependent care up to a maximum. The full unused FSA balances from the 2020 plan year were allowed to be carried over in plan year 2021, and the full balances from plan year 2021 were allowed to be carried over in plan year 2022.

Temporary layoffs: President Michael Drake affirmed in a November 2020 message that UC was committed to protecting jobs during the pandemic. To preserve health and welfare benefits for employees, while allowing campuses flexibility in addressing the financial challenges of the pandemic, President Drake approved temporary policy changes. From December 1, 2020, through June 30, 2022, temporary layoffs and reductions in time due to the COVID-19 pandemic were allowed to extend from four months up to a maximum of 12 consecutive months. Employees who experienced temporary layoffs because of the pandemic remained eligible for benefits and continued to receive the UC contribution to premiums for the full duration of the layoff.

Vaccine policies

Vaccines are one of the greatest public health achievements in history and have contributed to improved health and longevity of millions of people in the United States.[13-16] Between 1900 and 2000, the average life expectancy in the United States increased by more than 30 years, from 43.7 to 76.8, and infant mortality decreased from 100/1000 population to < 7/1000.[14,17] The decrease or elimination of vaccine-preventable infections played a critical role in these population outcomes that have positively influenced the health, growth, and economy of our nation.[18] The WHO estimates that global immunization efforts have saved 154 million lives since 1974, with 10.2 billion full health years gained.[19]

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It was with this background that the UC system began to actively discuss the role of vaccines in the COVID-19 mitigation response by February 2020. Although no vaccination yet existed for SARS-CoV-2, it was clear that efforts to develop safe and effective vaccines would be a global priority.

> *On May 15, 2020, the U.S. launched Operation Warp Speed with a goal of producing at least one vaccine to prevent COVID-19 by January 2021.* The operation was successful and exceeded the initial goal, with the first of multiple safe and effective COVID-19 vaccines authorized for emergency use in the U.S. in December 2020.

The UC system prior to the pandemic had limited vaccine requirements. The two exceptions were for students and health care workers. There are no federal or state laws that compel health care workers to be vaccinated. In California, the California Occupational Safety and Health Administration (Cal-OSHA) aerosol transmissible diseases standard requires employers to provide vaccination to susceptible employees who may be exposed to diseases that are transmitted by droplets or are airborne, including influenza, measles, mumps, rubella, tetanus, diphtheria, acellular pertussis, and varicella. The Cal-OSHA blood-borne pathogen standard requires employers make available hepatitis B vaccine to unvaccinated employees at risk of exposure. At UC hospitals and clinics all these vaccines were required for health care workers before the pandemic, though declinations or exemptions were available. The academic locations had vaccine requirements for students at the time of registration, including proof of vaccination or immunity against measles, mumps, rubella, pertussis, and varicella.

The COVID-19 pandemic generated a significant and systemwide discussion of vaccines for students and employees. These discussions were open, many occurring in public settings, such as UC Board of Regents meetings and meetings with union members or with the campus academic senates and the systemwide academic council. The systemwide subject matter expert groups, particularly the infection prevention group and the public health group, were instrumental in reviewing evidence generated by vaccine trials and federal (FDA and CDC) and state reviews of the vaccines' safety and efficacy. The bioethics group reviewed similar data and, once they were satisfied with the safety and efficacy of vaccines, made recommendations for vaccine distribution with an equity lens.

Several new vaccine policies were adopted during the public health emergency. The involvement of systemwide subject matter expert groups and the open discussion of vaccines enhanced the acceptance of vaccine policies recommended by the president and endorsed by the chancellors and regents. The policies were usually categorized as interim and were issued only after systemwide stakeholder review and were subject to reevaluation and change as the pandemic evolved.

In the summer of 2020, and in preparation for an expected winter surge of respiratory illness, **the president concluded that critical steps had to be taken to reduce the likelihood of severe disease** among students, faculty, and staff, particularly those on campus, and in turn to reduce the likelihood that our health system would be overwhelmed. Although there were no vaccines against SARS-CoV-2 yet available, influenza vaccine was available and had been used for decades in the U.S. to both prevent influenza and to reduce the severity of influenza illness. On July 31, 2020, the president of UC issued an executive order for the 2020–21 influenza season directing all locations to strongly encourage universal influenza vaccination for all students, faculty, staff, and their families to reduce transmission of a serious respiratory virus with symptoms similar to SARS-CoV-2. The vaccine was mandated for all students, faculty, and staff living, learning, or working on premises at any UC location by November 1, 2020, unless the individual had an approved medical exemption or disability or religious accommodation.

By early fall of 2020, it became apparent that one or more vaccines for SARS-CoV-2 could be available by early 2021. While vaccines were welcomed and offered hope for ending the public health emergency, the enormity of the decisions to recommend or mandate these new vaccines weighed heavily on the leadership of UC. The mRNA vaccines were the first to be tested and to receive emergency use authorization. The technology was new, the vaccines had been produced in record time, and they were authorized for emergency use only. All these facts increased the challenges related to decision-making around a mandate for approximately 600,000 individuals. In addition, the political environment was becoming more polarized, and misinformation was increasingly common. The leadership of UC had to weigh the safety and efficacy of the vaccines and consider the role these might play in reducing infection and mortality from SARS-CoV-2, the protection of the health capacity of UC and other health centers, and the safer return to on-site activities.

On December 14, 2020, President Drake took urgent action to issue an interim vaccine policy for health care workers. This policy was expanded to include employees at all UC locations on January 15, 2021. The early policy required vaccination against SARS-CoV-2 with limited exceptions for medical or religious reasons and offered the option for deferral for pregnancy. The initial policy required immunization, as the employee became eligible, prior to entering a UC facility and acknowledged that failure to comply with the vaccine mandate could interfere with an employee's ability to perform their job duties and result in discipline up to and including dismissal. **By the end of January 2021, 85% of health care workers had received the first vaccine in the primary series and immunizations were continuing.**

First Covid vaccine at UCLA Health. By the end of January 2021, 85% of health care workers had received the first vaccine in the primary series and immunizations were continuing

Credit: Ann Johansson

By early February 2021, the UC Health locations were seeing significant declines in test positivity in health care workers **(Figure 2)**. A manuscript describing the early impact of vaccination on health care workers at UC San Diego and UCLA was published in March 2021 and demonstrated that the absolute risk of testing positive after vaccination was 1.19% at UCSD and 0.97% at UCLA.[20]

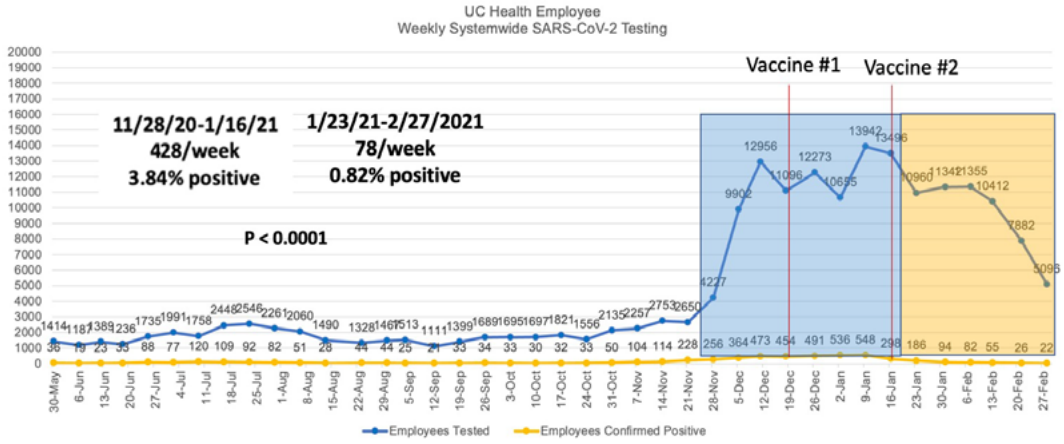
The effectiveness of vaccination and the impact of the mandate on vaccination rates in the hospital settings was important, as the U.S. experienced a major winter surge due to the virulent Delta variant of SARS-CoV-2 in 2020–21. That winter surge in hospitalization and emergency and intensive care was the greatest experienced by UC during the entire public health emergency. At UCSD, health care workers who were vaccinated had significantly less infection than the San Diego population during the winter peak of 2020–21 **(Figure 3)**.[21]

A health workforce that was not impeded by personal illness was critical in meeting the patient needs of the system during that difficult time.

FIGURE 2

Health employee testing and test positivity for SARS-CoV-2 before and after vaccine introduction

Source: UCOP Risk Services/ Occupational Health, UC Health Center for Data-driven Insights and Innovation

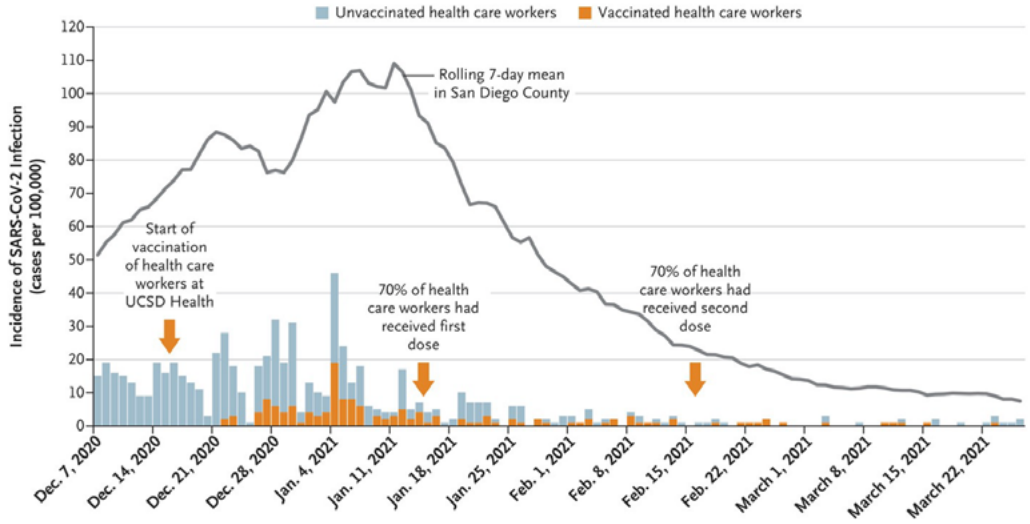


This data represents five UC Health centers (UCSF, UCD, UCSD, UCLA, UCI) and does not include campus employees.
Data reflects total reported UC Health employees tested for SARS-CoV-2 and confirmed positive reported by occupational health teams at each health center

FIGURE 3

Cases of SARS-CoV-2 infection in San Diego County and among health care workers at UC Health[21]

Source: New England Journal of Medicine[21]



As the vaccine mandates were associated with protection of the UC workforce in the spring of 2021, UC began to evaluate extending the vaccine requirement to all individuals living, learning, and working across the UC system. The EVP of UC Health also provided guidance to the California State University system regarding vaccine policy, and the two systems worked to align their policies **(Figure 4)**. On April 19, 2021, the White House announced that all individuals 16 years of age and older would be eligible for COVID-19 vaccination. The eligible group encompassed nearly all the UC campus communities.

The systemwide Fall Planning Group evaluated all data available and recommended universal vaccination by fall 2021 as part of a comprehensive strategy to prevent infection on campus and in the workplace.

FIGURE 4

Headline announcing UC and CSU intent to require COVID-19 vaccines for fall 2021 return to in-person classes


Los Angeles Times

latimes.com

U.S. CLIMATE SUMMIT

Biden makes case for emission targets

Canada and Japan join U.S. in committing to lower levels, but China and India balk.

UC, CSU AIM TO REQUIRE VACCINE BY FALL

University systems look to set national model in mandating COVID-19 shots for in-person learning.

Other measures included mandatory reentry testing, periodic asymptomatic testing, a period of seven days of sequestration following reentry testing with only essential activities for those not fully vaccinated, face coverings, symptom screening, contact tracing, and isolation and quarantine for those testing positive or exposed to the virus.

On July 15, 2021, the policy mandating vaccination against SARS-CoV-2 was extended to students and to all UC employees or trainees, subject only to limited exceptions and deferrals. All had to show proof of vaccination at least two weeks prior to arrival on campus.

> *By September 30, 2021, at the UC Board of Regents meeting, the UC Health Coordinating Committee, in collaboration with human resources and occupational health,* was able to document that 93% of employees and 97% of students were compliant with the vaccine mandate policy. These proportions compared with 59% of Californians and 55% of Americans overall vaccinated during the same period.

Achieving this level of vaccine compliance was not without challenges. A small proportion of individuals expressed personal objections to vaccination and declined to comply with the vaccine policies.

The vaccine policy was updated again effective September 1, 2022, to consolidate all vaccine requirements (influenza and COVID-19) in a single policy, update language, and extend the definition of covered affiliates to include K-12 students and children in day care programs or camps sponsored by the university or in university facilities. Minor technical edits were made in November and December 2022. In August 2023, the policy was updated given the end of the public health emergency. Both the COVID-19 and influenza vaccines were part of a mandatory vaccine program at all UC locations; however, individuals were considered compliant if they demonstrated either proof of up-to-date vaccination status or if they properly declined vaccination in an official opt-out program.

The influenza and COVID-19 vaccine programs were important in decreasing infection among health care workers during the winter surge of 2020–21 and likely played an important role in keeping campus locations open for in-person activities in fall 2021 when the Delta variant was surging nationally.

> *The UC campuses were able to contain viral transmission* when many peer campuses experienced outbreaks or were potential superspreaders in their local communities.[12,22,23]

Although positively received overall, the vaccine mandate policies were difficult to implement for many reasons. The policy process at UC benefits from open and transparent review and input on proposed policies by many stakeholders. The voices of faculty, staff, and students are important in drafting and revising policies. The UCHCC worked with systemwide expert groups that included faculty with expertise and staff with oversight of operations on the campuses. The academic council was represented on the subject matter expert groups through the chair and vice chair. Proposed policies were discussed on multiple occasions with union leadership and with represented staff. The need for and advantages of systemwide policies had to be continuously balanced with the needs of individual campuses. For some the policymaking process was too slow, and for others it was too fast. **For each policy eventually adopted, hundreds, if not thousands, of hours of discussion, drafting, and review took place. The increased workload of staff is an important consideration in planning for any future public health emergency.**

In addition to the drafting of new policies, the implementation of these policies was challenging. Because the UC system had only limited requirements for vaccines before the pandemic, the infrastructure for validating vaccination and tracking compliance was limited. Not all campuses had occupational health resources, and there was no centralized data repository for vaccine information. Compliance, especially with the requirements for fall 2021, was critical and required manual collection and aggregation throughout the system. Investments in occupational health, including the hiring of a chief health security officer, and investment in Health Insurance Portability and Accountability Act (HIPAA)-compliant data resources for vaccine tracking would represent advances in the health security of the UC system. Some locations, with the support of UCOP, have begun to invest in the electronic health record capacity that would facilitate automatic compilation of vaccine compliance.

Finally, the UC system, as a large public institution and national leader in mandating vaccination, faced opposition. Multiple lawsuits attempting to enjoin or reverse the flu and COVID-19 vaccine mandates were brought when each was issued, including cases brought by or on behalf of faculty members, staff, students and unions, and supported by Children's Health Defense, America's Frontline Doctors and other advocacy organizations. The UC system prevailed in those cases, though they were costly to defend, and to this day continues to defend cases related to its enforcement of the COVID-19 policy. So far, UC has spent $1,861,080 defending past litigation and anticipates additional expenses to defend against pending litigation. The science-based approach to informing vaccine recommendations that leveraged the expertise of the system, the open and transparent review and approval process, the inclusion of religious exceptions, and the university's willingness to review and revise policies as the pandemic developed were important elements in the UC system prevailing in all lawsuits to date related to COVID vaccine mandates.

Lessons Learned

- The priority for introduction of new policies during an emergency must be the health and safety of all of those at UC locations and the surrounding communities.
- Policies that supported basic needs for students (housing, isolation) and employees' families (child care) were especially important in ensuring individuals could continue to study and work.
- The policy decisions made by UC serve as a model for the state and nation.
- Having a common framework for creating a safer environment at each location was critical and reduced unnecessary and unproductive variation while supporting innovation across locations.
- Consistency in policies and procedures lowered health risks at each location and lowered the risk of both legal and union actions for perceived or actual inconsistencies.
- All policies were informed by systemwide subject matter experts and were subject to open discussion and debate through the established UC policy process.
- Most policies were issued on an interim basis and were reviewed frequently.
- When policies were published, a companion of Frequently Asked Questions accompanied the documents and were important resources to assist in communication and in implementation.
- Implementation of the vaccine policies was made more difficult by the limited resources at each location for occupational health and the absence of electronic records for capturing vaccine compliance outside of the health system. Investment in these resources will facilitate timely action in future emergencies.
- Strong public health policies are costly and require significant time and effort to implement. The investments led to safer workplaces and reduced worker turnover during and after the public health emergency.
- UC will always be a potential target for legal action. The incorporation of systemwide expertise, a transparent review process, issuance of interim policies, and frequent review potentially limited legal action and, when UC was sued, were important factors in the successful outcomes.

4

Governance of a Systemwide Response

CARRIE L. BYINGTON, M.D., AND AMINA ASSEFA, M.P.H.

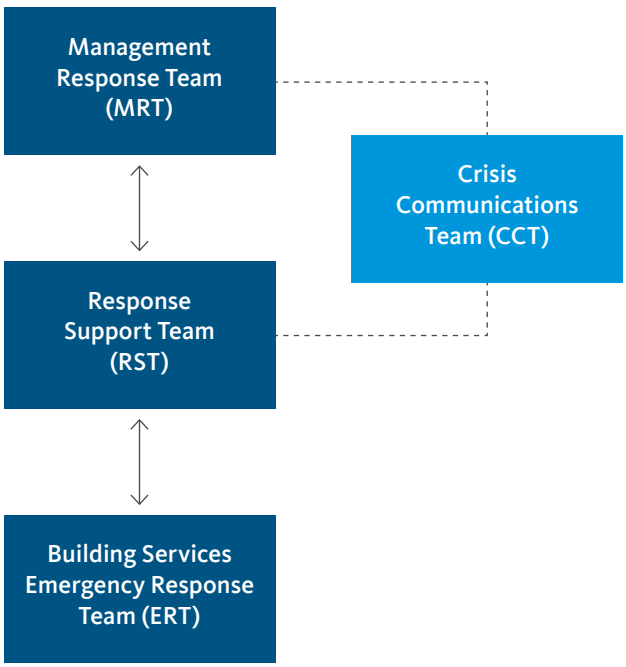
The University of California Office of the President (UCOP) uses a Management Response Team (MRT) to identify and respond to incidents that may become a crisis for UCOP or the UC system overall. The MRT is the executive-level oversight and strategic decision-making body for UC during a potential or actual crisis. The MRT is responsible for addressing issues and impacts on the UC system, as well as protecting the overall reputation and stability of the university. It is also responsible for the overall management of and response to UCOP-focused issues or events. UCOP Risk Services is responsible for coordinating the MRT.

The UCOP Management Response Plan, developed in 2010, describes the role of the MRT and other components of the UCOP emergency response structure. The plan establishes a protocol specifically for UCOP to follow in response to a major emergency, incident, significant issue, or reputational risk or event that has significant potential consequences and/or disrupts normal operations of UCOP or one or more of its campuses, medical centers, or national laboratories.

The UCOP Emergency Response Structure is depicted in **Figure 1**. The structure is based on an organizational model that integrates the major UCOP functional response roles of strategic executive policy guidance (management response), tactical support (response support), and local emergency management/response. The UCOP Management Response Plan underwent several revisions over time, with the last revision completed on April 5, 2019, just prior to the onset of the COVID-19 pandemic.

FIGURE 1

UCOP emergency response structure

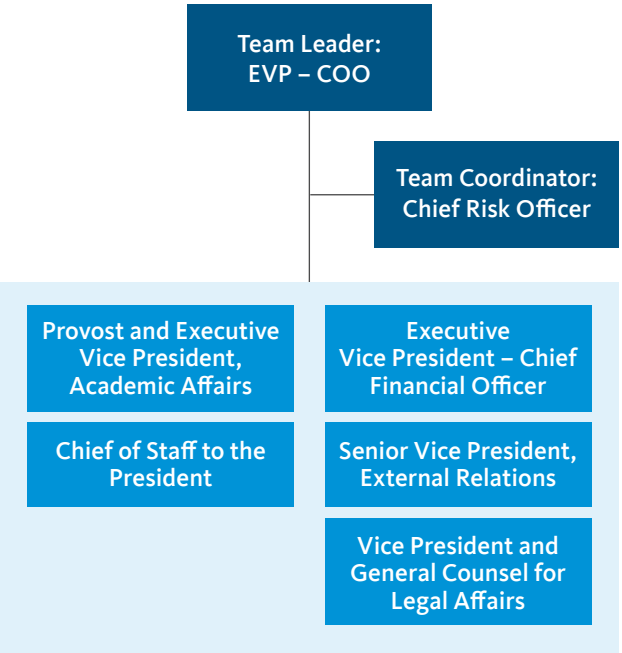


The configuration of the MRT leadership team is important, with key roles for both the executive vice president – chief operating officer (EVP-COO), who serves as the team leader, and the chief risk officer, who serves as the team coordinator. The chief risk officer reports directly to the executive vice president – chief financial officer (EVP-CFO) during regular operations, and the EVP-CFO is also a member of the MRT leadership team. The MRT composition is depicted in **Figure 2**.

The remaining leadership team, as outlined in the UCOP Management Response Plan (2019), includes the UC provost to advise on academic matters, the VP and general counsel to evaluate and advise on legal matters, and the senior VP of external relations to advise on communication with key stakeholders, including the governor, state legislators, and others. The final member of the leadership team is the chief of staff to the UC president, which allows the president to be constantly updated regarding the deliberations and recommendations of the MRT.

FIGURE 2

Organizational chart of the Systemwide Management Response Team



All UC locations also have a local emergency management and response structure. The UCOP systemwide response structure is not designed to replace these local processes, but rather to work in coordination with location-based incident commands and provide support and guidance when needed.

The UCOP 2019 Management Response Plan noted that most incidents would be appropriately managed at the local level. However, the UCOP MRT would act when incidents require UCOP support or resources or when the incident threatens the university as a whole. Presciently, the plan identified **a pandemic** as the crisis incident that could impact the entire UC system and require activation of the MRT for "high level management, strategic policy and financial decisions, crisis communications, humanitarian assistance or other crisis management functions."

> *Despite the recognition of the systemwide threat a pandemic could represent,* the MRT leadership structure outlined in the 2019 UCOP Management Response Plan did not include representation from UC Health.

On January 1, 2020, the EVP of UC Health contacted the UC president to discuss the rapidly developing situation in China, where an outbreak of severe pneumonia of unknown etiology was being reported in Wuhan. The incident had many similarities to the SARS outbreak in 2003 and had the potential to be disruptive to California and the UC system given normal travel patterns between California, China, and the rest of the world. The president introduced the EVP of UC Health to the MRT leadership team, and the initial planning for a potential pandemic began the week of January 6 as the UC system returned from winter curtailment.

The MRT held its first full meeting on January 29, 2020, and remained operational through March 7, 2022, or 768 days, representing the longest activation of the MRT in UC history.

At the start of the COVID-19 pandemic, it was quickly evident that health-specific knowledge, expertise, and guidance were needed to protect the UC community in both medical center and campus settings. This called for additional resources beyond the MRT's initial membership. For these reasons, on March 18, 2020, the MRT team leader charged the EVP of UC Health to establish and chair a subcommittee of UCOP's MRT named the UC Health Coordinating Committee (UCHCC) to advise on all aspects of UC Health's response to the pandemic. This charge was eventually broadened to include advising the entirety of the UC system and coordinating with external stakeholders such as state and federal agencies. The EVP of UC Health was given the authority to issue further guidance about the work and priorities of the UCHCC, in consultation with the chair of the MRT.

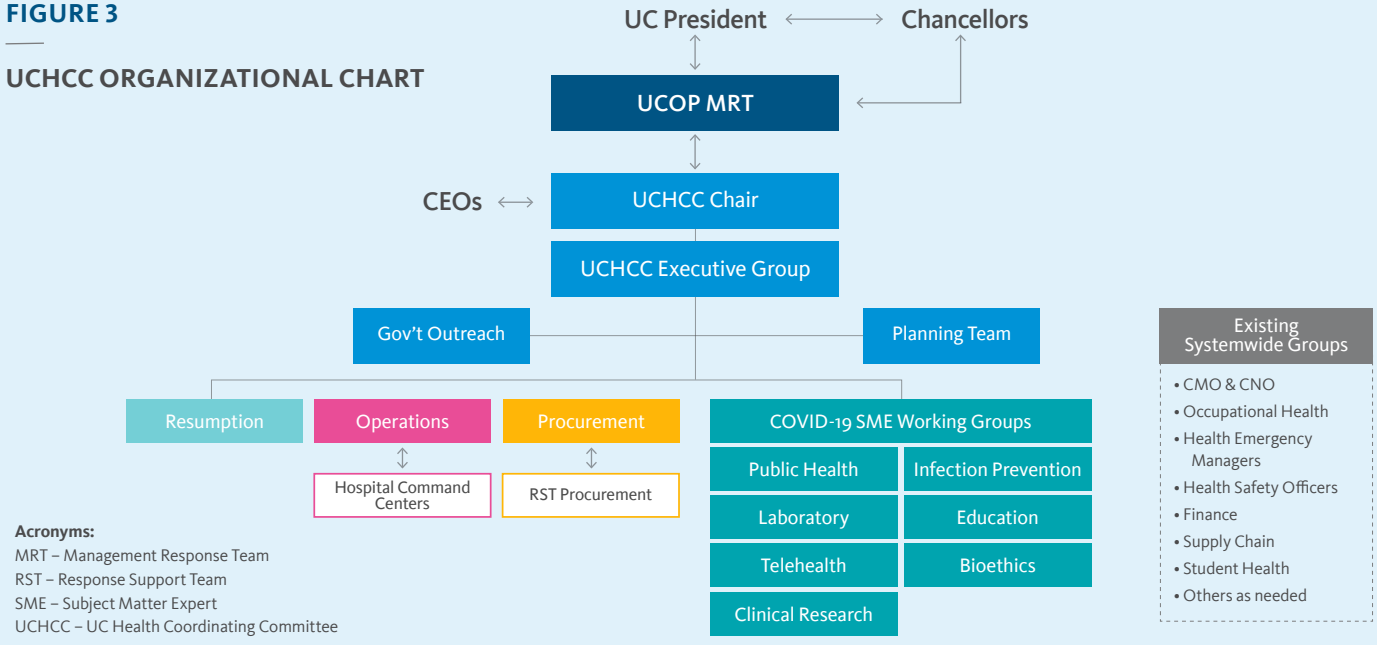
The UCHCC was charged to:

- ***Field questions from UC Health leaders and offer expert advice*** *through the incident command structure at each UC Health location*
- ***Facilitate collaboration among internal stakeholders****, including health care workers, patients, health professions students, and residents*
- ***Coordinate with external stakeholders****, including federal and state public health officials, other health systems, and relevant professional organizations*
- ***Report on its work and bring recommendations for action*** *to the MRT, which would escalate critical issues to the chancellors and president as needed*

The UCHCC created working groups of subject matter experts composed of faculty and staff from across the UC system to inform the regents, president, chancellors, and all employees, students, and trainees of evidence-based recommendations to protect the lives and health of individuals working and training in the UC system and the communities in which these were located. The organization of the UCHCC (i.e., a core leadership team plus systemwide working groups) allowed it to evolve with the pandemic and quickly address emerging issues and new systemwide needs. The UCHCC organizational chart (as of April 2020) is shown in **Figure 3**.

FIGURE 3

UCHCC ORGANIZATIONAL CHART



The UCHCC played a vital role in the MRT and contributed subject matter expertise related to all medical and public health aspects of the pandemic. These insights were critical in developing systemwide infection prevention strategies and the creation of evidence-based policies. The UCHCC also assisted in coordinating large clinical trials across the system, ensuring institutional review board activity was coordinated to allow maximum site participation in drug and vaccine trials. In addition, the education working group was able to interface with accrediting and licensing bodies to ensure that students could continue to make academic progress, take certification and licensure exams, and graduate to enter the health workforce. Specific contributions made by individual working groups will be discussed in the chapter 6.

Because of the importance of health on all campuses and the likelihood that another pandemic will disrupt the UC system in the future, the decision was made to establish the UCHCC as a standing component of the MRT.

The leadership of the UCHCC during the COVID-19 pandemic was provided by the executive vice president of UC Health, who was also an infectious diseases physician who had training, expertise, and experience leading pandemic response in hospital settings and nationally through professional organizations. These skills are not a requirement for the EVP of UC Health, and future leaders may not be expert in pandemic preparedness, response, and recovery.

> *The creation of a chief health security officer for the UC system* would address the need for constant preparedness and ensure the UC system has a leader in place to guide the UCHCC and the MRT during any future pandemics, epidemics, or infectious disease outbreaks.[24]

The MRT functioned as planned during the COVID-19 pandemic, with the important addition of the UC Health Coordinating Committee. The MRT followed the Management Response Plan in most areas, except for the production of a timely after-action report (AAR). The Management Response Plan recommends an AAR team be convened and meet no later than 30 days following the deactivation of the MRT and to issue a report with corrective actions within 30 days of convening. Although a preliminary lessons learned document was developed in May 2021, a full AAR was not undertaken in the time frame recommended. Through this report those recommendations have been completed. The duration of the MRT activation and the complexity of the response required additional time to process and document. As the MRT faces new emergencies, the intentional capture of lessons in real time should be incorporated into the regular meetings and briefings. These can then serve as a basis for future AARs so these can be completed more expeditiously.

Lessons Learned

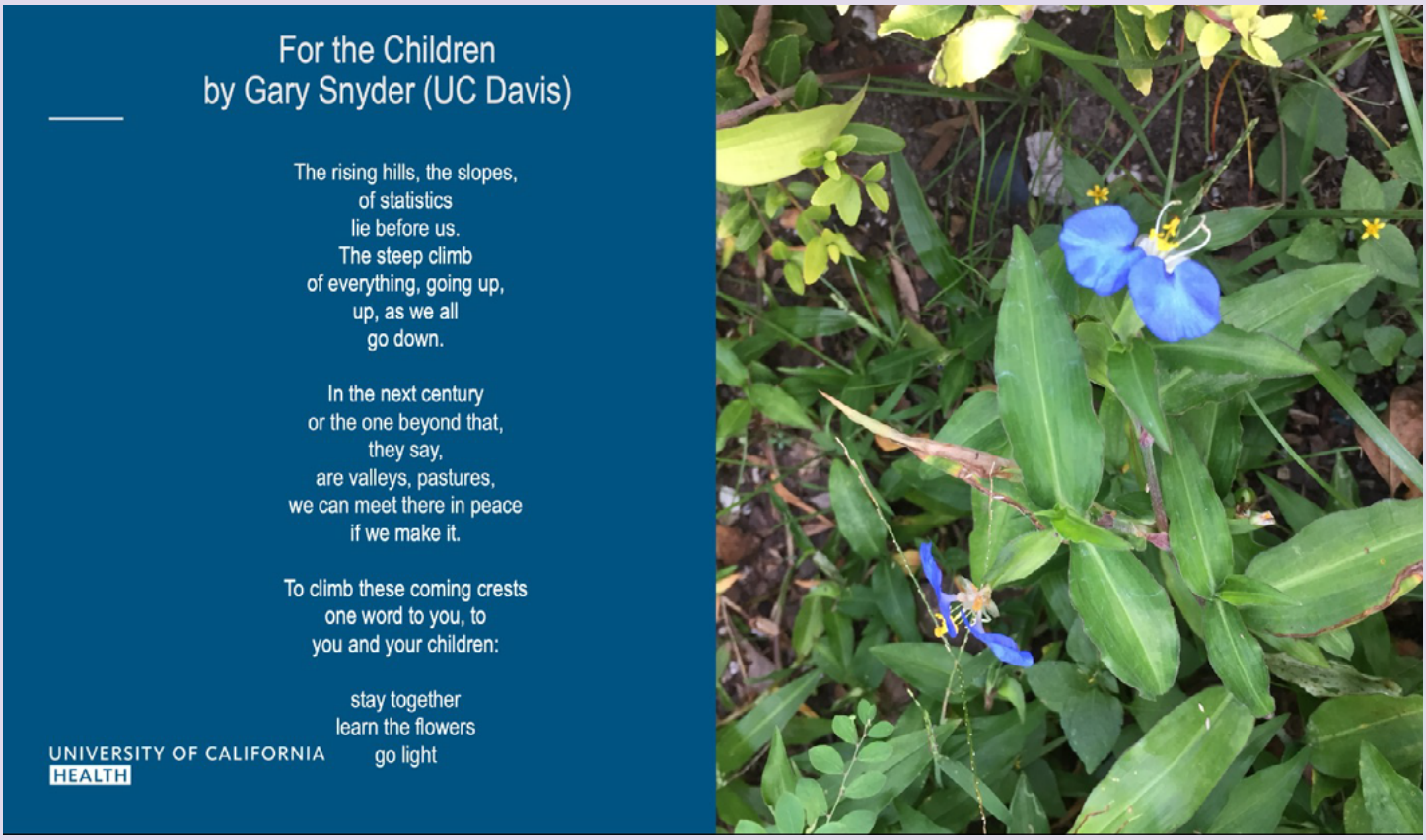
- Health-related emergencies, especially pandemics, are the most likely crisis to disrupt the entire UC system and require prolonged MRT activation.
- Health leadership is a requirement for the MRT leadership team.
- A chief health security officer for the UC system would ensure constant readiness for pandemics or other infectious disease outbreaks and ensure health leadership is always available for the MRT.
- The UCOP Management Response Plan was followed and allowed coordination of the COVID-19 response across the UC system.
- The UCOP Management Response Plan should be updated to reflect lessons learned during the COVID-19 pandemic.
- Timely after-action reports should be generated following each activation of the MRT and may require additional time and resources for creation after prolonged activations.

A POEM

For the Children, by Gary Snyder (UC Davis professor emeritus)

This poem was presented at the UC Board of Regents Health Services Committee in October 2020. UC Health had survived the initial COVID wave of spring 2020, but the situation felt precarious as we faced our first pandemic winter. The poem, by Gary Snyder, emeritus faculty at UC Davis, described succinctly the anxiety health professionals felt with the "rising slopes of statistics" and the remedy for it. The photo that accompanied the poem was one that I took in September 2020. The flowers in the picture are dayflowers (genus Commelina). They have a short life and were reminders of the fragility of life that we were seeing in and out of the hospitals each day. I identified the plant using the application iNaturalist. "Learning the flowers" as described by Gary Snyder became a new hobby and a source of comfort during the lonely and painful periods of the pandemic. UCSF researchers have demonstrated that "awe walks," where we shift our focus to notice and even photograph the environment, boost emotional well-being, confirming the advice in the poem.[25]

Carrie L. Byington



5

Preparing the Hospitals

CARRIE L. BYINGTON, M.D.

University of California Health is the largest academic health system in the United States. The system includes six academic health centers with acute and specialty hospitals owned and operated across the state of California (Figure 1). The UC Health hospitals are ranked among the best in California and across the nation. The health centers have a public service mission to support and improve the health of all Californians, as demonstrated by the commitment to serve Medi-Cal and Medicare patients, who account for 35% and 36%, respectively, of all patients cared for by the UC Health hospitals.

California is the largest and most diverse state in the U.S., with a population of almost 40 million in 2020. The size and heterogeneity of the state increased the complexities of pandemic response. Approximately one-third of the state's population was insured by Medi-Cal, an indication of social and economic vulnerability, and at risk for health disparities. Finally, the state borders Mexico and is a major travel hub, with two of the busiest international airports in the world, San Francisco and Los Angeles International, increasing the risks of pathogen importation. Against this backdrop, **it was apparent from early January 2020 that California was at risk from the SARS-CoV-2 pandemic and that the University of California must play an integral role with the state in preparing for and mitigating its effects.**

The UC hospitals employ an exceptional health professional staff, and their expertise was needed early in the pandemic by both the system and the state to inform infection prevention protocols, develop diagnostic testing, educate professionals and the public regarding disease treatment and vaccination, design clinical treatment protocols, and conduct research.

To support the broad needs of the system and the state, the UC Health division increased regular meetings with all campus health locations through existing platforms such as the vice chancellor/CEO meetings. These meetings focused on urgent clinical needs, support of employee health, regulatory requirements, and finances. Significant investments were also required to meet the emerging needs of UC health professionals, patients, campuses, and the state.

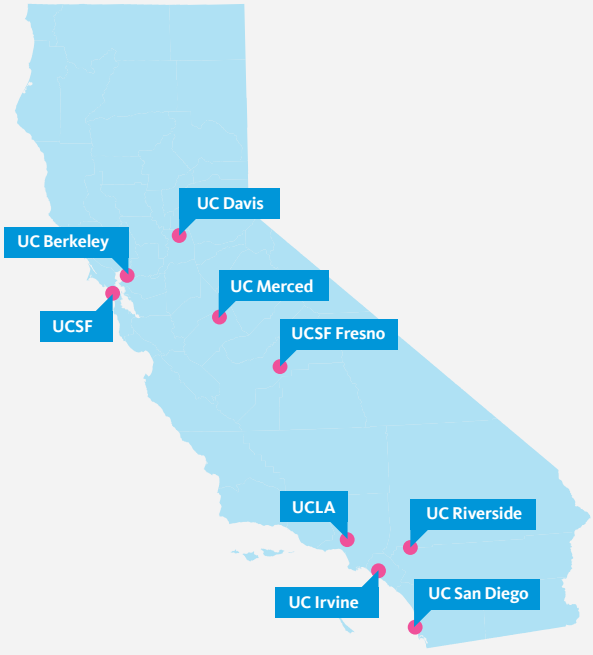
Health center CEOs and vice chancellors were called on to provide resources to meet the emergency needs early in the pandemic. The importance of philanthropy and community partnerships with businesses cannot be overstated. Examples include a partnership with Marc Bennioff, CEO of Salesforce, who used corporate resources to travel to China and purchase personal protective equipment (PPE) that was then donated to UCSF. These PPE resources were shared by UCSF across all UC Health

academic health centers and provided protection for health care workers and patients for the first year of the pandemic. In another example, UC San Diego Health, the San Diego County Health Department, and the Padres professional baseball team partnered with the city of San Diego, the co-owner of the Petco Park Major League Baseball (MLB) stadium. This partnership allowed the creation of a vaccine superstation that provided vaccines to hundreds of thousands of residents in the San Diego area, including health care workers and other essential employees.[26] The model of using an MLB stadium as a vaccine center was replicated throughout the nation, with more than 1 million vaccine doses administered in ballparks from January through March 2021.[27] These collaborative efforts allowed UC Health to meet important needs, while clinical income was declining due to stay-at-home orders and state-ordered restrictions on elective medical and surgical procedures.

The CEOs and vice chancellors meeting group was also an important venue for the identification of subject matter experts (SME) from across the system. These SME groups then evolved into working groups of the UC Health Coordinating Committee on COVID-19 **(See Chapter 6)**. The SME groups advised both the health system and the broader academic system located on 10 campuses, at the Office of the President and at the three national laboratories.

FIGURE 1

Map of University of California Health, including hospitals and academic units



UC Berkeley
Herbert Wertheim School of Optometry & Vision Science
School of Public Health
UCSF School of Medicine Regional Campus
– Joint Medical Program
– PRIME-US (Urban Underserved)

UC Davis
UC Davis Health
UC Davis Children's Hospital
UC Davis Comprehensive Cancer Center
School of Medicine
– Rural PRIME
– Tribal Health PRIME
Betty Irene Moore School of Nursing
School of Veterinary Medicine

UC Irvine
UCI Health
UCI Chao Family Comprehensive Cancer Center
School of Medicine
– PRIME-LC (Latino Community)
– PRIME LEAD-ABC (Leadership Education to Advance Diversity-African, Black, and Caribbean)
Sue & Bill Gross School of Nursing
School of Pharmacy & Pharmaceutical Sciences

UCLA
UCLA Health
UCLA Mattel Children's Hospital
UCLA Jonsson Comprehensive Cancer Center
School of Dentistry
David Geffen School of Medicine
– PRIME-LA (Leadership and Advocacy)
School of Nursing
Fielding School of Public Health

UC Merced
UCSF School of Medicine Regional Campus
– San Joaquin Valley (SJV) PRIME
– San Joaquin Valley (SJV) PRIME+

UC Riverside
UCR Health
School of Medicine
– PRIME LEAD-ABC (Leadership Education to Advance Diversity-African, Black, and Caribbean)

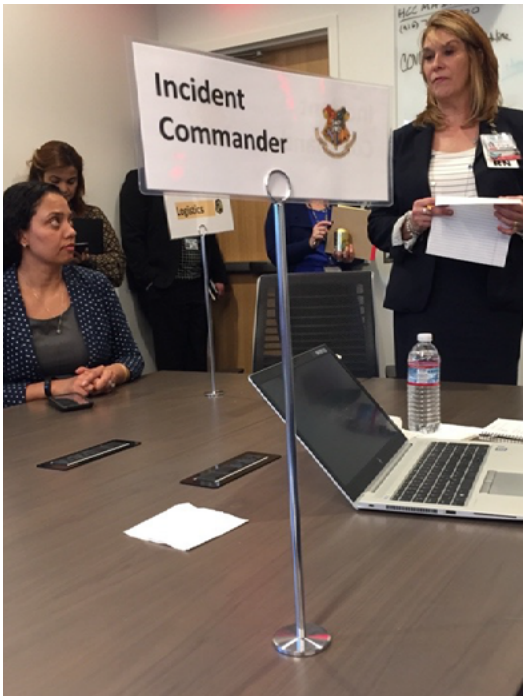
UC San Diego
UC San Diego Health
Moores Cancer Center at UC San Diego Health
School of Medicine
– PRIME-HEq (Health Equity)
– PRIME-TIDE (Transforming Indigenous Doctor Education)
Skaggs School of Pharmacy and Pharmaceutical Sciences
Herbert Wertheim School of Public Health and Human Longevity Science

UCSF
UCSF Health
UCSF Benioff Children's Hospitals
UCSF Helen Diller Family Comprehensive Cancer
School of Dentistry
School of Medicine
– PRIME-US (Urban Underserved)
– San Joaquin Valley (SJV) PRIME
– San Joaquin Valley (SJV) PRIME+
School of Nursing
School of Pharmacy

UCSF Fresno
UCSF School of Medicine Regional Campus
– San Joaquin Valley (SJV) PRIME
– San Joaquin Valley (SJV) PRIME+

Coordination through an incident command center model

An incident command center system (ICS) model was used across each health center to coordinate the emergency response to the pandemic. The ICS model was developed in the 1960s, initially to manage California wildfires.[28] The ICS allows a standardized approach and hierarchy to command, control, and coordinate emergency situations. The designation of an incident commander facilitates a single point of communication for collaboration with multiple agencies and organizations and enhances communication. Across the UC system, the incident commanders at each hospital location reported to the MRT and were able to share information and best practices regarding the local conditions of the public health emergency.



Incident command center, UC Davis, February 26, 2020, following the identification of the first case of community transmission of COVID in the United States

Credit: Carrie L. Byington, M.D.

Preparing the health care workforce

The most important asset of University of California Health is the health professional workforce. These individuals are highly trained and committed to providing exceptional health care to every patient. The health workforce includes world-class physicians, health care providers, and clinician-scientists who were called upon by state, national, and international organizations to provide advice regarding the mitigation of a new virus. Their expertise was vital for preparing the health system.

Among the first subject matter expert groups convened were the systemwide infection prevention practitioners and the clinical laboratory specialists. These groups existed before the pandemic and were able to rapidly respond to the needs of the system. The EVP for health worked to leverage these groups as part of the UC Health Coordinating Committee for COVID-19. Chairs for each group were identified, and the meetings and recommendations of these groups were placed in the context of the MRT governance structure.

Though there were many competing priorities in January 2020, some stood out and will be discussed in greater detail. These include infection prevention priorities and the development of diagnostic capacity for SARS-CoV-2.

The need for personal protective equipment (PPE) was obvious, though the specific types of PPE that would be required were unknown at the beginning of the emergency because the exact mechanisms for viral transmission had not yet been determined. Nevertheless, we recognized that most cases being described were respiratory and thus there would be a need for masks, gowns, and gloves, and potentially more advanced protective gear such as powered air-purifying respirators.

Assessing the quantity of PPE on hand, the estimated daily burn rate of the materials, and the stability of the supply chain were all critical components of the response. These data were not routinely collected at each location and when they were, they were collected in different formats from location to location. The standardization of data collection and the sharing of data across the system was critical for preparing for the first and later surges. **Working with procurement leaders across each campus was critical and coordinated through the UC Health team devoted to leveraging scale for value across the system.**

The supply chains for routine materials such as PPE, viral swabs, and viral transport media were all disrupted. At the same time, the daily burn rate for PPE increased more than 10-fold as the pandemic began.

> *The UC system began to purchase and stockpile PPE in January* through many networks, though the process was often highly competitive.

Several strategies benefited UC Health in competing for scarce resources. First, early preparation and increasing purchasing of PPE and other supplies in January helped to avoid periods of intense national competition. Secondly, purchasing supplies as a system increased our priority with suppliers as UC Health represented a single large contract. As a system, we were also able to work with CEOs of corporations that provided medical supplies to ask for discounts. Finally, developing the ability to monitor supply stores electronically across the system allowed for the movement and sharing of resources within the system.

UC Health also leveraged the unique resources of the system. Examples included looking to the student health infrastructure and the robust research enterprise for support. The student health centers had stockpiled N95 masks to be used in the case of wildfire. California saw significant wildfires in 2017–19, and campuses were prepared for the likelihood of poor air quality. In spring of 2020, it became apparent that most students would return home and continue their education through virtual instruction. Student health centers would also be largely virtual. The decision was made to re-deploy the bulk of N95 stores from the student health centers to the UC Health hospitals.

In a similar manner, most research laboratories were closed during early spring of 2020. These laboratories often had PPE supplies such as gloves, gowns, and masks. These also were collected and re-deployed for hospital use. Coordinating these efforts systemwide was important since some individual laboratories donated supplies to local organizations outside of the UC Health system prior to considering donating within the system. Finally, many campus locations worked to produce PPE through a variety of methods, including 3D printing of face shields, reuse of sterile material surgical kit coverings to make masks, and producing viral transport media in-house from campus laboratory resources.

Collecting PPE and supplies from the campuses to support the hospitals at UC Davis

Credit: Jennifer Carmichael, UC Davis

Infection prevention guidance and training

UC Health has robust infection prevention teams at each academic health center location. These teams met regularly before the pandemic to review and optimize infection prevention practices. As it became clear that SARS-CoV-2 would become a global pandemic, the infection prevention teams were on the forefront of protecting UC patients and employees.

The UC Health Coordinating Committee regularly convened the infection prevention subject matter expert group (SME) to discuss best practices for safer patient care and employee protection given the existing data. The group worked together to assess areas of general concern such as PPE requirements, identifying processes to prevent transmission in the hospital and clinical settings, and vaccine recommendations. Working together ensured that guidance at locations was aligned. Alignment was important for both the highest quality infection prevention guidance and for supporting confidence in the recommendations.

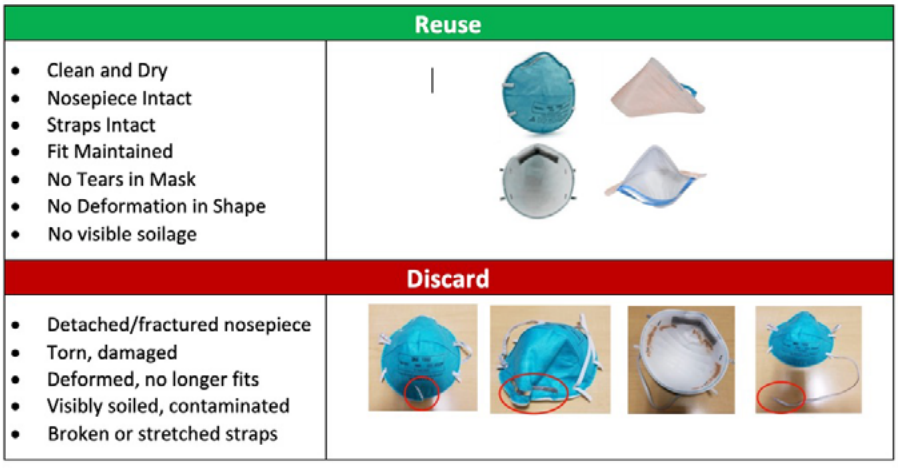
Some of the infection prevention recommendations were controversial, and all had financial and human costs. Especially challenging areas included the types of masks required for general use and specific procedures, the role of asymptomatic testing, and visitation policies. Guidance for all these issues was developed collaboratively with each location sharing their current practice and informed by local health requirements and CDC guidance if these were available.

Early in the pandemic, supplies of N95 masks were limited, and infection prevention experts issued guidance for reuse of these masks **(Figure 2)**. The infection prevention SME group worked to study the impact of the infection prevention policies adopted as the pandemic changed over time. The pandemic offered opportunities to reevaluate standing guidance such as fit-testing for N95 masks.[29] In the case of asymptomatic testing for health care workers, the team published in 2022 that the justification for maintaining such time and resource-intensive surveillance programs becomes more complex in the context of widespread use of highly effective vaccines in health care providers.[30]

The results of reassessment informed UC Health policy. Decisions were implemented consistently across facilities to reduce variation and ensure similar experiences and working environments, especially for staff who worked across locations. The SME also published jointly to further align systemwide policies and to inform other health systems.

FIGURE 2

Guidance for reuse of N95 masks prepared by UCI Health



The infection prevention policies that restricted visitation were the most difficult. Early in the pandemic, the lack of sufficient PPE resources, the absence of known treatments or vaccines, and concern for nosocomial transmission of asymptomatic COVID-19 resulted in strict visitation restrictions from the Centers for Medicare and Medicaid Services, Centers for Disease Control and Prevention (CDC), and California Department of Public Health. The UC Health system complied with the guidance, but the separation of family and support personnel from individuals who were vulnerable because of illness or were undergoing medical procedures took a toll on both patients and providers.[31] End-of-life care was especially difficult, and across the U.S., health care workers were often the only individuals present for those who were dying.[32] As a result of the COVID-19 pandemic, hospitals today, including all UC facilities, are better supplied with PPE, testing capacity, and knowledge regarding the appropriate use of PPE materials. The public also has greater experience using PPE in the work and school environments and even the home setting.

> *In the future, every effort should be made to support visitation for hospitalized patients* by ensuring adequate PPE supplies and staff trained to educate patients, support personnel, and providers in the appropriate use are available.[33]

The infection prevention team also played a critical role in educating and training health care providers across the system in infection prevention. This role was vital across all units and infection prevention officers were over-taxed. Further investments in infection prevention and employee health staff is needed to increase preparedness and response capabilities for future public health emergencies.

Infection prevention training at UC Davis Health, 2020

Credit: UC Davis Health

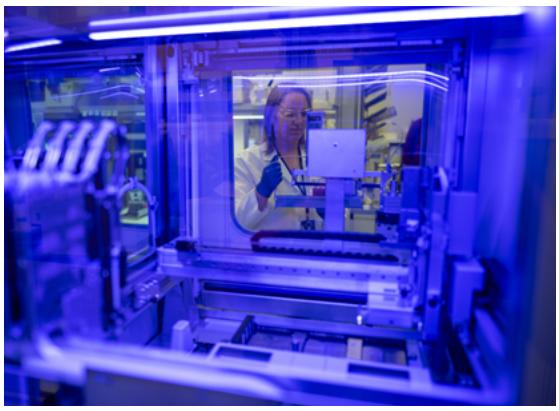
Meeting the challenge of diagnostics

One of the most important aspects required for mitigating the effects of a new infectious disease is the availability of accurate diagnostics able to deliver timely results. Unfortunately, the United States was not able to rapidly produce and deploy tests that could identify SARS-CoV-2 infection in individuals suspected of having COVID-19. There were many reasons for the failure, including the initial requirement that all testing be competed at the CDC laboratories in Atlanta, the failure of the CDC-developed test kit shared with public health laboratories, the inadequacy of state public health laboratories to handle the volume of testing required, stringent case definitions for testing, and finally regulations that prevented clinical laboratories from developing tests during a public health emergency.

UC Health pathology department chairs had a working group prior to the pandemic, and this group was leveraged to develop the diagnostic testing strategy for the academic health centers. In early January 2020 the EVP for health contacted the chair of the group, Steven Gonias, M.D., Ph.D., who served as chair of pathology at UC San Diego. Together they convened the pathology working group to discuss the urgent testing needs of the system. The group shared best practices as the testing landscape evolved. Early on, as there were no specific tests available for SARS-CoV-2, the system adopted a practice of situational awareness. Multiplexed respiratory viral panels were available in all academic centers that tested for common respiratory pathogens but could not identify SARS-CoV-2. These tests were used routinely, and in discussion with infectious disease experts at each site, we adopted the best practice of considering individuals cared for in the intensive care units for severe respiratory disease and who tested negative for known pathogens on standard testing to be potentially infected with SARS-CoV-2. This is how the first identification of community spread of SARS-CoV-2 was identified in the United States at the UC Davis Medical Center on February 26, 2020.[34,35]

Once the genomic sequence of SARS-CoV-2 was released on January 11, 2020, the teams began advocating to the CDC and FDA for permission to bring laboratory-developed tests (LDTs) for SARS-CoV-2 to our clinical centers. Unfortunately, this was not possible without FDA approval because the declaration of a public health emergency on January 31, 2020, set into motion regulations that required emergency use authorization for LDTs. No process was in place to coordinate work with CDC, FDA, academic health systems, and others who had capacity to rapidly develop singleplex polymerase chain reaction (PCR) tests for a new pathogen. The failure of the CDC assay for SARS-CoV-2, which was released on February 5, 2020, intensified the urgency for LDTs. Our subject matter expert groups and the UC Health Coordinating Committee continued advocacy efforts at the federal level, and on Saturday, February 29, the FDA opened a path for clearance of LDTs.[9]

Our laboratory teams worked around the clock from that date to validate PCR assays they had been developing and to seek emergency use authorization from the FDA. Scientists at the California National Primate Research Center and the Center for Immunology and Infectious Diseases also joined the effort, isolating, characterizing and culturing coronavirus samples from patients treated across UC Health in order to validate the tests.[36] By March 9, 2020, UC academic health centers began offering in-house PCR testing for SARS-CoV-2, one of the first health systems in the country to do so. By the end of March 2020, the UC academic health system had tested thousands of patients and by early April 2020 was posting results daily on social media to inform the communities we



UC Davis Health clinical lab scientists load the university's newly installed Roche Diagnostics Cobas 6800 instrument for high-speed COVID-19 testing

Credit: Wayne Tilcock, UC Davis Health

The next iteration of testing involved working with commercial partners to bring testing to scale. The UC system relied on historic relationships with large diagnostic companies to gain early access to high throughput testing platforms. At the peaks of the winter pandemic surges, the UC academic health centers were performing nearly 10,000 tests for SARS-CoV-2 per day.

Finally, the work on diagnostic testing expanded from the Clinical Laboratory Improvement Amendments (CLIA)-certified health system labs to address the needs of surveillance and diagnostic testing on campuses. The clinical pathologists were vital partners for the campuses as they developed their testing strategies. Many innovations resulted in better testing for campus communities. These included at UCLA the development of SwabSeq, a novel technology that applies next-generation sequencing to pooled samples that have unique barcodes and that allows testing of thousands of nasal and saliva samples at one time. These tests were turned into kits available for free in vending machines across the UCLA campus, allowing frequent testing and minimizing SARS-CoV-2 transmission on campus.[37,38] The efforts were funded by the National Institutes of Health through a $13 million contract from the Rapid Acceleration of Diagnostics (RADx) program and through sales of low-cost testing to communities outside of the UCLA campus, including other UC campuses, the California State University system, and the Los Angeles Unified School District.

Vending machines dispensing free COVID-19 tests on the UCLA campus

Credit: Denise Heady, UCLA

Increasing bed capacity

In spring 2020, prior to the first wave of the pandemic in California, Governor Gavin Newsom challenged all California health systems to increase bed capacity. The UC system has had a bed shortage for many years but worked to develop new bed capacity through a variety of means. Surge beds were created in units that had previously served as postsurgical or postanesthesia wards because during the first COVID wave all elective procedures were put on hold. Other space was put to nontraditional use to increase inpatient beds, including outpatient surgical locations, nonclinical sites within the existing hospitals, and temporary tent structures outside the hospital facilities. The state of California issued waivers that allowed the creation of double occupancy rooms in some formerly single rooms, which also helped to increase bed capacity.

By March of 2020, the UC system had created an additional 1,481 beds and had increased bed capacity across the system by 39% (Table 1). Importantly, many of these surge beds needed to support intensive care capacity and the staffing of these additional beds was difficult. Staffing was augmented by traveling teams, including teams provided by the National Guard, increasing shifts, and employing a team-based model for care delivery.

As the public health emergency waned, several lessons were clear. The pressure on UC Health system beds was increasing and the addition of new permanent beds became a more urgent priority. All health campuses engaged in both building new bed capacity, with a focus on modernization of bed spaces, and creating spaces that could convert to intensive care units if needed. In addition, the pandemic was a major financial stress for hospital systems across the United States, including California. Many distressed hospitals were identified in California at the end of the public health emergency. These facilities offered opportunities for UC to purchase and renovate existing spaces to increase overall bed capacity more rapidly.

TABLE 1

Increased bed capacity of UC Health academic health centers by March 2020

Hospital	Pre-surge Beds	Surge Beds	Total Beds	Surge Beds as % of Pre-surge
UC Davis Health	625	273	898	44%
UC Irvine Health	402	163	565	41%
UCLA Health	726	374	1,100	52%
UC San Diego Health	803	174	977	22%
UCSF Health	1,242	497	1,739	40%
TOTALS	**3,798**	**1,481**	**5,279**	**39%**

Expanding virtual care

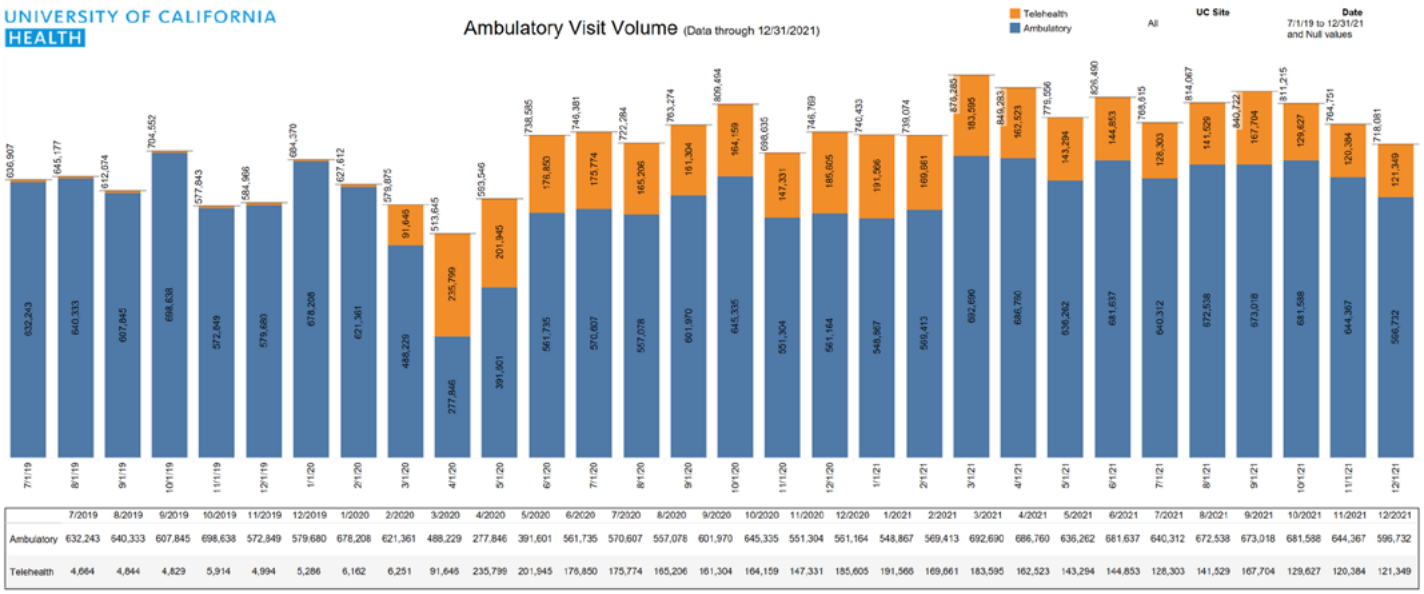
Prior to the pandemic, the UC Health system had a modest history of providing virtual care, with these visits representing less than 1% of all ambulatory care visits in 2019. At the onset of the pandemic, virtual visits began to accelerate quicky, and by March 2020, more than 91,000 virtual visits occurred, representing nearly 18% of all ambulatory visits. Virtual visits continued to increase, peaking at more than 235,000 in April 2020, representing 40% of all ambulatory visits.

The virtual care subject matter expert group of the UC Health Coordinating Committee worked to leverage the academic expertise related to virtual care to train providers in best care practices and to evaluate the specialties and conditions most amenable to virtual visits. Virtual critical care was an important component early in the pandemic, as many hospitals across California had no experience with critical care and relied on University of California providers for virtual access to subspecialty expertise.

Virtual care is now an integrated component of clinical care across the system, accounting for about 15% to 20% of ambulatory visits month to month. The addition of virtual care has increased the capacity overall for ambulatory visits from about 600,000 per month to nearly 800,000 per month **(Figure 3)**.

FIGURE 3

Ambulatory visit volume across UC Health academic health centers 2019–21, demonstrating the increase in virtual visits



	7/2019	8/2019	9/2019	10/2019	11/2019	12/2019	1/2020	2/2020	3/2020	4/2020	5/2020	6/2020	7/2020	8/2020	9/2020	10/2020	11/2020	12/2020	1/2021	2/2021	3/2021	4/2021	5/2021	6/2021	7/2021	8/2021	9/2021	10/2021	11/2021	12/2021
Ambulatory	632,243	640,333	607,845	698,638	572,849	579,680	678,208	621,361	488,229	277,846	391,601	561,735	570,607	557,078	601,970	645,335	551,304	561,164	548,867	569,413	692,690	686,760	636,262	681,637	640,312	672,538	673,018	681,588	644,367	596,732
Telehealth	4,664	4,844	4,829	5,914	4,994	5,286	6,162	6,251	91,646	235,799	201,945	176,850	175,774	165,206	161,304	164,159	147,331	185,605	191,566	169,661	183,595	162,523	143,294	144,853	128,303	141,529	167,704	129,627	120,384	121,349

Source: Center for Data-driven Insights and Innovation

Supporting health care workers

At the heart of the hospitals' response to COVID-19 was our health workforce. With over 100,000 health care employees, UC Health is the largest academic health system in the nation. The health of these frontline workers was the priority of each hospital CEO and of the UC Health coordinating team. Infection prevention education and access to personal protective equipment were keys to protecting our workers early in the pandemic. When COVID vaccines became available on December 15, 2020, health care workers were prioritized to receive vaccines first.

UC Health acted as a multicounty entity, with the California Department of Public Health, to coordinate the receipt and distribution of vaccines across the system. This required the identification of frontline health workers, and importantly this necessitated a consistent definition for health care workers across the system. The ability to automatically identify health care workers was a significant challenge. Intensive efforts were made at UC Health to create standard definitions across the academic health locations. These should be codified and added to electronic personnel records to improve future response.

UCLA Health nurse Eunice Lee, left, prepares to deliver the first Pfizer-BioNTech COVID-19 vaccine shot on the first day of vaccinations at Ronald Reagan UCLA Medical Center in Westwood (Dec. 16, 2020)

Credit: Ann Johansson

UC Health made a commitment to vaccinate all frontline health workers across the system within four weeks. Issues such as health equity and operational sustainability were key priorities. We wanted to ensure that all frontline workers had equal access to vaccines. We also had to ensure that vaccines were staggered in units such as the emergency departments and intensive care units so that we did not lose entire swaths of expertise should individuals have vaccine reactions. Each hospital worked with their local infection prevention teams and labor representatives to create venues and schedules for vaccination. **The UC system adopted a mandatory vaccination policy in late 2020 to support workplace safety.**

In addition to traditional infection prevention strategies to support workplace safety, the UC system had to understand the stressors and needs of the health workforce across the dynamics of the pandemic. The UC academic health centers found creative ways to support the basic needs of frontline workers through the course of the pandemic.

As other workplaces were shuttering, the health centers were ramping up and working through periods of great uncertainty. The basic needs of workers, including the ability to protect their families from infection, were important considerations. Early in the pandemic, when the modes of SARS-CoV-2 transmission were uncertain, all health centers provided resources for health care workers to quarantine from their families to limit potential spread. Health care workers also described difficulties in finding child care during the pandemic. Our campuses found innovative means to support essential workers by providing child care in partnership with community organizations and at times in partnership with health professional students who were unable to attend classes in person. Students volunteered to care for children of frontline workers. Several centers also addressed the needs of frontline workers by providing on-site commissaries where workers could shop for groceries or arranging home food deliveries.

Mental health support has also been critical for ensuring the health and well-being of essential workers. Programs such as the Healer Education Assessment and Referral (HEAR) team (https://www.theschwartzcenter.org/finalists/the-h-e-a-r-healer-education-assessment-and-referral-team/), established in 2009 at UC San Diego Health to promote the emotional well-being and mental health of health care workers, saw an increase in requests for debriefings, where staff process difficult cases, from approximately 30 per year to more than 130 in the first year of the pandemic. Each academic health center increased mental health services and capabilities for its health professionals during the pandemic and have maintained a focus on mental health following the end of the public health emergency.

Hospital quality

The hospitals performed in an extraordinary manner throughout the pandemic and achieved some of the best quality results nationally. All UC hospitals ranked in the top 10 for lowest mortality scores for hospitalized patients among Vizient peers in August 2022 (UCI Health #4, UC San Diego Health #5, UCSF Health #7, UCLA Health #9, and UC Davis Health #10).

UC Health leaders at the national Vizient Bernard A. Birnbaum Quality Leadership Award ceremony in 2022. UCLA Health, UC San Diego Health, and UCSF Health each received quality leadership awards for inpatient care — three of the thirteen awarded — and UCI Health received one of four quality leadership awards for ambulatory care.

Credit: Christopher Longhurst, M.D.

The role of the executive vice president for health

The leadership of the UC Health Coordinating Committee (UCHCC) during the COVID-19 pandemic was provided by the EVP of UC Health, an individual who happened to be an infectious diseases physician who had training, expertise, and experience leading pandemic response in hospital settings and nationally through professional organizations. These skills are not a requirement for the EVP of UC Health and future leaders may not be expert in pandemic preparedness. **The work across the system during the pandemic to coordinate vital functions was constant, dynamic, and unprecedented. The work required substantial focus, time and effort, and leadership.** At the same time, the day-to-day requirements of UC Health continued. Together the duties were greater than full time for a single individual.

The creation of a chief health security officer for the UC system would address the need for constant preparedness and ensure the UC system has a leader in place to guide the UCHCC and the Management Response Team during any future pandemics, epidemics, or infectious disease outbreaks and allow the EVP of UC Health to continue to guide and lead the health system.[24]

Lessons Learned

- Hospitals required intensive focus through an incident command model to deliver pandemic services while maintaining excellence in usual services.

- Early in the emergency, both infection prevention and laboratory services were critical for supporting the safer operations of clinical facilities and the campuses. These services were stretched during the pandemic and warrant additional investment at both the health system and campus levels.

- Occupational health should be a priority to support the health of the large UC system workforce.

- Additional data resources and employees were required to track and manage the pandemic priorities.

- The ability to identify individual employees as health care workers for the purposes of health policy and state funding remains a manual process and should be automated to reduce policy and process variations across campus locations and for ease of communication, mandatory reporting, and outcomes tracking.

- The pandemic demonstrated a significant shortage of hospital bed capacity across the system. Creation of new permanent beds, especially those that can be converted rapidly to intensive care unit spaces should be a priority over the next decade.

- The ability to staff beds is more difficult than creating beds during an emergency. The expansion of all UC Health professional schools to meet the future health workforce needs of California will be an important component of health security for the state and should be strategically planned.

- Virtual care is a permanent component of clinical care across the system, accounting for 15% to 20% of ambulatory visits. Additional work is required to identify the best technologies and the best uses of virtual care to increase access and enhance patient experience and outcomes.

- Clinical training programs will need to incorporate training in virtual care delivery.

- The health professional workforce suffered disproportionately from stress during the pandemic, and health workforce shortages are increasing. The support of the basic needs (workplace safety, child care, housing, food security, and family well-being) and mental health of health care workers should be prioritized to recruit and retain workers during usual operations and in times of emergency.

- The creation of a chief health security officer within the UC Health framework will ensure better preparedness and coordination during future emergencies and will allow the EVP of health to focus on the usual duties required by the system.

6

Harnessing the Capacity and Knowledge Across the University of California System

CARRIE L. BYINGTON, M.D.

One of the most important aspects of the UC Health response to COVID was creating the UC Health Coordinating Committee (UCHCC). The UCHCC addressed aspects of the pandemic response that were critical to all locations across the system and were being discussed at the state and national levels as well. Often the questions being evaluated and the policies derived from the UCHCC deliberations had no precedent.

Subject matter expert groups

The inclusion of faculty and staff from across the system helped to increase trust in the UCHCC recommendations and gain implementation support across all locations. The UC system demonstrated leadership by utilizing the capacity and expertise across the system to inform our decision-making.

As the public health emergency was unfolding, experts were being called upon across the nation to help guide the response. **One of the most important assets of the University of California system is the world-class expertise that exists across all campuses and national laboratories. Harnessing this capacity for the benefit of the system was a key accomplishment.**

Prior to the pandemic, some subject matter expert (SME) groups met regularly to inform operations. These included the chairs of the pathology departments and the clinical laboratory directors from across the health centers. The leads of infection prevention also had an affiliation that was supported by UCOP Risk Services through the Environmental Health and Safety Program. Laboratory services and infection prevention are two of the functions most in demand at the onset of a public health emergency. The UCHCC leveraged the two existing groups early on and these groups provided a template for the development of all additional SME groups.

The Office of the President and the regular meetings of the Council of Chancellors offered an additional opportunity for the EVP of UC Health to recruit members to all SME groups as they were being formed. The initial meetings of each group included an opportunity to ask who was **not** present that should be part of the group and efforts were made to recruit all individuals suggested. The inclusion of faculty and staff from each location increased the size of SME groups, a potential negative as we were working to be nimble and to respond rapidly. Indeed, some groups had more than 100 regular participants. However,

the risk of large groups was more than offset by the benefits of trust building across campuses and the resulting buy-in of recommendations. **While UCOP was expected to offer systemwide guidance, recommendations, and policy, the implementation was carried out locally on each campus, and trust was vital to ensure compliance at the local level.**

The following offers a brief description of the systemwide SME groups that informed the work of the UCHCC and examples of the most important deliverables of each group. New groups were added throughout the public health emergency as the priorities and the questions evolved. The groups described below also formed the backbone of experts who contributed to the administrative working group dedicated to evaluating infection prevention guidance and public health requirements for the return to in-person education and work on the residential campuses beginning in the fall of 2020.

Laboratory sciences

The clinical and research laboratories across the University of California are among the best in the nation. These laboratories process tens of thousands of specimens daily and offer routine as well as advanced and even experimental laboratory testing. All the clinical laboratories at the academic health centers are Clinical Laboratory Improvement Amendments (CLIA)-certified, meaning they can accept human samples for diagnostic testing that will be used as part of medical care. The assets of UC also include many research laboratories. These laboratories often are conducting state-of-the-art research with high-end laboratory equipment. These laboratories, however, do not routinely perform diagnostic testing or surveillance testing for public health purposes.

At the start of the public health emergency in January 2020, the UCHCC leveraged the clinical laboratory directors and chairs of pathology departments to plan for the diagnostic needs of the UC Health system. All clinical laboratories had expertise in developing laboratory-derived tests and were ready to develop assays by January 11, 2020, when the genomic sequence of SARS-CoV-2 was reported.[39] Unfortunately, federal regulations regarding diagnostic testing during a pandemic hindered all clinical laboratories in the U.S. in the rapid development of diagnostic testing. Food and Drug Administration (FDA) regulations during a public health emergency require emergency use authorization for laboratory developed tests. No process with either the FDA or the Centers for Disease Control and Prevention (CDC) was available to proceed.

From January to February 2020, the CDC was the only entity charged with developing and validating a test for the new virus. The failures of this strategy have been well documented.[40] A major component of the work of the laboratory diagnostics SME group early in the pandemic involved federal advocacy to change regulations.

During the early months of 2020, when there was essentially no diagnostic testing for SARS-CoV-2 readily available in the U.S., the diagnostic group, working with the infection prevention leads, developed best practices to identify individuals potentially infected with SARS-CoV-2. All hospitals routinely offered multiplex testing for a variety of common respiratory pathogens. If this testing was negative and the patient was not improving with conventional treatment, UC sought diagnostic testing from the CDC. Astute physicians at UC Davis advocated three times to the CDC for testing for a patient with no travel to China and identified the first known case of community-acquired COVID-19 in the U.S., changing national guidance for testing immediately.[34,35]

As of February 28, 2020:

China could do up to
1.6 million tests a week

South Korea had tested
56,000 people

The U. S. Centers for Disease Control and Prevention (CDC) had tested
459 people [40]

Laboratory and UC Health leaders also advocated with the FDA to allow laboratory-derived testing for SARS-CoV-2. That advocacy was important to the rule change on February 29, 2020, allowing an expedited path towards emergency use authorization (EUA) for laboratory developed tests.[9] Over the course of just two weeks, all of the clinical laboratories at UC were offering polymerase chain reaction (PCR)-based testing for patients with suspected COVID-19.[36] Later in the pandemic, the clinical labs participated in validation of commercially developed tests in an effort to scale testing to meet the needs of our health centers, campuses, and communities. By the close of the public health emergency in May 2023, the UC Health system had performed millions of SARS-Co-V-2 tests and incorporated this testing as a permanent offering within all clinical laboratories.

In addition to the clinical laboratories, many research laboratories became engaged in the efforts to contain SARS-CoV-2 on the campuses and in surrounding communities.

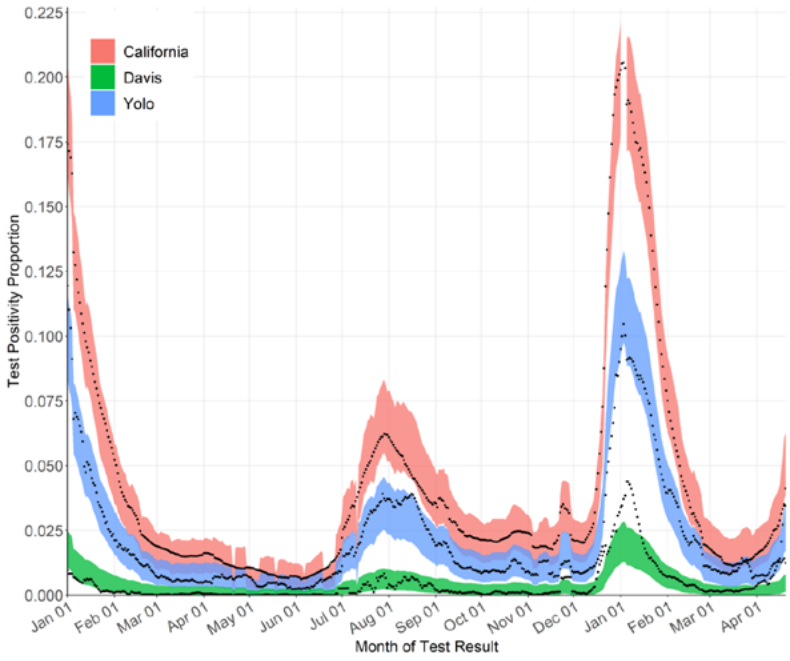
> *Research laboratories leveraged existing staff, expertise, and equipment* to repurpose basic science assets into resources for viral surveillance.

Basic science and clinical laboratory leaders worked together to ensure all state and federal regulations were met for clinical diagnostic testing, which required laboratories be CLIA-certified. UCSF and the Chan Zuckerberg Biohub used empty lab space and graduate student volunteers to develop a CLIA-certified COVID-19 testing facility that provided hundreds of thousands of free tests for the California Department of Public Health and for vulnerable populations, including the uninsured, those in nursing homes and jails, and the unhoused.[41] UC Davis converted PCR capacity dedicated to identifying plant pathogens to the Healthy Davis Together Initiative (https://healthydavistogether.org) which offered free saliva-based PCR testing to the entire Davis community, and also developed methods for wastewater and air testing. Launched in September 2020 and continuing through June 2022, the program performed nearly 900,000 COVID-19 tests and detected nearly 16,000 positive cases for the campus community, K-12 schools, and Davis businesses. The program resulted in greater testing for Davis residents compared with residents in adjacent counties and lower test positivity for Davis County as compared with adjacent Yolo County and California as a whole **(Figure 1).**[42]

FIGURE 1

Testing positivity rate (Jan 2021-Apr 2022)

Source: American Journal of Public Health[42]



Elizabeth McCarthy (center) labels incoming samples with fellow UCSF students Allison Wong (left) and Valentina Garcia

Credit: Noah Berger

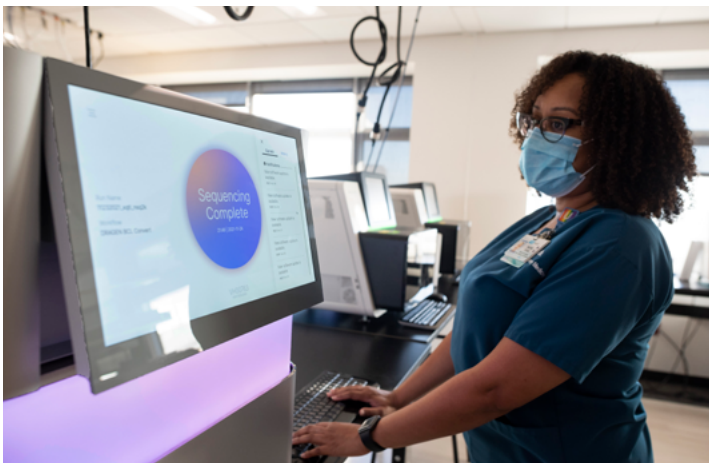
Testing kiosk at the UC Davis Activities and Recreation Center

Credit: Anjie Cook/UC Davis

UC San Diego launched the EXCITE laboratory, which provided low-cost PCR-based diagnostic testing for the campus community as well as K-12 schools in the local area and conducted wastewater surveillance.[43] Wastewater surveillance became a priority for the campus as the pandemic evolved and allowed focused human testing based on wastewater signals from campus buildings and reduced the overall testing burden and costs for the campus. Finally, the UCLA campus developed new sequence-based technology that allowed massive scaling of surveillance testing. Using pooled and bar-coded saliva and nasal samples and next-generation sequencing, funded through a $13 million National Institutes of Health Rapid Acceleration of Diagnostics award for novel diagnostics, thousands of human specimens could be tested and reported daily.[37,38] During the public health emergency, the UCLA SwabSeq lab provided approximately 2 million COVID-19 tests for the campus community, other UC and California universities, and the Los Angeles K-12 schools.

Wastewater samples collected physically every day and delivered to the UCSD Knight Lab at the Center for Microbiome Innovation

Credit: Erik Jepsen/UC San Diego



Rachel Young, laboratory supervisor and clinical laboratory scientist for the COVID-19 SwabSeq lab

Credit: Michal Czerwonka

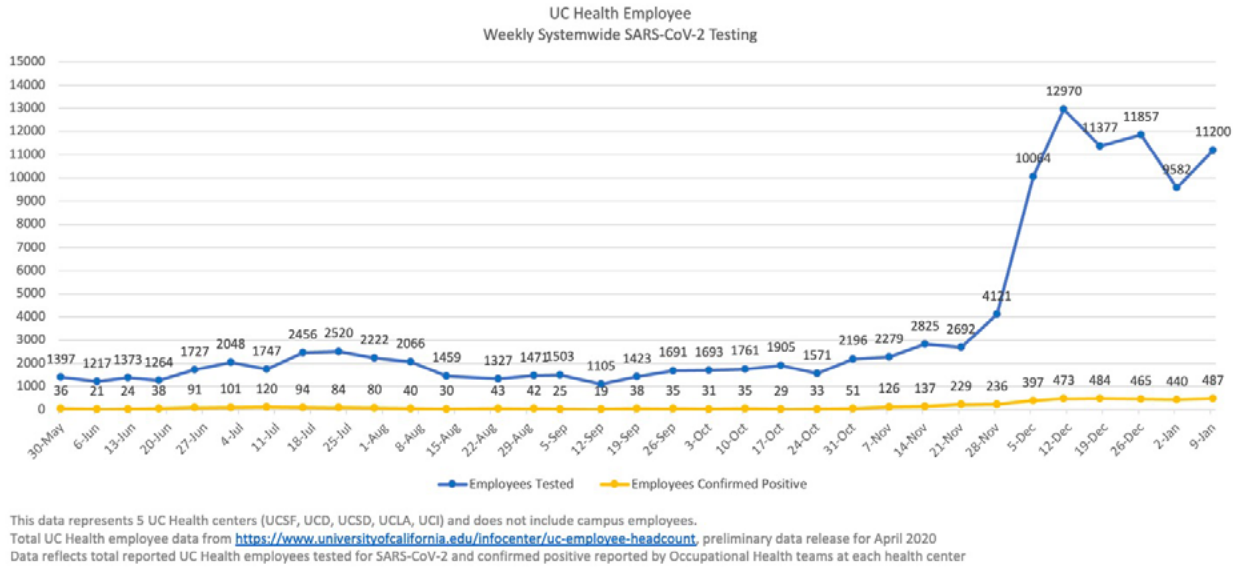
Infection prevention

The infection prevention (IP) leaders at each academic health center met regularly before the pandemic and had some coordination with UCOP for the purposes of advocacy at the state level with the California Occupational Safety and Health Administration. When the public health emergency began, these individuals, usually one or two per health center, were crucial SMEs regarding requirements for health and safety related to infection prevention in UC health facilities and academic locations. The IP working group was a key partner with the UCHCC, UC Environmental Health and Safety, and the campus locations to ensure consistency in the mitigation and response across locations.

The input of the IP SME was vital for hospital preparation. IP leads in each health center were called upon to educate and teach health care workers the necessities of infection prevention. This involved training health worker staff at all levels to understand and implement the infection prevention recommendations. Because these recommendations were evolving rapidly as information was collected from UC facilities, the state, and nation, the human resources of the IP group at each location were often stretched to meet the education needs of the facilities, to develop data tracking resources in collaboration with UC Health Center for Data-driven Insights and Innovation, such as the health worker COVID-19 test volume and positivity report **(Figure 2)**, and in most cases to provide the direct patient care that was often the major component of their faculty or staff appointment.

FIGURE 2

UC Health employee COVID testing by week, including test volume and positivity, January 15, 2021



Source: UCOP Risk Services/Occupational Health, UC Health Center for Data-driven Insights and Innovation

The most important function of the IP SME was to lead the evaluations of scientific evidence available for infection prevention measures. The group was brought together regularly to review historical and recent research findings that could be used to inform system policies such as the use of non-pharmaceutical interventions to prevent infection in the health care setting and in the non-health locations, such as offices, campus classrooms, and residence halls across the system.

The IP group evaluated evidence and through debate and discussion with leadership of the UCHCC made recommendations through the MRT to the chancellors and the president for interventions such as hand hygiene, distancing, masking, campus density, testing frequency for COVID-19, and isolation guidelines for those exposed or known to be positive for COVID-19. The group also contributed to travel guidance for employees and students. The output of the IP group was important for consistency across the system and limited variation in mitigation actions, and led to similar levels of safety at each location for patients, students, trainees, and employees, as was required by both the UC Regents' Principles for Responsible Operation of University Locations in Light of the SARS-CoV-2 Pandemic (https://regents.universityofcalifornia.edu/regmeet/may20/b2.pdf), adopted May 20, 2020, and the University of California Consensus Standards for Operation of Campus and ANR Locations in Light of the SARS-CoV-2 Pandemic (https://universityofcalifornia.edu/sites/default/files/consensus-standards-for-campus-operations.pdf), published May 22, 2020.

Public health

In conjunction with the IP working group, the UCHCC called together a public health (PH) SME representing public health leaders with pandemic experience from all campuses. This group began to meet in late February 2020 and in early March issued important guidance through the MRT to the chancellors, president, and regents.

On March 9, 2020, the group recommended that the University of California follow guidance issued by local and state public health authorities, implement travel restrictions curtailing all nonessential air travel, and implement non-pharmaceutical interventions, including hand hygiene and social distancing. These recommendations suggested moving UC in-person meetings, including the Board of Regents meeting scheduled for March 17, 2020, to a virtual format. The recommendations also included avoiding in-person classroom instruction whenever possible and moving to an online format. The groups urged the campuses to plan for students to leave at spring break and not return for in-person classes through the end of the semester. Sweeping health and safety recommendations of these types were unprecedented in the operations of the UC system. The recommendations sparked significant discussion and debate and were not uniformly embraced. However, over the course of the next week, the public health emergency continued to escalate, and on March 11, 2020, the World Health Organization declared a global pandemic.

On March 15, 2020, the PH and IP working groups issued an urgent recommendation to declare a state of emergency for the University of California system to facilitate immediate implementation of measures designed to protect our students, personnel, and the public. At the time, no treatments or vaccines were available and the primary tool for mitigation was social distancing for the purpose of slowing transmission to reduce illness, death, and stress to the health systems. The SME groups recommended maximum social distancing begin immediately, including transitioning to remote work and learning and protections for essential work that must be carried out in person. The groups warned that social distancing could be required through 2021 or longer and recommended close monitoring. On March 16, six Bay Area counties (Alameda, Contra Costa, Marin, Santa Clara, San Francisco, and San Mateo) issued shelter-in-place orders, the strictest in the nation. For the UC system, this included the UCOP offices in Alameda County and the UCSF academic and health center locations in San Francisco. Thousands of UC employees also lived in the six-county region. By March 19, Governor Gavin Newsom had issued shelter-in-place orders for the entire state. **The work of the PH and IP groups better positioned the UC system to prepare and meet the requirements of the new pandemic environment.**

In addition to strengthening the preparations of the system, the PH group initiated many valuable functions throughout the pandemic. These included developing the UC Health and California Department of Public Health (CDPH) Modeling Consortium to accelerate data modeling and other sciences to forecast the trajectory of the pandemic and to inform evidence-based public health policy. The consortium continues to meet monthly, addresses major public health issues, maintains shared data resources, and awards grant funding. Investigators from across UC and CDPH have published influential research, including research in vulnerable and marginalized populations, supported by the consortium.[44-59]

The modeling consortium evolved and expanded to become the California Collaborative for Public Health Research. Supported by the California Department of Public Health and housed at UCSF, the consortium's purpose is to strengthen public health research collaborations across California. The consortium has supported more than 35 equity-focused research projects led by interdisciplinary teams all UC campuses (See: https://cpr3.ucsf.edu).

Governor Gavin Newsom issues stay-at-home order on March 19, 2020

Source: facebook.com/CAgovernor

The PH workgroup also developed large-scale programs to support both campus communities and the communities that surrounded the campuses. All campuses adopted guidance to return to in-person learning, and the members of the PH group worked closely with campus administrators and modelers to develop evidence-based guidance. The campuses were islands of safety, with lower positivity rates than the surrounding counties.[12] In contrast to campuses across the U.S., no UC campus experienced large outbreaks that forced closures or a limitation of in-person learning.[22,60,61] College campuses were also noted to be potential locations of superspreading that increased COVID-19 surges in their neighboring communities, but this did not happen in UC communities.[23] The UC campuses adopted strict and layered mitigation efforts each semester that included masking and other non-pharmaceutical interventions, repeated testing at the start of each term, periodic asymptomatic surveillance testing, and isolation and quarantine facilities for students.[12] Students were organized to provide their peers with information about preventing COVID-19.[62]

Finally, many members of the PH group worked with their local communities to share public health strategies and resources to combat the pandemic. Healthy Davis Together was recognized nationally as a model and provided testing, education, and other resources to all those living in Davis County, resulting in lower numbers of cases and protecting the health of the community.[42]

Bioethics

> *The pandemic was replete with ethical dilemmas globally and locally.* The University of California is a values-driven institution with a public service mission. Our values and mission informed every aspect of the mitigation efforts, and all locations addressed ethical issues and values alignment throughout the pandemic.

At a system level, two issues were particularly important and required the creation of an SME focused on bioethics. The first was the obligation of the health system to prepare for the possibility of being overwhelmed with patients, resulting in insufficient resources to provide conventional care for all. While all hospitals within the UC system had surge plans for usual

events such as winter respiratory season, none had faced a scenario of crisis care, in which resources are so depleted that care functionally equivalent to the pre-emergency state is no longer possible. The second demand emerged with the development of the COVID-19 vaccines. The availability of vaccines, albeit under emergency use authorization, by the end of the first year of the pandemic was unexpected and welcomed internationally. However, it was clear that vaccine supplies would be insufficient for the demand, at least initially, and priority populations would have to be identified**. In both the planning for crisis standards of care and vaccine allocation there was a commitment to uphold the values of UC and to provide an equitable framework for operations.**

The bioethics working group was convened in March 2020, as the pandemic was declared and the first cases swept into Europe and the U.S. The waves of infection were uneven across the world, but it was clear that strong health systems in China, Italy, and New York City were being inundated with critically ill patients and their ability to provide care was being overwhelmed. UC Health was at risk of the same.

The supply chains for resources were disrupted globally and shortages of critical supplies and equipment were occurring. The bioethics working group was charged to create guidance for the allocation of resources across UC Health should we face critical shortages. Unfortunately, no such document had been developed for UC Health during the H1N1 pandemic. The members of the group worked around the clock to draft guidance in a very short time frame. They brought together expertise in in bioethics, critical care, geriatrics, psychiatry, and law and were supported by UC Health administration.

> *Respect for the moral equality and inherent dignity of each person*—regardless of age, disability status, or any other factor—was a central tenet in the drafting of triage guidance.

The group produced the document **Allocation of Scarce Critical Resources under Crisis Standards of Care** (page 93), which was published on April 16, 2020. The full report is included in the Appendix, as it is a valuable and enduring resource for the system. This document provides a firm foundation and can be revised as appropriate should the UC Health system encounter another public health emergency that disrupts or threatens the normal continuum of care.

Following release of the guidance, the bioethics working group surveyed 1,545 adults from May to September 2020. The sample included 1,067 laypersons and 478 health care professionals. Agreement with policy as drafted was moderately high among respondents, ranging from 67% to 83% across all domains. Health care professionals agreed more strongly with both prioritizing resources for and reallocating existing resources for those most likely to survive.[63] These findings suggest broad acceptability with the tenets of the policy, though if implemented in the future, additional assessment of community and health professional preferences would be indicated.

The California Department of Public Health also published Crisis Standards of Care in April 2020, and these were criticized initially for bias against the disabled and the elderly.[64,65] The California state guidance had to be revised and relied heavily on the work accomplished by the UC working group to provide more inclusive language for people with disabilities and additional protections for vulnerable populations.

> *Although the UC health centers experienced multiple surges of COVID-19,* including crushing winter peaks in 2021 and 2022, none had to implement crisis standards of care.

The ability to work across the system to share resources and the rapid immunization of our health care workers were likely two factors that protected the functioning of our hospitals.

The allocation of vaccines posed new ethical questions by the fall of 2020. Clinical trials were nearing completion, and the FDA was expected to review vaccine applications before the end of the year. The first COVID-19 vaccine (Comirnaty, Pfizer/BioNTech) was voted on by the FDA Vaccine and Related Biological Products Advisory Committee on December 10, 2020, and received emergency use authorization by the FDA on December 11, 2020. The Centers for Diseases Control and Prevention (CDC) Advisory Committee on Immunization Practices voted to recommend the vaccine for those 16 years and older on December 12, 2020, and the CDC issued approval and guidance through the Morbidity and Mortality Weekly Report published on December 13, 2020, a Sunday. Also on that day, the Western States Scientific Safety Review Workgroup (with representation from California, Nevada, Oregon, and Washington), which included four UC Health faculty members (from UC Berkeley, UCSF, UCLA, and UC San Diego) met and concurred with the federal processes and issued a statement that the Pfizer-produced vaccine was safe for public use. Vaccines began to ship across the U.S. on Monday December 14, 2020. UC Health began to administer COVID vaccines on December 15, 2020.

Part of the preparation for the vaccine rollout among UC employees involved work across the system, including human resources, the labor unions, and hospital CEOs, with the bioethics working group. The bioethics working group provided a framework for prioritizing vaccination, which incorporated national and state recommendations as elucidated by the National Academies of Science, Engineering, and Medicine, the CDC Advisory Committee on Immunization Practices, and the state of California interim guidelines. The framework provided rationale for vaccination and included principles of 1) maximizing benefit and minimizing harm, 2) recognizing the equal value of every person, 3) mitigating health inequities, and 4) promoting transparency.

Credit: Wayne Tilcock, UC Davis Health

In the UC workplace, prioritization was further determined by risk-based criteria including: 1) risk of acquiring infection, 2) risk of severe morbidity and/or mortality, 3) risk of negative societal impact, and 4) risk of transmitting infection to others. Health care workers were prioritized in the first group of employees to receive vaccines. They were categorized as 1A, the highest priority, by the state because of their daily exposure to SARS-CoV-2 by presence in hospitals and clinics delivering care to those with COVID-19 and, for frontline workers, their inability to work from home. Health care workers also, by means of their work, if infected, risked passing the infection to vulnerable patients in the health system.

Prioritization of high-risk health care workers for phase 1 vaccine allocation required a clear and consistent definition of "health care worker" across the system. The definition chosen, consistent with CDC guidance was: "paid and unpaid persons serving in healthcare settings who have the potential for direct or indirect exposure to patients or infectious materials and are unable to work from home."[66] These groups include not only clinicians (e.g., nurses, physicians, respiratory technicians, dentists, and hygienists) but also other workers in health care settings who meet the Phase 1A risk criteria (e.g., nursing assistants, environmental services staff, assisted living facility staff, long-term care facility staff, group home staff, and home care givers).[66] The identification of these personnel required significant, manual review of records at each location.

> *It remains aspirational to develop an electronic definition for personnel records* that would allow an automated query to identify at minimum health care workers, and preferably those engaged at the frontline providing direct care.

Across the UC health centers, we identified 101,141 health care workers, of whom 84,112 were classified as 1A and prioritized for vaccination over a four-week period from December 15, 2020, to January 15, 2021. The system received 100,535 vaccines for health care workers during this time-period, and 96% were administered in the first four weeks of the vaccine rollout. All 1A health care workers were offered vaccine, and 80% received the first dose and 28% the second dose of the vaccine by January 15, 2021. The successful vaccine rollout occurred at the same time as the most intense surge of COVID-19 hospitalizations experienced across UC Health during the public health emergency due to the alpha variants of SARS-COV-2, which resulted in thousands of hospitalizations across the health system.

Academic affairs and education

Statewide and county-specific stay-at-home orders, combined with the clinical uncertainties of SARS-CoV-2 transmission and shortages of personal protective equipment, created many operational difficulties for the education of health professional students. The UC Health Coordinating Committee academic affairs and education working group offered a convening function for the deans of the health professional schools to discuss clinical placements, professional competency testing, licensure, and other critical issues for students and trainees and to strategize systemwide solutions. The working group facilitated and supported systemwide action focused on sustaining the education and development of health professional students and trainees throughout the pandemic. All UC Health professional schools continued to accept, educate, and graduate students throughout the pandemic and continued to train residents and fellows.

> *An important activity of the working group was statewide advocacy* through state licensing boards and the California Department of Consumer Affairs (DCA) for the continued ability of health professional graduates to become licensed in the state of California.

One example is the order by the California DCA on April 3, 2020, to waive certain requirements of the California code for education in clinical settings for licensure. The directors of nursing programs were able to submit to the DCA evidence of substitute learning experiences in order for graduating students to be licensed. This was a result of intensive advocacy through the working group and UC Government Relations. Many similar initiatives were required for other health professional students.

Telehealth or virtual care

UC Health had a strong presence in the academic fields related to virtual care for decades before the pandemic. UC Davis established its first telehealth link in 1992 and work evolved over time, with the launch of the Center for Health and Technology in 2000, led by Dr. Thomas Nesbitt. Telehealth services enhanced care in rural areas and provided specialized services for cancer care and pediatrics. Across the UC system, there were many scholars who had evaluated technologies and applications for virtual care, but virtual care was not a major component of the usual care provided by the health system.

At the onset of the pandemic, the UC Health Coordinating Committee began to work with Nesbitt and others with expertise in virtual care across the system to advance our capabilities to provide care both within and outside of the system. The expansion of virtual care services was a vital component of the UC Health system's response to the COVID-19 pandemic. While virtual care was relatively limited prior to the pandemic, with 98,947 (1.3%) virtual visits recorded out of 7,305,791 in 2019, the system was able to pivot to virtual visits for many specialties and conditions early in the pandemic. In 2020, the UC Health system documented 1,678,410 (22.5%) virtual visits out of 7,455,426 total visits, an increase of more than 1.5 million visits in just one year. These visits included those for primary care and specialty services as well as mental health visits and were available at all academic health centers.

The virtual care collaborative assisted all locations in training providers, including residents and fellows, in best practices for virtual care in the ambulatory setting. Over 7,000 providers and staff were trained across the health system and 100 UC affiliate practices activated video visits. **New services were created, including virtual assessment of patients with mild to moderate COVID-19 symptoms, care companion services through MyChart to monitor patients recovering from COVID-19 at home, and virtual express care for urgent and after-hours visits.**

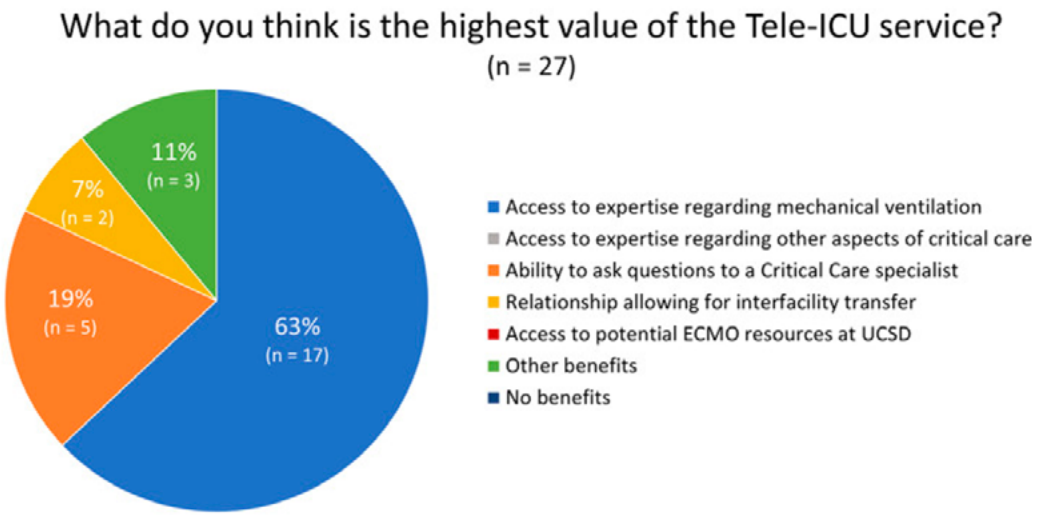
In the inpatient setting, Zoom and Epic-integrated services for specialty consultation, virtual rounding, care conferences, and discharge teaching were established to reduce viral exposure and maximize clinician capacity. Tele-ICU services allowed UC specialists to support community partner hospitals with virtual rounds and video consultations.[67] One effort at UC San Diego, the TEAM-based, Remote, E-Learning and Tele-ICU (TREAT) program, was launched in April 2020 to enhance provider education in areas without access to critical care specialists, primarily at El Centro Regional Medical Center in Imperial Valley at the California-Mexico border. These services increased provider knowledge and allowed patients to be cared for closer to their homes. Feedback from participating providers was positive **(Figure 3)**.[67]

The Virtual Care Collaborative met 28 times between March 2020 and December 2021. The working group included critical care physicians as well as staff from each of the health sciences campuses. During the meetings, each campus shared updates, ICU censuses, and lessons learned from working with other communities and provided general support and advice for each other. Most of those meetings, toward the end of the pandemic, addressed the future. Discussions focused on infrastructure needs and protocols that would allow the individual ICU programs at each location to act as one system in terms of providing remote ICU coverage to each other and throughout the state in future public health emergencies. **An important strategy identified, but not realized during the pandemic, is the cross-credentialing of critical care providers across UC Health.** Cross-credentialing would allow a licensed provider at one UC location to provide care on a temporary basis at another location, either in person or virtually, to mitigate staffing shortages that may occur during emergencies. The medical staff offices and the office of general counsel for UCOP have met and agree that cross-credentialing for emergency and routine support is possible. UC Davis has begun to cross-credential, however there is some reluctance to prioritize this activity systemwide given the end of the public health emergency.

FIGURE 3

Provider feedback regarding the UC San Diego Health TREAT program

Source: ATS Scholar[67]



Clinical research

Research was instrumental in increasing knowledge related to the mechanisms of action and the evolution of the emerging SARS-CoV-2 virus and, importantly, delivering tools to mitigate the impacts of the pandemic on human health. The UC system is a research-intensive system with thousands of scientists across the translation spectrum performing basic laboratory science, epidemiology, human clinical trials, and community-engaged implementation science. Many UC scientists pivoted during the pandemic and changed the focus of their research to addressing the questions related to the novel virus.

> *While all the research was carried out on individual campus locations,* the UCHCC played a role in coordinating activities where shared action improved the competitiveness of the research enterprise.

Working together as a system facilitated participation in clinical trials. For example, the remdesivir trial (Gilead Sciences/NIH-NIAHD) was the first randomized controlled trial of an antiviral for the treatment of COVID-19. The first patient was enrolled in the U.S. on February 21, 2020, and the data collection closed on April 19, 2020.[68] Nimbleness was required for trial participation, and the ability to rapidly standup a clinical trial from institutional review board (IRB) evaluation to first patient enrollment was instrumental in being selected as a study site. The years of work of the five Clinical and Translational Science Award (CTSA) sites (UCSF, UC Davis, UC Irvine, UCLA, and UC San Diego), collectively known as UC BRAID, were instrumental in providing an infrastructure that allowed the UC system to compete and participate. All UC academic health centers with CTSA sites (https://clinicaltrials.gov/study/NCT04280705#contacts-and-locations) participated in the trial, which was facilitated by IRB reliance.

In addition to facilitating clinical trials, the clinical research group, in collaboration with the Center for Data-driven Insights and Innovation, created the COVID Research Data Set (CORDS), which was released in July 2020 and is continually updated (also described in Chapter 7). By combining patient data from the five academic health centers, investigators are able to make discoveries using CORDS they otherwise couldn't using local data alone.[69-73] Leaders of the University of California Biomedical Research Acceleration, Integration, and Development (UC BRAID), working with campus IRB directors and UCOP, determined that usage of CORDS, a limited data set, is to be considered "non-human subjects research." As such, research use of this data set does not require individual IRB approval for investigators.

Research productivity was high during the pandemic, and UC researchers successfully competed for federal funding for COVID-19 related research. An analysis of research funding awarded through the National Institutes of Health (NIH) revealed that five institutions across the U.S., including UCLA Health, received $2.14 billion, or approximately 50% of all COVID-related funding.[74] UCLA Health was awarded large grants for clinical trial infrastructure, which was constructed on the backbone of infrastructure built for HIV clinical trials, through the AIDS Clinical Trials Group (ACTG). Across all of UC Health medical schools, NIH funding increased 25% during the pandemic from approximately $1.6 billion in 2019 to approximately $2 billion in 2023, according to the Blue Ridge Institute for Medical Research Rankings. The NIH rankings also improved for all medical schools during this time, except for UC San Diego, which was ranked 12th in 2019 and 13th in 2023 despite an increase in NIH funding of approximately $100 million, and UCSF, which was ranked number one in the nation in both 2019 and 2023.

Long-COVID working group

The last UCHCC working group established was the long-COVID/PASC group, which was established in August 2021. It was apparent at this point in the pandemic that there were increasing numbers of patients with post-acute sequelae of SARS-CoV-2 infection (PASC) in the state and limited guidance regarding the clinical evaluation and management of these individuals. Many were presenting as patients across UC Health to multiple types of health professionals, including those in primary care and subspecialists in cardiology, infectious diseases, pulmonology, psychiatry, rehabilitative medicine, and others. There was a need for systemwide coordination to meet the needs of patients and providers across the state.

At the time the working group was formed, multiple academic health centers within UC Health had launched or were about to launch multidisciplinary clinics dedicated to PASC. Bringing these leaders together helped inform those across the system of current research and best practices related to clinical care. It was also clear that no uniform definition existed for these patients, and therefore the evaluations were often complex and fragmented.

One of the first steps the working group took was to adopt a uniform ICD-10 code for encounters with individuals suspected of having PASC, ICD-10 code U09.9, which provided some structure for tracking presentation, interventions, and outcomes in the UC enterprise data warehouse.

The group also began to work with members in the myalgic encephalomyelitis/ chronic fatigue syndrome (ME/CFS) community in California to better understand the overlap, if any, between PASC and ME/CFS. The combined group focused on the educational needs of the community of patients and providers across the UC system and beyond. Together they presented the inaugural virtual UC systemwide grand rounds on October 14, 2022 **(Figure 4)**. The presentation drew more than 700 participants, both internal and external to UC.

FIGURE 4

UC Health inaugural systemwide grand rounds October 14, 2022

> *The long-COVID/PASC education modules, as of February 2024, have been viewed 21,103 times, with the modules on neurology, psychiatry, and cardiology being the most accessed.* More than 2,200 providers have sought continuing education credit for viewing the modules. Finally, the modules have been accessed by individuals throughout the United States and in 22 other countries across North and South America, Europe, Asia, and Africa.

Lessons Learned

- The UC system includes professionals with extraordinary subject matter expertise. The ability to address complex questions with world-class knowledge and real-time data is an asset of the system and was key to student, employee, patient, and community outcomes.

- Subject matter experts (SMEs) were committed and willing to support the UC system through the public health emergency, contributing tens of thousands of hours of over and above their usual duties.

- Coordination of expertise and best practices was vital to ensure similar experiences across the system and the various locations.

- Incorporation of SME groups with reporting through the UC Health Coordinating Committee to the Management Response Team and then to UC chancellors, president, and regents facilitated adoption of best practices in daily operations.

- With representation from across the system, answers from SMEs can be leveraged for the good of the system and the state through coordination and effective governance.

- Significant administrative support came from across UCOP, including UC Health, Emergency Management and Risk Services, Human Resources, Operations, and the Office of General Counsel to schedule, coordinate, document, and evaluate systemwide work.

- State advocacy informed by UC system expertise is an important component of the work of these coordinated groups and supports the system and the state.

- There are opportunities to codify sharing of resources, such as data and credentialed providers, across campus locations to better prepare the system for future public health emergencies.

- UC and especially UC Health are national leaders in research and can be expected to lead in future pandemics. Increased research funding is a mechanism to assist in the stabilization and financial recovery of the organization.

- The document entitled Allocation of Scarce Critical Resources under Crisis Standards of Care is included in the Appendix as a resource for future public health emergencies.

- The creation of a chief health security officer position would be the ideal to coordinate engagement with subject matter experts across UC during future public health emergencies.

7

The Importance of Data

CARRIE L. BYINGTON, M.D., ATUL BUTTE, M.D., PH.D., CORA HAN, J.D., AND PAGAN MORRIS, M.P.H.

University of California Health (https://health.universityofcalifornia.edu) includes six academic health centers with 12 hospitals, each with their own data resources and electronic health records. The health system shares a centralized clinical data warehouse, the UC Health Data Warehouse (UCHDW), which includes data from all owned or operated UC clinical facilities.

University of California health data

The UCHDW holds data on 8.7 million patients seen at a UC facility since 2012. These patients received care in approximately 378 million encounters. **In those encounters, UC Health conducted over 1 billion procedures, ordered or prescribed more than 1.3 billion medications, made more than 5.2 billion vital signs and test result measurements, including 35,000 sequenced cancer genomes, and assigned more than 1.1 billion diagnosis codes.** Over 850,000 of these patients receive primary care through UC Health. All hospitals and clinical sites owned or operated across UC Health now use Epic as the electronic health record, with unique instances of Epic across the enterprise. The unified UCHDW was created three years prior to the pandemic. The availability of a health data warehouse was essential for real-time monitoring of the pandemic in our clinical settings. Data had been copied into the centralized data warehouse on a monthly cadence, but during the pandemic, COVID-related data was copied nightly.

Impact of the pandemic

When the pandemic began, it was clear that the management of the pandemic requirements for clinical care provision and for state reporting could not be managed on a monthly tempo. The UC Health Center for Data-driven Insights and Innovation (CDI2) worked with informatics teams across the campuses and with operational leads to prioritize data fields for daily reporting and integration within the UCHDW.

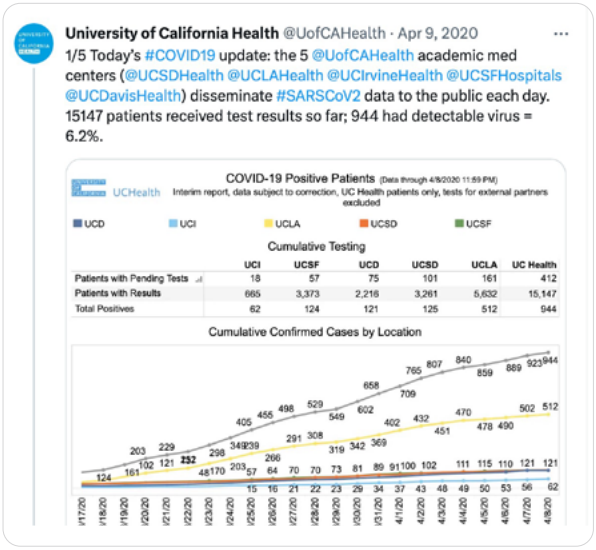
Over the course of the pandemic, fields captured included those critical for clinical care management, such as total bed capacity, intensive care unit beds, total ventilators, and ventilators in use. The data were integrated with the laboratory teams to monitor test positivity for SARS-CoV-2 daily and to identify patients with positive tests who were evaluated at any UC location and those who were admitted to the hospital. Beginning on April 9, 2020, we shared these data on social media using the UC Health account on Twitter, now X (@UofCAHealth) **(Figure 1)**.

The transparency was appreciated by patients, employees, students, regents, and the California Department of Public Health, as demonstrated by the growth of the UC Health account by thousands of followers during the pandemic and millions of views during the public health emergency. Data transparency also increased trust in the system and was a means of accountability for the system.

Using the UCHDW, we were also able to monitor the impact of COVID-19 on total bed capacity, ICU capacity, and ventilator use. Data on health care worker illness and staffing levels were also maintained. At the start of the public health emergency, these data were reviewed during daily meetings with the hospital chief executive officers, vice chancellors for health, and UC Health leadership. The intensity of the pandemic dictated the cadence of the meetings, which ranged from multiple times per day to multiple times per week over the course of the emergency. The real-time data reports were used to identify hot spots and clinical locations where capacity was stretched by patient illness or staffing levels. **For example, during the peak of the pandemic in winter of 2021, 48% of the bed capacity at UC Irvine was required by patients with COVID-19.**

FIGURE 1

First post on X social media of COVID-19 daily dashboards for UC Health, April 9, 2020



The team also worked with supply chain leads in the UC Health Leveraging Scale for Value team and procurement leads on each campus to monitor personal protective equipment, including equipment usage or burn rates. These data allowed us to both predict shortages and identify surpluses across the system so that supplies could be shared and/or redistributed to mitigate variation across campuses and ensure sufficient supplies. Data were also used to predict and to forecast future impacts; for example, test positivity could predict future hospital admission and staffing needs.

> *Importantly, the UCHDW was further used to help in the calculations and dissemination of vaccines, especially during the early days when vaccine supply was extremely limited.*

The pandemic demonstrated the need for real-time systemwide data for clinical care, operations, staffing, and supply chain. The availability of real-time data allowed greater collaboration across the health system and, by identifying areas of scarcity or excess, offered opportunities to share resources and detect trends and variation across the system. As the public health emergency subsides, new opportunities for systemwide use of real-time data are being identified by quality and population health teams at each location. **One of the greatest opportunities post-pandemic will be to continue to advance the capacities of the UCHDW to deliver real-time data for the system.** Prioritization of additional opportunities, such as improving patient outcomes, eliminating health disparities, and lowering the total cost of care, will be critical to guide investment and should be aligned with UC Health strategic planning, values, and ideally the needs of the state of California.

Health equity

During the pandemic, health disparities were glaring across the U.S. and in California. Age was the greatest predictor of outcome for those with COVID-19, with older individuals faring worse than younger individuals. However, after age, individual outcomes were strongly associated with geography, socioeconomic status, race and ethnicity, and other social determinants of health.

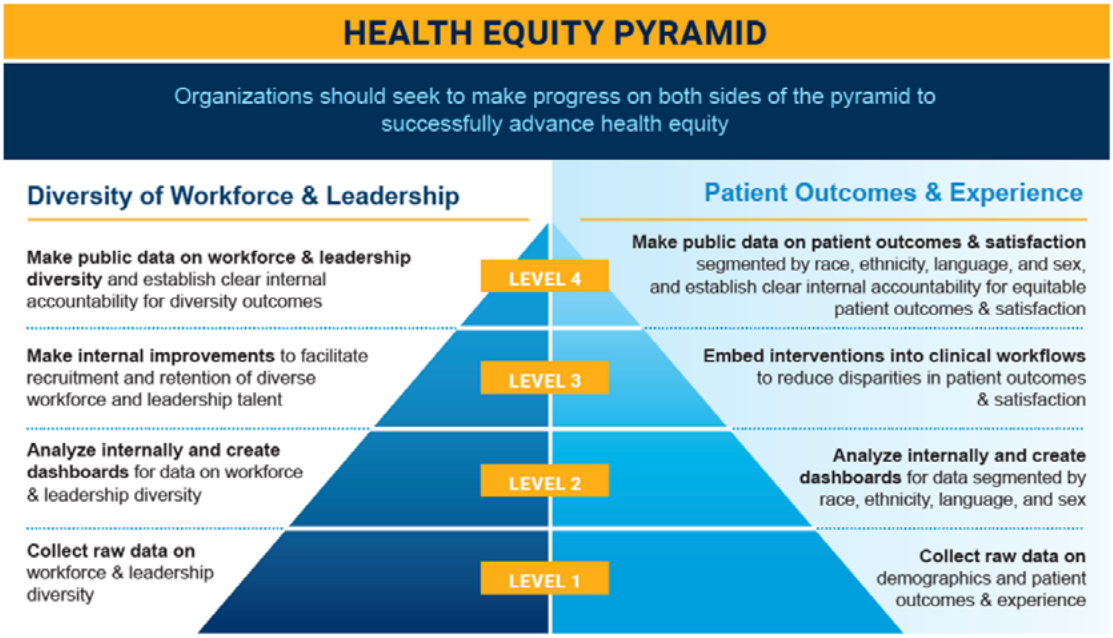
The University of California, as a land-grant institution, has a mission of public service. UC Health was committed to reducing health disparities prior to the pandemic and sought to invigorate efforts to address disparities during the pandemic. One mechanism was to improve the data we collected on our own patients.

The EVP of UC Health co-chaired a national working group sponsored by the Health Evolution Forum that examined the use of data to reduce health disparities. The group developed a health equity pledge to collect race, ethnicity, language, and sex data in a unified manner for quality reporting for priority areas across the health system. UC Health was a founding signatory to the health equity pledge, joining 40 other health organizations in October 2021 (See the Forum Health Equity Pledge, (https://www.healthevolution.com/community-focused-health/forum-health-equity-pledge-supporters/) and **Figure 2**).

FIGURE 2

Health equity pyramid developed to assist health systems in identifying areas of focus to advance health equity

Source: Health Evolution Forum



The lack of data on health care outcomes by race, ethnicity, language, and sex has obscured the deep level of health disparities in our state and the nation. This information is necessary to be able to identify specific areas for actionable change that will make a difference in improving health equity. Patterns are more easily identified with this additional data, allowing UC Health to more effectively tailor and test approaches to improve outcomes for people from groups that have not experienced the benefits of UC health care systems on an equal basis.

The work associated with fulfilling the pledge allowed UC to better measure outcomes for priority conditions such as hypertension and diabetes across the system. The disparities identified then offered opportunities for targeted interventions. All academic health systems identified hypertension management as one area for quality improvement. Leaders at UCSF designed an intensive program using pharmacists and health coaching combined with tracking of blood pressures to better control hypertension in Black/African Americans. These interventions are improving care and outcomes for UCSF patients. In 2023, UCSF received an award for health equity from the National Association of Accountable Care Organizations.

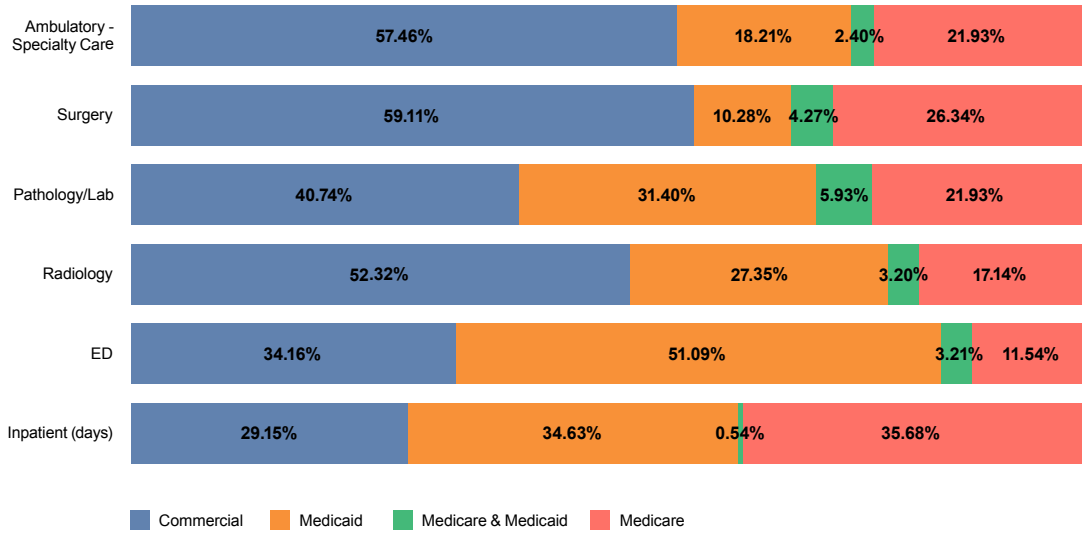
Other social determinants of health were also integrated into the UCHDW. These include the insurance status of UC patients. Among inpatients, Medicare and Medi-Cal accounted for 71% of payers across the system, with Medi-Cal eligible at 35%. As shown in **Figure 3**, Medi-Cal is a significant payor at all venues across UC Health and accounts for billions of dollars annually. Recognition of UC Health's role as an important safety net system for California creates new opportunities for collaboration with the state to ensure the high level of UC care is sustainable for the most vulnerable populations.

Finally, to better understand the UC Health patient population and the impact of social determinants on health outcomes, the CDI2 team added several indices to the UCHDW. Starting first with the UC primary care population and then advancing to all encounters, patients are classified using three separate indices: the Social Vulnerability Index, the Area Deprivation Index, and California's Healthy Places Index. These frameworks, calculated in the UCHDW for all patients at all locations, allow a deeper understanding of the potential vulnerability of each patient to poor health outcomes. The additional information can be used to better tailor local and systemwide population health resources for those at greatest risk for poor health outcomes. The transparency of the metrics also helps UC Health to ensure that we are acting in concordance with our stated value of public service designed to eliminate health disparities.

FIGURE 3

Dashboard shows the mix of patients by type of health plan coverage at UC-owned hospitals and non-hospital ambulatory clinics

Source: UC Health Center for Data-driven Insights and Innovation

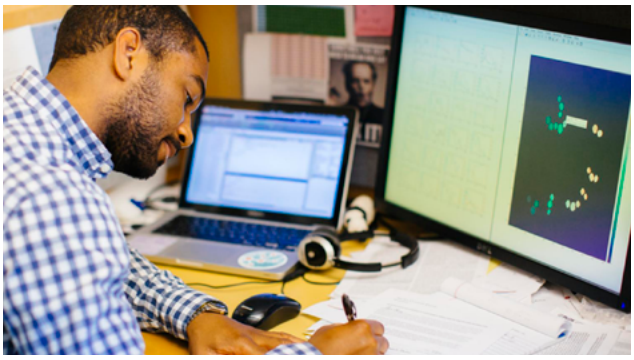


UC health data for research

The UCHDW was an important resource not only for operations, but also for research. The aggregating and sharing of data across the system helped to advance research in a manner analogous to the benefits seen in operations. Many investigators across UC were asking similar questions, and the availability of an aggregate dataset allowed for more rapid accrual of patients and their data. Trends in outcomes were more easily discerned in the larger UCHDW dataset than in individual campus data.

To encourage collaborative research, UC Health worked with the University of California Biomedical Research Acceleration, Integration, and Development (UC BRAID) group, a consortium of five clinical and translational science centers located at UCSF, UC Davis, UCLA, UC Irvine, and UC San Diego. The UC BRAID platform works to accelerate research by leveraging shared resources.

Working together, CDI2 and UC BRAID created the UC COVID Research Data Set (UC CORDS). The CORDS dataset includes all clinical and laboratory data associated with individuals tested for and diagnosed with SARS-CoV-2 at any UC Health location. UC CORDS is a HIPAA-limited data set. UC BRAID and CDI2 worked with institutional review board (IRB) directors at all 10 campuses to ensure approval for data sharing. By July 2020, the UC CORDS dataset was available to all UC investigators without the need for additional IRB approval. Hundreds of UC researchers have engaged with UC CORDS and have published significant results that advanced our understanding of COVID-19. Many papers have been published examining risks for mortality, impact of vaccination, medication use, rebound COVID, long COVID, and health disparities, among other topics.[69-73]



UC researcher analyzing data

Credit: University of California

Campus-level data

Like the hospitals, aligning mitigation work and tracking implementation across the campuses was important during the pandemic. The hospitals had some infrastructure developed through the UCHDW that could be leveraged for operations, public health reporting, and research, as described. All these functions were critical during the pandemic and revealed opportunities for increased coordination and interoperability for data resources across UC Health.

In a similar way, data aggregation across campuses in the realms of health, including occupational health for employees and student health, was also critical. Unlike the health system, the academic campuses did not have a shared infrastructure for collecting and aggregating health-related data.

The campuses all independently collected data from student health centers. Apart from UC San Diego, which utilized Epic, these centers utilized the electronic health record (EHR) known as Point and Click. The instances of the Point and Click EHR were mostly independent across campuses. Data was collected in different ways and interoperability of the EHR with automated data aggregation and sharing was not possible. The data from Point and Click was not integrated into the Epic EHR used in the health systems, nor aggregated in the UCHDW. For these reasons, aggregating data for elements such as the number or proportion of COVID-positive tests across campuses, the number of students in isolation, or the proportion of vaccinated students, all critical for campus operations, was a time-intensive, manual process.

Likewise, the occupational health infrastructure varied across the campuses. The locations with medical centers had stronger infrastructure for occupational health than locations without. Furthermore, there was not a systemwide approach to occupational health. This was something that evolved during the pandemic through the collaboration of the emergency management group, human resources, the UC Health Coordinating Committee, and subject matter experts in infection prevention and public health. While this collaboration allowed for alignment of recommendations and policies across campuses, the collection and aggregation of data remained a manual process. The ability to measure and monitor variables such as test positivity, COVID-related absences, and vaccine uptake in the employed population in an automated fashion remains aspirational. Similarly, the ability to define work location and to classify individuals as front-line health care workers is also challenging. The ability to identify front-line health care workers was important throughout the many phases of the health emergency for the purposes of allocating personal protective equipment, prioritizing testing and vaccination, and for the state and federal reporting required for pandemic relief funding.

In the post-pandemic period, there has been some movement to align campus health data with the health systems. UC Health sponsored a vaccine compliance project to assist campuses in developing the occupational and student health functions related to vaccine tracking.

Lessons Learned

- Real-time, systemwide data is required during an emergency to manage operations, to prioritize mitigation efforts, and to ensure equity of response across locations.
- Aggregation of data in the UC Health Data Warehouse enhanced the management of the public health emergency across the system and demonstrated the value of collection of uniform data to manage operations and enhance outcomes.
- Data transparency through publication on websites and social media enhanced trust.
- The data resources of the health system and the UC campuses are fragmented and present a barrier to developing a cohesive understanding of the impact of a public health emergency at individual locations and systemwide.
- The realization of real-time data aggregation reporting for COVID-19 offers an example for the system. Building internal data structures that are interoperable across the locations through regular investment between emergencies will enhance preparedness for the next emergency.
- The creation of a chief health security officer within the UC Health framework who could interact with the chief data officers across the system would enhance data preparedness.

8

Communicate Early and Often

CARRIE L. BYINGTON, M.D., AND HEATHER HARPER, M.B.A.

During crisis situations, communication is both vital and difficult in large, complex organizations. Effective communication must be accessible, accurate, and timely to engender trust. Trust is then the most important factor in achieving the changes often required to mitigate the effects of the crisis.

Across the UC system, leaders and managers in every unit, division, and school were faced with numerous questions as the pandemic evolved. Often these questions were similar across geography and location. From the onset of the pandemic, the UC system chose to address major questions related to pandemic mitigation efforts, including policy, as a system rather than as individual locations. The goal was to have every location operating under a similar health and safety support framework during the public health emergency. Examples included the Board of Regents Principles for Responsible Operation of University Locations in Light of the SARS-CoV-2 Pandemic (https://regents.universityofcalifornia.edu/regmeet/may20/b2.pdf), adopted May 20, 2020, and the University of California Consensus Standards for Operation of Campus and ANR Locations in Light of the SARS-CoV-2 Pandemic (https://universityofcalifornia.edu/sites/default/files/consensus-standards-for-campus-operations.pdf), published May 22, 2020. Individual locations were all required to meet the goals outlined in the framework and could meet those goals using means and methods that were supported by the unique capacities and resources at each location.

Communication among leaders for the purpose of shared decision-making

The goal of a systemwide response required a governance structure and process to adjudicate data and information, and to formulate responses and policies. The Management Response Team (MRT) structure, described in Chapter 4, formed the foundation for decision-making. A "battle-rhythm" emerged as the pandemic progressed that started with data review and discussion by subject matter experts (SME) within the UC Health Coordinating Committee (UCHCC). Analysis and recommendations from the SME were then presented to the full MRT. The MRT included multiple systemwide partners who could comment on and refine the recommendations based on operations across many locations. The recommendations of the MRT would then be presented to the chancellors and the president at standing Council of Chancellors (COC) meetings. The COC, which during normal operations meets monthly, was, during the pandemic, meeting as often as daily or at a frequency dictated by the urgency of the situation. Final recommendations were presented to the UC Board of Regents at either regularly scheduled meetings, Health Services Committee meetings, or special meetings.

> *Shared decision-making requires sharing access to data and offering opportunities for discussion and review. The systemwide UCHCC benefited by inclusion.*

Each SME group included membership from every location. Membership often included local leaders in the COVID-19 response as well as administrators familiar with campus operations and Academic Senate representation. The campus representatives were instrumental in ensuring communication from campus locations flowed to the system and vice versa. Although campus representation increased the size of each SME group, often in the range of 50 to 100 individuals, the active participation of campus experts increased confidence in the recommendations of the system. Chancellors and employees recognized the expertise of individuals from their home location, which included local knowledge of the operational capacities of each site.

Additional partners in the UCHCC and MRT included individuals from the office of general counsel and human resources, which conveyed the views of employees, including those represented by unions. Finally, representatives from communications were invited to facilitate creating concise messaging that reflected the plans of the system and that could be easily understood by all stakeholders. Their work included internal communications across the system, such as creating responses for frequently asked questions and maintaining updated websites for information sharing.

An important aspect of their work also included communication with external stakeholders, especially the media. The UC system was a leader nationally and in California regarding COVID policy for students and employees and thus became a reference point for reporters. Communications staff had increased duties related to media inquiries for major and urgent events, such as the first patients with COVID-19 admitted to a UC hospital, first evidence of community transmission, and vaccine mandates. The communications group also worked to share proactively positive stories with the media that highlighted the work of the system, including research accomplishments, delivery of health care to underserved populations such as agricultural workers, and progress with vaccine delivery, including administration of the one-millionth vaccine. Social media was an important means of communication during the pandemic for both internal and external stakeholders and created a significant new workload for communications teams.

Cascading information

When decisions were made, it was imperative to cascade information throughout the system as rapidly as possible, preferably close to real time. An environment of sharing and transparency was the goal, including sharing both what was known and unknown.

A number of resources were used to share information in an effort to reach deeply across the organization. UCOP leveraged an existing and trusted website (https://www.universityofcalifornia.edu/coronavirus) for information sharing from the university. On this website, the university created a dedicated hub with links to all systemwide guidance and specific campus guidance. Links included dashboards for ease of tracking information such as number of COVID-19 cases, test positivity at specific locations, and vaccine updates. Policy updates were also linked to the hub and landing page for coronavirus information. The site also allowed individuals to sign up for emergency alerts.

The UCOP and UC Health websites also included COVID-specific information and guidance. The UCOP coronavirus update landing page (https://www.ucop.edu/coronavirus/index.html) included links to the protocols currently in effect, the testing program, the process for reporting positive COVID-19 cases, the vaccination policy, and guidance for visitors to the UCOP offices in Oakland, Sacramento, and Washington, D.C. In addition, the site featured a link for asking COVID-related questions that were answered by experts across the system.

The UC Health page (https://ucop.edu/uc-health/reports-resources/uch-coordinating-committee-guidance/index.html) on the UCOP website included a link to reports and resources. On this page, all guidance from the UC Health Coordinating Committee was posted in real time for access by internal and external stakeholders. As guidance was retired, the website was updated. The site was also the home for the Board of Regents Principles for Responsible Operations during the pandemic and the University of California Consensus Standards for the Operations of Campus and ANR Locations in Light of the SARS-CoV-2 Pandemic. These documents directed the systemwide pandemic response.

The UC Health Coordinating Committee for COVID reports were also included on the UCOP site with links to systemwide policy documents on vaccination and leave to enable additional opportunities to link policy documents across the systemwide sites. Finally, all formal COVID-19 updates provided by the EVP of UC Health to the Board of Regents were archived and available on the UCOP site. These updates outlined the status of the pandemic across UC, the state, nation, and world as well as the work being undertaken by UC Health clinicians, educators, and investigators to mitigate the effects of the pandemic. Written updates were provided to the board from February 28, 2020, through January 28, 2022. Initially, updates were provided every few days, and the pace then changed to approximately weekly, then monthly, and finally quarterly as the evolution of the pandemic dictated.

In-person and virtual meetings

In addition to written material posted on websites, it was important to maintain communication between UCOP and campus stakeholders through both in-person and virtual meetings that allowed for the development of longitudinal relationships and trust building. As the lead of the UC Health Coordinating Committee for COVID, the EVP of UC Health had recurring meetings, briefings, and presentations with the UC Board of Regents at both full board meetings and meetings of the Health Services Committee. These meetings occurred monthly at minimum and during the early stages of the pandemic occurred more frequently. The regents were afforded unlimited time in asking questions. The meetings were, for the most part, in open session and available for livestreaming through Zoom and were archived for asynchronous viewing on YouTube.

> *These meetings were accessed by thousands across the system,* and many employees, students, and alumni indicated that these sessions provided valuable information and were considered vital for their personal pandemic preparedness, especially early in the pandemic.

Other venues for information sharing included UCOP town halls for faculty and staff, the systemwide meetings of the Academic Senate, and meetings with union leaders and represented employees. These meetings allowed for questions and answers and offered the opportunity to clarify information and to receive feedback from the UC community. These meetings were scheduled regularly throughout the pandemic, and individual groups could request meetings with the EVP of UC Health and others to address specific issues or concerns. For example, meetings with the California Nurses Association, UC nursing representatives, and the EVP were common during the pandemic to address issues related to personal protective equipment, infection prevention guidelines, and vaccine policies.

The systemwide SME groups also were an important form of communication with campuses. These groups allowed a feedback loop for exchange of information between campuses and UCOP. The groups also enabled individual campus representatives to hear from their peers as each were tackling similar problems. Campuses were able to exchange ideas and adopt best practices, as well as share capacities and strengths. For example, UC San Diego became the primary resource for infectious diseases modeling for the working group charged with planning a return to in-person education and work. Faculty members at UCSD were able to create scenarios modeling transmission under various conditions, including dormitory occupancy, masking, and

testing frequency. All campuses benefited from the scenario modeling for informing their specific decisions. The sharing of data for planning also decreased variation of the responses across campuses and resulted in similar outcomes across highly variable locations.

Social media

Social media was a new tool for conveying information for many at UCOP and was used extensively during the pandemic. As a public research institution, UC values data sharing and is committed to transparency. All campus locations had personnel that maintained dashboards for COVID-test positivity, individuals in isolation, proportion vaccinated, and other important aspects of COVID-19 response. UC Health tracked data on all patients tested for COVID-19, including those who were hospitalized or who died. We committed to share these data, in a de-identified and Health Insurance Portability and Accountability (HIPAA)-compliant manner, as widely as possible.

On April 9, 2020, UC Health began to share COVID data from all UC Health medical centers on Twitter **(Figure 1, Chapter 7)** and continued to do so daily throughout the pandemic. Other information related to clinical care, research, and education across all UC locations was also shared through @UofCAHealth **(Figure 1)**. The posts received millions of views and shares over two years.

Social media platforms, however, are evolving. Social media sites may be venues for misinformation and anti-science rhetoric that may be critical of the work performed by UC faculty and staff. Both systemwide and local expertise must be developed to ensure social media tools can be used to support accurate public health information sharing and to share resources in future public health emergencies.

FIGURE 1

Examples of UC Health posts on X social media amplifying clinical care and research related to the COVID-19 pandemic taking place across the system

Misinformation and disinformation

During an emergency, there is opportunity for misinformation. Misinformation is defined as false or inaccurate information that is spread regardless of the intent to mislead. This contrasts with disinformation, which is false information spread with the intention to be misleading or harmful. As the pandemic evolved from 2020 to the end of the public health emergency on May 11, 2023, the problems of misinformation and disinformation increased significantly. Social media, which had provided a new means of communication early in the pandemic, increasingly became a venue for both misinformation and disinformation. Further, these platforms continue to evolve and the increasing availability of artificial intelligence in platforms such as ChatGPT will add further challenges for communicators in the future.

> *For UC, the aspiration is to constantly develop as a trustworthy source of accurate and actionable information.*

This will require further research and new tools to ensure the veracity of information that is shared on social media either by the UC system or attributed to the system. A systemwide center for the study of effective communication and for combatting misinformation/disinformation is aspirational and would be a resource during future public health emergencies.

Lessons Learned

- Communication during a crisis is vital for effective response.
- The importance of communication professionals to a systemwide response requires their standing membership on the Management Response Team.
- Effective communication requires trust and relationship building.
- Longitudinal communication with stakeholder groups builds trust and understanding over time and decreases unnecessary variation in response.
- Many methods and venues for communication are required to reach all stakeholders.
- Creating a transparent process for decision-making and cascading of information helps to avoid mixed messages and miscommunication.
- Dialogue between campus locations and UCOP is necessary for informed decision-making and for implementation of effective policies and procedures.
- Peer groups help support knowledge sharing.
- Social media can be an effective tool for data sharing.
- Addressing misinformation and disinformation is an important and emerging area of research and scientific inquiry and deserves investment from the UC system as a mechanism to increase health security.

9

Moderating Financial Risks

CARRIE L. BYINGTON, M.D., MEGHAN GUTEKUNST, AND DIANNE KLEIN

The financial impact of the COVID-19 pandemic was substantial in all countries and impacted all economic sectors. The University of California system, one of the largest academic systems in the U.S., operates within both the higher education and health care sectors, two sectors that experienced significant disruption and financial losses during the pandemic.

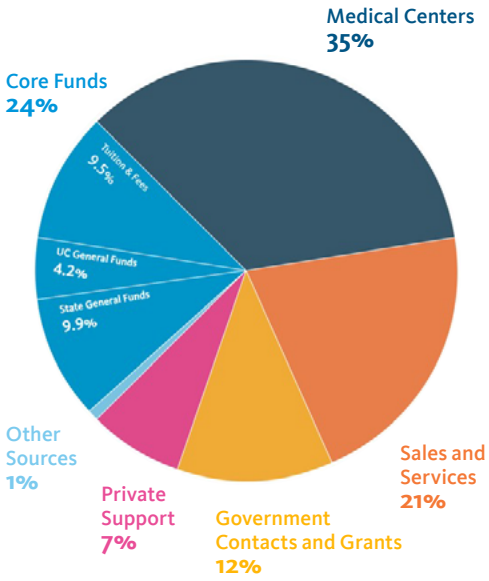
In early 2020, as it became evident that a global pandemic was likely, it was vital for the leadership of the UC system to develop strategies to mitigate the anticipated financial impact on the organization and to maintain the resources to sustain operations in the pandemic environment. The education and health enterprises of the UC system had an operating revenue budget of nearly $40 billion in fiscal year 2020 (July 2019–June 2020).[75] The sources of university funds are outlined in **Figure 1**.

The principal revenue sources of the university are the medical centers (35%), core funding, including state support and tuition (24%), and sales and services, which include elements of the clinical enterprise as well as housing and parking (21%). These revenue sources were predicted to be adversely impacted by the pandemic. Medical centers were predicted to have increased costs due to staffing and infrastructure needs and would be less able to cross-subsidize the campus operations. Sales and services revenue was predicted to decline, as campus operations converted to remote status, emptying campus housing and decreasing the need for other on-campus services. The impact of the pandemic on core funds was less predictable and depended in large part on campus policies related to tuition and the pandemic impacts to the state budget general funds.

One of the first and most important questions asked by leadership was, **"How long will the pandemic last?"** The answer to this question would drive the financial strategy of the organization. To answer in the most informed way possible required understanding both historical examples of previous pandemics and the behavior of other known respiratory viruses. We also chose to augment the historical data with near-real-time modeling of the novel epidemic.

FIGURE 1

The operating budget for the UC system for academic year 2019-2020 by source



Source: University of California

The influenza A pandemic of 1918, also known as the Spanish flu, is the prototypical pandemic experience of the 20th century. The pandemic began in the United States in March 1918 and spread globally, often with infection following troop movements during World War I. The pandemic had three waves in 1918 and 1919, infecting one-third of the world's population and killing 50 million to 100 million people, or between 2.5% and 5% of the global population. The case fatality rate for the H1N1 avian-origin influenza responsible for the Spanish flu pandemic was far higher than other influenza viruses. Economic consequences included, on average, a drop in gross domestic product of 6% and decreases in private consumption of 8% for countries that experienced an average mortality rate.[76] The mortality rates of individual countries were also associated with declines in the stock market; for example, an average population mortality rate of 2% was associated with real stock returns declining by 26%. In the U.S., the mortality rate was 0.5% and was associated with a 7% decline in stock market returns in 1918–19.[76] In the 1918 pandemic, uncertainty and fear produced a loss of confidence and change in economic behaviors and were the driving forces for the slowdowns experienced.

The influenza ward at Walter Reed Hospital, Washington, D.C., during the 1918–19 epidemic

Credit: Harris & Ewing photographers

In contrast, the novel, swine-origin H1N1 pandemic of 2009–10 had more modest impacts.[77] The virus emerged in March 2009 at the Mexico/California border. By June 2009, the virus had spread globally, and the World Health Organization declared the first pandemic of the 21st century. The novel influenza virus produced two waves of illness, and a vaccine was produced within six months. The pandemic was declared over by August 2010. The Centers for Disease Control and Prevention mortality estimate for the H1N1 pandemic of 151,700 to 575,400 deaths represents 0.001% to 0.011% of the world population, far lower than the 1918 pandemic. The economic impact was limited compared with the 1918 pandemic, in part because there was less uncertainty and fear in the population given the low mortality rates and the rapid availability of an effective vaccine.

The cause of the COVID-19 pandemic was identified as a novel coronavirus by January 2020. It was therefore critical to evaluate the most recent previous outbreak of a novel coronavirus, severe acute respiratory syndrome (SARS), caused by SARS-CoV-1 virus, which occurred in 2003–04. The behavior of SARS-CoV-1 could indicate how the new virus, named SARS-CoV-2, would behave. Overall, the rapidly spreading SARS-CoV-1 virus was identified in 30 countries, caused approximately 8,000 documented infections and 800 deaths, for a roughly 10% mortality rate, before it was declared contained in July 2003.[78] The economic impact of SARS, like the 1918 influenza pandemic described previously, was influenced primarily by fear and uncertainty. The virus was new, of an unusual animal origin (civet cat), spread in an airborne manner, including large outbreaks traced to hotels and apartment blocks where individuals had no physical contact with infected persons, and there was no available vaccine. Although the outbreak was contained in a matter of months, there were measurable impacts on gross domestic product in several countries depending on the intensity of their exposure to SARS cases. Hong Kong, China, and Singapore were most impacted with drops in GDP predicted to be measurable for 10 years. The global impact of the seven-month outbreak was approximately $40 billion. If the outbreak were to ever recur, it was hypothesized in 2003 that the expected impact to the U.S. alone would to be roughly $54 billion.[79]

> *UC Health subject matter experts also chose to evaluate prospective modeling in addition to historic examples to inform decision-making.*

In the United States, modeling was being performed locally on UC campuses, at other academic institutions, and at the Centers for Disease Control and Prevention. By March 2020, it was clear that COVID-19 was easily transmissible between people and that a significant global pandemic was underway. The winter experience demonstrated that even modern health systems in China, Italy, and the U.S. could be overwhelmed by the virus. In March 2020, there were no vaccines to prevent infection and there were no pharmaceutical agents proven to treat COVID-19. The primary control measures were non-pharmaceutical interventions (NPIs) including social distancing and masking. Immunity from infection was estimated to be approximately 1% of the U.S. population, and the duration and effectiveness of immunity for those who survived infection were unclear.

Mark Lipsitch, D.Phil., professor of epidemiology and the director of the Center for Communicable Disease Dynamics at the Harvard Chan School of Public Health, predicted that 40% to 70% of the global population would become infected.[80] The prediction was based on prior influenza outbreaks and a comparison of the infectiousness (R_0) of the novel coronavirus and influenza. The prediction, though frightening, was mathematically and biologically sound. This modeling provided confidence to the UC subject matter expert groups in our own planning for the system. In hindsight, the model, which was criticized for potentially overestimating the effect of the pandemic, proved to be an underestimate. In the U.S., as of July 2023, the Centers for Disease Control and Prevention reported that 77.5% of adults older than 16 years have been infected and for children, the proportions are higher, at 90% previously infected, exceeding the highest proportion predicted by the Harvard model.[81]

> *In answering the question regarding how long the pandemic would last,* the EVP of UC Health presented an estimate to the CFO, the president, and the Board of Regents that the UC system should prepare for at least two years of disruption **(Figure 2)**.

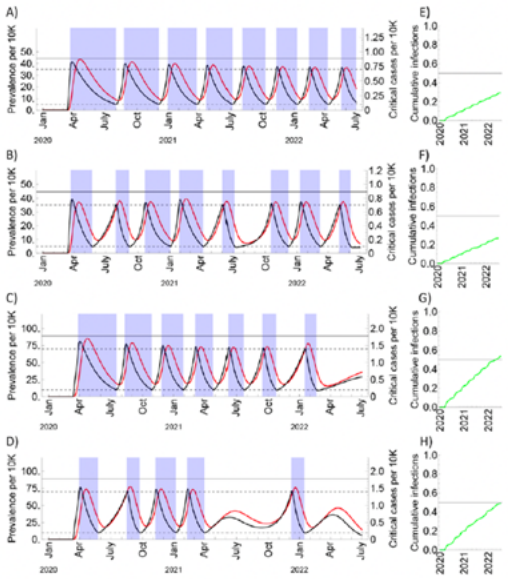
Until a vaccine was identified or until the population could generate durable immunity through infection, we would need to rely on periods of social distancing with other NPIs, and we could expect multiple waves of infection. **Figure 2**, from the published Harvard model, was shared for planning purposes, with option D presented as the most likely scenario. This was the preferred estimate because in the UC system and in the state of California, ICU capacity had been increased significantly, and we expected some seasonality of the virus to develop eventually, as is the norm for other human coronaviruses. **Figure 3** demonstrates the actual epidemiologic curve for hospitalizations with COVID-19 at all UC facilities, which is remarkably similar to option D in Figure 2.

Given the protracted nature of the predicted pandemic, the university immediately took steps to increase financial liquidity and ensure it could continue to operate through the uncertainty.

At UC Investments, a recalibrated investment strategy centered first on ensuring campuses would have the liquidity needed for operational expenses. Holdings were increased in the Short-Term Investment Pool (STIP), which is the university's primary source of working capital. UC Investments liquidated all $2 billion from the recently formed Blue and Gold Pool to further increase the university's cash. To take advantage of the unique investment opportunities that the pandemic provided, UC Investments shifted its asset allocations, putting an additional 10% in public equities and moving from long-term to short-term bonds.

FIGURE 2

Modeling estimates demonstrating predicted waves of SARS-CoV-2 infection prior to vaccination[80]



Source: Science[80]

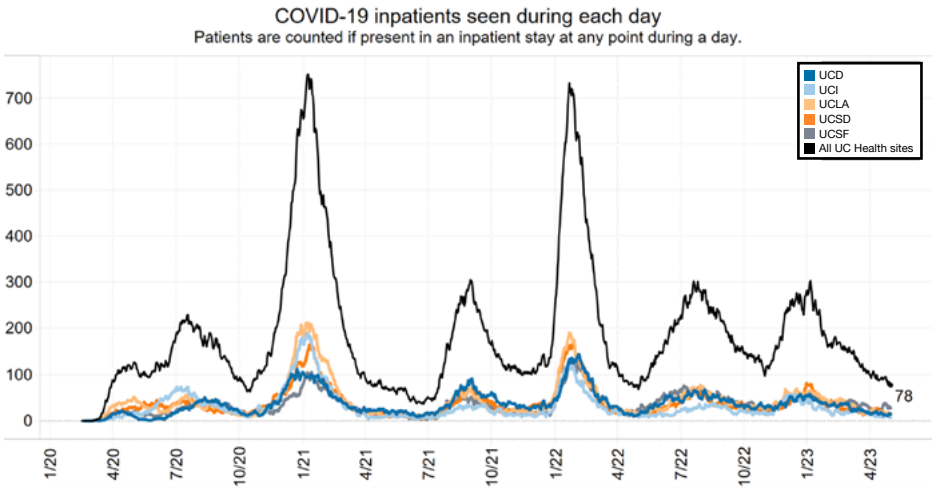
The result was a $37.7 billion increase in the university's assets under management in fiscal year 2020–21, the biggest annual gain ever at 28.9%.

In addition, the university utilized its access to the capital markets to issue almost $2 billion in bonds to fund working capital, which enabled the campuses to bridge the fiscal impact of the pandemic. Early in the pandemic, the university issued $1.5 billion in taxable debt at a cost of capital of only 1.43%. The proceeds were used systemwide to help offset the decline in revenues due to closed dorms and auxiliary facilities as well as the increase in expenses for personal protective equipment and other pandemic-related costs. As the pandemic persisted into the following year, the university issued an additional $475 million in taxable debt for working capital. The proceeds from the second transaction were targeted for campuses that experienced the most significant declines in auxiliary revenue.

FIGURE 3

The number of patients admitted with COVID-19 to hospitals in the UC Health system by month

Source: UC Health Center for Data-driven Insights and Innovation



Financial impact across the University of California

The financial impact across the system of the COVID-19 pandemic was significant **(Figure 4)** and demonstrated variation between medical centers and the academic campuses. As California was entering lockdown in March 2020, the university was transitioning to remote work and teaching. The spring semester/quarter was well underway, and tuition payments and payments for housing had already been collected by the university. In contrast, the medical centers, as safety net providers, remained open, but faced restrictions on nonessential surgical procedures, which reduced revenues. The strain on health centers' revenue was compounded by the increased needs compared to budget to meet the challenges of the pandemic. The medical centers were engaged in acquisition of equipment and supplies and expansion of bed capacity, with the creation of 1,500 new beds before March 2020. The new bed capacity required an increase in personnel, and market forces drove competition and costs for nurses, physicians, respiratory therapists, and other health professionals. Additionally, all personnel had to be trained in new infection prevention and treatment protocols. The medical centers also suffered a significant and acute revenue loss during the month of April 2020, when the state ordered the suspension of all nonessential surgical and medical procedures to preserve bed capacity for the treatment of patients with COVID-19 during the first wave of infection. For these reasons, the most acute losses at the medical campuses occurred earlier in the pandemic. The health centers were also able through infection prevention practices to return to more normal functioning and resolve financial losses more quickly than the academic campuses. **Eventually, many of the infection prevention practices adopted by the hospitals (masking, testing, vaccines) were also adapted to campus life, allowing a normalization of activities, including return to campus housing.**

Overall, the university experienced losses totaling more than $3.5 billion over 16 months: approximately $1.2 billion in the health centers and roughly $2.3 billion across the 10 campus locations. The financial losses from the health centers and from the academic campuses followed different trajectories (**Figure 5**).

FIGURE 4

Financial losses from March 2020 to June 2021, in $ millions

Source: University of California

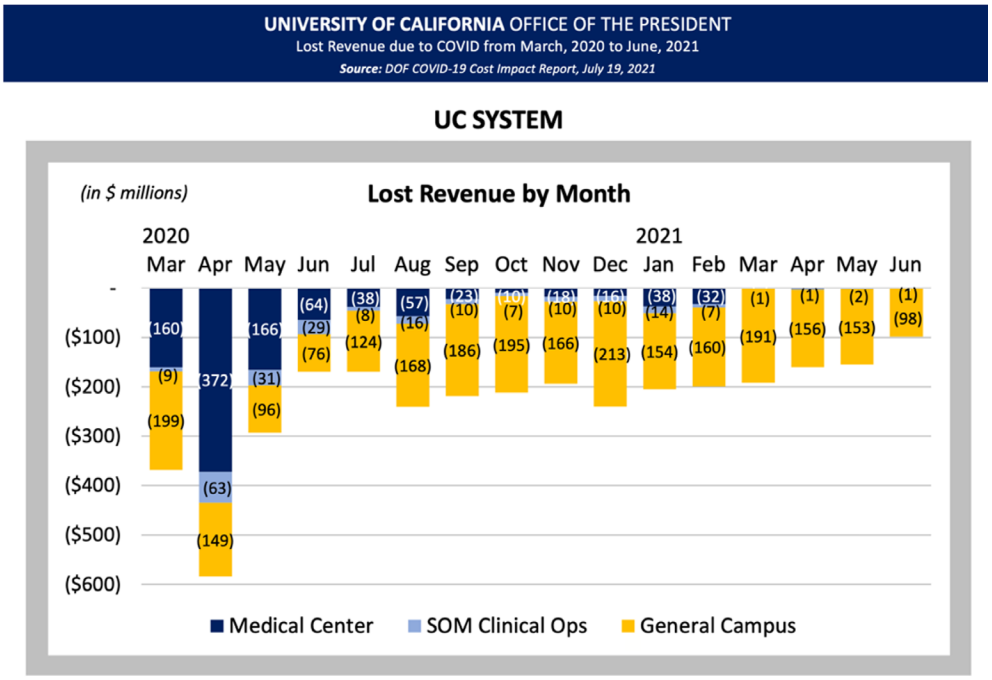
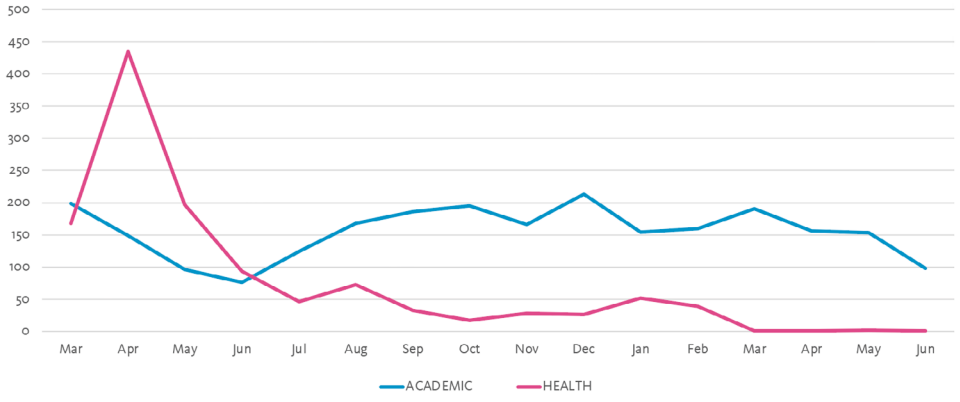


FIGURE 5

Operating losses from March 2020 to June 2021, in $ millions

Source: University of California



Recovery of financial losses

The university participated in all federal programs that were available to offset the financial losses experienced during the pandemic. The university received funds under the Coronavirus Aid, Relief and Economic Security Act (CARES) and the Coronavirus Response and Relief Supplemental Appropriations Act, 2021, to minimize the impacts of lost revenues and increased expenses related to COVID-19. In FY2019–20, the campuses received $245 million, and in FY2020-21 they received $456 million to provide emergency grants to students and cover institutional costs.

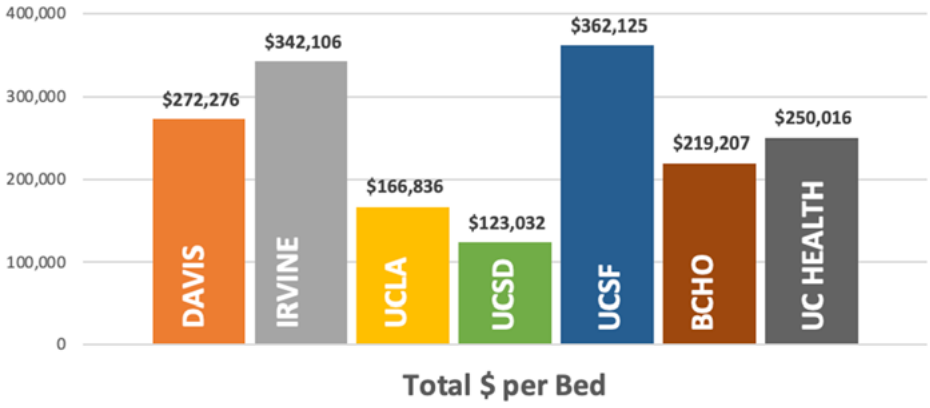
All the health locations also participated in CARES, including four phases of provider relief funds, rural rescue funds, funding for COVID hot spots, and the Health and Human Services stimulus plan. Each relief plan had different eligibility requirements for hospitals, practices, and even individual providers. Further, distribution amounts were often based on performance prior to the pandemic, and payments in some cases did not reflect efforts during the pandemic itself. This resulted in significant variation in relief funds across the health centers and required dedicated teams at each medical center location to manage applications for and distributions of relief dollars. Overall, the UC Health system received approximately $990 million in relief funds. On average the system received approximately $250,000 per hospital bed, but the amounts varied by location from a low of about $123,000 at UC San Diego Health to a maximum of approximately $362,000 at UCSF **(Figure 6)**.

Combined, federal relief totaled about $1.69 billion, representing approximately 50% of the financial losses experienced by the university. There was variation in the recovery of losses, with health centers recovering a greater proportion of losses (82%) compared with the academic campuses (30%). Further, much of the recovery dollars allocated to the academic campuses were for direct distribution to students and not for campus losses.

FIGURE 6

CARES Act relief funding per hospital bed across UC Health hospitals

Source: University of California



Lessons Learned

- Close and early collaboration between the offices of finance and health is required to determine the likely duration of the outbreak and the intensity of disruption.

- Fear and uncertainty are the most important drivers of human behavior and associated changes in the economic environment.

- Working to create a safe environment and to ensure confidence in the safety of the campuses and health centers can decrease the period of disruption and may lessen the subsequent financial losses.

- Recovery rates were different for the academic campuses and the health centers, with the health centers recovering more quickly.

- UC and especially UC Health are national leaders in research and can be expected to lead in future pandemics. Increased research funding is a mechanism to assist in the stabilization and financial recovery of the organization (see Chapter 6).

- During periods of uncertainty, cash allows maximum flexibility in meeting the variable needs of the campus locations as they incur expenses asynchronously from receipt of relief funds.

- Recovery of losses through federal programs requires intense attention at each location to ensure maximum return from each opportunity.

10

Academic-Government Strategic Partnership to Support Public Health Preparedness

CARRIE L. BYINGTON, M.D., AND LEYLA MARANDI, M.P.H.

The pandemic of SARS-CoV-2, which resulted in COVID-19, required a response, unprecedented in this century, from public health agencies and health systems worldwide. California, in January 2020, early in the public health emergency (PHE), became the second state in the U.S. to care for patients with COVID-19. As the largest and most comprehensive academic health system in California, the earliest patients, in collaboration with the California Department of Public Health (CDPH) and local health departments, were referred to the University of California Health system.

Both CDPH and UC Health are public entities and share a mission to serve all Californians. As such, the two organizations are often on the front lines responding to the public health needs of the state and should be natural allies. During the pandemic, CDPH called upon UC Health for support in clinical care, diagnostic testing, guidance for non-pharmaceutical interventions, research, including clinical trials, and once available, prioritization and administration of vaccines. The interactions, though often positive, did not always realize the full potential of intentional and strategic partnership.

To learn from past interactions and to prepare for future pandemics, UC Health and CDPH engaged in a planning grant from November 2022 to June 2024. One of the first undertakings was an analysis of CDPH-funded activities across UC Health related to the PHE. UC Health reviewed contracts from July 2020 to November 2022 and analyzed those specifically related to the COVID-19 response **(Table 1)**. A total of approximately $156 million was invested in CDPH-sponsored activities across the University of California, primarily at UC Health.

The investments occurred across all UC Health academic health centers, apart from UC Riverside. Had UC Riverside been included, additional support for the Inland Empire, an underserved geography hard hit during the PHE, would have been possible.

Both CDPH and UC Health are large and complex organizations, with many locations and units. During the PHE, investments occurred in a noncoordinated, nonstrategic fashion and were often based on preexisting local relationships. The investments resulted in new capacities and provided vital resources for the state on a short-term basis. However, feedback from UC Health

principal investigators who received financial support identified opportunities for coordination of activities across different campus locations and geographies. One example is work related to the genomic sequencing of the SARS-CoV-2 virus. Each location independently engaged in genomic sequencing and did not share scientific methods, processes, or reporting. Coordination and communication within and between organizations would support efficiency and effectiveness of investments.

TABLE 1

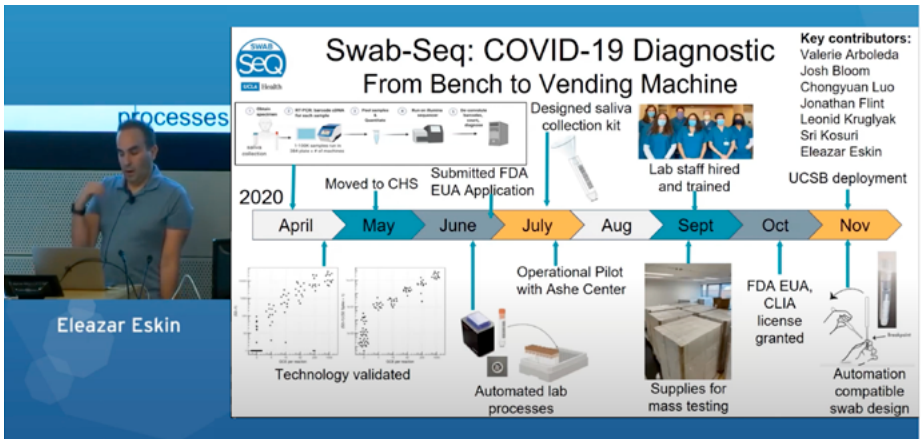
Analysis of CDPH investments in PHE response across University of California 2020–22

Category/Campus	Amount (Validation)	Description
COVID-19 Public Health Preparedness	**$74,473,246.00**	
UC Davis	$65,973,246.00	COVID prevention and surveillance activities, including viral genotyping
UCSF	$8,500,000.00	Modeling and research
Lab Services	**$36,259,536.00**	
UC Berkeley	$795,760.00	Genomic sequencing by UCB Innovative Genomics Institute
UC Davis	$7,100,000.00	Genomic sequencing by UCD Genome Center
UC Irvine	$600,000.00	Genomic sequencing by UCI Genomics Research and Technology Hub
UCLA	$23,301,608.00	Genomic sequencing by UCLA SwabSeq
UC San Diego	$2,476,112.00	Genomic sequencing by PIs at UCSD and Scripps
UCSF	$1,986,056.00	Genomic sequencing by UCSF Center for Advanced Technology
Resources/Education	**$500,000.00**	
UCSF	$500,000.00	COVID-19 educational resources complemented oral health education
Technical Assistance	**$762,500.00**	
UC Davis	$62,500.00	Strategies and training for staff on virtual Women, Infant, and Child program delivery during COVID-19
UCSF	$700,000.00	Guidance on school reopening during COVID-19
Workforce Development	**$44,636,798.88**	
UCSF	$44,636,798.88	Virtual Training Academy (contact tracers); Pathways Program
GRAND TOTAL	**$156,632,080.88**	

> *Throughout the PHE, both CDPH and UC Health developed new capacities and tools to address the pandemic.* Both organizations utilized their strengths and were required to develop new capabilities, such as diagnostic testing for employees and students or wastewater surveillance for viral pathogens.

On many occasions throughout the PHE, CDPH and UC Health worked collaboratively on issues of mutual relevance, such as infectious diseases predictive modeling and training contact tracing personnel, and many individual faculty members served on statewide committees related to pandemic response. There were, however, missed opportunities to work together to enhance the overall response and security of the state.

One example is diagnostic testing. UC Health had significant knowledge and capacity related to development, validation, and performance of both clinical and surveillance testing for SARS-CoV-2. All academic health centers and campus locations created new diagnostic testing locations for employees and students. Some campuses developed new testing methodology. UCLA is the prime example, developing the SwabSeq technology,[37,38] funded by the National Institutes of Health Rapid Acceleration of Diagnostics program and offering high-throughput, rapid, low-cost detection of SARS-CoV-2 from saliva or nasal swab. The SwabSeq technology was used by UCLA, other UC campuses, the California State University system, the Los Angeles public school system, and others, with more than 2 million tests performed in 2021–22.



A timeline of SwabSeq's testing and deployment presented by Eleazar Eskin

Source: Computational Genomics Summer Institute CGSI YouTube Channel

UC Health proposed to scale SwabSeq testing for the state and to perform approximately 1 million tests per week across the 10 campus locations of the UC system with an estimated cost of $100 million. This UC Health proposal was not seriously considered.

Instead, a no-bid contract for testing was awarded to PerkinElmer, a private company headquartered in Massachusetts, at a cost of $25 million to build out the laboratory and $1.7 billion in testing fees, many times more expensive than what was proposed by UC Health.

The resulting public-private collaboration did not meet the goal of 150,000 tests per week, averaging instead about 40,000 tests per week. Significant deficiencies, including lab processes, record-keeping, and training, were identified in the laboratory located in Valencia, California, through a CDPH inspection report.[82] The Valencia central laboratory, opened in October 2020, was closed by May 2022. Representatives of the state then approached UC Health to ask if the system would purchase the laboratory facilities abandoned in Valencia. UC Health declined.

A significant concern identified by both UC Health and CDPH was that, despite the large financial investments the state made to PerkinElmer, no permanent testing infrastructure was created and the overall capacity of California to deliver testing in future emergencies was not improved. Had the financial investment gone to UC Health, CDPH, or preferably an academic-government collaboration between the two organizations, the investment would likely have returned a sustainable increase in public health laboratory capacity for the state at a much lower cost.

Opportunities through strategic collaboration

Through a series of engagements during the planning grant period, UC Health faculty and staff engaged with CDPH leadership and staff to identify potential areas for strategic collaboration **(Figure 1)**. Over the course of the planning grant the areas for strategic focus were refined.

FIGURE 1

Areas of focus for the UC Health/CDPH planning grant for health security

Source: Carrie L. Byington, M.D.

At the conclusion of the planning grant, many important capacities of both organizations **(Figure 1)** had been discussed and areas of alignment refined. Several strategic opportunities were identified as the most likely to leverage the strengths of both organizations and, if advanced, to enhance the health security and pandemic preparedness in California. These are described in **Figure 3**. Other states, including New York and Texas, are investing in academic-government partnerships to enhance health security following the COVID-19 public health emergency. The Texas Epidemic Public Health Institute (TEPHI) (https://tephi.texas.gov/about/) was launched in 2021 with bipartisan legislative support and $40 million from the 87th Texas legislature, creating a new state agency housed at the University of Texas Health Sciences Center in Houston. **Figure 2** shows the goals of TEPHI, which are similar to those discussed in the UC Health/CDPH planning grant **(Figure 3)** and offer a potential model for future collaboration and infrastructure building.

Academic-government partnerships were critical to California for responding to the COVID pandemic, though the partnerships were not fully developed and should be strengthened in preparation for new public health threats. Areas of focus include building capacity for testing, technology development, and IT infrastructure. Public health's capacity and resources to respond to PHEs need continual investment and maintenance, which includes addressing a declining workforce, regulatory barriers, supply shortages, and ongoing IT challenges. These academic-government partnerships offer opportunities to sustain the gains in capacity, knowledge, and networks that were built during the COVID-19 pandemic and better prepare states and communities for future public health emergencies.

FIGURE 2

Strategic Goals of the Texas Epidemic Public Health Institute (https://tephi.texas.gov/about/), which are similar to goals of the UC Health/CDPH academic-government partnership and offer a model for the state of California

1. ***Ensure situational awareness of infectious diseases threats statewide***
2. ***Strengthen outbreak readiness of Texas' health care and public health systems***
3. ***Enhance business sector resilience to outbreaks***
4. ***Engage Texas communities in outbreak preparedness activities***

FIGURE 3

Strategic areas of opportunity to advance pandemic preparedness in California

Combatting misinformation

Misinformation is a public health threat. During the COVID-19 pandemic, misinformation contributed to vaccine hesitancy, which resulted in preventable death in the U.S. The importance of accurate information to support healthy behaviors and behavior changes in the many populations of the state during a public health emergency was discussed by the UC/CDPH executive steering committee as an area of significant need. UC Health has recently begun work, under the direction of Dean Schillinger, M.D., professor of medicine at UCSF and internationally recognized in the field of health communication, to establish a systemwide group of individuals with expertise in communication and combatting misinformation. This group will work to develop an evidence-based framework for trustworthy scientific communication that can be shared across UC and CDPH.

Diagnostic testing

Human diagnostic testing is critical for the management of a public health emergency. Important functions include the development, validation, and regulatory authorization of new diagnostic tests, scaling diagnostics for large population-based surveillance, and ensuring access to diagnostic testing, especially in priority populations. UC Health has a systemwide network of innovative Clinical Laboratory Improvement Amendments (CLIA)-certified laboratories located in each medical center. Research laboratories across the UC system have developed capabilities to deliver high-throughput CLIA-certified testing for public health surveillance purposes. At least 10 million COVID-19 surveillance tests were performed by the UC system for employees, students, and local communities (e.g., Healthy Davis Together) and in collaboration with CDPH and local health departments for high-need populations, such as in nursing homes, homeless shelters, prisons, and K-12 schools, and among agricultural field workers. Robust laboratory information systems have been developed for testing in nonclinical laboratory settings.

Environmental surveillance

Wastewater surveillance using polymerase chain reaction testing is the principal method of COVID-19 community surveillance today. Both UC Health and CDPH have developed expertise in this type of surveillance. UC Health developed expertise across many campuses to survey student residential buildings and places of employment. CDPH has recently received Centers for Disease Control and Prevention funding to serve as a Center of Excellence for wastewater surveillance. Unfortunately, financial constraints may limit or even eliminate wastewater testing capacity in California. Funding is required to create, in partnership with CDPH, a robust community wastewater surveillance program to provide representative sampling across California both during and between public health emergencies. Routine surveillance will increase the likelihood of early recognition of emerging pathogens or pathogens of pandemic potential.

Translating research to evidence-based health policy

The UC system and CDPH have collaborated on two projects related to modeling and research during the SARS-CoV-2 pandemic. The Modeling Consortium, launched in 2020 (with initial state funding of $1.25 million, July 1, 2021, through June 30, 2023), is a UC systemwide and CDPH effort to provide public health policymakers with timely, relevant evidence to support COVID-19 pandemic-related decision-making. The consortium has contributed evidence to state health policies, including vaccine allocation strategies, hospital capacity planning during surges, regional stay-at-home orders, school openings, booster campaigns, and daily COVID-19 and influenza projections through the California Communicable Diseases Assessment tool (CalCAT). See: https://skylab4.cdph.ca.gov/calcat/.

The consortium developed and executed the first-ever CDPH-UC-wide interagency Data Use Agreement that shares disaggregated COVID-19 surveillance data from CDPH with UC researchers and can serve as a model for future work streams. The consortium also sponsored new research initiatives related to COVID-19 through an RFP process based on CDPH priorities.

Using clinical data for real-world evidence

The UC Health and CDPH collaboration is an opportunity for the organizations to advance their missions by sharing rather than duplicating resources. Data is perhaps the most significant resource for both organizations, and our data sources are independent. During the pandemic, both organizations invested in upgrading their data systems. At UC Health, the enterprise data warehouse (EDW) captures data from all UC hospitals and clinics and is refreshed regularly. The EDW contains clinical information for approximately 9 million patients representing the diversity of California. All data have been coded for area deprivation index, social vulnerability index, and Healthy Places California. These data include millions of encounters and billions of diagnostic tests, radiographs, and prescription drug treatments. During the pandemic, COVID-related data, including positive SARS-CoV-2 tests, hospitalizations for and with COVID, ICU stays, health care worker positivity, vaccination, and other variables, were collected and shared publicly daily or weekly through social media and data sharing agreements with the Food and Drug Administration and National Institutes of Health. UC Health created a de-identified COVID data set (CORDS) for all patients across the system, and it is institutional review board (IRB)-approved for use by any UC investigator. The CORDS data is used by more than 200 investigators. CDPH maintains numerous public health data systems. The sharing and coordination of these data would allow for the generation of real-world evidence to inform policy. CDPH hopes to achieve more complete demographic information and higher quality data, recognizing that much of this opportunity begins in clinical settings. Better data interoperability is needed.

Workforce development

The pandemic demonstrated that public health agencies have significant workforce needs. At the time of the planning grant, CDPH reported 1,000 staff vacancies. Workforce priorities include encouraging training in traditional public health fields, developing new types of public health professionals who can adapt to future conditions, and upskilling the existing workforce in areas related to big data, artificial intelligence, modeling, new epidemiological methods, and other innovations.

The UC system is one of the largest educational organizations in the country and has a history of producing exceptional health professionals. The UC system includes five schools of public health. During the pandemic, numerous collaborations between UC Health and CDPH enhanced public health, including the Virtual Training Academy, which trained more than 10,000 case investigators and contact tracers. Workforce development priorities should be established through continued interactions with CDPH and UC Health deans and other training experts across the system, generating outputs such as just-in-time trainings, core competency training, and continued work on existing programs built between the organizations during the COVID-19 pandemic.

Clinical guidance

The University of California system includes the largest academic health system in the U.S., and the individual hospitals are among the highest rated for quality. The faculty and staff of UC Health includes world-class clinical experts in medicine, nursing, pharmacy, dentistry, ophthalmology, veterinary medicine, and public health, with 20 health professional schools to draw from.

The CDPH often required access to clinical experts during the COVID-19 pandemic to discuss aspects of care that impact public health. Examples included infection prevention strategies for hospitals and other clinical facilities, intensive care protocols for ventilation of patients, treatment guidance, and vaccine prioritization. Many members of UC Health Coordinating Committee subject matter expert groups participated in statewide committees in which clinical expertise was required.

The UC Health system can and does provide CDPH with clinical guidance both during periods of emergency and during periods of routine public health need. This is an area that, with coordination, can be streamlined and allow CDPH access to clinical guidance that represents the breadth of UC Health expertise.

Recommendations

It is clear in the year 2024, the SARS-CoV-2 pandemic is not yet over and that it is unlikely to be the last pandemic we face this century. California is the largest and most diverse state in the nation: it borders Mexico and has two of the busiest international airports in the world. California was the first or among the first to identify cases of infection in both the 2009–10 H1N1 pandemic (San Diego County and Imperial County)[83] and the 2019 SARS-CoV-2 pandemic (Santa Clara County and treated at UCSF). As such, California requires a robust pandemic preparedness infrastructure, which can inform our state and serve as a beacon for the rest of the U.S.

Given the transformative actions of both CDPH and UC Health during the public health emergency, we recognized the opportunity to evaluate the lessons learned by both organizations and to plan for collaborative activities that would build on the capacities of CDPH and UC Health that could benefit the state by creating a sustainable infrastructure for pandemic preparedness. This approach is well-aligned with recent recommendations from the U.S. Centers for Disease Control and Prevention that recognize the importance of integrating public health and health care to protect the health of the nation.[84] Thus, CDPH and the Regents of the University of California, through the Office of the President, have committed to establishing a formal academic-government partnership to ensure public health readiness. This partnership will secure the health, safety, and wellness of all residents across the state's 58 counties and localities from future pathogenic outbreaks and other emerging public health risks.

Lessons Learned

- As the COVID-19 pandemic took hold in 2020, the California Department of Public Health (CDPH) and UC Health had to simultaneously maintain core responsibilities and engage in an emergency response at an unprecedented scale.
- Both organizations built significant new capacity based on their strengths. The efforts of both organizations were often duplicated and under-coordinated. Unfunded collaborations have been difficult to maintain following the end of the public health emergency.
- Throughout the pandemic, CDPH and UC Health engaged in collaborative work on issues of mutual relevance. However, the collective work was often reactive, ad hoc, fragmented, temporary, and lacked strategic planning for long-term sustainability.
- Joint efforts with UC Health and CDPH produced critical insights about the virus, transmission dynamics, and treatment approaches, and enabled efficient distribution of resources and timely policy adjustments. There were, however, potentially missed opportunities to work together to enhance the overall response and security of the state.
- A permanent infrastructure and governance for an academic-government partnership for health security did not develop spontaneously during the COVID-19 response and has required intentional effort following the public health emergency to plan a sustainable partnership.
- Implementation of these recommendations and the creation of a sustained academic-government partnership for health security offers an opportunity to capture the lessons of the pandemic to better secure the health, safety, and wellness of all residents across the state from future pathogenic outbreaks and other emerging public health risks.

A POEM

Cold Solace, by Anna Belle Kaufman

The poem below is a fragment of the poem "Cold Solace" by Anna Belle Kaufman, a poet who has worked with the UCLA Cancer Resource Art Therapy Program. This poem was presented at the UC Board of Regents Health Services Committee meeting on December 15, 2020.

Like the author, I was contemplating the death of a beloved one, as my only sister died of cancer just 10 days before the meeting. Even in the face of great loss, however, I had a sense of hope in the enormous work we were undertaking as a system. In December 2020, UC health care workers were simultaneously facing the greatest surge of COVID-19 cases we had yet seen at our hospitals and we were working to deliver on the largest vaccine effort the state or nation had ever endeavored to complete. The impossibly great work felt like it could be the something of "sweetness and substance," and there was hope that the effort might bring about the end of the pandemic.

In 2024, as I was completing the after-action report and contemplating the lessons of the pandemic, especially those of the UC Health/California Department of Public Health academic-government partnership, this poem rose to the surface again. ***Capturing the lessons, sustaining the capacities, and building a more permanent infrastructure to better support the health security and pandemic preparedness of California is another source of hope, of "sweetness and substance" to be offered to the world.***

Carrie L. Byington

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Appendix

Allocation of Scarce Critical Resources under Crisis Standards of Care

April 16, 2020

TO: Vice Chancellors for Health Sciences
Chief Executive Officers
Chief Medical Officers
Chief Nursing Officers
Health Professional School Deans
Members of the Critical Care Bioethics Working Group

Dear Colleagues:

Over the past weeks, the University of California made significant progress preparing for a potential surge of patients with COVID-19. I am grateful to the clinicians, scientists, educators, and administrators across the enterprise who have risen to the challenge, especially those on the front lines of patient care.

News images from around the world made clear that extraordinary measures were needed to be prepared. We have responded.

Although the supply chain for personal protective equipment (PPE) has been disrupted, we have sufficient supplies to meet our current needs and near-term projections for additional patients through June 2020. We are working aggressively to procure additional supplies and are grateful to many people who have donated supplies.

We have also developed in-house testing for SARS-CoV-2 in all of our facilities and added sufficient capacity to begin supporting public health departments and others, such as nursing homes in our communities. We have launched clinical trials, and have over 300 research projects related to COVID-19 underway or in the planning stages that will advance our ability to care for patients. Importantly, UC Health has met the Governor's charge to increase our hospital beds by 40 percent to deliver surge capacity to the state. To date, we have added 1,481 beds. We now have 550 intensive care unit beds and more than 700 ventilators, with the ability to surge further if needed. We believe we can care for our patients and communities during the predicted surge.

Another important step we have taken is to develop the attached guidance for the allocation of scarce critical resources should we need to operate under crisis standards of care conditions. This guidance was thoughtfully developed by an 18-member working group of bioethicists and critical care specialists drawn from across our academic health centers. The report addresses a difficult topic - how life-sustaining treatment will be allocated in the unlikely event that a surge exceeds our available resources. The intention is to save the most lives possible by making decisions based only on clinical criteria and treating all individuals equally. I thank the members of the working group for developing carefully reasoned recommendations that demonstrate how to apply the core values of UC under exceptionally difficult situations.

Our work in this important area will continue. If the current situation changes such that the guidelines are needed, the working group will review the results of the implementation and refine the document

as needed. UC Health will also seek additional community stakeholder input, beginning with our hospital patient advisory committees and the UC Health Committee on Diversity and Inclusion.

Understandably, this topic is sensitive and might add to a sense of public concern without proper context. If you receive media inquiries about the systemwide guidance, please refer them to Claire Holmes, senior vice president of external relations and communications, at UCOP.

Our collective efforts are more important than ever and will impact California and the nation as we work together to end the threat of COVID-19.

With Gratitude,

Carrie Byington

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CALIFORNIA

Allocation of Scarce Critical Resources under Crisis Standards of Care

University of California Critical Care Bioethics Working Group

April 16, 2020

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Executive Summary

Introduction: The COVID-19 global pandemic has obligated hospitals worldwide to consider scenarios in which the demand for critical resources could outstrip the supply. This report, based upon the collaborative work of individuals representing the six medical campuses of the University of California, aims to articulate guidelines for the triage of critically ill patients in the event that essential resources, such as ventilators, become scarce. In such extreme scenarios, sound ethical principles represent the backbone of an allocation scheme predicated on saving the most lives while respecting human equality.

Respect for the moral equality and inherent dignity of each person—regardless of age, disability status, or other extraneous factors—requires that all individuals (including prisoners and undocumented persons) be included and evaluated in the same triage pool of individuals requiring treatment in acute care settings. Consistent with the central goal of saving as many lives as possible, triage decisions will be based on *medically relevant prognostic factors for surviving the acute critical illness*, rather than on quality of life, life-years, or social value considerations, which may be biased. Individuals already on ventilators in chronic care settings will not be triaged unless they present in acute care settings, and personal home ventilators belonging to patients will not be re-allocated to other patients.

This report applies to the situation when standard practice is replaced by Crisis Standards of Care and includes detailed sections on the following: resource allocation principles and application, the triage decision protocol algorithm, considerations for pushing the supply chain, and a number of essential supplemental resources and references.

Resource Allocation Principles and Application: Crisis Standards of Care (CSC) are applied when a health system is so overwhelmed by a public health event that critically ill individuals, who would normally receive any reasonable therapy, may receive limited treatment or non-traditional provision of care if system surge capacity is exceeded. Essential to CSC are the duty to plan and steward scarce resources while maintaining transparency, fairness and consistency. This includes developing a system of triage. All critically ill patients, not only those suffering from a specific public health emergency, are included in triage planning. In order to be prepared, activation of a triage plan should begin just prior to the point when a system exceeds surge capacity. This will allow for implementation of triage to go into effect at the time CSC is activated.

Each hospital should appoint a cohort of rotating Triage Officers who will implement triage decisions in key utilization areas (emergency departments and intensive care units). Triage Officers should be physicians with established expertise in the management of critically ill patients. The Triage Officer should be part of a Team, consisting of at least one other licensed health care professional and at least one administrative staff member who will conduct data-gathering activities. Triage officers and Teams are supported by a Triage Review Committee, which serves to adjudicate appeals and review all assessments that may trigger the reallocation of a potentially life-sustaining treatment. The Committee should make reasonable efforts to be representative of the community served by the hospital.

When a patient is being evaluated for possible admission or transfer to the ICU, the Triage Officer/Team will assign an allocation score, according to the detailed algorithm in Part III of this report.

This score will determine a patient's initial triage category to receive critical care services. The Triage Officer/Team and attending physician should collaborate to determine how best to communicate the results to the patient, family, or surrogate. Social work, spiritual care, and palliative care services should be available to assist patients and families in this process. The need for ongoing utilization of a crisis triage protocol should be continuously evaluated, and triage should be suspended immediately once critical resources are no longer scarce.

A Triage Decision Protocol Algorithm has been configured based upon the need for critical care, likelihood of benefitting from critical care and determination of an allocation score. This allocation score is based upon the Sequential Organ Failure Assessment tool (SOFA) and co-morbidities associated with low likelihood of short-term survival from a critical illness. Patients are then assigned to triage categories based on a multi-principle scoring scheme. Allocation of resources will then be based upon these groupings and resources currently available at the facility. Reassessment of individuals' allocation scores and available resources is iterative.

Supportive care and palliative care are integral to a system operating under CSC. Palliative care services may be stretched beyond their capacities during a crisis and challenged to provide direct comfort to families. Hospital leadership should plan to expand palliative care services in anticipation of CSC, and consider training allied health professionals to augment the work of traditional palliative care practitioners and those on the front lines providing psychological support.

Operating under CSC requires our health systems to ensure proper communication and transparency with the public and coordination with state and local public health officials. Crisis standards and this triage allocation algorithm should be communicated in a manner whereby all people have access to relevant information, with qualified interpreters as necessary. Respecting requests for religious accommodation and respecting the needs of persons with disabilities are essential for fairness, equity, and broad communication.

Pushing the Supply Chain and Final Points: UC Health must plan appropriately for allocation of scarce resources. A parallel process is also essential: continuation of aggressive measures to acquire needed equipment such as ventilators. These efforts include sharing information on inventories across the UC system in order to reallocate resources, exploring alternatives to single use invasive ventilation by gathering data on the utility and safety of non-invasive ventilation, and investigating the efficacy and safety of splitting ventilators between two patients.

This report reflects a concerted effort by our working group to create a just triage plan to save the most lives under CSC conditions. We are guided by principles of justice, a duty to plan, and a duty to steward scarce resources. We are confident that we will overcome this pandemic in solidarity with our community of Californians, and we maintain our commitment at the University of California to serve our patients with the highest standards of care.

I. Background

A. Purpose

The purpose of this report is to provide guidance about a triage management scheme for the allocation of scarce resources and to articulate its ethical underpinnings. The COVID-19 pandemic may lead to a crisis state during which demand exceeds the supply of resources of individual hospitals within the University of California system. Essential to emergency preparedness is the development of a just strategy for allocation of scarce resources in the event that hospitals exceed their surge capacity. Those resources may include ventilators, dialysis/continuous renal replacement equipment, extracorporeal membrane oxygenation (ECMO) devices, and personnel.

The goal during the COVID-19 pandemic, as in other pandemics, is to save the most lives. To that end, the guidelines developed in this report focus on assessing the likelihood of short-term survival benefit from mechanical ventilation in particular, although the principles and triage team structure can be applied to other scarce resources. This report outlines the guiding ethical principles, the structure of the triage team, an assessment instrument for resource allocation, and critical elements to support the triage framework. This process of triage and resource allocation must be fair and transparent, applied evenly and equitably across all people in need of scarce resources.

B. Guiding Ethical Principles

Public health emergencies may require difficult decisions in situations of extreme time pressure, limited resources, clinician strain, and broader social upheaval. It is vital that these decisions be guided by widely accepted and publicly endorsed ethical principles.

One of the most familiar frameworks for biomedical ethics centers around a few key principles.[1] Here we lay out those principles as well as some of their most important implications for public health crises:

1. Beneficence and Non-Maleficence.[2 3 4] There is a duty to promote health and avoid harm. This general principle has several important corollaries:

    a. Duty to Care.[5 6] Healthcare workers have a duty to care for patients in their charge, and patients should not be abandoned. Healthcare organizations have a reciprocal duty to support and protect healthcare workers, for example with adequate PPE.

    b. Duty to Promote the Public Good.[3 4] There is also a broader duty to promote the common good of the population as a whole, which includes the duty to save the greatest number of lives possible during a pandemic.[3 4]

    c. Duty to Plan:[5 7] There is a duty to plan for public health crises, including a duty to enact plans that prevent or mitigate resource shortages.

    d. Duty to Steward Scarce Resources.[5 7] Once shortages occur, there is a duty to carefully steward scarce resources in order to save as many lives as possible.

2. Respect for Persons.[2 3 4 8] There is a duty to recognize and respect the inherent dignity and worth of each human being, as well as their moral equality. This general principle implies, among other things:

    a. Respect for Individual Rights and Freedoms.[4] Individuals have inherent rights and freedoms that must be respected, although it might be necessary to curtail some individual liberties during a public health crisis.

    b. Respect for Autonomy. There is a duty to respect the decisions of autonomous individuals and to enable people to make reasoned and informed choices, whenever doing so is feasible during a public health crisis.

3. Justice. There is a duty to enact only those policies that are just. Justice has many aspects:

    a. Fairness and Consistency.[2 3 5 6 8] Policies must be applied consistently across people and time, and any differences in treatment must be based on medically relevant differences among individuals. Decision makers must be neutral and strive to eliminate bias.

    b. Proportionality.[5] Crisis planning policies and restrictions must be appropriately limited in time and scale according to the scope and severity of the crisis.[2]

    c. Protection for Populations with Special Needs or Vulnerabilities. Plans and decisions should take into account the special needs or vulnerabilities of certain populations.[4]

    d. Avoid Exacerbating Existing Disparities.[2 3 8] Decisions should not exacerbate existing disparities in health outcomes or access to healthcare.

    e. Duty to Collect Information.[2 3 8 9] There is a duty to collect the full range of relevant facts before making decisions and to revisit decisions as new information emerges.

    f. Transparency.[2 3 8] The public has a right to know what decisions were made, who made them, and the reasoning behind them.

    g. Public Involvement.[5] When feasible, input should be sought from people who stand to benefit from or be harmed by policies. When public participation is not feasible, responsible parties should seek to understand the perspectives of those affected by their decisions, including underrepresented or vulnerable communities.

In a severe crisis, these principles may be in tension, either with each other or with themselves. For instance, the obligation to provide a needed resource to the extremely ill may conflict with the need to promote the common good by giving those same resources to people who are more likely to survive. In such situations medical institutions must shift from their traditional focus on individual patients to a focus on populations, the common good, and the protection of civil society – that is, a shift to crisis standards of care.[3 10] As the National Academy of Medicine (formerly, Institute of Medicine) wrote, “Ultimately, this shift represents not a rejection of ethical principles but their embodiment.”[10]

There is no single formula for resolving every moral conflict, but following in the footsteps of various federal and state institutions, we will generally balance the competing needs in this way:

> *We seek to achieve the greatest medical benefit for the greatest number of patients, but only in ways that show proper respect for the intrinsic worth of each person, for the moral equality of all people, and for the requirements of justice.*[2 8]

Later sections of this document detail the rationale undergirding this general framework, its origin in the policies of state and local government, and the reasons for the specific policies endorsed in this document.

C. Equality and the Application of Ethical Principles to Triage

The previous section explained that the primary ethical guideline during a pandemic is to do the greatest medical good for the greatest number of people, but that this principle is constrained by the requirement to show proper respect for the moral equality of all people. Here we explain some of the important ways in which triage protocols must respect equality and human dignity. Appendix 3 discusses these in more detail, as well as additional ethical issues related to triage protocols.

Equality the Default. Triage protocols give priority to individuals who are most likely to survive. In making triage decisions, clinicians and other members of the Triage Team must therefore look at all factors that are relevant to prognosis for survival. The requirement to respect moral equality entails a strong presumption that other factors should not be used to triage patients. Any deviations from this rule (for example, priority for critical workers) must be shown to ultimately respect the moral equality of all people.

The Goal of Objectivity. In situations where the need for critical resources exceeds availability, allocation decisions should be determined by the difference that a resource would make on overall predicted survival of the acute episode, rather than on a first-come, first-served basis. In addition, triage protocols should be implemented using widely applied objective medical criteria, or expert opinion if such criteria are not available.[2]

Prisoners and Undocumented Immigrants. Reports from some public forums indicate that some citizens believe that prisoners and undocumented immigrants should be de-prioritized during triage, but this is not permissible.

Application of Triage Protocols to All Who Need Scarce Resources. When resources become scarce, some people who need those resources will be suffering from conditions related to the pandemic and others will be suffering from unrelated conditions. In such situations, triage protocols should be applied to all who need the scarce resource, not just those suffering from conditions related to the pandemic.

Reallocation. In a triage situation, there could be a patient who is already using a resource—e.g., a ventilator—and another patient who needs the same resource. If the second patient is more likely to survive on the ventilator than the first patient, the question arises of whether the resource should be reallocated to the second. Equality requires that reallocation be considered, and reallocation is permitted whenever indicated by the triage protocol, subject to (a) any legal constraints, and (b) the

additional protection of an automatic appeals review by the review committee in such cases, as described below.

Disability and Return to Previous State of Health. Some triage protocols make allocation decisions based not only on overall predicted acute-episode survival but also on quality of life after treatment. Such protocols are sometimes viewed with suspicion by individuals with disabilities, who fear that they are seen as having lower quality of life than non-disabled individuals and therefore that they will be assigned lower triage priority in virtue of their disabilities. To ensure non-discrimination against individuals with disabilities, triage protocols must either not score individuals based on their quality of life after treatment, or assess at most how far treatment will return the patient to *their own baseline* quality of life.

General Recommendation to Protect and Provide for Vulnerable Populations. Hospitals should take deliberate, active steps to ensure that vulnerable or marginalized populations receive equal access to scarce resources. These might include, among other things, (1) reaching out to organizations and services designed to serve groups with special needs or groups that are particularly vulnerable or disadvantaged; (2) ensuring access for those with disabilities, limited English language skills, and other groups with functional needs; (3) mitigating or eliminating, as far as possible, the sense of distrust that some historically disadvantaged people might feel toward the medical system in general or a triage system in particular; and (4) being prepared to participate in regional or statewide plans designed to ensure that the same resources are available and in use at similarly situated facilities—a step that helps mitigate or eliminate disparities of access and distribution among facilities. Allocation decisions should aim to align with national standards when feasible.

As noted earlier, these and other ethical issues related to triage are discussed at greater length in Appendix 3.

II. Resource Allocation Principles and Application

In a pandemic crisis, in spite of our best efforts to expand surge capacity, the number of patients needing care could exceed the resources available to treat them. In light of this, we need to proactively plan for a worst-case scenario, even as we make all efforts to maximize our resources. Some key points about those plans are listed below, and details are provided in the sections that follow. *It is critical to keep in mind that any plan will be imperfect and will need to be adjusted as the crisis progresses.*

Crisis Standards of Care. In the event we face a critical shortage of life sustaining therapies including ventilators, dialysis/CRRT, ECMO, ICU beds or personnel, we will need to transition to crisis standards of care (CSC). CSC are used when health care systems are so overwhelmed by a public health event that it is impossible to provide the normal, or standard, level of care to all patients. Critically ill individuals who normally would receive “any reasonable therapy,” even therapies of unlikely benefit during a non-crisis situation, may receive limited treatment and non-traditional provision of care when hospitals exceed their surge capacity and adopt CSC. This is necessary to maximize the number of lives saved during a pervasive or catastrophic public health event such as a pandemic, even though it may increase the risk to the individual patient of a worse outcome.[7 13]

CSC involve a plan for triage and allocation of scarce resources, and that plan is detailed in the sections that follow.

Scope of Crisis Standards. As detailed below, any triage system will need to include all patients in acute care settings, including non-COVID-19 patients. This applies to individual hospitals, but ideally it would also mean that all hospitals in a region would coordinate with the local or regional government (e.g., county public health officials) about when to activate CSC. The means of regional communication should be set up in advance. Coordinating with other hospitals in the region maximizes resources within the community and increases equity of care.

Preparation. The sections that follow detail the preparatory steps hospitals should undertake. Among other things, the hospital (and region, if appropriate) should preselect the Triage Officer(s) and Teams. The Triage Team should be appointed in such a way that the participants are never providing clinical care to triaged patients at the same time. Sub-specialties to be represented may include but are not limited to: Pulmonary Critical Care, Surgical Critical Care, Neurocritical Care, Burns, Trauma, and Cardiac Critical Care. Triage Officers should be available through the command center 24/7 for consultation on new patients. Emergent unexpected presentations requiring rapid decision making should follow the predetermined triage criteria set forth below. We recommend starting the process of triage scoring prior to exhausting resources so that when CSC are enacted, preparation for triage has already been completed.

Communication. As detailed below, it is imperative to communicate early with the community about the potential need for rationing of resources. The institution's communication officer should reach out to the media to help inform the region (resources for this are available in the attached Toolkit). Once the region has converted to CSC, patients and families—both those already admitted and those presenting for treatment—should be immediately informed of a region's conversion to CSC, including the use of triage. They should likewise be informed when clinical decisions are being made based on these standards.

Fairness and Consistency. Any process of tertiary triage and rationing must be fair and transparent applied evenly across all patients. Specific steps are detailed in the sections below. Among other requirements, there can be no perception of disparity that would erode trust in the system.[11] [12] Tertiary triage will occur for patients already in the hospital in addition to those who are arriving to the emergency department. Triage criteria and specific limits of resources should be known to providers; a briefing is recommended at least daily during CSC. Frequent reassessment of prior triaging should occur regularly and with any significant changes in resources, for example loss or gain of staff, or an unexpected delivery of ventilators.

A. Thresholds: *When* to Enact Crisis Standards and Implement Triage Allocation Plans

During a pandemic or other public health crisis, frequent reports to the regional authority from each facility on the number of ventilators available and the number of patients potentially requiring mechanical ventilation within 24 hours will be necessary. Triage and allocation will be implemented if a hospital or region is confronted with a severe shortage of life sustaining treatments where all preventive and preparatory measures have been exhausted, including access to needed resources at other hospitals. Defined threshold triggers, which may vary according to local resources and circumstances, will be used to identify the need to start triage.

When infrastructure allows for this, the decision to initiate crisis triage should be made by an identified regional authority with situational awareness of regional health care demands and resources.[14] Specific levels of regional coordination will vary according to regional circumstances and institutions. Acknowledging this variation, it may also be appropriate for a designated hospital administrator to make the decision that a threshold has been reached and therefore crisis triage is in effect. Individual healthcare providers will not make individual decisions at the bedside to adopt CSC.[15]

The National Academy of Medicine offers the following "Continuum of Care" framework for delineating thresholds for contingency standards and CSC: standards of care fall along a continuum of three levels, reflecting the incremental surge in demand relative to available healthcare resources:

1. Conventional care is everyday healthcare services.
2. Contingency care arises when demand for medical staff, equipment, or pharmaceuticals begins to exceed supply. Contingency care seeks functionally equivalent care, recognizing that some adjustments to usual care are necessary.
3. Crisis care occurs when resources are so depleted that functionally equivalent care is no longer possible.[16]

Activation of triage plans should begin prior to the demand for critical care services exceeding resources. At 20% surge capacity (i.e., 20% over standard hospital capacity) standard of care can still be met; however, for most institutions to maintain standard care at 100% surge capacity, resources will need to be conserved, reused and/or substituted. Beyond 100% surge capacity standard treatment will likely change to crisis standards of care (CSC) due to limited resources such as ventilators. Hence, 80-90% surge capacity represents the threshold for activation of the triage plan in preparation for the need to allocate limited resources. It is important to reiterate that the transition to a CSC should be declared within a region by local health authorities. However, in some circumstances a hospital administrator may need to declare an internal CSC.

The goal is to start the process of triaging patients prior to resources being completely depleted. Ventilators and the staff required to operate them are likely to be a critical resource on which triage allocation will be based. This is based on knowledge of the current COVID-19 crisis and evidence from global experience with this disease. Patients fighting COVID-19 may need a ventilator for 21 days or longer.

Availability and demand for life saving resources must be assessed frequently during the triage process. This is required to identify changes in patient status and to allow reallocation of critical resources. Reassessment includes individuals who were previously deemed non-survivable or those who were not provided critical resources, based on improvement in their condition and/or improvement in available resources. Real-time information is important to allow constant feedback and reevaluation of crisis or contingency conditions.

B. Triage and Prioritization: *How* to Implement Triage Allocation Plans

i. General Considerations

The implementation of triage allocation plans will involve the following general considerations, described in more detail in the sections that follow:

- Triage allocation plans should only be invoked when the institution's operational mode converts to a CSC, as determined by institutional leadership and/or regional health authorities.
- All crisis allocation decisions should be made by a third-party Triage Officer or Triage Team. This will enable the attending physician and supporting clinicians to maintain the duty to care for the individual patient, with the standard goals of prolonging life and alleviating suffering, within the resource constraints imposed by the crisis.
- Triage decisions should be made solely on the basis of the uniform application of clear allocation criteria, detailed in Part III below. In general, any considerations other than those captured by the allocation criteria should not impact triage decisions.
- The results of triage decisions should be communicated to the patient and/or family, who should have an opportunity to understand the basis for the decision. Clinicians should document the disclosure and discussion with the patient/family in the medical record.
- Disagreements about the triage allocation decision should be adjudicated by a limited appeals process, described below.

ii. Triage Officers and Teams

The following can serve as models for Triage Officer and Triage Team composition, which can be adapted to local hospital circumstances as necessary. Triage Team establishment should be reviewed by the individual institution’s Diversity and Inclusion Division or Officer.

Each hospital should appoint a cohort of rotating Triage Officers who will implement triage decisions in key utilization areas (e.g., emergency department, ICUs). Triage Officers should be physicians ideally with established expertise in the management of critically ill patients (such as Intensivists and Emergency Medicine physicians). They should possess strong leadership skills, and effective communication and conflict resolution skills. Ideally, senior faculty should be prioritized. Prior experience in emergency management training is also ideal. Triage Officers will oversee the triage process, assessing all patients who are candidates for the critical resource, assigning a level of priority for each, communicating with treating physicians, and allocating or re-allocating critical care resources to the highest-priority patients as described in the algorithm below. Hospitals might consider a process whereby Triage Officers are nominated by the chairs/directors of the clinical departments or divisions that provide care to critically ill patients, and approved by the Chief Medical Officer and the individual(s) responsible for emergency management.

Where personnel resources permit, the Triage Officer should be part of a team, consisting of at least one other licensed health care professional (e.g., nurse and/or respiratory care practitioner) with acute care (e.g., critical care or emergency medicine) experience, and at least one administrative staff member who will conduct data-gathering activities, documentation and record keeping, and assist liaising with a hospital Command Center and patient placement/bed control. The staff member must be provided with appropriate computer and IT support to maintain updated databases of patient priority levels and scarce resource usage (total numbers, location, and type). Health systems are encouraged to work with their local health information technology offices to create tools to facilitate data collection and capture (e.g., tabulation of items used to calculate triage allocation scores) in the permanent medical record, as well as reporting these items to facilitate triage allocation decisions. Triage Team members provide information to the Triage Officer and help facilitate and support the triage decision-making process. A representative from hospital administration and/or hospital incident command center should be linked to the Triage Team, in order to supervise maintenance of accurate records of triage scores and to serve as a liaison with hospital leadership.

A roster of approved Triage Officers and team members should be maintained that is large enough to ensure around-the-clock availability, on short notice, with sufficient rest periods between shifts. Shifts should last no longer than 13 hours (to enable 30 minutes of overlap and handoffs on each end). Team decisions and supporting documentation should be recorded in the patient's medical record and reported daily to appropriate hospital leadership and the command center.

iii. Triage Review Committee

In addition to the Triage teams, institutions should develop a Triage Review Committee to serve four functions: (1) adjudication of any appeals of the initial triage decisions, (2) review of any allocation assessment that triggers the *reallocation* of a potentially life sustaining treatment, (3) review of any allocation assessment concerning an unrepresented patient, and (4) ongoing oversight and review of triage processes, crisis conditions, and need for modification.

The Triage Review Committee should ideally include representation from: Triage Officers and Teams, the Chief Medical Officer/Chief Nursing Officer, Bioethics, Legal Affairs, Diversity and Inclusion, Critical Care, and Palliative Care. In addition, the Triage Review Committee should have representation consistent with the patient population being served. Institutions could consider including on the Triage Review Committee a lay community member that is not a member of the hospital's staff.

iv. Resource Availability and Allocation Priority

When determining a patient's initial allocation of a scarce resource, such as a ventilator, the following steps should be undertaken:

Assess current availability of resources. Resource allocation decisions in times of scarcity require an accurate, complete, and real-time working knowledge of available resources. As COVID-19 disease may result in severe respiratory failure due to ARDS, all relevant resources (e.g., ventilators, ICU rooms, medication, etc.) should be accounted for across an institution or region, twice daily in ideal circumstances, and no less than once per day.

Calculate allocation score and assign to triage category. When a patient is being evaluated for possible admission or transfer to the ICU, the Triage Officer/Team will assign an allocation score, according to the detailed algorithm in Part III below. This score will determine a patient's initial prioritization category to receive critical care services. When an unstable patient, who has not yet been triaged by the Triage Officer/Team, presents to critical care providers, immediate stabilization should proceed per usual standards of care. This may include ventilatory support, endotracheal intubation, and positive pressure ventilation, until the Triage Officer/Team is able to assess the patient and determine his or her allocation score.

With the exception of patients (or their surrogates) who elect to defer or decline particular interventions, there are no categorical exclusions to triage pool participation and triage assessment. Patients who either elect to defer or decline interventions or are not allocated critical care services will receive the most appropriate next level of available medical care, which always will include appropriate symptom management and palliative measures when indicated.

Determination of which allocation levels will receive services. The Triage Officer/Team, in consultation with the hospital incident command center or other appropriate administrators, will determine which allocation level(s) will receive limited resources, based on currently available resources. Individuals within the same category should be triaged by the methods described below.

v. Communication of Triage Decisions to Patients and their Surrogates

The Triage Officer/Team and attending physician should collaborate to determine how best to communicate the results to the patient, family, or surrogate. The optimal method of communication may vary depending on an attending physician's relationship with the affected person(s), the workload of the treatment team or triage team, and other factors. Social work, spiritual care, and palliative care services should be available to assist patients and families in this process.

A written, plain language explanation of the triage and appeals process should be provided to the patient and/or surrogate(s). Decisions should also be verbally explained clearly with supporting medical information in the patient or surrogate's native language, using medical interpreters as necessary. These patient and/or surrogate(s) communications should include:

- An explanation of how the triage decision was made and the limited appeals process
- An explanation of the medical facts supporting this decision in plain language
- An explanation of what could happen to the patient without critical care support
- The options available for ongoing treatment, including palliative care services
- An offer of referral for support services, including social work and spiritual care

vi. Appeals and Automatic Review

An appeals process of triage decisions is necessary to ensure fairness and equity. However, real-time appeals of triage decisions should be permissible only to ensure that the triage policy was followed appropriately (that is, to ensure the triage score was calculated correctly). Appeals contesting the allocation framework itself should not be considered. All appeals should be made to the Triage Officer/Team by the attending physician of record or other licensed health care worker (e.g., registered

nurse, respiratory care practitioner, clinical social worker) involved in the care of the patient in consultation with the attending physician. In deciding whether to request an appeal, the Attending Physician should take into account concerns voiced by the patient, family members, or other members of the clinical team.

Every allocation decision (including initial assessment and reassessment) for an unrepresented patient (i.e. an individual who lacks decisional capacity and for whom there is no appropriate surrogate) should ***automatically*** be reviewed by the Triage Committee prior to assignment to an allocation level. Similarly, every case where a ventilator or other scare resource is to be reallocated should ***automatically*** be reviewed by the Triage Committee prior to reallocation.

For any appeal or automatic review, the Triage Review Committee will independently evaluate for catastrophic conditions and re-calculate the score, based on a review of all relevant information. All appeals and reviews should be resolved expeditiously (ideally within 30 minutes of the request). Results of the review should be communicated to the attending physician, who should collaborate with the Review Committee members to determine how best to communicate the results to the health care team member requesting the review. Social work and spiritual care should be available to assist in communicating decisions to patients and families.

vii. Continual Reassessment of Crisis Conditions, Thresholds, and the Results of Allocation Policies

The need for ongoing utilization of a crisis triage protocol should be continuously evaluated, and triage should be suspended immediately once critical resources are no longer scarce. Institutions should consult with local health authorities regarding these decisions, which should be made in conjunction with hospital or health system leadership.

In addition, because widespread acute care triage would be novel, if this policy is implemented and triage teams perform allocation decision making over a prolonged time period, the institution should take steps to develop and deploy, in a timely way, a method of tracking the implementation of this policy, defining and describing quality performance of Triage Teams, and longitudinally analyzing their performance. This is likely to require allocating a quality analyst or individual with equivalent capabilities, to be overseen by appropriate institutional authorities, to process the data emerging from local triage team activities, so that it can be regularly reported to institutional authorities for the purposes of oversight. Data collection should include data on morbidity and mortality outcomes to assess trends by demographic factors such as gender, race and ethnicity, geographic location, or socioeconomic status.

At the conclusion of an emergency triggering crisis standards of care and implementation of the triage protocol, a formal report describing the institution's experience, patient outcomes, community response, and lessons learned should be developed and shared with providers, institutional leaders and governing authorities, patients, and the public. Feedback from these stakeholders should be utilized to evaluate and update, as appropriate, all aspects of the triage framework.

C. Special Patient Populations

i. Catastrophically ill patients not expected to survive

Certain new acute medical conditions may be so catastrophic or profound that the patient is at a very high (~90+%) risk of death in the acute setting. In non-crisis circumstances, some patients in these categories might survive with extensive and aggressive intervention, although it is not possible to predict which specific patient will do so. Existing illness or injury severity scoring systems were not specifically designed for triage situations that would involve prioritizing patients for care; however, in a crisis situation it is reasonable to employ them to prioritize allocation of dramatically limited critical care resources because they are better suited than alternative methods for an emergency clinical triage protocol. Such clinical scoring systems allow for real time decision making that avoids allocating scarce resources to those extremely unlikely to benefit. They are objective, reproducible, and provide transparency regarding severity evaluation by providing a validated assessment of those least likely to survive in the short term, even with aggressive treatment.

Patients who have a catastrophic condition but who receive intubation prior to initial evaluation (for example, pre-hospital intubation during cardiac arrest, urgent intubation in the emergency department prior to imaging diagnosis of severe stroke or traumatic brain injury) will be re-evaluated within 1 hour after hospital arrival in order to determine whether or not critical care resources should be continued based on their prioritization. As detailed further in the triage algorithm (below, Part III), all patients including these are considered eligible for critical care resource allocation during crisis. Patients with an acute catastrophic condition will be included in the Blue category (lowest priority for critical care resources due to extremely high risk of death).

ii. Patients receiving solid organ transplants

Prioritization of patients after or listed for transplant of heart, lung or liver include special considerations.

Overall, transplant patients have a high degree of clinical instability with a disproportionate probability of good outcome, including long term outcome if they are transplanted. The working group debated this extensively, and the degree of uncertainty around the timing of a transplanted organ made it difficult to justify adjustments for patients who are listed but who have not yet received an offer for organ transplantation.

For those who have an active offer under consideration by the transplant team, where the patient is the primary recipient, it is reasonable to suspend triage decisions temporarily until the final decision on an organ offer is made (i.e., the procurement team has decided not to accept the organ or the patient receives a transplant). Patients whose offer is declined by the transplant team should re-enter the triage pool in the same position they were in previously. Should another new offer be received, the process would repeat.

For those who have been transplanted, their critical care needs in the immediate post-transplant period largely arise from the need for supportive care for successful engraftment of the donated organ. The time to achieve this varies by organ, but can be on the order of several days. Because of their excellent prognosis post-transplant with successful engraftment, this working group proposes allowing a

temporary suspension of triage rules for post-transplant patients, as detailed in the allocation algorithm in Part III below. Additionally, patients who are experiencing delayed graft function or graft failure within the first 90 days post-transplant should be treated as if they do not have end-stage organ failure when assessing their triage allocation score.

iii. Immediate post-operative care of complex surgical patients

Patients who undergo complex surgical procedures may have postoperative critical care needs that are largely due to the nature of the procedure and portend an otherwise excellent recovery prospect (e.g., cardiac procedure requiring temporary pacemaker insertion or transient circulatory support, staged abdominal surgery where the abdomen is left open). Because of this, we propose to make allowances for a temporary exemption for patients undergoing complex or staged surgical procedures that extend until a predefined period from the final operative procedure.

iv. Participants in clinical research studies

A fundamental principle of clinical research is the position of therapeutic equipoise—a state of uncertainty regarding the benefits and risks of the investigational intervention. Under conditions of equipoise, the potential benefit of an investigational intervention or drug should be thought of as equal to either usual care or placebo. As such, it is impossible to determine whether a study product will benefit an individual participant *a priori*; thus, an investigational study participant should not necessarily be prioritized over usual care for any individual patient.

Patients who participate in clinical research studies may also be critically ill. This illness could be due to the underlying medical condition for which the patient is enrolled in research (e.g., progression of disease in a patient with advanced end-organ disease or malignancy) or due to an agent being studied in the research study (e.g., efficacy or toxicity from a novel antiviral therapy used to treat an ailment such as COVID-19; efficacy or toxicity from a novel antineoplastic agent used to treat an underlying cancer). In any case, during a time of scarce critical care resources under a declaration of crisis standards of care, the resources needed to provide support for a critically ill research participant may be limited.

The principle of reciprocity for patients participating in studies related to the pandemic that caused the public health crisis might suggest the following: patients who are undergoing research that may ameliorate the crisis have assumed risks to themselves by participating in a trial; thus, it could be argued that these study participants could reasonably be afforded priority access to critical care resources. Additionally, the principle of the multiplier effect (see Appendix 3 for detailed discussion) might suggest that it would be reasonable to prioritize those who serve to test an intervention that could save lives and lead to a more rapid resolution of the public health crisis. Reallocating the provision of life-sustaining critical care resources away from study participants under the triage allocation decision process could also bias study results in the estimation of mortality outcomes.

However, there are important countervailing considerations, including concerns regarding undue *inducements* to participate in such research. Informed consent to participate in research by a participant or their surrogate is a central canon of human subject research ethics. Should participation in clinical research result in triage prioritization for life-sustaining treatment, this could unduly influence

or induce a decision to participate in a study with unknown risks. Furthermore, the crisis may aggravate the *vulnerable status* of participants experiencing significant economic duress due to a pandemic or disaster situation. Such individuals may be unduly influenced to participate in research due to provision of payment for care by the study sponsor(s).

Furthermore, in response to the reciprocity argument above, we point out that the principle of informed consent also implies that a patient or their surrogate has been made aware of and accepted the risk of potential adverse effects of treatment, including the potential that these adverse effects might not be mitigated by medical care, potentially resulting in morbidity or death. Taken together, there is significant concern with prioritizing research study participants, both in terms of disproportionate advantages for critical care resources and in terms of excessive inducements to consent. [17]

This workgroup weighed these potential pros and cons of using clinical research participation status in triage allocation decisions and determined that, in light of the above considerations, *participants in clinical research studies should not be afforded special consideration for critical care triage allocation decisions during a declaration of crisis standards of care*.

D. Supportive Care

i. Extending Palliative Care

As the scope of the pandemic grows, and institutions are forced to change their operational mode to crisis standards of care, the demand for primary and specialist palliative care will sharply increase. All of the public-facing documents that deal with the problem of responding to a pandemic emphasize the important role for palliative care in assisting with symptom management, decision-support, and emotional and spiritual support for patients and families.

Each UC health system has a program in specialist palliative care, though there is wide variation in the size and composition of programs across the UC systems. Similarly, most large non-academic health systems also have specialist palliative care providers, but overall access to palliative care is inadequate in many parts of the State. All medical practitioners are encouraged to embrace and practice “primary palliative care,” particularly with the recognition that specialist palliative care practitioners are few in relation to need. The large number of hospital admissions and severity of disease in the COVID-19 pandemic will exacerbate this shortage.

In addition to challenges related to volume and personnel resources, the circumstances of COVID-19 will substantially alter the typical ways in which palliative care providers are able to support patients (e.g. being with patients, facilitating family meetings, providing decision support to patients and surrogates). Strategies for infection control, and for preservation of limited PPE, for example, will force hospital leaders and clinicians to devise creative and flexible approaches to ensuring the highest possible quality of care for the many patients who will die during the pandemic.

As early as possible, hospital leaders and palliative care teams should devise plans to accommodate the surge in demand for palliative care services and the adaptations that will be required to deliver those services, given the unique constraints posed by the circumstances of the pandemic. Such

strategies should take into account local on-the-ground strengths and resources, as well as leveraging partnerships with allied experts such as social workers, chaplains, pharmacists, and others to extend services as much as possible.

ii. Iterative Clarification of Goals of Care

To the extent possible, realistic goals of care should be established at the time of admission and reassessed with any significant change in clinical status. At a minimum, chart documentation should include identification of a health care proxy or surrogate medical decision-maker, contact information for this designated individual and alternate if available, identification of existing advance care planning documentation, and acquisition of copies for the chart. Completed POLST forms should be reviewed and included in the medical record. For patients at risk for escalation of care, such as older adults, those with significant cardiac or pulmonary comorbidities, and individuals with compromised immune systems, clarification of goals will be particularly important.

Since these guidelines recommend the reassessment of ventilator allocation decisions every 72 hours, communication with patients and families should emphasize the concept of a “time-limited trial,” with clear markers of improvement that are assessed and used to inform the unfolding conversation about achievable goals. Conversely, interval events that further compromise outcomes should serve as opportunities for urgent reassessment of care goals and code status. Anticipated outcomes should be clearly articulated to the patient and families and anticipatory guidance be provided that aligns with care goals, or as necessary, resource allocation.

iii. Psychosocial Support

1. Patients and families

For critically ill and dying patients, contact with families and loved ones is often a vitally important component of care. Final conversations can promote acceptance of the severity of illness and provide a sense of closure and completion of relationships. The nature of medical care during the COVID-19 pandemic, however, upends all the normal modes of providing psychosocial support to seriously ill patients and their loved ones. Policies on infection control and visitor restriction, while necessary in this crisis, are likely to result in significant emotional distress for patients and families, strained decision-making for surrogates, and challenges with grief for the bereaved.

It is imperative and urgent that administrators, IT professionals, clinical leaders in social services, mental health, chaplaincy, palliative care, and other disciplines partner in devising novel, creative ways to maintain supportive communication and contact with patients and families, despite the limitations required for the pandemic response. In particular, for patients who are likely to die because of an unfavorable allocation score, skilled psychosocial support should be provided to convey continued care and concern for the patient and their loved ones. This communication may be provided in anticipation of, during, and following admission. Local or institutional grief support resources should be explored and, as available, provided to families and loved ones.

Frontline clinicians facing difficult communication tasks may benefit from COVID-specific conversation guides developed by palliative care experts.[18] [19] [20] (See accompanying Toolbox for examples of resources for patients, families, and healthcare workers.)

2. Health care workers

Not only patients and families, but health care workers too, are likely to face significant moral distress and emotional fatigue in the dire circumstances of the pandemic. Many will need support above and beyond their routine strategies for emotional and physical self-care. Health system leaders should partner with local mental health experts (e.g. departments of psychiatry or clinical psychology, departments of social work, etc.) and existing internal support resources (e.g. employee assistance programs) to devise strategies to respond to and support health care workers in distress. (See accompanying Toolkit for examples.)

E. Ensuring Trustworthiness

i. Public Engagement and Transparency

The guiding principles in Part I stress that institutions must be transparent and engage with the public. Ideally, pandemic planning would take place well in advance, with strong public input. In the middle of a crisis, the most robust forms of public input might not be possible, but the values of transparency and public engagement still imply at least three concrete requirements. Institutional leaders must: use publicly-informed documents or guidance to shape the policies they develop, provide open and honest channels of communication with the public during the crisis, and seek meaningful public engagement to the extent possible, including after-the-fact review and revision of pandemic policies.

Regarding the use of publicly informed guidance, this document's policies and guiding principles were formulated using publicly informed policies, as detailed in Appendix 3. We include some further discussion of public communications and engagement in the sections below.

1. Individual institutions

Individual institutions must provide open and honest channels of communication with the public during a crisis. Since each UC Hospital and clinic serves a unique local population, communications must be tailored to meet the particular needs of local communities, including those populations that may be most vulnerable during a pandemic due to poverty, disability, access to healthcare, language or cultural differences, and other factors.

As part of those communications, each hospital should prepare patient education and staff education materials geared toward addressing the patient care and medical decision-making questions that may arise during the pandemic and during a period of scarce resources. (See Toolbox for examples.) As the Institute of Medicine wrote, "Transparency regarding limited resources forms a critical part of communication even before, but certainly during, a patient's hospital admission. Clinicians and facilities need to inform patients and families of the time-limited nature of trials of ventilator therapy and other

scarce resources."[5] Patient education materials should include language translations for the various populations in the local catchment area.

Communications should also extend beyond each hospital and into the community, with the goal of communicating information about the pandemic crisis and triage plans. These public education efforts should be made also in relevant non-English languages, and should be coordinated with state and local public health officials.[5] When relevant, institutions should make use of alternative communication channels (e.g., social media) in addition to the typical media sources.

During public communications, the type of information, specificity, and details should be tailored to the concerns and educational level of the target population. Messaging should include efforts to inform and provide resources to assist those populations with special needs, e.g., the elderly, impoverished or homeless individuals, those with physical disabilities, pregnant persons, children, those with mental illness or cognitive disability, those with pre-existing medical conditions or bedridden individuals, individuals with drug or alcohol use disorders, and those who are socially isolated and may have limited access to information.

In particular, UC Health entities should not overlook their obligations under federal civil rights laws to help ensure all segments of the community are served by:

- Providing effective communication with individuals who are deaf, hard of hearing, blind, and visually impaired through the use of qualified interpreters, picture boards, and other means;
- Providing meaningful access to programs and information to individuals with limited English proficiency through the use of qualified interpreters and through other means;
- Making emergency messaging available in plain language and in languages prevalent in the affected area(s) and in multiple formats, such as audio, large print, and captioning, and ensuring that websites providing emergency-related information are accessible;
- Addressing the needs of individuals with disabilities, including individuals with mobility impairments, individuals who use assistive devices or durable medical equipment, and individuals with immunosuppressed conditions including HIV/AIDS in emergency planning;
- Respecting requests for religious accommodations in treatment and access to clergy or faith practices as practicable.[21]

In addition, UC Health entities should consider adopting, as circumstances and resources allow, the following practices to help ensure all segments of the community are served:

- Making use of multiple outlets and resources for messaging to reach individuals with disabilities, individuals with limited English proficiency, and members of diverse faith communities; and
- Stocking facilities with items that will help people to maintain independence, such as hearing aid batteries, canes, and walkers[21]

As one part of the overall goal of fostering meaningful public engagement during the crisis, each hospital's Triage Team should be attentive to concerns expressed by patients and families both prior to and during the implementation period of the pandemic triage decision framework. Each hospital should have some mechanism in place to seek ongoing feedback from the local community impacted by this

triage policy. Results of these efforts should be shared both with local hospital leadership and with the UC Health Critical Care Bioethics Workgroup on a routine basis.

2. University of California Governance

In its role of overseeing one of the largest and most influential healthcare systems and research enterprises in California, the University's governance structure has a key role to play in educating Californians who may be impacted by these unanticipated changes and by the implementation of crisis standards of care policies. Constructive and transparent communication will require ongoing engagement and collaboration with the media, healthcare advocacy groups, other healthcare institutions in California and nationally, and other key stakeholders. These efforts should also include direct engagement with the community impacted by crisis standard of care policies.

Ensuring trustworthiness will require open and honest communication regarding the realities of resource limitations, the impact of the COVID-19 pandemic on the healthcare system, and its ability to provide the usual level of care that members of our community otherwise expect.[5] University leaders and UC Health are also responsible for communicating the reasoning behind decisions to implement these crisis standards of care in pandemic emergencies.

When communicating with the public about that reasoning, University leaders and UC Health may draw on guidelines by the California Department of Public Health for healthcare surge during emergencies.[4] These guidelines emphasize that "during a healthcare surge, the delivery of care will shift from individual-based to population based outcomes" and therefore, institutions will have to "consider a departure from the individual patient-based outcomes that physicians have been long conditioned to uphold in favor of an approach that saves the most lives."

Public communications should make it clear that, as the National Academy of Medicine (Institute of Medicine) report states, "crisis standards justify limiting access to scarce treatments, but neither the law nor ethics support the intentional hastening of death, even in a crisis."[5] In this regard, communications can emphasize and clarify that this policy does not endorse the practice of euthanasia, and that physician assisted suicide for terminally ill patients (as permitted under California's End of Life Options Act) is entirely distinct from the allocation of scarce resources under crisis standards of care. Contrary to some mistaken characterizations in the media, triage decisions under crisis conditions do not amount to physicians "choosing who lives and who dies"; rather, the crucial triage decision is who will medically benefit most from allocation of scarce critical resources. In the process of triage allocation, no patient is abandoned or left without access to palliative or supportive care.

It is important that these communications begin early. The CDPH guidelines note, "Moving to a population-based set of treatment protocols represents a radical departure from patient-based decision making. It is essential that efforts be made well in advance of a healthcare surge to generate public understanding and acceptance for the change." This is sound advice. Californians have no historical reference point for the current Covid-19 pandemic: our State and the UC Health system have never in living memory encountered an analogous pandemic on this scale, nor have we encountered a natural disaster with the capacity to strain our statewide healthcare system to this extent.

University leaders should also seek community input into policies as the situation unfolds, seeking out dialogue with formal authorities, citizens at-large, and local opinion leaders.[22] All parties should come away from this process understanding why crisis standards are necessary and how these standards will be applied within a community context.[5] Establishing public trust will require open and honest communication regarding the realities of resource limitations, the impact of the COVID-19 pandemic on the healthcare system, and our ability to provide the usual level of care that members of our community otherwise expect.[5]

ii. Alignment among UCs, CDHP, and the Public

To uphold the principles of fairness and consistency, patients at different hospitals in the same affected area should not receive vastly different levels of care.[5] Thus, each UC hospital and UC Health as a whole needs to coordinate planning, communication, and real-time pandemic response with local county public health agencies and the statewide California Department of Public Health's (CDPH) crisis triage plans.

Coordination is particularly important in order to maintain fairness for vulnerable populations. The IOM report notes that, "Consistent policies may also help eliminate unfair local efforts to discriminate against vulnerable groups on the basis of factors such as race or disability," and furthermore, "building trust is particularly important in more vulnerable populations, including those with preexisting health inequities and those with unique needs related to race, ethnicity, culture, immigration, limited English proficiency, and lower socioeconomic status."[5]

At the same time, efforts to keep policies consistent across institutions or geographic regions should not unduly limit the ability of institutions to adjust their response to the particular needs of the local community. While consistently employing the same pandemic triage decision framework, each UC institution should have sufficient ability to tailor its general response to this pandemic according to circumstances on the ground, taking sufficient account of its unique patient population and particular local circumstances. For individual institutions, "flexibility is necessary [in accord with local circumstances], but [this] requires careful deliberation and documentation where local practices do not follow common guidance."[5]

In summary, public engagement and communication should include efforts to solicit input from the local communities most impacted by decisions, while at the same time coordinating this with the interests of communities across the entire state. Transparency, clear communication, and accountability before, during, and following this pandemic are essential for building and maintaining the public's trust.[5]

III. Triage Decision Protocol Algorithm

This resource allocation schema (Figure 1) is developed to prioritize critical care services by using a ranking system to estimate the likelihood of survival of critical illness with ICU interventions. Crisis situations necessitate that critical care management shift from the practice of early transfer to intensive care units for signs of early decompensation to one of allocating critical care to the patients who have already decompensated and require life-sustaining treatment. If a patient is assessed as meeting criteria for the consideration of ICU care (see Table 1 for inclusion criteria), they will enter the triage

decision pool and assessment should proceed as described below. Goals of care are considered in all cases, as described in Part II above, and no patient who expresses that they would refuse critical care interventions should be placed in an ICU.

Critical care during crisis needs to be allocated first to patients most likely to survive their acute critical illness, in order to maximize the number of lives saved. As such, the next step would be to assess for an immediate catastrophic illness or injury that portends low likelihood of short-term survival (Table 2). These patients are not categorically excluded from critical care, but instead categorized at the lowest level, such that they could potentially still receive ICU care were sufficient resources available, but because of their extremely high risk of death, should be the last patients to receive critical care resources in a crisis situation of shortage.

Additionally, in service of the goal to maximize the number of lives saved in the acute care setting, the remaining patients will be evaluated using an aggregate, multi-modal scoring system that accounts for acute illness severity using the Sequential Organ Failure Assessment system score (SOFA)[23], with additional consideration for severe life-limiting comorbidities expected to affect near-term survival and moderately severe chronic comorbidities that can influence acute care outcomes (Table 3). Where available, primary data has been evaluated (see References for Assessment of Critical Care Survival Schema appendix), and where no or limited data are available, expert consensus from UC specialty physicians has been sought. Scoring systems when available are used, but for several conditions such as severe malignancy or severe baseline neurological impairment their presence should be assessed as major or severe.

For medical comorbidities and chronic conditions that limit short-term survival, this workgroup recommends the use of the list in Table 3; though as the crisis evolves, the criteria should be revisited and adapted to meet local needs. Clinical groups at the institution should define these severe conditions prospectively and not change them ad hoc from patient to patient. Any time the clinical criteria are modified, all patients assigned allocation scores should be reevaluated. Because comorbidities that limit survival exist across all major organ systems (e.g. cardiac, pulmonary, neurological, oncologic/hematologic, gastrointestinal/hepatology, etc.), none is excluded from comorbidity assessment due to special considerations (such as age or organ transplant status).

Figure 1: Resource allocation diagram by allocation score criteria

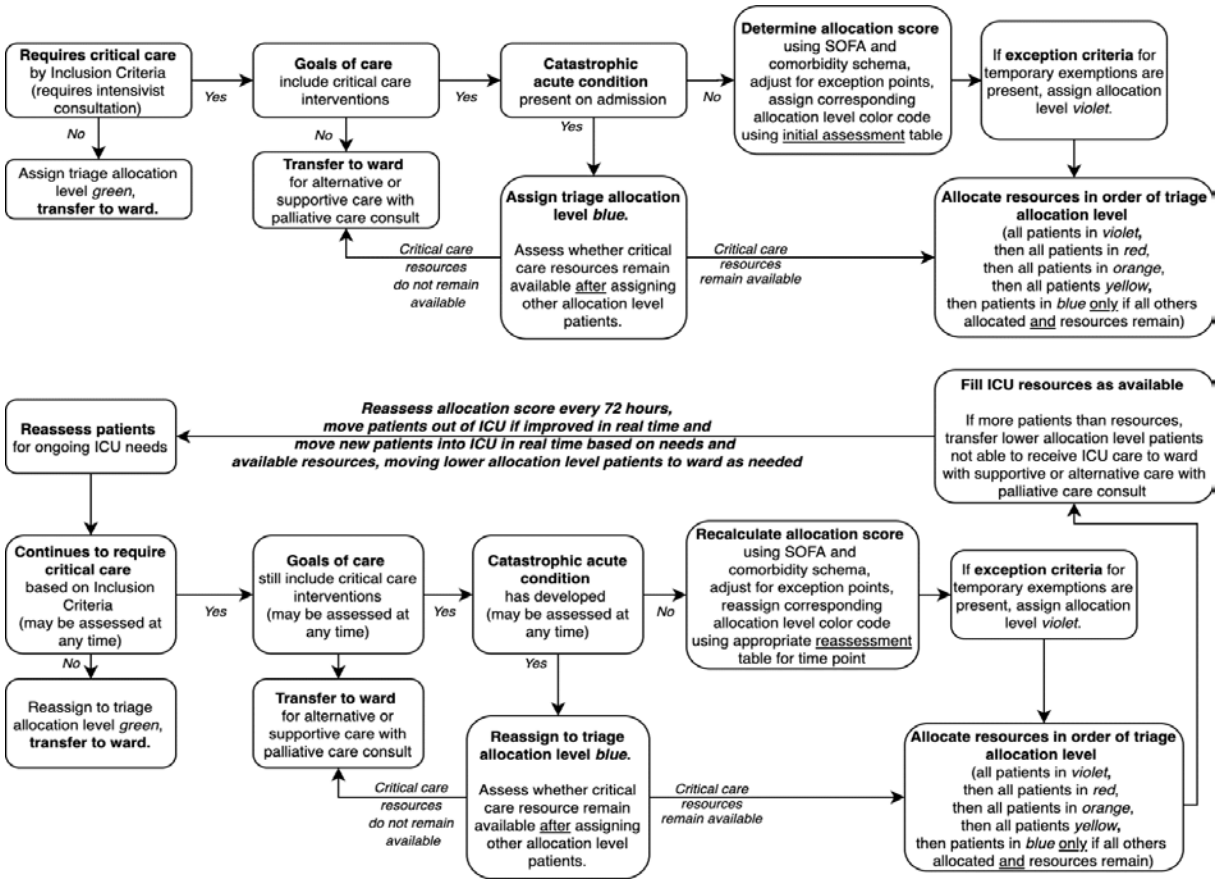

Table 1: Inclusion criteria for consideration of critical care

Patient has an acute medical condition that would potentially benefit from critical care	
Requires invasive mechanical ventilation	● Refractory hypoxemia (SpO2<90% on non-rebreather mask at flow of ≥15 LPM) ● Respiratory acidosis with pH < 7.20 on arterial blood gas ● Clinical evidence of respiratory failure ● Inability to protect airway
Requires vasoactive support for hypotension or unstable rhythm	● Systolic blood pressure < 90 mmHg with clinical evidence of shock (end-organ failure) refractory to volume resuscitation ● Unstable bradyarrhythmia refractory to electrolyte replacement ● Unstable tachyarrhythmia requiring vasoactive drip or cardioversion ● Requires mechanical circulatory support
Requires extracorporeal life support	● Above criteria, plus assessment of acceptability by ECMO team
Requires intensive neurologic monitoring or intervention	● Acute neurologic condition (e.g. intracranial/intraventricular hemorrhage, subarachnoid bleed with unsecured aneurysm, traumatic brain injury, or ischemic stroke with mass effect or acute hydrocephalus, severe CNS infection) with Glasgow Coma Scale < 13 ● Status epilepticus refractory to initial antiepileptic therapy ● Spinal cord injury at or above C5 with ASIA-A and B criteria[24]
Requires intensive interventions for trauma or major surgical condition	● Trauma causing significant instability or neurologic insult ● Post-operative condition with significant instability or requiring close critical care observation ● Post-operative from endovascular or thrombolytic management of high-risk (e.g., ST-elevation) myocardial infarction, stroke, or thromboembolic disease for first 24 hours post-event

Table 2: Catastrophic medical conditions with low likelihood of short-term survival present at presentation

Refractory cardiac arrest	● Any unwitnessed out of hospital cardiac arrest without ROSC prior to arrival ● Any witnessed cardiac arrest with inability to obtain ROSC after 60 minutes from onset without a shockable rhythm present
Hypoxic-ischemic brain injury after cardiac arrest	● Coma (inability to respond to verbal commands) after ROSC from cardiac arrest with non-shockable rhythm without confounding drugs, toxins, or metabolic derangements
Severe burns	● American Burn Association expected mortality ≥90% (Table 17 in Appendix 8)
Severe trauma	● Trauma Injury Severity Score predicting ≥90% mortality (Table 15 in Appendix 8)
Severe neurological injury (rule out confounders to clinical assessment such as sedation, transient seizure, or treatable hydrocephalus)	● Supratentorial intracerebral hemorrhage with ICH Score $\geq$ 5 ● Brainstem intracerebral hemorrhage with deep coma (GCS $\leq$ 5) ● Aneurysmal subarachnoid hemorrhage with Hunt-Hess score of 5 (Table 16 in Appendix 8) ● Traumatic brain injury with $\geq$ 90% predicted death or persistent vegetative state at 6 months on IMPACT score[25] ● Ischemic stroke with NIH Stroke Scale score $\geq$ 22 and either not eligible for acute revascularization or > 24 hours after revascularization treatment

N.B.: ROSC=return of spontaneous circulation, ICH=intracerebral hemorrhage; GCS=Glasgow Coma Scale

Table 3: Medical comorbidities and chronic conditions that limit short-term survival.

Major comorbidities that are associated with increased risk of short-term mortality from critical illness	Severely life-limiting comorbidities associated with high mortality even in absence of critical illness (survival typically ≤ 1 year), and which are correlated with significantly increased risk of short-term mortality from critical illness
• Pre-existing neurological condition (dementia, stroke, other neurodegenerative disease) with baseline modified Rankin Score ≥ 4 • ACC/AHA Stage C heart failure, NYHA Class II-IV • Severe, inoperable multi-vessel coronary artery disease or valvular disease • WHO Class 3 pulmonary hypertension (symptomatic with minimal exertion, asymptomatic only at rest) • Moderately severe chronic lung disease (e.g., COPD, IPF) but not requiring chronic oxygen or ventilation • End stage renal disease on dialysis • Cirrhosis with MELD <20 and history of prior decompensation	• Minimally conscious or unresponsive wakeful state from prior neurological injury • ACC/AHA Stage D heart failure • WHO Class 4 pulmonary hypertension • Severe chronic lung disease with FEV_1 < 20% predicted, FVC < 35% predicted, or in absence of PFTs, chronic home O_2 at rest or mechanical ventilation • Cirrhosis with MELD score ≥20 • Metastatic cancer with expected survival ≤1 year despite treatment • Refractory hematologic malignancy (resistant or progressive despite conventional initial therapy) • Terminal illness with Clinical Frailty Scale Score ≥8

N.B.: In the absence of appropriate expertise (which can include triage officer, backup officer, primary team, or rapid consultation) to evaluate, the patient is NOT docked for major comorbidities. Points for the items included in this table may be added to a patient at any time if they are discovered after admission to the ICU and reprioritization may be done as necessary.

It should be noted that these conditions appear on these lists only because they help predict short-term survival in critical illness: the fact that someone will, for example, have less than 5 year expected survival is not alone a reason to add triage points unless that fact correlates with short-term mortality. Moreover, among the conditions that correlate with reduced short-term survival, more priority points are assigned to those severely life-limiting comorbidities than to major comorbidities, since the former have a greater influence on short-term mortality than the latter, such that even in absence of critical illness they shorten survival.

Table 4: Multi-principle strategy to allocate critical care resources during crisis

Principle	**Specification**	**Allocation Point System**			
		1	2	3	4
Current Overall Clinical Status	*Prognosis for acute survival (SOFA or MSOFA[26] score)*	SOFA score < 6 or MSOFA <6	SOFA score 6-9 or MSOFA 6-8	SOFA score 10-12 or MSOFA 9-11	SOFA score > 12 or MSOFA>11
Co-occuring conditions that moderate mortality	*Co-occurring conditions that influence acute survival*	…	Major comorbid condition(s)	…	Severely life-limiting condition(s)
Deductions see Table 5 below.					

Table 5: Special considerations for triage allocation: exemptions and point adjustments

Group	Initial Triage	First reevaluation	Second reevaluation	Reevaluations thereafter
Critical worker (see Appendix 3 for definition)	Exempt for 72 hours, then initial triage at that time as usual, start triage clock at time 0 and deduct 4 points	Deduct 4 allocation points	Deduct 2 allocation points	Deduct 2 allocation points
Pregnant person (If estimated gestational age ≥24 weeks; if intrauterine fetal demise or delivery, then triage as usual)	Triage as usual, deduct 4 points	Triage as usual, deduct 4 points	Triage as usual, deduct 4 points	Triage as usual, deduct 4 points
Pre-transplant, active organ offer	Exempt only during time offer being evaluated, start triage clock at time of pause	Triage as usual	Triage as usual	Triage as usual
Post-operative, complex non-transplant surgery	Exempt for 120 hours, then initial triage at that time as usual, start triage clock at time 0	Triage as usual	Triage as usual	Triage as usual
Post-operative, transplant surgery	Exempt for 240 hours, then initial triage at that time as usual, start triage clock at time 0	Triage as usual, treat as if severe life-limiting comorbidity is resolved regardless of graft function for 90 days	Triage as usual, treat as if severe life-limiting comorbidity is resolved regardless of graft function for 90 days	Triage as usual, treat as if severe life-limiting comorbidity is resolved regardless of graft function for 90 days

A. Initial Triage Allocation Assessment

During a crisis declaration, an initial triage assessment shall occur at the time each new patient is determined to potentially need critical care. Patients will be assessed by a consulting critical care physician to determine whether they meet the requirements for critical care (Table 1). Those not meeting the inclusion needs for ICU care are assigned triage category **green** and are not currently ill enough to require critical care. They should be reassessed as needed if their clinical status deteriorates.

The Triage Team will review each case referred for critical care for catastrophic illnesses and injuries with consultation from the appropriate specialists when needed (Table 2). Those deemed to meet these catastrophic criteria are assigned triage category **blue** and only allocated to critical care during crisis if there are still resources after every patient in the other triage levels (**red, orange, yellow, violet**) are allocated.

The Triage Team will then assign an initial allocation score based on the points system outlined in Table 4 by calculating SOFA scores (Table 10) and adding additional chronic illness points (Table 3)

and making any pertinent adjustments to the score for special considerations (Table 5). Patients in triage level **violet** are temporarily exempt (e.g., active transplant organ offer) from triage prioritization and will enter the schema once their temporary exception lapses. Patients who have a catastrophic condition that would assign them to category blue should not be superseded by exceptions and moved to the violet category.

A summary of the delineations of these triage categories for initial triage is found in Table 6. Patients shall be categorized for entry by assigning all of the patients in the top triage category (**red**) and if all patients are assigned at that level and resources remain, assigning all of the patients in the next triage category (**orange**), and then the lowest triage category (**yellow**).

Within triage categories, patients should be treated equally, since the discriminative ability of single point changes of SOFA score on predicting survival between patients is limited. Individual triage allocation points, therefore, should not be used to make a rank list for order of allocation of critical care, even within categories. Should resources be limited to the point where all patients in a particular triage category are not able to receive critical care, tiebreakers shall be used to determine which of the patients receive critical care. The method to determine how to allocate in ties is described further below.

Table 6: Initially assigning patients to triage categories using multi-principle scoring

Triage Categories	Assessment of Mortality Risk/Organ Failure
Red Highest priority for critical care services, higher likelihood of survival. Use life-saving resources as available.	Allocation Score 1-3
Orange Intermediate priority for critical care services, intermediate likelihood of survival. Use life-saving resources as available.	Allocation Score 4-6
Yellow Lower priority for critical care services, higher risk of death. Use life-saving resources as available.	Allocation Score 7-8
Green Critical care not currently needed due to clinical stability. Use alternative forms of medical intervention or defer or discharge. Reassess as needed.	No significant organ failure AND/OR No requirement for life-saving interventions
Blue Lowest priority for critical care services due to extremely high risk of death. Use alternative forms of medical intervention and/or palliative care or discharge. Reassess as resources become available.	Acute catastrophic condition (Criteria from Table 2)
Violet Temporary exemption from triage allocation scoring. Continue to use critical care resources until exemption lapses.	See criteria in Table 5

i. Patients Presenting to the Emergency Department

The working group recommends that whenever feasible, without compromising patient safety, emergency department physicians delay the initiation of critical care services (e.g., intubation) until an assessment is made by a critical care physician for inclusion criteria and by the Triage Team for assessment of catastrophic conditions and prioritization by calculating allocation scores. However, in patients too unstable to defer initiation, the working group recognizes that intervention should not be delayed. Patients who come to the hospital already receiving critical care interventions upon arrival to the emergency department (e.g., intubations in the field) should continue to receive those interventions until the Triage Team can evaluate their candidacy and triage category. It is likely not feasible for the Triage Team to coordinate with EMS to prevent these interventions from being given prior to arriving at the hospital.

ii. Patients Presenting from the Hospital Ward

Similar to the recommendation to defer initiation of critical care in the emergency department until a triage assessment is made, this working group recommends that patients on the hospital wards be delayed for initiation of critical care services until this evaluation is completed whenever feasible and without compromising patient safety. However, in situations where critical care cannot safely be delayed while this determination is made (e.g., code blue), critical care should be initiated immediately, and a triage assessment should be made as soon as possible about whether to continue critical care, ideally within an hour of initiation of critical care.

iii. Patients Already in Intensive Care Units at the Time of Crisis Declaration

All patients already admitted to intensive care unit beds shall have their initial triage category calculated, with the baseline time of entry as the time a crisis declaration was made. Any patient determined not to require critical care on the strict inclusion criteria (Table 1) shall be assigned to **green** and transferred to the ward, to be reassessed for critical care at any time should their condition deteriorate in the future. Those meeting any catastrophic condition criteria (Table 2) shall be assigned to **blue**, and critical care resources shall no longer be allocated unless all patients in other triage categories are assigned and additional resources remain. The remaining eligible patients shall be ranked by their triage category and beds assigned equally for preexisting ICU patients and those requiring entry de novo from the emergency department or ward.

B. Re-triage Allocation Assessments

All patients who are allocated critical care services will be allowed a therapeutic trial of a duration to be determined by the clinical characteristics of the disease. The decision about trial duration will ideally be made as early in the public health emergency as possible, when data becomes available about the natural history of the disease. The trial duration should be modified as appropriate if subsequent data emerge that suggest the trial duration should be longer or shorter. Centers should also adjust the reevaluation time window to their individual needs (e.g., if the 72-hour readjustments recommended here are not adequate to keep pace with the inflow of new patients, consider reducing to every 48 hour reassessments). For the initial duration of trials, this working group recommends reassessment every 72 hours.

According to the protocol recommended here, the triage category will be reassessed every 72 hours from the initial assessment and new categories assigned for changes in clinical status. Change in triage category to level **blue** should be made at any time if there is a catastrophic complication (Table 2) that would preclude critical care and need not wait until 72h reassessments. Additionally, patients should be assessed daily by the intensivist for their need for ongoing critical care and changed to level **green** if they no longer require intensive care.

The first 72-hour reassessment follows the schema in Table 7. Triage categories are assigned more strictly than at initial presentation, and any patient with significant clinical worsening determined by SOFA score would be categorized lower. The 144-hour assessment and each assessment thereafter follow the schema in Table 8, and the criteria for significant worsening are tighter.

Table 7: Multi-principle triage category first re-assessment (Hour 72)

Triage Categories	**Assessment of Mortality Risk/Organ Failure**
Red Highest priority for critical care services, higher likelihood of survival. Use life-saving resources as available.	Allocation Score 1-3
Orange Intermediate priority for critical care services, intermediate likelihood of survival. Use life-saving resources as available.	Allocation Score 4-6
Yellow Lower priority for critical care services, higher risk of death. Use life-saving resources as available.	Allocation Score 7-8 OR Increase in allocation score of ≥ 3 points from increase in SOFA from any initial score[1]
Green Critical care not currently needed due to clinical stability. Use alternative forms of medical intervention or defer or discharge. Reassess as needed.	No longer ventilator dependent or actively weaning from ventilator AND/OR No longer in need of circulatory support/drips
Blue Lowest priority for critical care services due to extremely high risk of death. Use alternative forms of medical intervention and/or palliative care or discharge. Reassess when resources become available.	Acute catastrophic condition (Table 2)*
Violet Temporary exemption from triage allocation scoring. Continue to use critical care resources until exemption lapses.	See criteria in Table 5

* If a patient develops a catastrophic condition (Table 2) before first reassessment, re-triage to blue

Table 8: Multi-principle triage category re-assessment (Hour 144, then each 72h thereafter)

Triage Categories	Assessment of Mortality Risk/Organ Failure
Red Highest priority for critical care services, higher likelihood of survival. Use life-saving resources as available.	Allocation Score 1-3
Orange Intermediate priority for critical care services, intermediate likelihood of survival. Use life-saving resources as available.	Allocation Score 4-6
Yellow Lower priority for critical care services, higher risk of death. Use life-saving resources as available.	Allocation Score 7-8 OR Increase in allocation score ≥ 2 points from increase in SOFA since previous assessment[1]
Green Critical care not currently needed due to clinical stability. Use alternative forms of medical intervention or defer or discharge. Reassess as needed.	No longer ventilator dependent or actively weaning from ventilator AND/OR No longer in need of circulatory support/drips
Blue Lowest priority for critical care services due to extremely high risk of death. Use alternative forms of medical intervention and/or palliative care or discharge. Reassess when resources become available.	Acute catastrophic condition (Table 2)*
Violet Temporary exemption from triage allocation scoring. Continue to use critical care resources until exemption lapses.	See criteria in Table 5

[1] Despite low or moderate previous score, patient has worsened significantly
[2] If a patient develops a catastrophic condition (Table 2) before reassessment, re-triage to blue

C. Tiebreakers

In the case of fewer critical resources available within a tier than beds available, tiebreakers should be implemented to determine the next allocated patients. This working group considered age, using the life-cycle principle, which is not based on social utility, but rather the justification that individuals should be afforded equal opportunity to pass through the stages of life from childhood, young adulthood, middle, then old age. There is public health precedent for such a determination in the allocation of influenza vaccines, and other studies of ethics and aging support it as well[27]. However, after extensive discussion of this methodology, the working group believed that ethical problems as well as potential conflict with existing statutes precluded its use. Therefore, for individuals within the same triage

category, if there are fewer resources than needed to allocate every patient within that triage level, allocation should proceed by random lottery. Likewise, determining discontinuation of ventilators from patients within the same triage category should proceed by random lottery.

D. Triage Code Status Orders

Under crisis standards of care, decisions about who should receive critical care resources are guided by a population health approach to save the most number of lives. This necessitates prioritizing the allocation of scarce resources to those most likely to survive critical illness. Physicians cannot, in good conscience, offer medical interventions (including CPR) that they judge to be of no benefit, or to be disproportionately harmful, to patients. Furthermore, the law does not require physicians to do so, even if patients or their surrogates request such medically non-beneficial or harmful interventions.

This working group recognizes that triage allocation decisions may conflict with the previously stated goals and wishes of patients or their health care surrogates, who may have expressed preferences for aggressive treatment measures, including intensive care and cardiopulmonary resuscitation in the event of cardiac or respiratory arrest. For purposes of these triage guidelines, an arrest is defined as loss of spontaneous circulation that requires chest compressions, defibrillation, or emergency electrical pacing, and/or respiratory failure requiring intubation and mechanical ventilation if life is to be prolonged. Resuscitative efforts are defined as the performance of chest compressions, invasive mechanical ventilation, defibrillation, or electrically assisted cardiac pacing.

Under a declaration of crisis standards of care, it would be medically inappropriate and medically ineffective to provide resuscitative efforts to those who are not currently eligible to receive critical care resources following a cardiac or respiratory arrest. Resuscitative efforts are clinically indicated only if supportive critical care, such as a ventilator, is available after the patient is stabilized from the arrest. If there are no ventilators or other available critical care resources available to be allocated to a patient following resuscitation efforts, then attempting resuscitation is medically non-beneficial (medically futile) in that it is extremely unlikely to achieve the desired outcome of prolonging life. Attempting resuscitation in these circumstances does not benefit a patient who cannot be supported through critical illness and in fact may contribute to and prolong suffering for the patient.

As such, for any patient whose triage priority level is lower than the threshold for ICU admission for critical care resources such as ventilatory support, which is almost always required following resuscitation, we recommend that a code status order be entered by the triage officer indicating: (1) that specified critical care resources are not available for the patient at the present time, and (2) that as such, no resuscitative efforts should be made if the patient experiences cardiac or respiratory arrest. This order would not preclude the use of elective or emergent electric cardioversion for patients who are not pulseless with unstable arrhythmias, which should still be assessed to receive defibrillation as deemed appropriate by the treating physician(s). This order should remain in place unless and until sufficient resources become available for the patient to receive critical care. If and when resources become available for the patient, goals of care shall be addressed with the patient and/or their duly-designated health care surrogates. This goals of care conversation should be done prior to reversion of code status to Full Code and transfer to the intensive care unit for provision of critical care to ensure that such a transfer is still aligned with their desired outcomes.

IV. Supply Chain and De-escalation of Crisis

UC Health must plan appropriately for the deployment of crisis standards of care and allocation of scarce resources in the event that hospitals exceed their surge capacity; however, we must also emphasize that such a scenario represents an intolerable situation that demands diligent efforts to swiftly resolve. *Situations of ventilator or other critical resource scarcity should not be allowed to continue a single hour longer than absolutely necessary.*

Therefore, implementation of a triage system of scarce resource allocation must exist in parallel with continual efforts to push the supply chain of those resources. This is a critical component of a duty to steward scarce resources and the duty to care for every patient. UC Health should consider applying the following steps to augment the inventory of critical care ventilators at our hospitals and across the University of California system:

1. Development of a system to share resources across the UC medical campuses: Information sharing regarding inventory of unused resources can facilitate a system by which a campus with a scarcity can temporarily acquire ventilators from campuses in surplus. This scenario is feasible given the geography of the state and the potential for COVID-19 cases to surge at different times across California. Planning should include UC hospital incident command systems' participation in regional medical operations centers, which can promote the use of shared regional resources such as ventilator pools or caches.
2. Re-purposing operating room ventilators, using improvised ventilators or other resources for Critical Care usage: Adaptations may be necessary based upon the severity of disease and the type of operating room or other alternate ventilation techniques available.
3. Early utilization of non-invasive ventilation and other techniques: Although there is significant fluidity in the treatment of COVID-19, early data demonstrates a benefit from the use of high flow nasal cannula, awake self-proning and non-invasive ventilation in an attempt to avoid the need for invasive ventilation. Given these potential benefits, hospitals should consider acquiring additional non-invasive equipment. It is critical to review these non-invasive techniques and equipment to optimize utilization and to properly protect health care providers from aerosolization. BiPAP and CPAP machines should both be considered along with the appropriate personal protective equipment.
4. Patients who are not allocated specific resources (such as a ventilator) should be considered for mitigating care (for example, intubation and supplemental oxygen without a ventilator) if this could meet a care need such as airway protection.
5. Allocating one ventilator to two patients: Data on outcomes from this practice are scarce. Private companies and Schools of Engineering (including some within the University of California system) are in the process of developing connectors and splitters in order to create this accommodation. It is too early for this report to make a strong recommendation on the clinical application of this technique.
6. Philanthropy: The University of California and its individual campuses have already engaged in conversations with the private sector, regionally, nationally and internationally to acquire ventilators and potentially manufacture ventilators. These efforts should be redoubled if we approach situations of scarcity.

These and other steps can potentially improve time to de-escalation of the triage process by improving the availability of ventilators or other scarce resources. Patterns of infection of COVID-19 across the world increasingly provide us with a lens as to what we may expect regarding safe timing of de-escalation. As of the publication of this report, we suggest that triage assessment should continue until 30% of ventilators are not in use, with continual reassessment and a readiness to reenact triage until a clear pattern emerges that the institution and region no longer require implementation of crisis standards of care and the infrastructure for disaster preparedness can be relaxed.

V. Conclusions

The thresholds and recommendations outlined in this resource allocation algorithm for prioritization for triage should be evaluated by the UC Office of the President on a regular basis as the crisis situation evolves. Additional data regarding prognostication of outcomes in a particular disease state may become relevant as the crisis unfolds. For example, this working group does not currently recommend the use of COVID-19-specific decision tools, as the data that underpins them is not robust and the triage pool will contain both COVID-19 cases and patients with other acute conditions. But over time, specific disease state clinical markers or comorbidities might emerge as useful in prognosticating COVID-19-specific outcomes and the proportion of such cases in the ICU will likely increase. If this becomes the case, the decision protocol in Part III may be updated and revised accordingly. (Note that updates to this triage algorithm will be made at the level of UCOP, not by individual hospitals.)

In accord with the principle of transparency, this report is intended to be a public document, subject to public feedback, critique, and revision as necessary in order to more fully align with the needs and interests of all Californians.

Appendix 1: Review of Prior Research and Reports

As part of our public role, UC Health hospitals may face extremely challenging ethical questions during the Covid-19 pandemic that do not arise during everyday operations. For instance, they might have to decide how to allocate scarce resources to some patients and not others. Because our hospitals' decisions are part of a *public* effort, they should be governed by the choices and values of the citizenry, just as all public policies should be. This view is echoed in the writings of previous government institutional efforts to prepare for the possibility of influenza pandemics (such as the H1N1 epidemic of 2009.

To our knowledge, California has not conducted any surveys of the ethical values that Californians would like to bring to bear on triage and other pandemic-related issues. Likewise, federal institutions such as the CDC and VA endorse the *principle* of surveying the public, but have not conducted those surveys. In light of this, we conclude that the best sources of ethical guidance—the ones that best reflect the values of the public—include ethical guidelines put forward by the CDC, Veterans Health Administration, and California Department of Public Health. Although the CDC, VA, and California guidelines are not informed by direct surveys of the public, they are at least created by institutions indirectly responsible to the citizenry. In addition, we looked for insights from state guidelines from Maryland, Minnesota, and New York, as described below. While these guidelines come from states other than California, they have the advantage that they were based on deliberation with the general public.

A. Prior Public Engagement Projects on Flu pandemic Algorithms

Many important decisions faced by a society might best be made by decision makers in partnership with the public. Public deliberation projects involve a sponsor that convenes a group of people, ideally a representative cross-section of the public. Participants are informed about an issue or issues, and then they are asked to deliberate and debate the issues in order to bring to light their values after listening fully to the perspective of others. Content is reported to decision makers in order to assist them in understanding public perspective.[28] There are methodological criticisms to public engagement projects like these and concern over their applicability to larger policy questions. First, the best way to approximate public will is by engagement with a random sample of citizens, which was in general not performed in any public engagement project listed below. In addition the context is contrived with participants given a fixed series of principles, a priori defined, or a document to review, thus with associated biases. Finally, the information and training given to participants may also be biased toward one viewpoint or another.

Some groups have used deliberative methods to enlist community participation in decisions concerning allocation of scarce resources in hypothesized pandemic scenarios in the hope that qualitative and quantitative analysis of these representative bodies might inform policy. In 2005 the CDC and IOM along with other public institutions sponsored the Public Engagement Project on Pandemic Influenza (PEPPI). Roughly 250 citizens from Georgia, Massachusetts, Nebraska, and Oregon participated with 50 stakeholders in a deliberative process concerning the early allocation of limited supply of vaccine in the early days of an influenza pandemic. Participants were asked how such vaccines should be

allocated. By and large citizens articulated “assuring functioning of society” as a primary goal with “reducing individual deaths and hospitalizations due to influenza” as a secondary goal.[29]

In 2006 the New York State Department of Health commissioned the Task Force on Life and the Law to “consider ethical and clinical issues in the allocation of ventilators in an influenza pandemic”. This task force produced a draft guideline in 2007,[30] structured predominantly on guidelines from the Ontario Health Plan for Influenza Pandemic. They adopted a triage criteria which excludes patients based upon severe chronic organ failure, catastrophic injury, and SOFA score. To solicit comments, these guidelines were published in the New York Times, on the State Register, and on the Department of Health website. Four community meetings of about 25-50 participants each were held in 2008 to discuss the guidelines, as were 3 additional meetings with healthcare providers. A third party vendor, under the guidance of the Task Force, also executed an extensive community engagement project in 2011 along 13 counties in New York, although further information concerning the results of these experiences is not shared in their documents. Draft Guidelines were presented for comment at professional forums including: “Confronting the Ethics of Pandemic Planning: The Summit of the States,” (2008), the Institute of Medicine Workshop on “Altered Standards of Care in A Mass Casualty Event” (2009), the American Medical Association’s “Third National Congress on Health System Readiness” (2009), the Public Health Preparedness Summit (2011), and the American Society for Bioethics and Humanities Annual Meeting (2011 and 2012). They were published in a peer reviewed journal.[31] These projects resulted in the following changes to their final guideline. First, the guidelines stressed the need for triage officers and the triage infrastructure are to be hospital specific. Second they recommended that chronic care facilities not be included in the acute care of severely ill patients. Although there was a narrowing of the exclusion criteria to eliminate severe end organ failure, the format of triage and conclusions concerning age and care providers were essentially unchanged.[7]

Starting initially as a pilot project,[32] and finalizing in a community engagement forum[33] researchers at Johns Hopkins used similar deliberative methods to engage 324 participants in the Baltimore area concerning allocation of mechanical ventilators in time of scarcity. They were given a representative disaster scenario and expertise on key characteristics of mechanical ventilation. They were asked to deliberate on allocation of mechanical ventilators when needs exceed supply, and whether providers should ever be allowed to remove one person from mechanical ventilation who needs it in order to benefit another. They were given a list of six ethical principles upon which to deliberate. The group was diverse in ethnicity and religious background, about 25% were health care workers. The group stressed the need for transparency, and in general were open to the idea of using a combination of ethical principles in triage decisions. They expressed concerns of bias in decision making and patient abandonment. The group valued mostly the principles of survival of current illness and living longer, followed by the principle of value to others. In general first come first served, life stages and lottery decisions were less valued. While there was not unanimity, a majority (63.1%) favored the idea that removal of a ventilator from one patient might be acceptable. Based upon this experience this project recommended a triage protocol that weighed predominantly principles of early survival with early exclusion of non-survivable presentations to health care providers, and acute illness severity with a severity of illness tool. It also placed primary importance on long term survival via comorbidity evaluation. In the case of tiebreakers life stage and eventually lottery would be employed. This approach has found its way into triage policy from the State of Maryland[9] as well in part in guidelines from the University of Pittsburgh.[14]

B. Review of IOM and Other State-specific Principles

There is an extensive literature on the ethics of pandemic management and triage. When choosing which literature to use as sources or comparisons, we must seek documents that have the stamp of public authority, which includes policies based on the views of the public and/or policies created by institutions that are responsible to the public. This method is endorsed in the writings of U.S. Government institutions, including the Centers for Disease Control and the Veterans Administration.[2 3 8] It is also endorsed by the National Academy of Medicine, whose recommendations were made in response to a request from the U.S. Department of Health and Human Services.[5]

Several sources fulfill these criteria to varying degrees:

- Some are federal or California documents created by government organizations that are responsible to all U.S. citizens or to Californians in particular. These include reports by the Veterans Health Administration (VHA), the Centers for Disease Control (CDC), and the California Department of Public Health (CDPH).
- Some are guidelines from states other than California, though ones that have the advantage that they were based on at least some deliberation with or input from that state's public. These include state guidelines from Maryland, Minnesota, and New York.
- Finally, there are reports from the Institute of Medicine (IOM), now known as the National Academy of Medicine. Although the IOM is not a government body, its reports were generated at the request of the Department of Health and Human Services and have been widely influential.

General Comparison of These Sources

The documents listed above make remarkably uniform recommendations about the principles to be used during pandemic management. Differences between them are often small matters of phrasing. When a principle is absent from a document, often it is implicit in the way the document reasons about policy. Table 9 below compares only the principles which are explicitly stated. Definitions of the principles follow the table:

Table 9: Comparison of Principles Explicitly Stated

	VHA	CDC	CDPH	MD	MN	NY	IOM
Save the Greatest Number/Pop. Health	Yes	Yes	Yes	Yes	Yes	Yes	
Respect Persons/Individual Rights	Yes	Yes	Yes		Yes		
Protect Populations with Special Needs			Yes		Yes	Yes	
Fairness/Consistency	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Avoid Exacerbating Disparities		Yes			Yes	Yes	
Duty to Care	Yes		Yes	Yes	Yes	Yes	Yes
Duty to Steward Resources	Yes	Yes	Yes		Yes	Yes	Yes
Duty to Collect Information	Yes	Yes		Yes	Yes		
Transparency/Public Involvement	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Proportionality	Yes				Yes		Yes
Accountability	Yes				Yes		Yes

Principles:

Duty to save the greatest number of lives/promote population health: Providers should save the greatest number of lives possible[4] and focus on benefits to the population as a whole.[3]

Duty to Respect Individual Rights: Healthcare organizations should respect the rights of patients,[4] as well as the autonomy and intrinsic worth of persons.[3]

Protect populations with special needs: Healthcare organizations should take into account the special needs of various groups.[4]

Avoid exacerbating existing disparities: Responses to a pandemic should not exacerbate existing disparities in health outcomes.[3]

Duty to collect information: Decisions should be based on the best available evidence, and decision-makers should conduct research to improve the quality of information.[3] Policies should be changed in light of new information.[9]

Fairness/Consistency: The protocols could be viewed as fair by all parties.[5] Any differences in treatment must be based on appropriate differences between individuals.[6] Decision makers should be impartial and neutral.[3] Like groups must be treated alike.[5] The public may feel that scarce resources have not been allocated fairly if patients at different hospitals in the same affected area receive vastly different levels of care.[6]

Duty to Care: providers should provide medical treatment to the specific patients under their care, and patients should not be abandoned.[5] Health care institutions have a reciprocal duty to support healthcare workers,[6] including the provision of adequate personal protective equipment. Duties to care may extend outside healthcare workers' professional roles, e.g., when healthcare workers must care for their children.[6]

Duty to Steward Resources/Plan: Healthcare institutions and workers must steward scarce resources in order to advance the goal of saving the most lives.[5] Plans for a crisis should be in place before the crisis occurs.[7]

Transparency/Public Involvement: the public should be allowed to provide input into ethically-laden decisions about pandemic management, and the values driving policy should be explicitly communicated to the public.[5] Transparency also implies candor in communication about disasters.[5]

Proportionality: Policies and restrictions must be appropriately limited in time and scale according to the scope and severity of the crisis.[5]

Accountability: Individuals in the healthcare system at all levels must accept and act upon appropriate responsibilities.[5]

How These Sources Prioritize Principles

The documents listed above make remarkably uniform recommendations about the principles to be used during a pandemic. All of them prioritize population health and focus on saving the greatest number of lives possible, although always with some caveats or restrictions. The VHA gives the most explicit defense of not merely maximizing lives saved. They first state their position:

> Decision-making in pandemic influenza planning and response must be based on achieving the greatest good for the greatest number…*within constraints of respect for human dignity and fairness….*[2]

They note that this echoes a recommendation from the CDC:

> We have concluded that a classic utilitarian approach to defining priorities, 'the greatest good for the greatest number,' is not a morally adequate platform for pandemic influenza planning. We recommend an approach to ethical justification, that, like utilitarianism, evaluates the rightness or wrongness of actions or policies primarily by their consequences, but, we further recommend that planning should take into account other checks ('side constraints') grounded in the ethical principles of respect for persons, non-maleficence, and justice.[8]

The VHA then highlights a case intended to show why the goal of maximizing lives saved must be constrained by the requirements of fairness and human dignity:

> This guidance is based on the fundamental assumption that decision-making in pandemic influenza planning and response must be based on achieving the greatest good for the greatest number (the principle of utility) within constraints of fairness and human dignity…. Although a strictly utilitarian approach to pandemic planning and response might justify concentrating health care resources (staff, beds, supplies, and drugs) on saving those lives that have a high likelihood of being saved, an approach that balances utility, fairness and human dignity, as advocated in this guidance, requires that steps are also taken to provide for those who are not expected to survive.[2]

Appendix 2: Evaluation of SOFA, Frailty scoring

Table 10 - Sequential Organ Failure Assessment Tool[34]

Organ System	0	1	2	3	4
P_aO_2/FiO_2 on arterial blood gas (or SpO_2/FiO_2 when ABG not available)[1]	≥400 (≥512)	300-399 (357-511)	200-299 (214-356)	100-199 (89-213)	<100 (<89)
Platelet count ($10^3/\mu L$)-	≥150	100-149	50-99	20-49	<20
Bilirubin (mg/dL)	<1.2	1.2-1.9	2.0-5.9	6.0-11.9	≥12
Hypotension **(vasopressor doses in mcg/kg/min)**	None	MAP < 70 mmHg	Dopamine < 5	Dopamine 6-15 or Epinephrine <0.1 or Norepinephrine < 0.1	Dopamine > 15 or Epinephrine ≥ 0.1 or Norepinephrine > 0.1
Glasgow Coma Scale Score	15	13-14	10-12	6-9	<6
Creatinine (mg/dL) **or** **(Urine output (mL/24h))**	<1.2	1.2-1.9	2.0-3.4	3.5-4.9 (<500)	>5 (<200)

[1.] For patients on low-flow oxygen systems, use estimated FiO_2 from Table 13 below.

Table 11 - Modified Sequential Organ Failure Assessment Tool

Organ System	0	1	2	3	4
S_pO_2/FiO_2 on arterial blood gas	>400	316-400	236-315	151-235	≤150
Liver	No scleral icterus or jaundice			Scleral icterus or jaundice	≥12
Hypotension **(vasopressor doses in mcg/kg/min)**	None	MAP < 70 mmHg	Dopamine ≤ 5 or Dobutamine any dose	Dopamine 6-15 or Epinephrine <0.1 or Norepinephrine < 0.1	Dopamine > 15 or Epinephrine ≥ 0.1 or Norepinephrine > 0.1
Glasgow Coma Scale Score	15	13-14	10-12	6-9	>6
Creatinine (mg/dL)	<1.2	1.2-1.9	2.0-3.4	3.5-4.9	>5

1. For patients on low-flow oxygen systems, use estimated FiO_2 from Table 10.

Table 12 - Estimation of FiO2 for patients on low-flow oxygen systems[36]

Flow (L/min)	Mean FiO_2	
	Mouth Closed	Mouth Open
Nasal Cannula		
1	0.24	0.28
2	0.30	0.38
3	0.35	0.43
4	0.40	0.50
5	0.45	0.56
6	0.48	0.60
Face Mask		
7	0.51	0.64
8	0.50	0.66
9	0.56	0.71
10	0.59	0.73
11	0.60	0.75
12	0.62	0.76
13	0.64	0.77
14	0.68	0.79
15	0.70	0.81
N.B., If mouth closure at time of evaluation unknown, use left column for mouth closed.		

Conclusions:

1. SOFA-based models evaluated on their prognostic performance fell under 5 categories:
    a. Single SOFA scores at fixed times
    b. Sequential SOFA measurements
    c. Individual SOFA components
    d. Combination of SOFA with over covariates
    e. SOFA patterns automatically discovered from the data
2. For predicting mortality, SOFA-based models at admission seem to be competitive with severity of illness models limited to the first 24 hours of admission, and models based on sequential SOFA scores have comparable performance with other IOF (individual organ failure) scores.

3. The combination of SOFA-based models with admission-based models results in superior prognostic performance than either model alone.

Figure 2: Frailty Index[37]

Fatigue: "How much of the time during the past 4 weeks did you feel tired?" 1 = All of the time, 2 = Most of the time, 3 = Some of the time, 4 = A little of the time, 5 = None of the time. Responses of "1" or "2" are scored as 1 and all others as 0. Baseline prevalence = 20.1%.

Resistance: "By yourself and not using aids, do you have any difficulty walking up 10 steps without resting?" 1 = Yes, 0 = No. Baseline prevalence = 25.5%.

Ambulation: By yourself and not using aids, do you have any difficulty walking several hundred yards?" 1 = Yes, 0 = No. Baseline prevalence = 27.7%.

Illnesse: For 11 illnesses, participants are asked, "Did a doctor ever tell you that you have [illness]?" 1 = Yes, 0 = No. The total illnesses (0–11) are recoded as 0–4 = 0 and 5–11 = 1. The illnesses include hypertension, diabetes, cancer (other than a minor skin cancer), chronic lung disease, heart attack, congestive heart failure, angina, asthma, arthritis, stroke, and kidney disease. Baseline prevalence = 2.1%.

Loss of weight: "How much do you weigh with your clothes on but without shoes? [current weight]" "One year ago in (MO, YR), how much did you weigh without your shoes and with your clothes on? [weight 1 year ago]" Percent weight change is computed as: [[weight 1 year ago - current weight]/weight 1 year ago]] * 100. Percent change > 5 (representing a 5% loss of weight) is scored as 1 and < 5 as 0. Baseline prevalence = 21.0%.

Conclusions:

1. The Frailty Index is among the most popular frailty definitions and predictive of mortality.
2. The mortality risk according to the Frailty Index has never been quantified with meta-analysis in the literature.
3. All meta-analyses suggested that the frailty measured by the Frailty Index is a significant predictor of short term mortality.

Appendix 3: Ethical Controversies in Triage

This appendix discusses the general ethical framework from section 1 as well as some of its implications. Its sections include:

- Choice of Guiding Principles
- Public Engagement Projects on Flu Pandemic Choices
- Specific Ethical Issues Related to Triage
    - Equality the default
    - General Recommendation to Protect and Provide for Vulnerable Populations
    - Prisoners and Undocumented Immigrants
    - Disability and Return to Previous State of Health
    - Application of Triage Protocols to All Who Need Scare Resources
    - Reallocation of Scarce Resources
    - Triage Protocols and Pre-Existing Health Inequities
    - Triage Priority Based on Age
    - The Multiplier Effect and Pregnancy
    - Priority to Health Care Workers, First Responders, and Other "Critical Workers"

Choice of Guiding Principles

Hospitals in America have both a private and public role. Part of the time they operate in the free market, contracting with individual consumers and insurance companies. However, they are also expected to play public roles. For example, EMTALA requires Medicare-participating hospitals to provide emergency care to all patients, regardless of their insurance status or ability to pay, thus making hospitals part of a public safety net for health care.

During a severe pandemic or other crisis, the public role of hospitals increases. Hospitals move from being largely private institutions to being essential players in a public health effort whose aim is to preserve as many lives as possible and help maintain the functioning of civil society.

As part of this public role, hospitals during a pandemic could face vexed ethical questions that do not arise during everyday operations. For instance, they might have to decide how to allocate scarce resources to some patients and not others. Because the hospital's decisions are part of a public effort, they should be governed by the choices and values of the citizenry, just as all public policies should be. This view is echoed in the writings of U.S. Government institutions, including the Centers for Disease Control and the Veterans Administration. It is also endorsed by the National Academy of Medicine, whose recommendations were made in response to a request from the U.S. Department of Health and Human Services.

To our knowledge, neither the Federal Government nor California has conducted any surveys of the ethical values that the public would like to bring to bear on triage and other pandemic-related issues. Likewise, federal institutions such as the CDC endorse the principle of surveying the public, but have not conducted those surveys. In light of this, the next-best sources are those that are either created by a government institution indirectly responsible to the citizenry and/or based at least partly on public input.

Documents which meet these requirements to varying degrees include:

- Ethical guidelines put forward by the CDC, Veterans Health Administration, and California Department of Public Health. These are not informed by direct surveys of the public, they are at least created by institutions indirectly responsible to the citizenry.
- State guidelines from Maryland, Minnesota, and New York. While these guidelines come from states other than California, they have the advantage that they were based on deliberation with the general public.
- Reports from the Institute of Medicine (now the National Academy of Medicine). The Institute of Medicine is not a government body, but its reports were generated at the request of the Department of Health and Human Services and have been widely influential.

Fortunately, there is no need to adjudicate the precise merits of these documents or others, since all are in broad agreement about the ethics of crisis and pandemic management. The ethical guidelines presented in the opening section of this document represent a distillation of the recommendations in these federal and state guidelines. They reflect the best possible attempt to represent the values of the citizenry in our decisions.

Public Engagement Projects on Flu Pandemic Choices

As noted above, many of the most important decisions about pandemic management should be made by decision makers in partnership with the public. Given the importance of public input, we here review some of the existing literature on public engagement projects regarding flu pandemic choices. The projects have important limitations, but the limited information collected during the projects accords with the general principles outlined in this document.

Public deliberation projects involve a sponsor that convenes a group of people, ideally a representative cross-section of the public. Participants are informed about an issue or issues, and then they are asked to deliberate and debate the issues in order to bring to light their values after listening fully to the perspective of others. Content is reported to decision makers in order to assist them in understanding public perspective (Siegel et al, American Medical Association Journal of Ethics. 2013. 15(1): 56-64). There are methodological criticisms of public engagement projects like these and concern over their applicability to larger policy questions. First, the best way to approximate public will is by engagement with a random sample of citizens, which was in general not performed in any public engagement project listed below. In addition, the context is contrived with participants given a fixed series of principles, a priori defined, or a document to review, thus with associated biases. Finally, the information and training given to participants may also be biased toward one viewpoint or another.

Some groups have used deliberative methods to enlist community participation in decisions concerning allocation of scarce resources in hypothesized pandemic scenarios, with the hope that qualitative and quantitative analysis of these representative bodies might inform policy. In 2005 the CDC and IOM along with other public institutions sponsored the Public Engagement Project on Pandemic Influenza (PEPPI). Roughly 250 citizens from Georgia, Massachusetts, Nebraska, and Oregon participated with 50 stakeholders in a deliberative process concerning the early allocation of limited supply of vaccine in the early days of an influenza pandemic. Participants were asked how such vaccines should be

allocated. By and large citizens articulated “assuring functioning of society” as a primary goal with “reducing individual deaths and hospitalizations due to influenza” as a secondary goal.[29]

In 2006 the New York State Department of Health commissioned the Task Force on Life and the Law to “consider ethical and clinical issues in the allocation of ventilators in an influenza pandemic”. This task force produced a draft guideline in 2007, Allocation of Ventilators in an Influenza Pandemic: Planning Document: Draft for Public Comment[30] structured predominantly on guidelines from the Ontario Health Plan for Influenza Pandemic. They adopted triage criteria which exclude patients based upon severe chronic organ failure, catastrophic injury, and SOFA score. To solicit comments, these guidelines were published in the New York Times, on the State Register, and on the Department of Health website. Four community meetings of about 25-50 participants each were held in 2008 to discuss the guidelines, as were 3 additional meetings with healthcare providers. A third-party vendor, under the guidance of the Task Force, also executed an extensive community engagement project in 2011 along 13 counties in New York, although further information concerning the results of these experiences is not shared in their documents.

Draft Guidelines were presented for comment at professional forums including: “Confronting the Ethics of Pandemic Planning: The Summit of the States,” (2008), the Institute of Medicine Workshop on “Altered Standards of Care in A Mass Casualty Event” (2009), the American Medical Association’s “Third National Congress on Health System Readiness” (2009), the Public Health Preparedness Summit (2011), and the American Society for Bioethics and Humanities Annual Meeting (2011 and 2012). They were published in a peer reviewed journal.[31] These projects resulted in the following changes to their final guidelines. First, the guidelines stressed the need for triage officers and the triage infrastructure to be hospital specific. Second, they recommended that chronic care facilities not be included in the acute care of severely ill patients. Although there was a narrowing of the exclusion criteria to eliminate severe end organ failure, the format of triage and conclusions concerning age and care providers were essentially unchanged.[7]

Starting initially as a pilot project (Daugherty Biddson et al. Annals ATS.2014.11(5). 777-783) and finalizing in a community engagement forum (Daugherty Biddson et al. Chest.2018.187-195) researchers at Johns Hopkins used similar deliberative methods to engage 324 participants in the Baltimore area concerning allocation of mechanical ventilators in time of scarcity. They were given a representative disaster scenario and expertise on key characteristics of mechanical ventilation. They were asked to deliberate on allocation of mechanical ventilators when needs exceed supply, and whether providers should ever be allowed to remove one person from mechanical ventilation who needs it in order to benefit another. They were given a list of six ethical principles upon which to deliberate. The group was diverse in ethnicity and religious background, about 25% were health care workers. The group stressed the need for transparency, and in general were open to the idea of using a combination of ethical principles in triage decisions. They expressed concerns of bias in decision making and patient abandonment. The group valued mostly the principles of survival of current illness and living longer, followed by the principle of value to others. In general, first come first served, life stages, and lottery decisions were less valued. While there was not unanimity, a majority (63.1%) favored the idea that removal of a ventilator from one patient might be acceptable.

Based upon this experience, this project recommended a triage protocol that weighed predominantly principles of early survival with early exclusion of non-survivable presentations to health care providers,

and acute illness severity with a severity of illness tool. It also placed primary importance on long term survival via comorbidity evaluation. In the case of tiebreakers, life stage and eventually lottery would be employed. This has found its way into triage policy from the State of Maryland[9] as well in part in guidelines from the University of Pittsburgh[14].

Specific Ethical Issues Related to Triage

Some of the most vexed ethical issues in pandemic and crisis planning concern the formulation of triage protocols. Here we comment on some of the most prominent issues. In each case we try to bring to bear the views of the public on each of the contested issues, either through direct examination of public documents or through the application of the values expressed in those documents.

General Recommendation to Protect and Provide for Vulnerable Populations. One of our core ethical principles is the protection of vulnerable populations, and all the public documents we surveyed all direct hospitals to take deliberate, *active* steps to ensure that vulnerable or marginalized populations receive equal access to scarce resources.[3 4 7] These might include, among other things, these steps:

- Hospitals can reach out to organizations and services designed to serve groups with special needs[4] or groups who are particularly vulnerable or disadvantaged.[38] Such groups might include "social service agencies, home care providers, community health centers, community organizations, faith-based communities that serve low income people and other populations with health disparities as well as those with access and functional needs."[38] Those groups can call attention to access barriers and other sources of potentially unequal treatment.
- Facilities should ensure access for those with disabilities, limited English language skills, and other groups with functional needs. [38]
- The Maryland guidelines note that placing too great a priority on the criterion of long term survival may further disadvantage people who are already disadvantaged, since poorer people and people of color are more likely than other groups in society to have serious health problems.[9] This issue is discussed further below.
- Facilities should mitigate or eliminate, as far as possible, the sense of distrust that some historically disadvantaged people might feel toward the medical system in general or a triage system in particular.[7]
- The New York guidelines note that hospitals should be prepared to participate in regional plans designed to ensure that the same resources are available and in use at similarly situated facilities (i.e., all facilities in one area affected by the pandemic) to reduce inequalities of access and distribution among facilities. (New York 2017, pp. 32/33).

Prisoners and Undocumented Immigrants. Notes on Maryland public forums indicate that some citizens believe that prisoners and undocumented immigrants should be de-prioritized during triage.[9] However, all public documents we surveyed reject such de-prioritization. Some do so in explicit discussions of prisoners and/or undocumented immigrants,[38] or in statements of general principles that are incompatible with de-prioritization.[4 8 38] Others public documents reject it implicitly, by not including de-prioritization in their triage protocols. On the basis of the public consensus, we conclude that prisoners and undocumented immigrants should not be de-prioritized.

Disability and Return to Previous State of Health. Some triage protocols make allocation decisions based not only on overall predicted survival but also quality of life after treatment. Such protocols are sometimes viewed with suspicion by individuals with disabilities. Standard health measurement scales such as QALY and DALY scales generally give a lower rating to the quality of life of individuals with disabilities than to those without. The concern is that individuals with disabilities will therefore be assigned lower triage priority in virtue of their disabilities. For instance, if a non-disabled patient and a blind patient could both be saved by allocating them a ventilator, standard QALY scoring would tell you that the non-disabled patient will have a better "quality of life" after recovery, simply because they are not blind.

The public documents we surveyed offer this guidance:

- The California guidelines label "change in quality of life" an "appropriate criterion for resource allocation" and add that "The benefit of the population of patients during a healthcare surge will be maximized if treatment is provided to patients who will have the greatest improvement in quality of life. Change in quality of life can be defined by comparing functional status with treatment to functional status without treatment."
- The CDC offers no concrete guidance, merely surveying different triage options.
- The Maryland guidelines do not discuss the issue explicitly but the Maryland protocol does not score individuals based on quality of life.[9]
- The Minnesota guidelines say that rationing should not be based on "judgments that some people have greater quality of life than others."[38]
- New York also concludes that "factors that reflect quality of life judgments rather than estimates of mortality should be eliminated from the triage process."[7] They also reject policies about withdrawing care from chronically ventilator-dependent patients that would *de facto* prioritize non-disabled individuals over individuals with disabilities.[7]
- The VHA guidelines do not directly address the issue but their triage protocol does not include quality of life assessments.

The consensus of these documents is not to triage based on expected quality of life after treatment. The only possible exception is California's general remarks about "change in quality of life." However, that remark is ambiguous between (a) triaging patients based on their expected quality of life after treatment, as scored on some health measurement scale such as a QALY scale, and (b) triaging patients based on how far the treatment returns them *to their own baseline* quality of life.

On the basis of our assessment of these documents, we conclude that triage protocols should either not assess patients based on expected quality of life after treatment or, to ensure non-discrimination against individuals with disabilities, assess at most how treatment will return the patient to their own baseline quality of life.

Application of Triage Protocols to All Who Need Scare Resources. When resources become scarce, some people who need those resources will be suffering from conditions related to the pandemic and others will not. For instance, during a ventilator shortage caused by an influenza pandemic, some might need a ventilator because they are suffering from influenza, but others will need a ventilator for other reasons—they suffer severe COPD exacerbation, require ventilation under general anesthesia, and so on. In such situations, the consensus of all public documents is that triage protocols should be applied to all who need the scarce resource, not just those suffering from conditions related to the pandemic.

Reallocation. In a triage situation, there could be a patient who is already using a resource—e.g., a ventilator—and another patient needs the same resource. It is also possible that the second patient is more likely to survive on the ventilator than the first patient. In such situations and ones like them, the question arises of whether you should reallocate the resource to the second patient. The documents surveyed offer this guidance:

- The VHA document clearly states that scarce resources may be withdrawn from one patient when doing so 'optimizes scarce resources', though they caution about legal concerns over withdrawal of treatment.[2]
- The CDC asks hospitals and states to "address the issue," and then clearly writes in a way that, at the very least, does not disallow withdrawal—e.g., "Policies for withdrawal of patients from ventilators need to be the least restrictive possible…"[3]
- The CDPH guidelines state that during surge and crisis situations, "certain lifesaving efforts may have to be discontinued" and elsewhere that "a healthcare provider may determine that…care being provided to an individual will be discontinued or withdrawn…" In addition, the California guidelines discuss the New York guidelines as "an example of standards that might be implemented during a catastrophic emergency," and as explained below, the New York guidelines allow withdrawal and reallocation.[4]
- Maryland notes that participants in public forums "expressed concern" over withdrawal of a ventilator and reallocation to another patient, and that professionals expressed concern about the legal ramifications of withdrawal, as well as the emotional, psychological, and moral distress of withdrawal. In the end Maryland sanctions withdrawal so long as is done "with caution" and allows a limited appeals process. There is extensive discussion of whether withdrawal is legal under Maryland law, indicating that withdrawal is not legally unproblematic.[9]
- Minnesota speaks of withdrawal in general as something that might happen when implementing crisis standards of care and has one specific reference to the possibility of reallocation using Minnesota guidelines.[38]
- The New York guidelines allow withdrawal and reallocation.[7]

On the basis of the consensus in these documents, we conclude that reallocation is permitted whenever indicated by the triage protocol, subject to (a) any legal constraints, and (b) any additional protections a Triage Committee may wish to put in place regarding reallocation—e.g., special appeals procedures.

Triage Protocols and Pre-Existing Health Inequities. Triage protocols often triage patients based at least partly on their chance of survival *simpliciter* or longer-term survival. Some population sub-groups in the United States (e.g., racial and ethnic minorities) disproportionately suffer from health conditions which will reduce their chances of survival during a pandemic—e.g., when a patient with pre-existing COPD becomes infected with CoVid-19. Some would argue that these pre-existing health disparities are the result of social injustices and therefore that it is problematic to de-prioritize such individuals during triage.

The Maryland guidelines take up this issue and state:

> "Although important, placing too great a priority on the criterion of long term survival may, in certain circumstances, further disadvantage people who are already disadvantaged; poor people and people of color are more likely than other groups in society to have multiple and serious co-morbidities because of poorer access to medical care and because of the direct debilitating effects of poverty on health."[9]

Likewise, the New York guidelines comment that:

> "It is not appropriate for a triage officer/committee to compare patients within the same [triage priority] category. …[among other problems], such comparisons may intensify inherent biases in the health care system and the disproportionate and disparate provision of care for already disadvantaged populations."[7]

The documents we surveyed draw these conclusions:

- The VA guidelines do not attempt to correct for the problem that populations with greater rates of health problems will be disproportionately de-prioritized in most triage protocols.
- The CDC guidelines do not address this problem specifically, though they do discuss the making of distinctions *within* a triage category: "steps should be taken to ensure that all patients reaching the highest priority group have equitable access to the pool of ventilators. This assures that allocation does not exacerbate pre-existing inequalities in access to health care or disproportionately impact vulnerable populations."[3]
- After describing the problem in the quote above, the Maryland guidelines state that: "Because of concerns about compounding injustices associated with systematic disadvantage and the arbitrariness of co-morbidities, unlike other algorithms that have been proposed for ICU triage in a disaster, the scoring system to be used here does not distinguish between one and multiple co-morbidities or between mild and moderate co-morbidities. Patients whose co-morbidities are so serious that they are expected to live no more than 12 months even with successful ICU treatment are assigned a score of 3."[9]
- The Minnesota and CDPH guidelines do not address this issue directly, although there are many places where they generally indicate a need to protect vulnerable and disadvantaged populations.
- The New York guidelines offer the solution quoted above—a restriction against comparing patients within the same triage category.

The recommendations from these public documents are not entirely consistent. In light of this, our working group examined the issue ourselves, attempting to bring to bear our guiding principles. This situation creates a tension between our goal of not exacerbating pre-existing inequities and the goal of maximizing the number of lives saved. In the end the committee agreed on two things. First, we adopted a protocol that comports with the Maryland system, which does not distinguish between one and multiple co-morbidities. Second, we concluded that we should not attempt to further prioritize

anyone on the basis of any potential pre-existing health inequalities, with each member endorsing that conclusion for some or all of the following reasons:

- The working group had no public mandate for taking its own judgments on controversial public issues about justice and injustice in healthcare generally, and then implementing them during a public health crisis.
- Even if the working group decided to make such judgments, any attempt to correct for pre-existing health inequities would have to say *how much* correction is required, which would in turn even more controversial and pragmatically impossible value judgments about the type and degree of the injustices in our society. The working group felt it was not possible for it to do this, and that in addition, as above, it had no public mandate for rendering judgments on such complicated and contentious public issues.
- Many public documents stress that the most important goal during a public health crisis should be maximizing the number of lives saved.

In addition, the committee felt that it should be known that this issue revealed to us that a satisfying choice is not always available in extraordinary circumstances, and that during a public health crisis, sometimes a choice is inevitably tragic, involving substantial moral costs no matter what.

Triage Priority Based on Age. Young people will often receive *de facto* priority in a triage protocol because those protocols always place a heavy weight on likelihood of survival, and young people are in general more likely to recover from illness than older ones. However, a separate ethical issue is whether we should, in addition, give independent weight to youth, prioritizing it to some extent regardless of its effect on survival. (Often the rationale for doing so is that young people have longer expected lifespans, so preserving the lives of younger people saves more “life years.”) A case will make the issue clearer. If a 20-year-old has a 20% chance of survival with a ventilator, but a 55-year-old has a 50% chance of survival, who should be given the ventilator? If one cares only about lives saved, one favors the 55-year-old. If one places intrinsic weight on youth, then (based on average lifespan), one might favor the 20-year-old. The average male lifespan in America is 75, and (.20 x 55) is greater than (.5 x 20).

The Working Group recognizes the importance of this issue and began initial deliberations about it. In the midst of those deliberations we were advised that priority based on age was likely to constitute illegal age discrimination. For that reason, age is not a factor in triage in our protocol.

Priority to Health Care Workers, First Responders, and Other “Critical Workers”. Most major documents about triage discuss the possibility of giving priority to police officers, firefighters, some healthcare workers, and other individuals who are essential to fighting the pandemic and maintaining the functioning of civil society. This is one of the most difficult issues for any triage working group to confront, because many of the members of that group are likely to be healthcare workers who could benefit from priority assignment. In light of this, the working group took strict steps to ensure that it was not imposing its own views on this issue but rather attempting to comply with the recommendations of state and federal governments, as recorded in public documents.

Those documents discuss three possible justifications for giving triage priority to critical workers:

1. *Reciprocity*. A public health emergency demands sacrifices from all citizens, but not all suffer the same risks. Some argue that because some critical workers take more risks in the name of the public good, those critical workers are owed some level of priority in triage in return.
2. *The Multiplier Effect*. Because certain individuals are involved in saving the lives of others, an argument can be made that when you save that individual, you potentially save others as well. For instance, some might make the case that when you save a tailor, you save just him, but that when you save an ICU doctor, you are not only saving her but at least have the possibility of saving the others she will go on to help when she returns to the workforce.
3. *Incentivizing the Work Force*. Some express concern that during a pandemic, especially a protracted one, an increasing number of critical workers will refuse to perform duties that put them at risk, either by leaving their positions, taking paid or unpaid leave, or refusing to undertake certain risky tasks. One way to mitigate this phenomenon might be to give some level of priority to critical workers. (Note that this is essentially a variant of the multiplier effect: the claim is that by offering priority, we incentivize job performance which in turn allows critical workers to continue saving others.)

It is important note that these rationales are different from those based on "social value":

4. *Social Value*. Judgments of social value assess individuals based on how they contribute to society. For example, some people might think an entrepreneur is more important to society than an unemployed artist, that a teacher is more valuable to society than a cashier, and so on. *We reject the use of any judgments of social value during triage.*

With respect to reciprocity, the public documents we consulted say these things:

- The California Public Health guidelines say nothing about reciprocity in general and do not contain a specific triage protocol. They do discuss the New York guidelines as "an example of standards that might be implemented during a catastrophic emergency," and as noted below, the New York guidelines reject priority for critical workers.[4]
- The CDC reports are unclear. They only note that reciprocity arguments are sometimes given by others, saying that "…some may argue that the ethical principle of reciprocity may provide ethical justification for giving priority to those who put themselves at risk during a severe pandemic (i.e., health care providers and emergency responders), especially prior to the availability of a vaccine."[3]
- The Maryland guidelines examined priority for critical workers but only on the basis of a multiplier effect, not reciprocity.[9]
- The Minnesota guidelines endorse reciprocity in general, saying "fairness requires society to protect those who take on risk on behalf of the public" (Minnesota 2020, p. 23), but then principally discuss personal protective gear and training rather than priority

for treatment. Their protocol ultimately gives some level of priority to critical workers, but the principal rationale seems to be the multiplier effect.[38]
- The New York ventilator guidelines consider priority for critical workers but only on grounds of work incentives.[7]
- The VHA guidelines consider priority to critical workers but only on grounds of a multiplier effect.[2]

These documents suggest that even if reciprocity is given some weight during the design of protocols, it should not be the principal factor. Instead, the multiplier effect should be the principal basis, if any, for giving priority to critical workers.

There are two questions to ask about the multiplier effect, one factual and the other moral. The factual question is whether saving certain individuals does, in fact, lead to saving other lives as well. Here it is important to note that the question is not whether saving any *particular* health care worker, police officer, or firefighter (etc.) will lead to others being saved. (Probably not—any one individual, in any profession, is usually dispensable or replaceable.) Instead, the question is whether a *general policy* of prioritizing some individuals will, over time, have a multiplier effect. We can lose any one or another ICU physician, but if we lose too many in the aggregate during a pandemic, more people will die.

We know of no research that attempts to measure multiplier effects during actual pandemics, although the VHA does quote troubling projections about possible shortages of health care workers during a crisis and does give priority to them for preventative measures such as vaccines.[2] We must therefore fall back on our best estimates and educated guesses, and in our estimation, it is plausible that, in some dire situations, priority to certain groups of people would, over time, have a multiplier effect.

Even if a multiplier effect exists, there is a moral question of whether its existence is *morally* relevant and should lead to priority access to scarce resources. The documents we relied upon render these conclusions:

- The VA triage criteria give no priority to critical workers because they believe it is a less justifiable a criterion than the others they selected, though they did view priority to critical workers as a “reasonable” criterion for allocation.[2] They also noted that priority to critical workers has these potential drawbacks: (a) it may violate equity and/or degrade public trust if perceived to apply too broadly, (b) it might be too difficult to define who is a “critical” worker, and (c) it would be problematic to allocate resources to critical workers who are too ill to serve in their role, even if they recover.
- The CDC reports are unclear. As noted above, they appear in some ways sympathetic to priority for critical workers, though they caution about misuse—e.g., when a healthcare worker is given higher priority for a ventilator, but is so sick that she is unlikely to recover quickly enough to help others during this pandemic.[3]
- The California Public Health guidelines say nothing about this issue in general and do not contain a specific triage protocol. They do discuss the New York guidelines as “an example of standards that might be implemented during a catastrophic emergency,” and as noted below, the New York guidelines reject priority for critical workers.[4]

- The Maryland guidelines examined priority for critical workers during public surveys but do not include that priority in their protocol.[9]
- The Minnesota guidelines endorse priority for critical workers, placing them on a separate triage track.[38]
- The New York ventilator guidelines consider and reject priority for critical workers.[7] Their concerns echo the CDC's: (a) critical workers on a ventilator are unlikely to return to their crucial occupations quickly, (b) it is difficult to determine who is a critical worker, and (c) some of the people they surveyed objected to the appearance of favoritism.

The evidence from these public documents is not consistent. However, it is notable that none of the documents which explicitly discussed the priority issue objected to priority for critical workers in principle. Instead, they raised various practical problems for putting that principle into practice. In light of this, this working group concludes that priority could potentially be given to critical workers so long as it can be done in a way that avoids or substantially mitigates the practical difficulties. Specifically, any proposal for priority critical workers would have to meet these standards:

A. The definition of "critical worker" must be clear, naming very specific job categories or circumscribing a class of individuals with enough specificity that they can be identified by those charged with employing the triage protocol.
B. There must be a plausible argument that *each* category of critical worker included in the definition would have a multiplier effect.
C. The definition of critical worker must not be overly broad, so that vast numbers of individuals are on the priority track and an objectionably small number of resources would be left for the general public. Concretely, the proposal should not have the implication that, for example, most ICU beds would be allocated only to critical workers, leaving almost none for the general public.
D. There must be a plausible argument that giving priority access to the specific resources in the proposal (e.g., ventilators, ICU beds) would allow the critical workers to return to work quickly enough to have a multiplier effect.
E. The proposal, if made public, must not be one that would evoke widespread accusations of favoritism and degrade people's trust in the medical system.

In Appendix 4, we have an included a flowchart that can help hospitals determine whether their proposed policy on critical workers meets these conditions. We employed this chart ourselves, doing our best to (a) describe a class of critical workers who would plausibly have a multiplier effect, without (b) having that definition run afoul of the pragmatic problems described by some of the public documents. Although not perfect, we believe the following is a reasonable combination of ethical and pragmatic demands:

- When critical workers are prioritized, it should be done as described in the protocol above. However, critical workers will not be prioritized if it seems highly unlikely the treatment will allow them to live and return to work during the next year.

- Critical workers are:
    - **EMTs**
    - **Police Officers**
    - **Firefighters**
    - **Critical healthcare workers, as defined below**
    - **Other individuals who, over time, might be revealed to have a multiplier effect roughly equivalent to the individuals above, given the specific way the pandemic unfolds.**

And a "critical healthcare worker" will be defined as:

- **any health care worker who (a) has been disproportionately exposed to COVID-19 through the workplace, and who works in a field that is (b) necessary for the control of the pandemic, and where in addition (c) prioritizing workers in that field is reasonably viewed as a necessary step to maintain adequate medical staffing in that field during the pandemic.** Early data out of the National Health Institute in Italy has found that 1 in 10 people infected by COVID-19 are health care workers. Attempts are currently being made across the United States to understand the proportion affected by community spread, close contacts, or work-related exposures.

This definition requires some interpretation by anyone employing it. This has the advantage that it may be interpreted in light of the particular circumstances faced by each hospital. However, those interpreting the definition must pay special attention to restriction (C) above -- the definition of critical worker must not expand so far that vast numbers of individuals are on the priority track and an objectionably small number of resources would be left for the general public. The general public cannot benefit from a 'multiplier effect' if most scarce resources are going to critical workers.
It is worth noting that, on the surface, this definition might seem to restrict the class of critical healthcare workers to those who deserve reciprocity rather than those who produce a multiplier effect, since it partly focuses on those who have taken risks in the service of the public good. However, that was not the rationale for circumscribing the class of critical healthcare workers in this way. Instead, the definition constitutes a compromise between identifying <u>all</u> healthcare workers who could realistically produce a multiplier effect while at the same time meeting the restrictions outlined above, especially restrictions C and E.

We note that the working group examined two other definitions that we considered reasonable. One would restrict the class of critical healthcare workers to those suffering from COVID-19, which could conceivably enhance public acceptance of the policy, as well as narrow the class of critical healthcare workers, should the group identified in our original definition prove unworkably large:

- A critical healthcare worker is any health care worker who (a) has been disproportionately exposed to COVID-19 through the workplace, (b) who is suffering from COVID-19, or (when diagnosis is not yet available) who is reasonably suspected of suffering from it, and who works in a field that is (c) necessary for the control of the pandemic, and where in addition (d) prioritizing workers in that field is reasonably viewed as a necessary step to maintain adequate medical staffing in that field during the pandemic.

A third definition is similar to the previous one, but contains terms that are more concrete and perhaps easier to employ in practice. It could be used if our original definition proves too vague to work in practice:

- A critical healthcare worker is someone who meets these conditions: (a) they have been disproportionately exposed to COVID-19 through the workplace, and (b) they are infected with COVID-19 or, when testing is not feasible, are reasonably suspected of having COVID-19, and (c) they participate in direct care for COVID-19 patients as part of their job.

The Multiplier Effect and Pregnancy. Pregnant persons might be seen to offer a multiplier effect, since some would argue that if we can save them and the fetus they are carrying, we are saving two lives instead of one. The documents we surveyed offer these opinions on this issue:

- The Maryland guidelines offer some priority for pregnant persons in their third trimester, so long as the mother's and fetus's prognosis for survival is not poor.[26]
- The New York guidelines state that pregnant persons should not receive special access to ventilator treatment and are instead subject to the usual adult triage procedure, though they note that pregnant persons might be prioritized for vaccines and other preventive measures.[7]
- Although there is no explicit discussion of pregnancy, the VA, CDC, and Minnesota guidelines give no priority to pregnant persons.
- The California guidelines say nothing about this issue in general and do not contain a specific triage protocol. They do discuss the New York guidelines as "an example of standards that might be implemented during a catastrophic emergency," and as noted above, the New York guidelines reject priority for pregnant persons except in the case of preventive measures.[4]

The evidence from these public documents is not entirely consistent. The majority of public documents give no priority to pregnant persons, but the Working Group also noted that multiple public sources did give *in principle* endorsement to the multiplier effect (explained above) as a basis for priority, and many people would regard the saving of pregnant persons, during at least some stages of pregnancy, as creating a multiplier effect.

In light of this, our working group examined the issue ourselves, attempting to bring to bear our guiding principles. This was perhaps the most vexed issue we discussed, and the Working Group noted that any group should takes steps to avoid imposing its own views on the significance of fetal life, since we recognize both the sharp divisions in society about this issue, as well as the disagreements among philosophical and bioethical experts. In the end, we sought the advice of medical experts on the critical care of pregnant persons, and they advised us that giving priority to pregnant persons before week 24 of pregnancy was unlikely to produce a multiplier effect, since any person at that stage of pregnancy who need the kinds of scarce resources discussed in this document were extremely unlikely to carry a fetus to term. The group therefore elected to give priority to pregnant persons only at week 24 and

after. In addition, because the rationale for giving priority to a pregnant person is the multiplier effect, no priority will be given to such persons once they have delivered.

Special Considerations for Transplant Patients. Transplant patients are selected for likelihood of survival using structured, detailed methods and receive considerable attention to prepare them for a life-saving procedure. Hospitals that house transplant programs are specially resourced and trained for these complex procedures and this expertise should be employed when available. Post-transplant patients received an organ that represents a potentially saved life. Patients who are awaiting transplant have a theoretical prognosis that is better than their underlying organ failure would confer because of the chance for full organ function with transplant—particularly for heart, liver, and lung transplantation. However, these factors must be balanced against the prognosis of a patient with acute illness without chronic organ failure. Furthermore, just allocation of resources may prioritize patients with new acute illness over patients with or slated for organ transplants because organ transplant patients have already consumed considerable health care resources, and many other patients in need might have limited access to transplant. We resolved these questions in favor of some considerations (see Part II for details) for patients who have an available organ for transplant, or who are immediately post-transplant) but not for patients awaiting transplant with no immediately available organ.

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Appendix 4: Worksheet for Examining Priority for Critical Workers

This is a flowchart designed to tell us whether a **proposal for priority to critical workers** can address the major objections found in public documents

Step 1: Formulate your proposal so that it can be examined.

- A proposal must give priority to several **categories of critical workers**. Give a precise definition of each category that is included in your proposal—e.g., "ICU Nurse," "1st-year medical student," "palliative care doctor," "home health care aide," "police officer," "researcher on COVID-19 who is not a provider," etc. Try to avoid vague categories like "healthcare worker" or "critical worker."
    - If you cannot define each of these categories precisely, then the proposal fails—start over. (To see if you have a precise definition, use this test: suppose you picked a random healthcare worker out of the hospital, could you say whether they fall into any particular category or not? If not, your categories are probably too vague.)

- A proposal must also tell us **how much priority to give to critical workers**. Define this level of priority with precision—e.g., "subtract 1 point from the triage scale," "separate track for critical workers," "tie-breaker with a triage category," etc. If you cannot define the level of priority with precision, then the proposal fails—start over.

- For reasons that will become clear, a proposal can only be evaluated against **a projection of how severe the pandemic is likely to become**. Drawing on CDC reports and other things, take your best educated guess about the likely severity as well as the possible range of possible variants.

Step 2: Determine whether the proposal has multiplier effects.

- **Taking each category of critical workers in your proposal one-by-one,** estimate as best you can what would happen if **that category** of critical workers were given the level of priority you want to assign to them.

- Also estimate what would happen if those same workers were not given priority, as best you can.
    - **NOTE:** Even if critical workers are not given priority, many will live and return to their jobs. You are trying to imagine the marginal difference between what will happen with and without priority.
- **For each category of critical worker in your proposal,** is it plausible that giving priority to those workers has a multiplier effect—i.e., saving those critical workers allows additional people to be saved as well?
    - If no, then the proposal fails—start over.

Step 3: Determine whether the proposal is overly broad.

- New York objected that some definitions of "critical worker" are so broad that massive numbers of people will be "critical workers," effectively putting vast number of people on a priority track and leaving an objectionably small number of resources for the general public.

- Does your definition have this problem? (E.g., if we enacted your proposal, would most of the ICU now be filled with critical workers?)
    - If yes, then the proposal fails—start over.

Step 4: Determine whether the proposal offers priority to the wrong things.

- Some public documents object that giving priority to certain **kinds of treatment**—e.g., ventilators—cannot have a multiplier effect, since critical workers who need vents are unlikely to recover well enough to produce a multiplier effect

- Using your best educated guesses about the extent and nature of the pandemic, ask of each resource that you are prioritizing: are critical workers receiving priority to **those specific resources** unlikely to be able to return to work quickly enough to have a multiplier effect?
    - If yes, then the proposal fails—start over.

Step 5: Determine public response.

- Ask yourself: if this proposal were made public on the front page of the Los Angeles Times and San Francisco Chronicle, would it evoke widespread accusations of favoritism and degrade people's trust in the medical system?
    - If yes, then the proposal fails—start over.

If you have reached this step, then the proposal has overcome all the major objections in public documents. It is a **candidate** for adoption.

- If multiple proposals pass, then one must be picked using other criteria—presumably including which one is likely to produce the greatest multiplier effect.

Appendix 5: Ventilation and Mortality Considerations with COVID-19 Patients

Endotracheal intubation and mechanical ventilation are used to treat respiratory failure—often categorized as hypoxemic or hypercapnic respiratory failure, or a combination of the two. The procedures may also be undertaken to ensure airway protection in the absence of significant pulmonary disease, such as with severe, acute neurologic or metabolic processes. With the exception of elective surgeries, endotracheal intubation is generally performed as an emergent or urgent procedure to prevent the life-threatening complications of hypoxemia and acidemia.

Based on the published data, approximately 15-20% of patients hospitalized for COVID-19 disease will meet the definition of severe or critical disease—as defined by the 2019 American Thoracic Society guidelines on community acquired pneumonia. [Wu Z, et al. Characteristics of and Important Lessons from the Coronavirus Disease 2019 (COVID-19) Outbreak in China Summary of a Report of 72 314 Cases from the Chinese Center for Disease Control and Prevention. JAMA. Feb 24 2020.] Upwards of 16% of all hospitalized patients with COVID-19 may require ICU admission. [Grasselli, et al. Critical Care Utilization for the COVID-19 Outbreak in Lombardy, Italy. JAMA. 2020.] Respiratory failure is a common occurrence with severe COVID-19 disease with 39% of those patients requiring mechanical ventilation, including 14% requiring invasive mechanical ventilation. [Guan W, et al. Clinical Characteristics of Coronavirus Disease in 2019 in China. NEJM. 2020] Severity of disease, ICU utilization rates, and the use of mechanical ventilation may be influenced by several factors including, healthcare delivery systems, and the age distribution and prevalence of comorbid conditions in affected patient populations.

Data regarding survival and other outcome measures for patients with severe COVID-19 disease, particularly those who require mechanical ventilation, is limited. A small (and ongoing) cohort of critically ill patients from Washington state (n=21) reveals a mortality rate of 50%, thus far. However, 8 of those patients are still mechanically ventilated with a mean follow up of only 7.5 days. 2 patients (10%) have thus far survived to discharge from the ICU.[Arentz, M, et al. Characteristics and Outcomes of 21 Critically Ill Patients With COVID-19 in Washington State. JAMA. February 24, 2020.] Patients and their advocates should be counseled on our most up to date understanding of potential outcomes associated with disease severity and potential interventions.

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Appendix 6: Sample Guidelines for ECMO/ECLS Indications and Contraindications in Adult COVID-19 Patients

Background:
A subset of COVID-19 patients present with severe pneumonia and can rapidly develop ARDS. ECMO/ECLS is an invasive and resource-intensive therapy that has been used successfully in the treatment of ARDS in previous influenza virus epidemics, suggesting that it may have the potential to benefit select patients with COVID-19. However, there is limited clinical experience in using ECMO/ECLS for ARDS in the setting of COVID-19, and details about the natural course of the infection, late complications and chances of pulmonary recovery remain unknown. Additionally, resources for the administration of ECMO/ECLS may become limited in the setting of this pandemic, and risk of COVID-19 exposure to healthcare personnel administering ECMO is substantial.

The use of ECMO/ECLS can be considered in carefully selected patients as outlined below.

Indications:
The primary indication for ECMO/ECLS in COVID-19 will be acute respiratory failure requiring VV-ECMO. A subset of patients have developed concurrent cardiomyopathy resulting in cardiogenic shock. Because the latter group of patients have thus far had poor outcomes, evaluation for VA-ECMO will be extremely selective.

1. VV ECMO: Acute respiratory failure
    a. Severe hypoxemia - PaO_2/FiO_2 <100 for >6 hours despite optimal care
        i. Lung protective ventilation – P_{plat} <30 cmH_2O and VT <6 ml/kg PBW
        ii. Higher PEEP attempted (unless contraindicated)
        iii. Persistent hypoxemia despite use of <u>BOTH</u> of the following adjunctive therapies:
            1. neuromuscular blocking agents
            2. prone positioning

AND/OR:

    b. Severe CO_2 retention/ hypercapnia with refractory acidosis (pH <7.25) despite optimal lung protective ventilation – P_{plat} <30 cmH_2O and VT <6 ml/kg PBW for >6 hours.

2. VA ECMO: Heart failure / cardiogenic shock
    a. Heart failure / Cardiogenic shock refractory to conventional medical management:
        i. SBP <85, MAP<55, CI <1.8 on <u>≥</u> 2 of the following:
            1. Dopamine > 15 mcg/kg/min
            2. Dobutamine > 15mcg/kg/min
            3. Epinephrine > 0.05 mcg/kg/min
            4. Norepinephrine > 0.3 mcg/kg/min
            5. Vasopressin > 2 u/h

AND:

    b. Signs of systemic hypoperfusion

i. Worsening metabolic acidosis
ii. Rising lactate
iii. New onset of organ dysfunction:
    1. Oliguric/anuric renal failure
    2. Acute liver failure

Contraindications:

Patients with any of the contraindications noted below have a higher risk of poor outcome but may be deemed acceptable ECMO/ECLS candidates in rare, carefully evaluated cases. See general guidelines for resource allocation if a scarcity of ECMO equipment and providers exists.

- Age > 60
- Severe neurologic injury
- Ongoing or recent cardiac arrest
- Aortic dissection, severe peripheral vascular disease, severe aortic insufficiency (in cases of VA-ECMO)
- CNS or other major hemorrhage
- Mechanical ventilation >7days
- Underlying pulmonary disease requiring chronic use of O2
- Immunodeficiency
- History of ESRD on chronic hemodialysis
- Advanced liver disease
- Advanced shock with multiorgan failure

Appendix 7: Broader Community: Regional Coordination and Collaborating with Departments of Public Health

There are a number of reasons for individual institutions, or a set of academic medical centers, to be concerned about the approaches across the community to allocation of scarce resources in the setting of a pandemic crisis. First, states (ref NY, MD and the many others) or other broad regions may enact allocation strategies that may direct or guide the policies of individual facilities. Second, crisis allocation mechanisms will often propose to suspend institutional policy due process rules and maybe contradict state or local law. For instance, in California clinicians must facilitate transfer to another provider willing to provide a refused treatment. What is the significance of this rule in the setting of no available beds? Is it suspended by virtue of infeasibility? Similarly Medicare appeal processes will be violated by most crisis allocation mechanisms. Additionally, many institutions have due process provisions within hospital policies that will need to be suspended in the crisis standards of care. Whether these rules are enacted by a regional set of institutions or across a state has implications for the legal risks and willingness of institutions and providers to adhere to triage policies. Thirdly, the principle of justice demands that similar cases be treated similarly. If a patient at one facility is subjected to triage rules while another at a nearby institution is not, this is not only unjust, but will promote hospital shopping and may cause wasteful transfers. Lastly, if a common set of allocation criteria exist across institutions, these are easier for the public to digest and this will facilitate public understanding of the rules, leading to greater transparency.

In California, individual hospitals began working on developing pandemic policies soon after it became clear that COVID-19 was spreading beyond China. Many institutions had prior policies from the H1N1 epidemic and experience with Ebola. Much early policy work adopted schemas from the IOM principles and statewide model policies such as New York. In several regions institutions worked together to try to build similar policies. For example, in southern California, more than fifty institutions participated in SCBCC meetings reviewing principles and individual institutions' policies. Most of these facilities focused on multi-principle prioritization system from University of Pittsburgh.[14] During this period, there was interest in working with state and local departments of public health. Policy generation appeared to develop more quickly at the individual institutional level than at the state level in California.

Appendix 8: Clinical Decision Support Tools for Triage Allocation

Table 13: Glasgow Coma Scale

Criteria	Description	Score
Best Eye Response (1-4)	No eye opening	1
	Eye opens to painful stimulus	2
	Eye opens to verbal command	3
	Eye opens spontaneously	4
Best Verbal Response (1-5)	None	1
	Incomprehensible sounds	2
	Inappropriate words	3
	Confused	4
	Oriented	5
Best Motor Response (1-6)	No motor response	1
	Extension to painful stimulus	2
	Flexion to painful stimulus	3
	Withdraws from painful stimulus	4
	Localized to painful stimulus	5
	Obeys commands	6

Table 14: Trauma Score System (Boyd et al,, 1987)

Parameter	***Points***
Respiratory rate	
10-24	*4*
25-35	*3*
>35	*2*
0-9	*1*
Respiratory effort	
Normal	*1*
Shallow, retractive	*0*
Systolic Blood Pressure	
>90	*4*
70-90	*3*
50-69	*2*
<50	*1*
No carotid pulse	*0*
Capillary refill	
Normal	*2*
Delayed	*1*
Absent	*0*
Glasgow Coma Scale	
14-15	*6*
11-13	*5*
8-10	*4*
5-7	*3*
3-4	*1*

Table 15: Trauma Injury Severity Score Survival Probabilities (Boyd et al., 1987, Domingues et al., 2018)

Trauma Score	***Probability of Survival***
16	*99%*
15	*98%*
14	*95%*
13	*91%*
12	*83%*
11	*71%*
10	*55%*
9	*37%*
8	*22%*
7	*12%*
6	*7%*
5	*4%*
4	*2%*
3	*1%*
2	*0%*
1	*0%*

Table 16: Hunt-Hess Scale for Intracranial Hemorrhage

Criterion	Grade
Asymptomatic, mild headache, slight nuchal rigidity	1
Moderate to severe headache, nuchal rigidity, no neurologic deficit other than cranial nerve palsy	2
Drowsiness or confusion, mild focal neurologic deficit	3
Stupor, moderate to severe hemiparesis	4
Coma, decerebrate posturing	5

Table 17: American Burn Association mortality estimates (Taylor et al., 2014)

Age (yrs)	Burn Size (% total body surface area)									
	0-10%	11-20%	21-30%	31-40%	41-50%	51-60%	61-70%	71-80%	81-90%	91%+
5.0 - 19.9	Out-patient	Very high	Very high	High	High	High	Medium	Medium	Medium	Low
20.0 - 29.9	Out-patient	Very high	Very high	High	High	Medium	Medium	Medium	Low	Low
30.0 - 39.0	Out-patient	Very high	Very high	High	Medium	Medium	Medium	Medium	Low	Low
40.0 - 40.9	Out-patient	Very high	Very high	Medium	Medium	Medium	Medium	Low	Low	Low
50.0 - 59.9	Out-patient	Very high	Very high	Medium	Medium	Medium	Low	Low	**Low/ Expectant**	**Low/ Expectant**
60.0 - 60.9	Very high	Very high	Medium	Medium	Low	Low	Low	**Low/ Expectant**	**Low/ Expectant**	**Low/ Expectant**
70.0 +	Very high	Medium	Medium	Low	Low	**Low/ Expectant**	**Expectant**	**Expectant**	**Expectant**	**Expectant**

Outpatient: Survival and good outcome expected, without requiring initial admission.
Very high: Survival and good outcome expected with limited/short-term initial admission and resource allocation (straightforward resuscitation, length of stay < 14 – 21 days, 1 – 2 surgical procedures).
High: Survival and good outcome expected (survival ≥ 90%) with aggressive and comprehensive resource allocation, including aggressive fluid resuscitation, admission ≥ 14 – 21 days, multiple surgeries, prolonged rehabilitation.
Medium: Survival 50 – 90% and/or aggressive care and comprehensive resource allocation required, including aggressive resuscitation, initial admission ≥ 14 – 21 days, multiple surgeries and prolonged rehabilitation.
Low: Survival < 50% even with long-term aggressive treatment and resource allocation.
Expectant: Predicted survival ≤ 10% even with unlimited aggressive treatment.

Table 18: Modified Rankin Scale (Wilson et al., 2002)

The Modified Rankin Scale and Corresponding Sections of the Structured Interview

Modified Rankin Scale[3]	Structured Interview for the Modified Rankin Scale
5=Severe disability: bedridden, incontinent, and requiring constant nursing care and attention.	5=Severe disability; someone needs to be available at all times; care may be provided by either a trained or an untrained caregiver. Question: Does the person require constant care?
4=Moderately severe disability: unable to walk without assistance, and unable to attend to own bodily needs without assistance.	4=Moderately severe disability; need for assistance with some basic ADL, but not requiring constant care. Question: Is assistance essential for eating, using the toilet, daily hygiene, or walking?
3=Moderate disability; requiring some help, but able to walk without assistance.	3=Moderate disability; need for assistance with some instrumental ADL but not basic ADL. Question: Is assistance essential for preparing a simple meal, doing household chores, looking after money, shopping, or traveling locally?
2=Slight disability; unable to carry out all previous activities but able to look after own affairs without assistance.	2=Slight disability; limitations in participation in usual social roles, but independent for ADL. Questions: Has there been a change in the person's ability to work or look after others if these were roles before stroke? Has there been a change in the person's ability to participate in previous social and leisure activities? Has the person had problems with relationships or become isolated?
1=No significant disability despite symptoms; able to carry out all usual duties and activities.	1=No significant disability; symptoms present but not other limitations. Question: Does the person have difficulty reading or writing, difficulty speaking or finding the right word, problems with balance or coordination, visual problems, numbness (face, arms, legs, hands, feet), loss of movement (face, arms, legs, hands, feet), difficulty with swallowing, or other symptom resulting from stroke?
0=No symptoms at all.	0=No symptoms at all; no limitations and no symptoms.

Table 19: Clinical Frailty Scale (McDowell, Xi, Lindsay, & Tuokko, 2004; Rockwood et al., 2005)

Score	Description
1 – Very Fit	People who are robust, active, energetic, and motivated. These people commonly exercise regularly. They are among the fittest for their age.
2 – Well	People who have no active disease symptoms but are less fit than category 1. Often, they exercise, or are very active occasionally
3 – Managing well	Medical problems are well controlled, but not regularly active beyond routine walking
4 – Vulnerable	Not dependent on others for daily help, but symptoms limit activities. Common complaints include being slowed up and/or tired during the day
5 – Mildly frail	More evident slowing; need help in high-order IADLs. Impairs shopping and walking outside the home, meal preparation, and housework.
6 – Moderately frail	Need help with all outside activities and keeping house. Often have problems with stairs, need help with bathing, may need minimal assistance with dressing.
7 – Severely frail	Completely dependent for personal care, from whatever cause (physical or cognitive). Even so, they seem stable and not at high risk of dying within 6 months.
8 – Very severely frail	Completely dependent for personal care, approaching end of life. Typically, they could not recover even from a minor illness
9 – Terminally Ill	Approaching the end of life. This applies also to those with a life expectancy of < 6 months who are not otherwise evidently frail.
N.B on scoring frailty in dementia: Degree of frailty corresponds to degree of dementia. **Mild**: Forgetting details of recent event, but remembering the event itself, repeating same question/story, social withdrawal **Moderate**: recent memory is very impaired, even though they seemingly can remember their past life events well. Can do personal care with prompting. **Severe**: Cannot do personal care without help.	

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