Reassessing the Value of Minimally Invasive Technologies in the Era of COVID-19

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KEY TAKEAWAYS

- **U.S. hospital capacity has been severely strained by the COVID-19 pandemic.**
- **Minimally invasive technologies are capacity-conserving technologies that could reduce burdens on healthcare providers and hospitals while also shielding patients from unnecessary in-hospital exposure to pathogens.**
- **Current payment systems that encourage bed volume and labor-intensive procedures make capacity-conserving alternatives less attractive.**
- **Better policies would support greater investment in minimally invasive technologies and a more holistic notion of value.**

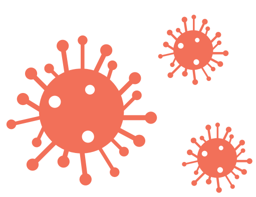
ABSTRACT

The emergence of COVID-19 threatens to strain U.S. healthcare resources for the foreseeable future. While the virus has altered the health and economic landscape for the worse in many ways, it also presents an opportunity to accelerate the uptake of valuable and underutilized strategies and technological approaches that could improve healthcare efficiency, particularly in the face of widespread transmissible diseases. Minimally invasive procedures are just one example of "capacity-conserving healthcare technologies" that can enable access to needed technologies while reducing burdens on healthcare providers and hospitals and shielding patients from unnecessary exposure to vectors of infection. Current payment systems that encourage bed volume and labor-intensive procedures make capacity-conserving alternatives less attractive. Better policies would support greater investment in minimally invasive technologies and a more holistic notion of value that explicitly acknowledges the benefits they bring to patients by reducing fear of contagion and disease transmission, to hospitals by expanding surge capacity, and to society by reducing disease transmission and increasing economic activity. Such policies will improve the lives of patients and their caregivers, strengthen our future pandemic response and increase social welfare.

INTRODUCTION

Debates over rising U.S. healthcare costs have long emphasized the need to better match the prices of healthcare goods and services to the value they generate. At a basic level, the value of a healthcare technology derives from its ability to increase the patient's quality-adjusted life-years (QALYs) and reduce healthcare expenditures, and most formal health-technology assessments recognize and quantify these elements of value.[1, 2] But an intervention can generate value in many other ways—including impacts on productivity, equity, scientific spillovers, value of hope and insurance value—that are often excluded from value assessments of health technologies.[1, 3, 4] The list of "novel" elements of value has been added to over time, as new events have revealed previously underappreciated ways in which health technology can improve well-being.

The COVID-19 pandemic has been one such revealing event. In its early days, we learned how vulnerable U.S. healthcare systems were to two previously untested challenges: widespread prevalence of a highly transmissible disease, and sudden surges in local demand for specific healthcare resources such as ventilators and intensive care unit (ICU) beds. The implications of these challenges quickly became clear in early hotspots like Lombardy, Italy, and Manhattan, where the virus spread rapidly through the population and hospital resources were quickly strained. The fall surge repeated these challenges on a broader scale in the U.S., with hospital capacity strained in many states.



Recent experiences have brought into sharp relief two previously under appreciated elements of value: capacity conserving and contact-minimizing technologies.

Uncertainty surrounding COVID-19 has also led patients to postpone needed treatment for fear of contracting the disease in a healthcare setting. We do not yet know how much of this care will be merely delayed versus foregone completely, but recent studies have begun documenting increased deaths occurring outside the hospital in the early phase of the pandemic.[5] The eventual mortality and morbidity associated with hospital care foregone or delayed during the pandemic could be enormous.

Recent experiences have brought into sharp relief two previously underappreciated elements of value: capacity-conserving technologies that create flexible hospital surge capacity, and contact-minimizing technologies that reduce transmission of communicable disease. Since the early days of the pandemic, healthcare systems have rushed to implement new technologies and procedures that create value by doing one or the other, or both.

But these changes have been implemented *in extremis*; the policies that guide hospitals' day-to-day operations and investment decisions in more normal times have not historically emphasized these sources of value, and in fact have even discouraged the adoption of some capacity-conserving technologies. For example, minimally invasive procedures that use arthroscopic, catheterized or laparoscopic devices and remote operation of instruments as an alternative to more labor-intensive open surgeries can shorten hospital stays and reduce in-hospital exposure to pathogens. But fee-for-service reimbursement formulas and overhead accounting rules that reward bed volume and labor usage rather than the value of services have led to underinvestment in such technologies, especially considering their particular value in the context of a pandemic. COVID-19 presents an opportunity to rethink these policies.

To correct this situation and prepare for the next pandemic, we need a more holistic notion of value that explicitly acknowledges the benefits that accrue to patients in the form of reduced fear of contagion and reduced disease transmission, to hospitals in the form of expanded surge capacity, and to society as a whole in the form of reduced disease transmission and increased economic activity.[6, 7] While traditional methods of evaluating health technology may capture the value of disease reduction in a risk-neutral fashion by estimating the expected lives lost from infection, they do not capture the willingness to pay to avoid this risk from the perspective of a risk-averse person. Broadening our definition of value from

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one that focuses only on QALYs and healthcare expenditures to include these other elements will lead to better health, efficiency gains from provider and societal perspectives, lower costs and greater social welfare.

COVID-19 AND HOSPITAL CAPACITY

Treating the influx of COVID-19 patients effectively requires matching available hospital capacity to the number of patients needing hospitalization, either by decreasing the flow of patients or by increasing hospital capacity. At the start of the pandemic, the U.S. response involved both strategies. In March 2020, policymakers strove to "flatten the curve" of the epidemic by imposing stay-at-home orders and laws limiting the size of group gatherings, and requiring social distancing and mask wearing to reduce transmission and the number of cases. While these policies did reduce transmission and probably saved lives,[8-11] they came at an enormous economic cost—according to Congressional Budget Office projections, the slowdown following these restrictions led to an estimated economic hit of $7.9 trillion, or 3% of cumulative real GDP over 10 years,[12] with deteriorating recent estimates of 3.4% of real GDP.[13]

At the same time, the healthcare system rushed to add emergency surge capacity for the onslaught of COVID-19 patients. The crisis of the pandemic enabled rapid implementation of temporary measures. Hospitals reallocated existing space and added beds to treat COVID-19 patients, the Army Corps of Engineers built temporary field hospitals on college campuses and in convention centers, and the U.S. Navy deployed hospital ships to New York and Los Angeles harbors, all at enormous expense.

Many healthcare systems also initially took the step of postponing elective procedures and nonurgent care appointments, although they subsequently moderated that stance.[14-19] Patients also, of their own accord, chose to postpone some care to limit their exposure to the virus.[20, 21] A recent study of healthcare claims for over 6 million U.S. beneficiaries found sharp reductions in the use of high-value preventive care such as mammograms and colonoscopies, and in elective procedures such as cataract removals in the early weeks of the pandemic.[22]

But these actions are expensive and have important drawbacks. First, temporary facilities are inferior care settings compared to permanent hospital facilities. They cannot serve all types of patients and lack access to many services a permanent hospital provides. A decompensating patient in a field hospital cannot simply be wheeled to the ICU on a different floor; they must be transported to a permanent hospital, with all the costs, delay and additional exposure that entails. And while temporary facilities may relieve the need for more hospital beds, they cannot address a shortage of trained personnel, which may actually be the more binding constraint.[23-25]

Second, we are only now beginning to understand the enormous long-term costs associated with delaying regular care. New research suggests that while the direct impact of COVID-19 is large, the impact of regular care foregone or postponed may be five to 10 times greater.[5, 26-28] Ultimately, the direct and indirect economic and health costs associated with these stopgap measures to match healthcare capacity and surge demand will be staggering.[29-31]

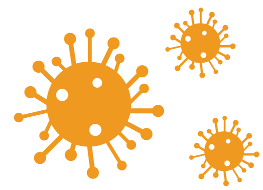
With new variants of the virus emerging, COVID-19 continues to pose a real and present threat. The need to find a more efficient approach to expanding hospital capacity is urgent. In particular, we should implement strategies to get more healthcare out of the capacity we already have.

The U.S. healthcare system has long struggled to make the best use of its existing capacity. This challenge has historically been framed as an opportunity for cost cutting,[32] such as in studies that highlight the share of "wasteful" U.S. healthcare expenditures.[33-35] But a different frame is more relevant here: "Excess" capacity is also a mechanism for keeping more high-quality healthcare capacity in reserve to use during demand surges. While "excess" capacity may sit in reserve and underutilized for periods of time, it is not "wasted." It is providing insurance value, in the same way that the premium dollars that a homeowner pays for earthquake insurance are not "wasted" if an earthquake never strikes. Canceling such an insurance policy saves money today, but gambles heavily on a family's future financial well-being. The COVID-19 pandemic has illustrated how this analogy applies to "excess" hospital capacity too: Short-run efficiencies entail long-run gambles of patient access to care in emergencies.

MINIMALLY INVASIVE TECHNOLOGIES AND HEALTHCARE CAPACITY

One promising way to get more out of existing healthcare capacity is to invest in minimally invasive technologies as an alternative to open surgical procedures. Minimally invasive alternatives are available for many procedures, ranging from lumbar fusions to appendectomies, and are typically associated with less pain, shorter hospital stays and fewer complications.[36-39] While only a subset of patients requiring a given procedure may be candidates for a minimally invasive version, there is evidence that minimally invasive options are not currently being fully utilized for the eligible population. U.S. hospitals vary widely in their utilization of minimally invasive procedures for common surgeries: In one study including more than 500 U.S. hospitals, the share of appendectomies performed minimally invasively ranged from 41% to 93% across hospitals.[40] And while roughly half of all mitral valve surgeries in Europe and Vietnam are performed through minimally invasive approaches, they account for just 23% of all mitral valve surgeries in the U.S.[41]

The hospital length-of-stay reductions associated with minimally invasive procedures can be large. A study in one Italian hospital found that, among 143 patients undergoing mitral valve repair for severe symptomatic functional mitral valve regurgitation, those who had a surgical valve repair stayed in the hospital 11 days on average, compared to an average of five days for patients who had a MitraClip implanted via a minimally invasive percutaneous procedure.[42] Such length-of-stay reductions are important to patients.[43, 44] From the hospital's perspective, switching eligible patients from surgical to percutaneous valve repair would save almost 55% of the bed-days currently used for recovering surgical mitral valve repair patients. This "saved" capacity could be used to increase hospital revenues by treating more valve repair patients, but it could also be used as surge capacity for additional COVID-19 patients.



The saved capacity from leveraging minimally invasive technologies could be used as surge capacity for additional COVID-19 patients.

Importantly, such a shift to minimally invasive technology increases capacity not just of hospital beds and patient rooms, but also of medical staff to care for those patients.

A strategy of expanding surge capacity by adopting minimally invasive technologies will be more beneficial for hospitals that are more likely to experience a demand surge that exceeds their existing capacity. As became clear during the initial U.S. COVID-19 surge in March, different U.S. cities came closer to their healthcare capacity thresholds depending on whether they were located in regions with outbreaks. Even within cities, available bed capacity can vary widely across hospitals. By implementing capacity-sparing technologies more aggressively, any of these facilities could expand their surge capacity without the large capital investments that would be required to build it.

MINIMALLY INVASIVE TECHNOLOGIES AND EXPOSURE TO INFECTION

Shifting toward minimally invasive capacity-sparing technology also delivers benefits beyond its impact on healthcare capacity. Because these procedures generally involve fewer complications and shorter recovery time relative to their open-surgery equivalents, patients experience less pain and downtime, and can resume their normal, productive lives more quickly.[37-39]

Minimally invasive procedures can also reduce patients' fear of contagion because they involve shorter hospital stays. The data published to date suggest that the probability of contracting COVID-19 in a healthcare setting varies widely depending on local conditions and the preventive measures being taken at specific hospitals. One study of a large urban dialysis population in northwest London found 300 COVID-19 cases among a cohort of 1,530 patients (19.6%) receiving hemodialysis over six weeks in March and April 2020.[45] Another study over the same time period in a London hospital found that 15% of COVID-19 inpatient cases were "definitely or probably hospital acquired."[46] A third study at a Boston hospital in March through May 2020 concluded that nosocomial COVID-19 infection was "rare."[47] But in any healthcare setting, shorter hospital stays reduce exposure and therefore the risk of infection, all other things being equal. One 2010 study analyzing pre-COVID hospital-acquired infection data found that extending length of stay by one day increases the probability of catching a hospital-acquired infection by 1.37%.[48]

Hospital-acquired COVID-19 and other infections are dangerous. In one study, patients with hospital-acquired (non-COVID) infections had an increased mortality rate 2.6 percentage points higher than similar patients without hospital-acquired infections (5.7% versus 3.1% mortality).[49] By comparison, the case fatality rate for COVID-19 has ranged from 2% to 6% in the U.S. since March.[50]

Joint-replacement surgeries are experiencing a similar dynamic during the pandemic, as interest is increasing in moving these procedures out of hospitals and into ambulatory surgical centers to address both capacity and infection concerns.[51, 52] In the same way, minimally invasive versions of other surgical procedures can reduce exposure to infection and reduce the amount of care that is postponed and the negative health outcomes associated with delay.

Finally, minimally invasive technologies will also reduce COVID-19 exposure and transmission to patients and those who come into contact with them. For many indications, patients undergoing the minimally invasive version of a procedure are less likely to be discharged to a nursing home than those undergoing a traditional surgery. For example, in addition to requiring shorter hospital stays, coronary artery bypass graft (CABG) recipients were 38% less likely to be discharged to an acute care facility if they received a minimally invasive robotic procedure versus an open sternotomy.[53] Given the many devastating COVID-19 outbreaks seen in U.S. nursing homes,[54] reducing the number of discharges to such facilities will further reduce the chances that a CABG recipient acquires COVID-19.

CONCLUSION

COVID-19 is the current and most pressing example of a novel infectious disease causing a global pandemic, but it will not be the last. Recent experience has revealed the need for better preparation to meet the next pandemic, and policymakers in Washington, D.C., have begun to take up this challenge: In June, Senator Lamar Alexander, chairman of the U.S. Senate Committee on Health, Education, Labor and Pensions, introduced an act to ensure U.S. manufacturing capacity for diagnostic tests, treatments and vaccines, and a stockpile of critical supplies such as masks and ventilators. At the same time, Senator Alexander recognized the need to improve state and local capacities to respond to a pandemic threat, including better planning to ensure that doctors and hospitals can continue to provide healthcare services and outpatient treatment during a pandemic.

Supporting hospital efforts to expand capacity to deploy minimally invasive technologies can play an important role in new plans for future surge capacity in many situations, not simply the next pandemic—for example, many natural disasters require local hospital capacity to handle unexpected surges of trauma patients. Because existing fee-for-service payment models do not account for low-probability, high-cost events such as hospitals exceeding capacity during emergency surges, hospitals tend to underinvest in technologies that address such events.

Hospitals currently face several barriers to adopting these technologies. First, volume-based reimbursement rules ensure that hospitals make more money when beds are full. If minimally invasive technologies are employed to create surge capacity, hospitals will lose money on the empty beds, even though that capacity is serving a valuable purpose.

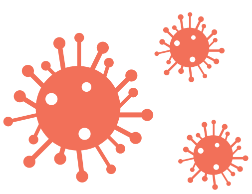
Second, reimbursement for overhead drives much of hospitals' contribution margins. Procedures that require longer hospital stays involve higher charges for per-diem items like personnel labor and room and board, which in turn permit higher overhead charges. As a result, hospitals face disincentives to adopt technologies that shorten hospital stays.

Third, many minimally invasive procedures involve highly innovative and sometimes expensive technologies and devices. Much of the reimbursement for such procedures is passed through to the technology provider. Combined with the lower overhead associated with shorter hospital stays, this tends to limit hospital profitability on minimally invasive procedures. In one study, valve replacement hospitalizations resulted in a median contribution margin (hospital profit) of −$3,380 for transcatheter aortic valve replacement (TAVR) and $2,390 for open surgical valve replacement.[55] That is, hospitals lost money on the median TAVR patient, but made money on the median open-surgery patient.

Finally, certain practice requirements, such as the requirement that surgical suites have a full surgical kit available for minimally invasive procedures, even though their complication rates are much lower than those for open surgery, serve to raise the costs of minimally invasive procedures without providing commensurate benefit.[56] Ironically, some U.S. hospitals that had been planning to expand their capacity to perform minimally invasive procedures prior to COVID-19 may have postponed those plans in the face of financial strain caused by the pandemic.

Policymakers should review these and other policies and the incentives they create for hospitals to invest in minimally invasive technologies. At the same time, support for such technologies could be tailored to help address existing health disparities. Since COVID-19 disproportionally affects communities of color,[57-59] incentives that are targeted to hospitals serving vulnerable populations can protect those groups in the same way that early Coronavirus Aid, Relief, and Economic Security (CARES) Act investments were targeted toward hospitals hardest hit by the pandemic.[60-63] More generally, policymakers and payers should broaden the concept of value used to evaluate such technologies for reimbursement—beyond QALYs and healthcare costs, such evaluations should explicitly account for their ability to reduce disease transmission, conserve healthcare resources as a strategic reserve and address patient priorities, particularly in the context of a pandemic.

The observations made here suggest several fruitful areas for further research. In particular, more analysis is needed to estimate the incremental value that results from technologies' ability to provide insurance against the risk of exceeding hospital capacity, reduce hospital-acquired infections and reduce the amount of treatment that is postponed during a pandemic. While prior research has identified some of these novel sources of value, there are currently no estimates of many of these components.[1]



Policymakers and payers should broaden the concept of value used to evaluate technologies. Such evaluations should explicitly account for the technology's ability to reduce disease transmission, conserve healthcare resources as a strategic reserve and address patient priorities, particularly in the context of a pandemic.

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