Hospital transfers across U.S. regions to address the “space” shortage in a pandemic: a public good

George L. Anesi, MD, MSCE, MBE[1,2,3]

1 Division of Pulmonary, Allergy, and Critical Care, University of Pennsylvania Perelman School of Medicine, Philadelphia, PA, USA.

2 Leonard Davis Institute of Health Economics, University of Pennsylvania, Philadelphia, PA, USA.

3 Palliative and Advanced Illness Research (PAIR) Center, University of Pennsylvania Perelman School of Medicine, Philadelphia, PA, USA.

Corresponding Author:

George L. Anesi, MD MSCE MBE

Division of Pulmonary, Allergy, and Critical Care

University of Pennsylvania Perelman School of Medicine

3400 Spruce Street, 5037 Gates Building

Philadelphia, PA 19104-6021

george.anesi@uphs.upenn.edu

Tel: 215-908-4563

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The novel Coronavirus Disease 2019 (COVID-19) pandemic has made hospitals everywhere dust off and update, or feverishly write, pandemic preparedness and response plans to accommodate, among other challenges, surges of acute care patients above their local norms.[1] Naturally, hospitals look to expand capacity within their own footprint first, by canceling elective care and expediting discharges, maximizing utilization of existing licensed beds, and opening new beds in both clinical and non-clinical areas.[2,3] When that is not enough, or often in parallel, hospitals may look locally or regionally for assistance in the form of diverting or transferring patients to other hospitals, either those with normally lower acuity or those that are not facing a simultaneous surge.[4] That approach—analogous to the routine practice of packed emergency departments temporarily diverting ambulances to nearby hospitals—works far better for a localized disaster that may heterogeneously impact hospitals in relative close proximity leaving clear transferring (without capacity) and receiving (with capacity) hospitals. During a pandemic the scale of COVID-19, however, this approach can break down when an entire region peaks together and local transfer acceptance capacity evaporates.[1]

In this issue of *Clinical Infectious Diseases*, Michelson and colleagues put forward a scaled up approach to this transfer paradigm looking instead at inter-region transfers—from one part of the U.S. to another—as a method to expand bed capacity, or more accurately load-balance, on a national scale.[5] Their manuscript reports a sophisticated simulation study to assess specifically how transfers of patients between different regions of the country could alleviate hospital and intensive care unit (ICU) bed shortfalls during a pandemic, using a projected, continued COVID-19 pandemic as the use-case. They report that in simulation, in all scenarios except the highest-volume ICU scenario, inter-region transfers, with mean transfer distances upwards of 300 miles, could fully resolve any bed shortages. This study has a number of notable strengths: it is of vital importance for the ongoing

pandemic and future threats; it takes a sophisticated and interesting simulation approach; and it uses national data to create a full picture of the U.S. healthcare infrastructure under study.

Simulation studies are definitionally theoretical and the accuracy of their predictions depend on multiple layers of assumptions and inputs any of which may turn out to be flawed or different than the ultimate reality (as correctly noted by the authors). The authors importantly included ranges of various inputs to help illustrate corresponding ranges of potential outcome scenarios. Fundamental to weighing a simulation result's utility is identifying which assumptions involved in the complete scenario model may be most vulnerable to inaccuracy or whose variation within would most alter the presented results. The authors identify COVID-19 patient estimates as their model's most influential vulnerability. That is actually an acceptable weakness, all things considered, because it means that we think the model is internally strong and just requires accurate inputs from the specific threat to give helpful results. Said another way, the authors have given us a useful tool for pandemics, and our—the scientific community's—job is to feed into it well informed and evolved predictions of COVID-19, the current threat of interest.

Michelson and colleagues focus on hospital—ward and ICU—beds. This is the "space" component of the disaster preparedness "four Ss" canon, alongside staff (personnel), stuff (equipment), and system (coordination).[2,3] The preparedness literature will tell us that we have to consider any given one of the four Ss in close context with the others, or we risk creating Noah's Ark without the animals or feed—a beautiful field hospital without the clinicians or equipment to run it, for example. The authors, appropriately for a single study manuscript, narrowly addressed their selected outcome—hospital beds. It is up to us readers to put it in the appropriate complete preparedness context.

In that light, let us highlight three additional important concerns about the realization of this space solution. First, transport. A non-trivial proportion of critically ill patients—those being considered for transfer from one ICU to another—are or may be too sick to travel, and even those that are safe for transfer require critical care transport capabilities that are not built for the volumes and distances necessitated in the simulation.[6] These vulnerabilities include both equipment, such as critical care–capable ground and air transportation, and critical care transport clinicians.

Second, the authors state an assumption of interchangeability of hospital beds among hospitals, but there are additional layers of complexity here. Many hospitals that run routinely at significantly less than full capacity are not staffed, even via back up lists, for their full capacity, and certainly not staffed or with the equipment for all their ICU beds to be filled by critically ill patients with severe respiratory failure. This either reduces the transfer acceptance capacity assumed in the model or requires added investment in personnel and equipment to pair with the bed capacity.

Finally, coordination and implementation (system). Pandemic preparedness certainly has myriad local pieces,[7] but large components—such as a national inter-region transfer program—likely fall within the public health infrastructure and the domain of the federal government or at least coordinated local governments, as the authors note. These specific components of pandemic preparedness are therefore more akin to what microeconomists would call a public good—a good that is non-rivalrous (participation by one party does not reduce availability to others, and in this case might actually increase access to the good for other parties) and non-excludable (while theoretically possible, it is unlikely that such a national program would overtly exclude any specific regions).[8]

Public goods—think national security—are traditionally understood to not be effectively funded or executed by normal market-based approaches because due to their non-excludable nature, no individual person or entity is incentivized to make the necessary expenditures in cost and effort. No U.S. citizen or association, for example, would independently fund and operate a national security apparatus that all citizens would then benefit from for free. Even for those of us who believe in a competitive market-based society, public goods, which are market imperfections, are instances when centralized government funding and execution are justified. If no individual person or entity is incentivized to take it on but the public agrees this is a good approach, we can elect officials who put our collective resources towards it and we all benefit.

Michelson and colleagues have shown us a countermeasure to an extreme hospital capacity shortage in a pandemic. Its realization would require matching those identified space resources with adequate personnel (staff), equipment (stuff), and centralized coordination (system).

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