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Design for Implementation of a System-Level ICU Pandemic Surge Staffing Plan

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Background: The current coronavirus disease 2019 pandemic is causing significant strain on ICUs worldwide. Initial and subsequent regional surges are expected to persist for months and potentially beyond. As a result of this, as well as the fact that ICU provider staffing throughout the United States currently operate at or near capacity, the risk for severe and augmented disruption in delivery of care is very real. Thus, there is a pressing need for proactive planning for ICU staffing augmentation, which can be implemented in response to a local surge in ICU volumes.

Methods: We provide a description of the design, dissemination, and implementation of an ICU surge provider staffing algorithm, focusing on physicians, advanced practice providers, and certified registered nurse anesthetists at a system-wide level.

Results: The protocol was designed and implemented by the University of Pittsburgh Medical Center's Integrated ICU Service Center and was rolled out to the entire health system, a 40-hospital system spanning Pennsylvania, New York, and Maryland. Surge staffing models were developed using this framework to assure that local needs were balanced with system resource supply, with rapid enhancement and expansion of tele-ICU capabilities.

Conclusions: The ICU pandemic surge staffing algorithm, using a tiered-provider strategy, was able to be used by hospitals ranging from rural community to tertiary/quaternary academic medical centers and adapted to meet specific needs rapidly. The concepts and general steps described herein may serve as a framework for hospital and other hospital systems to maintain staffing preparedness in the face of any form of acute patient volume surge.

Key Words: advanced practice providers; coronavirus disease 2019; disaster; pandemic; staffing; workforce

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In 2012, the National Academies of Science released the Crisis Standards of Care to provide hospitals with a framework for designing and implementing disaster response plans (1). This guidance was the culmination of several years of work examining the H1N1 pandemic, as well as other infectious and natural disasters, which have the potential to overwhelm communities and hospital systems, even those considered well-prepared. Subsequently, medical and surgical professional societies have provided special hospital recommendations for preparedness in the case of mass casualty events (2–7). In 2017, the Centers for Disease Control and Prevention along with the Department of Health and Human Services, seeking to standardize approaches, released an updated National Influenza Pandemic Preparedness Plan that identified essential domains facilities must address to prepare for future pandemic events (8). Among many items addressed, the document provided significant guidance for health system preparedness promoting implementation of surge strategies so that patients receive care that is safe and appropriate to their level of need, thereby conserving higher levels of care for those who need it.

Many types of mass casualty events, such as natural disasters, terrorist attacks, manufacturing or industrial accidents, and infectious pandemics, much like the current coronavirus disease 2019 (COVID-19) outbreak, will likely result in overwhelming numbers of critically ill patients (3). These events create surges in patient volumes that can rapidly supersede baseline bed and staffing capacities and capabilities. This, in turn, may require responses ranging from minor augmentations to a full-scale crisis response. Recognizing the uniqueness of individual hospitals regarding physical space, geographic location, and baseline staffing models, it is likely that an internal discrepancy may emerge between local bed capacity and provider staffing capacity and capabilities, especially in the ICUs in the management of critically ill patients. Vital to developing a response to the surge in patient volumes is the ability to determine staffing and space capacity, inclusive of reallocation and augmentation of both space and staff. Equally important is the need to assure that the plans for bed capacity augmentation are matched by a proportional expansion of provider capacity.

In March 2020, the Society of Critical Care Medicine (SCCM) conducted a nationwide survey of over 150,000 critical care professionals to assess ICU preparedness in light of the COVID-19 pandemic. Nearly all respondents reported that they had significant concerns about their institution's preparedness, and over half reported expecting or already experiencing staff shortages (9). Thus, there clearly is a pressing need for critical care disaster planning. With a focus on ICU staffing and spatial needs, drawing on the frameworks previously described by both SCCM and the American College of Chest Physicians for disaster planning, we present a system-wide algorithm for optimizing provider staffing needs for ICUs to align with parallel processes for bed capacity and nursing staffing expansion. This article describes the process undertaken to develop and implement the plan for leveraging system resources and augmenting staffing capabilities in response to the COVID-19 related surge throughout the University of Pittsburgh Medical Center (UPMC) system, comprised of 40 community and academic hospitals. It is our hope that this document may serve as a model framework to assist hospital systems in provider staffing (including physicians, advanced practice providers [APPs], certified registered nurse anesthetists [CRNAs]), to assure effective, efficient, and quality care throughout the protracted COVID-19 pandemic and other potential surge events.

MATERIALS AND METHODS

Vital to our initiative, a steering committee was initially assembled to identify the resources provided by various critical care professional societies to guide the creation of our framework. We then designed a strategy prompting individual hospitals within the system to define their current state of operations; identify any critical care resource needs; and create a bed capacity plan to accommodate escalated patient volumes. With this information, we briefed local hospital leadership on this framework, prompting the development of a staffing model for their facility optimizing local resources while simultaneously identifying potential gaps that could be augmented by mobilizing system resources, especially in the instances of staff illness or quarantine.

Steering Committee

Key stakeholders were identified and a core steering team was constructed with the following structure: physician representation from critical care medicine (CCM) and system-wide capacity management; senior leadership from anesthesia and CRNAs; system-level executive APPs leadership; and representation from the UPMC ICU Service Center. This center coordinates critical care services across the entire hospital system, focusing on optimizing care delivery and resource utilization, improving patient and family experiences, expansion of telemedicine, and establishment of tertiary-level critical care for underserved populations.

Surge Plan Document Development

As a first step in creating a plan toward augmenting both space and staff, it became necessary to identify the spectrum of surge capacity. This is depicted in **Figure 1**, an illustration of the escalating imbalance between demand and supply of available resources as an event moves closer to crisis level. Additionally, preparedness requires planning for surge capacity of staff, ICU space, and supplies across that spectrum of disaster severity from conventional to contingency and to crisis (**Fig. 2**).

Considering these defined tiered approaches, it was recognized that the current COVID-19 required a similarly tiered approach for staffing and spatial needs that would optimally allow hospitals to adapt to rises in patient volume and demands for ICU bed capacity. The SCCM provides an effective model to incorporate non-ICU trained staff of all disciplines (physicians, nurses, APPs, and others) to greatly augment the trained and experienced ICU staff in creation of a tiered staffing model. The SCCM model also projects that a critical care-trained physician technically should be able to oversee four groups of 24 patients each, all requiring ICU-level care and/or mechanical ventilation (**Fig. 3**). Various other non-ICU physicians who have had prior training but do not regularly provide primary care in ICU settings, coupled with experienced ICU APPs, can be used to make such care effective. The use of telemedicine critical care services was integral to our proposed surge critical care staffing plan. Critical care support can be supplemented and supported by using remote telemedicine critical care services, if available. For COVID-19 patients, in general, significant personal protective equipment and specialized training is required. Additionally, those requiring ICU-level care and mechanical ventilation as a result of severe pneumonia and a form of acute respiratory distress syndrome demand many more human and materiel resources, further putting strain on already finite staffing levels.

Thus, we asked each hospital ICU team to develop contingency plans for potential staffing deficiencies while also acknowledging the more-involved care needs of these ICU-level patients. By first defining baseline patient to caregiver ratios, it simplified the task of determining when surge volumes supersede caregiver capabilities, prompting action to augment care delivery. With an appropriate tiered augmentation plan, teams could effectively match capabilities with volumes.

Framework Design

Our first recommendation to each facility was to identify current staffing resources. We classified all critical care providers currently providing care in ICUs, as well as telemedicine critical providers as "tier I" providers. All other airway capable providers as well as those with prior critical care training, experience, and skills, as well as nonairway providers that are ICU-capable providers (i.e., APPs), we classified as "tier II" providers. Last, those providers who do not have previous critical care or acute experience or skills were classified as "tier III" providers. A separate classification that we identified as a "flex" tier would be those

Level	COVID Status (pending + high risk)	Capacity	What?	Action Steps	ICU Telemedicine
1	-	<100%	Prepare	Identify COVID care locations and assess potential alterations in workflow	Plan
2	+	<100%	Cohort	Assess team structures and consider reassigning APPs (+/- medical trainees); consider telemedicine capabilities	Plan
3	+	100%-120%	Creative Space & Staff	Optimize patient ratios; Optimize Tier II providers; Identify potential Tier III providers; Provide educational resources for Tier II and III providers; Consider procedure team; **Explore telemedicine for Tier I support**	+
4	+	120%-200%	Augment Staffing	Activate Tier II and III providers to expand capabilities; Modify documentation requirements of Tier I providers; Provide further education and training; Identify gaps that may need central staffing mobilization; Investigate intrasystem transfer to balance system capcity; **Initiate telemedicine to expand Tier I capabilities**	++
5	+	>200%	Further Augment Staffing	Maximize all tier I, II, III providers; Limit documentation requirements; Institute mandated shift work (12 on-12 off); Continuous contact with centralized staffing to support further augmentation; **Optimize Telemedicine**	+++

Figure 1. Coronavirus disease 2019 (COVID-19) surge capacity working definitions. Adapted from Crisis Standards of Care (1). APP = advanced practice provider.

Decreasing ← Morbidity and Incident demands → Increasing

	Conventional	Contingency	Crisis
Space	Usual patient care spaces maximized	Patient care areas re-purposed (PACU, monitored units for ICU-level care)	Non-traditional areas used for critical care or facility damage does not permit usual critical care
Staff	Additional staff called in as needed	Staff extension (supervision of larger number of patients, changes in responsibilities, documentation, etc')	Insufficient ICU trained staff available/unable to care for volume of patients, care team model required & expanded scope
Supplies	Cached/on-hand supplies	Conservation, adaptation and substitution of supplies with selected re-use of supplies when safe	Critical supplies lacking, possible allocation/reallocation or lifesaving resources
Standard of care	Usual care	Minimal impact on usual patient care practices	Not consistent with usual standards of care (Mass Critical Care)
ICU expansion goal	X 1.2 usual capacity (20%)	X 2 usual capacity (100%)	X 3 usual capacity (200%)
Resources	Local	Regional/State	National

Normal ← Operating Conditions → Extreme

Figure 2. A framework for outlining, contingency, and crisis surge response. Reprinted from Christian et al (5). PACU = post-anesthesia care unit.

who might comprise a procedure team: providers with skill sets in intubation, bronchoscopy, central line insertion, arterial line insertion, prone positioning, etc.

Once these staffing tiers were identified and organized, we developed a surge plan utilizing clinical experience caring for COVID-19 patients early in the pandemic, in addition to expert

Figure 3. In this model, care for each of four groups of 24 patients is provided by a team managed by a critical care-trained physician. Our tired staffing tool focuses on the top two provider level layers of the above pyramid (inclusive of the critical care physician level). Reproduced with permission from Halpern and Tan (10). Copyright© 2020 the Society of Critical Care Medicine. APP = advanced practice provider, CAA = certified anesthesiology assistant, CRNA = certified registered nurse anesthetist, DO = doctor of osteopathic medicine, MD = medical doctor, RT = respiratory therapist.

opinion. Based on a review of the literature as well as experience, our steering committee came to a consensus that a single tier I provider either as a remote telemedicine resource or on-site should be able to provide oversight care for 7–12 COVID-19 positive patients alone or with the help of a dedicated procedure team. Once that initial threshold is reached, tier II providers should be added until a second threshold reached. We identified that with the assistance of two tier II providers, a tier I provider could be able to provide oversight care for up to 16 COVID-19 ICU-level patients (two tier II providers caring for up to eight patients each). Once a second threshold of 16 patients has been reached, an additional eight-patient team may be added for the ultimate threshold for a single tier I provider of 24 patients.

By the time the second patient threshold of 16 patients is reached, it is recommended to consider activating tele-ICU support to serve as an expert resource. Furthermore, each tier II provider teams can be supplemented by adding a tier III provider, able to care for up to four COVID-19 positive patients under the direct supervision of a tier II provider and indirect oversight of a tier I provider. Once the ultimate threshold of 24 patients has been reached, additional tier I providers (either remotely or on-site) must be added to extend the algorithm based on patient volumes. A pictorial representation of the algorithm is provided in **Figure 4**. As not every hospital in the system has trainees, we purposefully excluded them to ensure this framework could be employed at each location. Clearly, house-staff can be used interchangeably with tier II and tier III providers based upon their specialty and level of competence.

We feel that a flexible, easily scalable, on-demand real-time, ICU telemedicine service is an integral component of surge staffing, particularly given the uncertainties of critical care individual provider services during an ever-changing pandemic. This design is very consistent with previously described approaches to ICU telemedicine, which emphasizes customizing the telemedicine service to local contexts, that is, prioritizing the human (rather than the technological) side of the telemedicine encounter. The work by Kahn et al (11–13) largely suggests that the value of telemedicine is highly sensitive and dependent on implementation strategy, a concept that we fully embraced in our process of surge planning.

Implementation

The UPMC hospital system comprises 40 rural, community, and tertiary/quaternary hospitals. Senior leadership participating in bed capacity management and surge planning at each facility (including chief medical officers and chief nursing officers) were identified and contacted. Initial meetings between the hospital personal and steering committee members were conducted where the needs of facilities and status of preparations were elucidated, the process was explained, and the algorithm was provided. Follow-up meetings were subsequently usually held within 48 hours to evaluate the development of surge planning from each facility.

Parallel processes were designed and implemented for nursing and other essential bedside providers across the system, and this is not discussed in this article since this was not the primary mission of our steering committee. An APP operations team was established to support the core mission of the UPMC Central Workforce Staffing Center (CWSC) in developing strategy to support the needs for APP staff for all UPMC clinical and nonclinical areas in response to patient care surge related to COVID-19. The CWSC APP operations section provides 24/7 support for staffing needs not filled within the local business unit. Further, the Operations team ensures practice readiness through emergency disaster credentialing, just-in-time critical care training, in-patient electronic health record training, and matching appropriate practice experience and skillset with need. Once the appropriate specialty or practice is determined, deployment of the identified APP resource is pertinent to geographic proximity to facility as well as credentialing and privileging. Requests are processed relative to

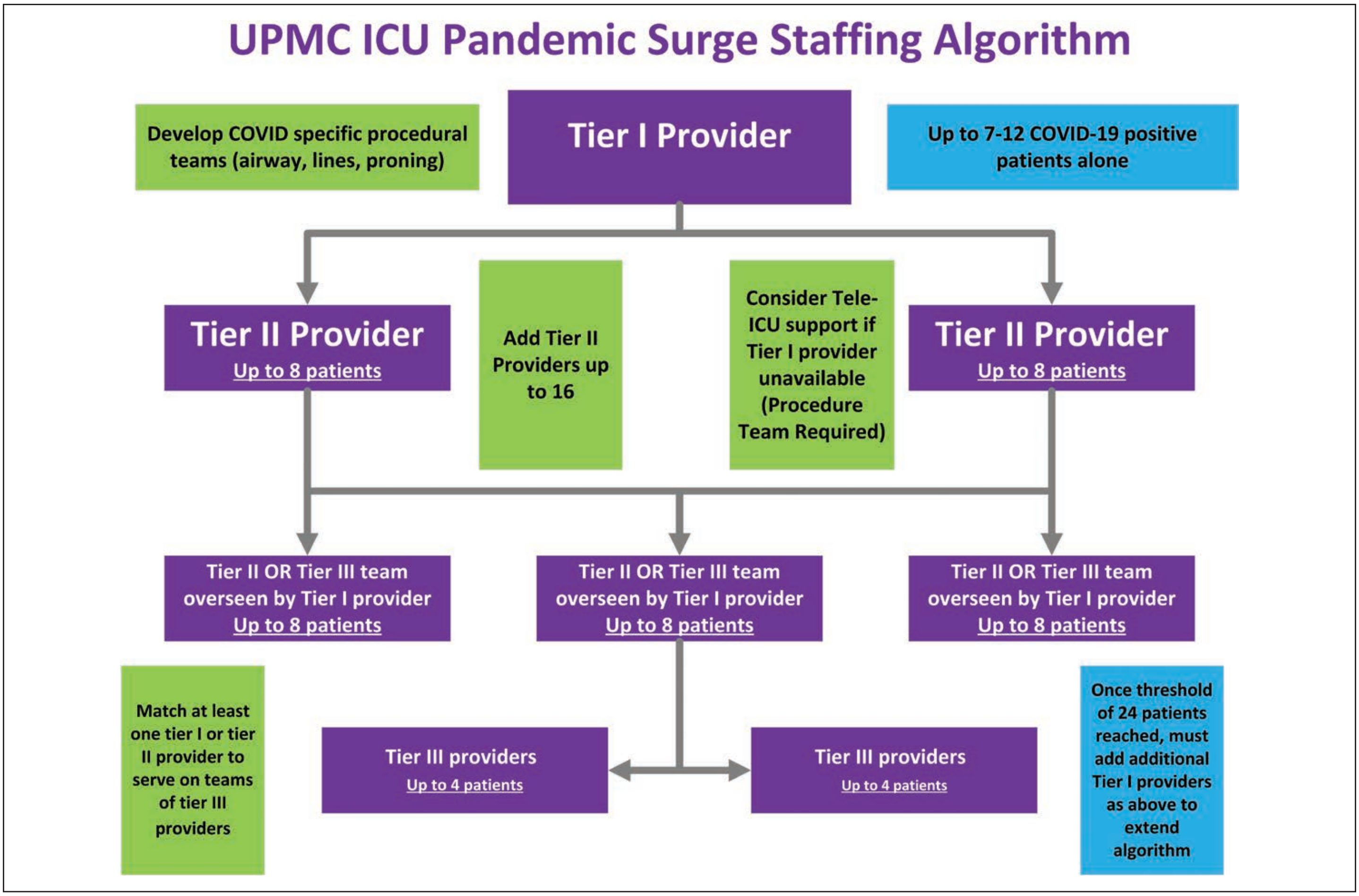

Figure 4. The University of Pittsburgh Medical Center (UPMC) ICU pandemic surge staffing algorithm. COVID-19 = coronavirus disease 2019.

need (emergent, urgent, and nonurgent) and processed with an APP resource that best possess requested acute care/critical care skills or specialty practice experience.

Recognizing that reassignment of tier II and tier III providers from non-ICU care platforms to the ICU in support of the described tiered staffing model presents a challenge of bridging knowledge gaps, our committee elected to provide all APPs throughout the system, as well as hospital leadership teams, the resources assembled by the SCCM specifically tailored to address critical care for the non-ICU clinician (14). These valuable resources provided non-ICU providers with the just-in-time training and resources needed to allow them to seamlessly move into the ICU and provide direct patient care services under the supervision of more experienced tier I and tier II providers.

Because almost half (47.5%) of those surveyed in SCCM's COVID-19 preparedness report stated that their ICUs were not equipped with a telemedicine system to help manage COVID-19 patients, this was also identified as a critical pillar of care. Additionally, tele-support services could offset the on-site workload, freeing up critical care-trained professionals to perform procedures and to oversee more patients. UPMC's tele-ICU services were thus robustly created and rapidly expanded using a shared electronic health record and telephonic communication, in the initial absence of an integrated telemedicine infrastructure.

RESULTS

UPMC has 40 hospitals throughout Pennsylvania, New York, and Western Maryland. It has a bed capacity of roughly 5,500, and a baseline ICU bed capacity of 750 beds with the potential to expand to approximately 1,500. As a result of the COVID-19 outbreak, rapid dissemination of our surge staffing plan to all facilities was essential, and requests from individual hospital leadership throughout the system for assistance with provider surge planning were substantial. Initially, each of the system's hospitals were required to create a bed capacity plan to accommodate a patient surge of two-fold or an increase to 200% of their baseline capacity. This space plan allowed our team to guide each hospital leadership team through the process of generating a plan for ICU provider staffing using the above model. The concept of a standardized guide for individual facilities to adapt based on their own local resources and identified needs was well received. A myriad of baseline staffing arrangements were encountered throughout the system. The models ranged from full-time intensivist coverage with a full complement of resident and fellow-level trainees, to daytime intensivist accompanied by around the clock APP coverage with nighttime tele-ICU support, to a high-intensity critical care consultation model in support of hospitalists and surgeons acting in the primary role. Our steering committee framed each staffing model using the described tiered model and then assisted in building out the staffing surge plan by identifying local and potential system staffing resources. When gaps were recognized in local staffing capacity, centralized plans were developed to augment individual facilities, whether that included augmentation of existing tele-ICU capabilities, deployment of critical care-trained APPs, or providing training to non-ICU providers, as tier III providers. Application of a standardized framework throughout the system allowed for simultaneous monitoring of patient volumes and targeted deployment of tiered staffing resources to match the individual hospital needs while balancing system demand.

Figure 5 is a representation of the surge plan that was designed for one of our community facilities. Baseline capacity and surge plan were established. Staffing model was categorized using the standardized framework. Tier I providers consisted of daytime intensivist with nocturnal tele-ICU support. Tier II care consisted of resident coverage, both day and night, augmented by procedural support at night by anesthesiology. Due to concurrent inpatient pulmonary responsibilities and the presence of established infrastructure to provide tele-ICU care, it was determined that surge staffing would consist of tele-ICU to provide both daytime and nighttime tier I coverage of the expansion unit. Residents' limited number of ICU rotations and concurrent clinical responsibilities precluded an expanded resident model from being generated. A gap was identified that would require tier II staffing from centralized staffing to augment capabilities in the setting of a surge in patient volumes or self-quarantine due to COVID-19 exposure or illness. APPs could be deployed to provide tier II and tier III support, as volumes demanded. Last, a potential need in procedural coverage was identified that could be augmented by local CRNAs or gap-filled with centralized staffing, if needed.

A disaster preparedness credentialing and privileging process allowing providers to move between UPMC-system hospitals and provide on-site critical care coverage or deliver telemedical care within the system rapidly was quickly developed and implemented. Providers privileges from their primary patient care location were extended throughout the system allowing for rapid activation of credentials to facilitate the deployment of provider workforce.

In the early weeks of this pandemic, a robust COVID-19 specific tele-critical care system was designed to augment existing tele-ICU infrastructure. Intensivists have been staffed 24 hours per day within the UPMC Operations Center, manning telephones with video-response for any of the UPMC hospitals. This design drew on the high density of tier I critical care providers located within the Pittsburgh-based academic medical centers from the Departments of CCM and Pulmonary, Allergy, and Critical Care. Volunteers from the two departments provided seamless coverage to respond to calls for assistance and guidance for critical care issues related to the COVID-19 outbreak.

As the volumes associated with the COVID-19 pandemic varied between hospitals and within hospitals over time, this provider staffing plan became the standard by which UPMC hospitals identify specific needs and the system responds to augment provider staffing. This consistency of terminology and role-definition provided an opportunity for rapid deployment of resources that met the individual needs of each situation, especially given the uniqueness of each hospital and situation.

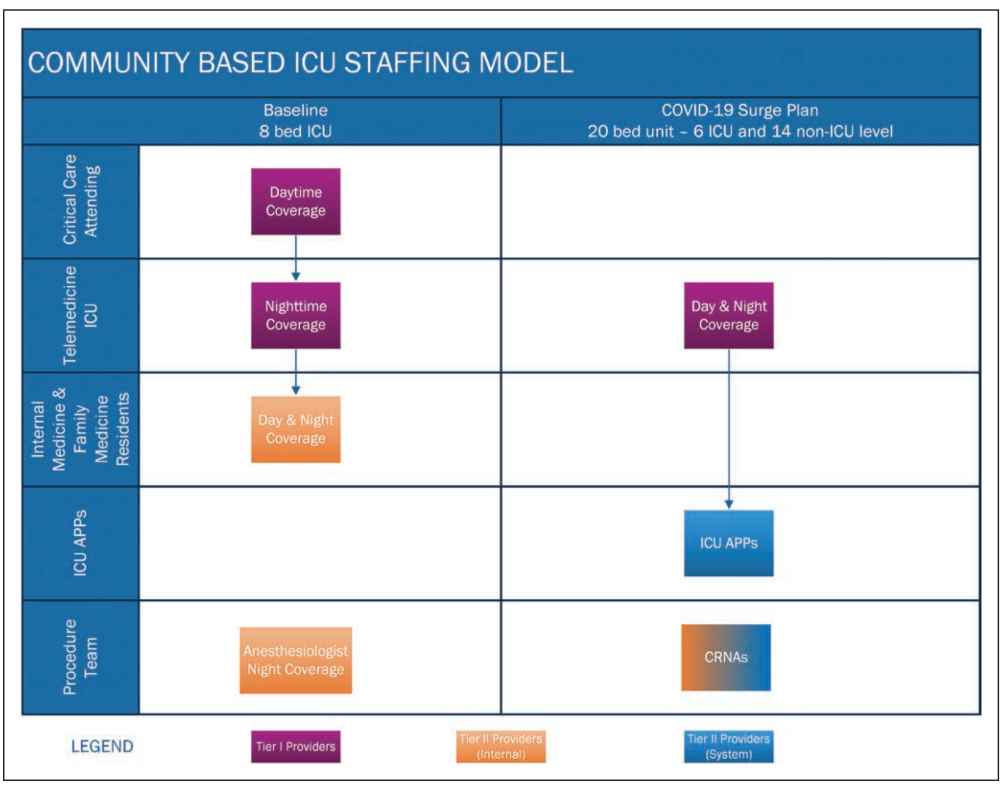

Figure 5. Representative community hospital surge staffing plan. APP = advanced practice provider, COVID-19 = coronavirus disease 2019, CRNA = certified registered nurse anesthetist.

DISCUSSION

The majority of ICUs have provider staffing that typically function at or near capacity to optimize variable cost structures. Further, the number of ICU beds is shrinking nationwide resulting in a contraction of provider staffing, especially in nonurban or academic hospitals. The SCCM's ICU Readiness Report, conducted in late March 2020 to evaluate the state of ICU preparedness during the height of the COVID-19 outbreak in the United States showed that 82% of respondents reported ICU resource shortages, including bed capacity, and 58% reported ICU staffing issues (9). Sixty-one percent reported patient volume surges, and 58% reported ICU staffing shortages. This leaves very little room for expansion and exposes those hospitals that are vulnerable to strain. Any surge in volume immediately affects the ability of staff to care for patients. Events whether natural, industrial, acts of terror, or infectious pandemics present unique challenges to both individual hospitals or healthcare systems as they generate the potential for large numbers of critically ill patients. To optimally prepare for this, and to ensure that medical and surgical care is delivered in the most reliable, efficient, and safe way based on the resources available, tiered staffing and capacity surge planning is essential and paramount. We have presented a model framework for hospitals across one of the largest systems in the world, ranging from community to tertiary/quaternary academic medical centers, for use to urgently plan for allocation of telemedical services and centralized workforce utilization in the case of large influx of critically ill patients. Although initially developed and rapidly disseminated for implementation during the current COVID-19 pandemic, UPMC has adopted this ICU provider staffing model for rapid assessment and response for staffing requests in response to volume surges secondary to a myriad of increased demands during times of disaster and vulnerability of a healthcare system. Furthermore, we hope it may serve as a valuable planning tool for other institutions and health systems to use during those times when mass critical care measure may be demanded.

Last, it is our hope that in times of future national crisis and regional ICU capacity surge that a model such as this one could be used to facilitate coordination between hospital systems to augment patient care capabilities outside the confines of a singular hospital system or region.

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