Technological Change in Health Care Delivery:

Its Drivers and Consequences for Work and Workers

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Executive Summary

Unprecedented challenges confront the U.S. health care sector. The spread of COVID-19 has exposed and amplified many of the underlying weaknesses of the U.S. system, including a lack of widespread access to care, inefficiencies, and runaway costs. The U.S. health care industry also lags behind other domestic industries and other countries' health care systems in terms of technology adoption. There exists an untapped potential for new technology to propel changes in health care delivery; COVID-19 may speed up some of these changes, such as the use of telemedicine and autonomous robots in hospitals. While some new technologies may be able to improve outcomes both for patients and for health care workers, this is not a foregone conclusion. The consequences of technological change in health care will depend on the choices policymakers and industry stakeholders make in this current moment of crisis and in the future.

This report examines the drivers of technological change in the U.S. health care industry and explores how technologies may be used in response to the challenges facing the industry over the next five to 10 years. We also assess how technological change in health care may affect health care workers, who represent 12% of total employment in the United States—around 18 million workers. As recent events have emphasized, workers throughout the health care industry—whether janitors, nursing assistants, registered nurses, or doctors—are essential to the functioning of our society and economy. Women and people of color make up a greater share of workers in health care than in the economy at large, and many of the sector's front-line workers have not completed a college degree.

We asked the following three questions in our research:

- What factors are likely to drive technology adoption and implementation in the U.S. health care industry?
- What are the new technologies that have the potential to affect employment, wages, skill requirements, and the organization of work?
- What are the potential consequences of these technologies for different health care occupations, and how are those effects likely to vary by race, ethnicity, gender, age, and educational attainment?

Our research involved interviews with hospital and home health agency administrators, union representatives, health care IT experts and consultants, and technology developers. We also attended health care conferences and trade shows, and analyzed government-collected labor market data. We conducted 32 interviews overall, either in person or via web or telephone, between April 2018 and June 2019.

Drivers of Technological Change

Our interviews showed there are four objectives guiding the health care industry in the United States; these establish the conditions and motivations for technological change:

- ***Increasing access to health care and reducing the cost of care.*** Ideally, technology can facilitate providers' ability to offer care to more people. Subsumed within this objective is the goal of using technology to reduce the unit cost of care delivery.
- ***Consolidating and coordinating health care delivery.*** Consolidating care allows providers to serve more patients with a broader range of services while helping to reduce costs through economies of scale and scope. It may necessitate increased reliance on new technologies for managing patient flow and coordinating care delivery.
- ***Facilitating chronic disease prevention and management.*** A shift toward "value-based care" (away from fee-for-service care) has given providers a financial incentive to keep patients healthy and better manage their chronic conditions. This calls for technologies that help monitor and nudge patients and facilitate regular communication with their providers.
- ***Responding to demographic trends.*** People are living longer, increasing the prevalence of conditions that will require long-term care. Providers will turn to technology that responds to the increasing demand for long-term care, in particular, home care.

New Technologies in Health Care

Our research identified three types of emerging technologies most aligned to the health care sector's guiding objectives:

- ***Digital communications and telepresence.*** In simplest terms, this category includes any smartphone or internet-connected computer. However, digital communications technologies have a broad range of applications, including in the home care setting and in the virtual provision of patient care, e.g., telehealth, telemedicine, and telehospitals. Digital technologies have aided the transition from paper-based to electronic health records and allowed for richer, more data-dependent ways of leveraging interconnected health records.

- ***Semi-autonomous service robots.*** While humanoid, caregiving machines largely remain the province of fiction, a simpler form of service robot already traverses hospital hallways. These robots accept external commands from users and can maneuver and operate on their own by taking in, processing, and reacting to information absorbed through sensors. They can pick up soiled sheets and dirty dishes, and they can deliver meals and medications, among many other tasks.
- ***Artificial intelligence.*** The use of artificial intelligence (AI) in health care has only just begun. AI differs from other technologies in its ability to "teach" itself: rather than following predetermined, detailed directions provided by programmers, one particular form of AI—machine learning—allows technology to develop its own rules and responses once "trained" by existing data. AI can essentially supercharge existing digital technologies, including those allowing for virtual care delivery.

The consequences of these technologies for work and workers depend on how they are put to use towards addressing the objectives guiding the health care industry. For example, regulation has promoted the use of electronic visit verification (EVV), which monitors direct care workers through a smartphone. This technology has facilitated documentation but it has also increased micro-management of workers. However, similar technology could be used by the same workers in a very different manner, potentially empowering them to serve as a patient's point person for the entire team of providers contributing to their care plan. For example, service robots and other AI applications could be used simply to trim the workforce and justify more limited activities and pay for workers. Or, they could be used in such a way that they free up time for these workers to focus on other activities, in particular those that depend on skills at which humans excel compared to robots, such as empathy and communication. The ways in which new technologies are deployed hinges on the choices that we make about the future direction of the industry.

Choice Points

Increasing access to health care while improving the quality of that care and containing its costs are common goals across the sector. How to get there remains a subject for debate. The federal government has an outsized stake as the funder of Medicare and Medicaid, giving it leverage and buying power. Workers enjoy stable jobs and long-term careers, especially women, people of color, and those with little or no formal education beyond high school. And as stated previously, unions and their members are well-represented in the health care sector; they have played a key role in preserving and improving wages and working conditions.

New technologies, if thoughtfully deployed also may improve the performance of the health care industry. To that end, our research identified three specific choice points regarding new technologies and how they are deployed:

- ***Don't underestimate the power of payment models.*** Provider organizations will only invest in a particular technology if they think it makes sense financially. Hastening the shift toward value-based care (from fee-for-service care) will likely accelerate the adoption and diffusion of quality-enhancing health care technologies. Likewise, Medicare and Medicaid account for a substantial share of our national health care bill. If policymakers think telehealth will improve access while containing costs, then reimbursement rules can be tweaked to ensure virtual visits are adequately reimbursed. This has happened, albeit on a temporary basis, in response to the COVID-19 pandemic.
- ***Encourage experimentation with novel uses of technology.*** Careful experimentation will be necessary to assess the effectiveness and quality of care delivered virtually. In addition to adjusting reimbursement rules, this may require adapting state-based medical licensing and harmonizing scope-of-practice rules to allow responsibility and accountability across a wider range of health care professionals. Policymakers and managers should assess the effectiveness of technologies intended to empower front-line workers with better health care information and patient data, to enhance the role of frontline workers in patient care.
- ***Prioritize the work,* not *the technology.*** By default, most employers focus on the amount and variety the technology under consideration *can* do, then give it as many tasks as it can manage, leaving remaining tasks for workers. Using a *work-centered* approach to new technology begins instead by asking, "What are people—RNs, direct care workers, etc.—really good at, and how might technology best exploit these strengths?" This approach respects human dignity as well as the constraints imposed by economics and technology: human labor will long remain part of the health care delivery process, will be in shorter supply, and cannot be altogether supplanted by new technology. Addressing worker shortages will require that workers be paid more and that they take on new roles, and it will require investments in upskilling.

High Road versus the Current Path

Given the challenges facing the U.S. health care industry and the opportunities that new technologies present, the choices we make now can lead us in one of two directions. Policymakers and industry leaders can choose a high-road path, in which the benefits of technological change are shared among patients, providers, and health care workers alike. Or, they can continue along the default trajectory, in which technology is deployed primarily to increase returns for atomized actors, and to reduce staffing and increase micromanagement of workers. Taking the high road will require coordinated efforts to improve industry outcomes that involve a voice for all stakeholders—in particular, health care workers.

Our findings suggest that technological advances in health care can be used to help build the high road if they are deployed in specific ways: toward the fulfillment of value-based care; under the auspices of policymakers and managers open to experimentation; and via the adoption of a work-centered approach. Table ES.1 offers some examples of how the same type of technology could affect health care workers differently under these two, stylized scenarios.

TABLE ES.1

Impact of Technologies on Health Care Workers along the Default-Path and High-Road Scenarios

Technologies	Default-path work outcomes	High-road work outcomes
Digital communications and telepresence	Digital communication technologies such as electronic visit verification are used to increase surveillance and monitoring of workers Chatbots are used to limit staffing, with a limited use of telemedicine	Digital communications technologies are used to augment the role of home care workers and to improve coordination of care across providers Telemedicine is used to expand access to care and extend job opportunities and job quality for nurses and frontline health care workers
Semi-autonomous service robots	Autonomous robots are used to reduce staffing for orderlies, dietary clerks, and laundry workers	Autonomous robots are used in a way that allows for upskilling and an enhanced role in relation to patients: e.g., orderlies become "transporter and telehealth techs" and dietary clerks become "healthy food ambassadors"
Artificial intelligence and machine learning	AI/ML (such as that embedded in clinical decision support) is used to diminish people's jobs and the role of human-oriented skills in the provision of care	AI/ML (such as that embedded in clinical decision support) is used to improve efficiencies while enhancing people's jobs, creating new roles for skilled work, and amplifying human-oriented skills in the provision of care

Along the high road, adapting payment rules and embracing experimentation would increase options for the application of telehealth technologies, which could create new avenues for patient engagement and new career opportunities. Likewise, digital communications in the form of EVV hardware and software would be left behind in favor of more empowering uses for this same technology. Under an augmented home health model, an aide would take on the role of

care coordinator for their client—using the smartphone not simply for clocking in and clocking out, but for connecting themselves to the rest of the care team. Furthermore, he or she would be trained (and compensated) to leverage their proximity to the client, serving as a two-way information conduit and front-line care coordinator.

Where do semi-autonomous service robots figure along the high road? We expect hospitals to continue using these technologies, though we see big differences in how they are deployed under the two scenarios. Along the default path, employers use robots to relieve themselves of labor obligations and to de-skill workers' jobs. Under the work-centered approach that characterizes the high road, employers instead consider how robots could assume some of the less enjoyable, lower valued-added tasks for which workers have long been responsible, freeing those workers (such as dietary clerks or orderlies) to enhance their roles and to provide compassionate care as only humans can. It would have the additional benefit of bolstering patient perceptions of genuine empathy, which could also be a boon to hospitals' performance metrics.

Artificial intelligence permeates many existing technologies, including autonomous robots and chatbots—with more applications coming online daily. However, potential applications of AI and machine learning are seemingly boundless—and at this stage, largely speculative. It is up to us to imagine applications that would fit within a high-road vision for the future of the health care industry. For instance, in the future, AI such as clinical decision support (CDS) could equip the next generation of caregivers to fill a new, highly trained and well-compensated role interacting with and examining patients while interfacing with a standardized but self-evolving diagnostic and treatment system powered by AI and machine learning (ML). In its initial incarnation, the machine would sit physically in the exam room alongside the practitioner and the patient. Later on, the machine could instead be used by teleproviders delivering care remotely. Aside from supporting efforts to optimize for cost, access, and quality of care, this type of AI/ML deployment could generate job opportunities in an entirely new category of highly-trained and well-compensated medical professional.

The Path Forward

Our nation's health care sector has a history of underperformance in the areas of access, quality, and cost. The COVID-19 pandemic has further exposed the frailty and ineffectiveness of the system, and pointed to the need to leverage technology toward more efficient use of the health care workforce. Technology can play an important role in moving the nation toward the health care high road, particularly if we are thoughtful in how and to what ends it is deployed. Our research suggests greater use of technology in a work-centered approach could not only improve industry performance for patients and providers, but could also improve job quality and career prospects for health care workers. We submit that getting there will require a bold change of direction.

That said, early indications are that telehealth and semi-autonomous robots have both played key roles in the system's and policymakers' response to the pandemic. The use of telehealth, in particular, was actually facilitated by a direct but thus far temporary policy pronouncement by the Trump administration to commit to Medicare and Medicaid reimbursement for such services. It remains to be seen how permanent pandemic-related sectoral changes will become.

The unique manner in which the United States delivers and finances health care seems to provide a guarantee that present market forces will not beget solutions to leverage the use of new technologies for improvements in industry performance and worker wellbeing. Without careful, coordinated decision-making, technological choices are likely to undermine workers' job quality and their ability to exercise their voice at work. The effect of this will be to limit the possible ways in which technology could be used to improve outcomes for patients, providers, frontline workers, taxpayers, and society at large.

SECTION ONE
Introduction

Not so long ago, most patients in the United States expected their doctor to enter the exam room carrying a manila folder filled with mismatched papers covered in scribble. Even today, almost 15% of office-based physicians do not employ even a basic electronic health record (EHR) system despite federal incentives encouraging health information technology (IT) adoption.[1]

The sector's performance relative to other domestic sectors has been just as tepid as its embrace of new technologies—since productivity and costs are, at best, flat. The domestic health care sector also does not fare well next to those of other, industrialized economies, which generally provide better care at lower cost to more of their citizens.[2,3]

Popular entertainment touts a coming society awash in technology—artificial intelligence, automation, robots. Indeed, health care seems perfectly positioned to embrace technological change—which makes observers of the labor market wary. Policymakers note that health care and social assistance accounts for 12.4% of all employment in the United States; over the 2018–2028 decade, that number is projected to grow by 3.4 million jobs to 13.8% of employment. Furthermore, as of 2019, health care jobs accounted for 18 of the 30 fastest-growing occupations in the country.[4]

Union members are well-represented in the health care sector, with unions holding a more steady share of workers compared with other industries; the absolute number of union members in the sector grew by 47,000 during the most recent recession.[5] Despite the current gloom permeating the overall U.S. economy in spring 2020, the history of the health care workforce would seem to indicate workers—and their ability to organize and bargain collectively—could maintain a strong position alongside the adaptation of ever-advancing technology.

Likewise, the media and popular press continue to highlight the prospects for technological change in health care delivery. Both have covered the advance of robotic surgical systems like those manufactured by da Vinci that allow for increased precision and dexterity on the part of surgeons and, arguably, improved outcomes for patients. The media reports regularly on new

applications of artificial intelligence (AI) aimed at detecting malignancies and other anomalies in digital images, with speculation the technology soon may overtake the capabilities of even the world's best-trained radiologists.[6,7]

This study found a much more nuanced reality, one that will be shaped by the actions of policymakers, employers, and unions and that will yield more than simply a net increase or net decrease in sectoral employment:

1. The health care sector's performance should be evaluated on how it optimizes across three goals—patient access, cost containment, and care quality—the so-called "Iron Triangle of Health Care."
2. In approaching the Iron Triangle, health care policymakers and employers must acknowledge and confront four sectoral imperatives that may impel technology adoption—increasing access to health care; consolidating and coordinating the organization of care delivery; facilitating the prevention and management of chronic diseases; and responding to demographic shifts.
3. Three forms of technology are employers' primary tools for responding to these imperatives—digital communications and telepresence, semi-autonomous service robots, and artificial intelligence.
4. Providers determine how to deploy these technologies based on health care policymakers' and employers' decisions on payment models; the inclination of sectoral actors toward experimentation; and the selection of either a work-centered approach or a technology-centered one to technological change.
5. The United States' current default adoption path is marked by the continued, slow, and uneven pace of transition from fee-for-service to value-based care, and a largely technology-centered approach to technological change—but with a relative openness to experimentation.
6. Along the default path, unions have played and would continue to play an important, albeit somewhat constrained, role in mitigating the negative impacts of technological change on rank-and-file members by using bargaining table strength to gain wage and employment guarantees as well as worker involvement in the technology deployment process.
7. Moving forward, increasing demand for health care will modulate many of the negative labor market effects engendered by technological change. The displacement of hospital workers responsible for moving people and supplies, and a job quality deficit for and a related severe shortage of home care workers, all will require important consideration.

8. One viable option is a high-road path, characterized by an accelerated shift from fee-for-service to value-based care, encouragement of experimentation with respect to care financing and delivery, and a work-centered orientation toward technology adoption.

9. The role of health care unions along the high road would be even stronger, as workers could serve as a countering influence to employers' tendency toward technology-centered over work-centered approaches to technology adoption and deployment.

10. In broad terms, the high-road path ensures the fruits of technological advancement, including improvements in wages and job quality, are shared more broadly with workers and to the benefit of patients. Jobs for home care workers and orderlies, for example, could be redefined to require more from and pay more to those who hold them; other roles could be newly created or expanded as we find more creative ways to use new technologies.

The research for this report took place before the full impact of COVID-19. That said, where lessons from the pandemic inform our findings or predictions, we strive to explain how.

An Industry Studies Approach to Technological Change in Health Care

This research considers technological change not as an external, uncontrollable force acting upon employers, but as the product of actions by employers, workers, and policymakers, among others, all operating within a well-defined industry context. In our view, this makes our approach unique and our findings incremental. However, "industry studies" methods may be most understood and appreciated when contrasted with other, more common approaches to social research.

Most analyses of the present wave of technological change use either the micro or macro perspectives. *Micro* studies, often very statistically sophisticated, usually begin by asking what emergent technologies do well and where they continue to fall short. Then, investigators review existing jobs to show which are composed predominantly of tasks technology can undertake more cheaply or more productively than humans can.[8]

Alternatively, some authors view technological change from a very *macro* perspective. These studies tend to be rooted in qualitative cases and aim for far-reaching conclusions. For example, one recent carefully produced and well-sourced study concluded that technological change is likely to annihilate the professions as we know them, with grim effects on employment, wages, and job quality. This study also argued that technology effectively would democratize the provision of professional services by making them available to the masses at very low cost.[9]

Both micro and macro studies often demonstrate a distinct theoretical tradition. (See Box 1.) While both have their place, even together they cannot connect the dots in a way that is credible and actionable. Micro studies tend to ignore the political, regulatory, and sometimes even economic nature of how managers and others bundle tasks into jobs:[10] just because a task can be automated or otherwise transferred from a person to a machine doesn't mean that it will be. Furthermore, these studies necessarily look backward rather than forward, as they are, of course, dependent on existing, historical data. Macro studies typically pay too much attention to individual megatrends, and are prone to apocalyptic pronouncements.[11,12] What these micro and macro approaches have in common are a tendency toward deduction over induction and the predisposition to view human agency as a postscript, when acknowledged at all.

We characterize ours as an industry studies approach and see it not as micro or macro, but as *meso* in nature.

While micro and macro approaches can yield important data, we characterize ours as an industry studies approach and see it as more *meso* in nature. Our goal is to understand the structures and processes—be they markets, firms, organizations, or other institutions—that bind the context in which human beings operate and generate the phenomena we observe and the data that underpin them.

> **"We need to examine…the labor market circumstances of employees, the incentives facing employers, and the larger legal, political, and regulatory systems within which they operate. What combination of incentives, exposure to new ideas, availability of skilled workers, regulatory reform, and pressure will lead employers to rethink how they organize their work and structure their production?"[13]**
>
> **— Paul Osterman, an industry studies researcher**

Much of what we learn about a particular sector—health care, in this case—is not applicable to other industries—and we know the health care sector is characterized by a number of idiosyncratic features. However, we accept these limitations in exchange for increased confidence in the causal mechanisms we uncover and the ability to deliver finely nuanced, meaningful policy recommendations.

BOX 1

The Labor Market and Workplace Impact of Technological Change: Some Basic Theory

Close observers of the employment relationship have long held strong opinions about the ways in which technological change would shape the working world. Technological determinism—the idea that changes in productive technology drive social and economic relations—forms the core of Marxist ideology, as best articulated by Karl Marx himself and later by Harry Braverman, Stephen Marglin, and David Noble, among others. To varying degrees, each thought technological change inevitably favored employers over workers (or capital over labor, as Marx phrased it), facilitating managers' efforts to shrink employment rolls and put downward pressure on wages and job quality.

Many institutional economists of the mid-20th century found this approach too limited to explain what they were observing. In general, U.S. unions did not simply *oppose* technological change in their lobbying, their bargaining, or on the shop floor. Instead, these scholars argued, unions respond in varying but predictable ways to management's modernization imperative. According to Sumner Slichter and his colleagues, unions often allowed technological change to occasion increases in wages and job security—key facets of job quality—and sometimes even employer-sponsored investments in lucrative new skills.[14] These theories, themselves the product of industry studies research, spawned a debate over whether and when technological change resulted in "upskilling"—providing workers increased earnings alongside their higher productivity—or "downskilling," akin to the processes favored by the Marxists.

By 2000, labor economists' attention turned to "skill-biased technological change" (SBTC)—the notion that new technologies appeared to boost the wages and employment levels of those with high skill levels, while displacing workers with fewer skills. Most often associated with Alan Krueger,[15] others advanced this work by breaking jobs down into tasks, concluding that computers and other forms of IT excel at predictable, repeated tasks that can easily be coded into software.[16] As a result, the argument goes, people who do work of this sort would face shrinking opportunities in the labor market, along with eroded benefits and employment conditions.

A number of scholars have challenged the explanatory power of the SBTC thesis, as even the idea that new technologies are task-biased in their effects on workers appears open to question.[17] While the latest technologies, such as artificial intelligence, can tackle tasks that are once-off in nature and difficult to program, these task-biased arguments often omit a genuine role for human agency, much like the Marxist approaches of 150 years earlier. They also tend to ignore noneconomic drivers of behavior and decision-making, namely the regulatory environment, workplace politics, and issues of technological acceptance. All three of these drivers, among others, play prominently in industry studies.

Research Questions

This report and the larger project in which it rests were undertaken with the thought that while technological change will have a profound effect on work and workers, it almost certainly will be more nuanced than what has largely been stated. The admonition "robots are coming for *your* job" not only lacks actionability and specificity, it ignores the reality that new technologies are better at some tasks than others and worse at some tasks than humans.

Three questions guided our approach:

- ***What factors drive technological choices?*** What factors are likely to drive which technologies are adopted and how they will be implemented in the workplace—and what are the leverage points where public policy could mitigate or shape the effects of technology? In our view, most existing studies ignore these questions, instead marveling at emerging technologies rather than examining the workers potentially affected and the workplaces in which they would be installed and deployed.
- ***What are the relevant technologies?*** What new technologies in a given sector or industry have the potential to significantly affect employment, wages, skill requirements, and the organization of work in the near and medium terms?
- ***How will this play out for workers?*** What are the likely impact scenarios for specific occupations and wage levels—and how are those effects likely to vary by race, gender, age, and educational attainment? Existing studies generally have embraced an implicit notion that while technology determines its own labor market effects, it at least does so on an egalitarian basis. We reject both of these assumptions, prompting us to learn more about the various ways that otherwise similar technologies might be deployed to the benefit of all of the economy's stakeholders.

The admonition "robots are coming for *your* job" not only lacks actionability and specificity, it ignores the reality that new technologies are better at some tasks than others and worse at some tasks than humans.

Data and Methods

As industry studies research relies on primary data as its hallmark, this report depends on interviews with such sectoral actors as hospital and home health agency administrators, union representatives, health care IT experts and consultants, and technology developers. We also attended health care conferences and trade shows targeted mainly at would-be investors, where

we had the opportunity for more than a dozen less formal but equally informative conversations with those operating in the front-line health care technology space. We conducted 32 interviews overall, either in person or via web or telephone, between April 2018 and June 2019.

This report expands other studies. We employed existing research to explain or flesh out learnings that arise from our firsthand data collection. We also turned to government-collected labor market data as a basis for situating this report, in particular, for illuminating trends in pay and employment.

What This Report Covers and What It Does Not

An industry study proves overwhelming without clearly defined scope conditions. With few exceptions, this report focuses on *direct patient care*. In other words, what sorts of technologies should we expect sectoral actors to call upon in addressing key challenges in health care *delivery*? And, how does this technology change the interactions between front-line workers and their patients, as well as the contexts in which these interactions take place? In the wake of the last decade's focus on the transition from paper-based records to electronic health records (EHRs) and its implications for care delivery, we have decided to include two occupations related more to record-keeping than to direct patient care. Even so, we focused on a relatively small number of occupations emerging from our fieldwork. Aside from coming up in multiple interviews, each of these roles appears on 1199SEIU's list of the most-populated health care job titles, provided to us by union officials:

- food service workers
- home health and personal care aides/assistants (collectively referred to as "direct care" or "home care" workers)
- janitors and cleaners
- laundry workers[18]
- licensed practical/vocational nurses (LPNs/LVNs); henceforth, LPNs
- medical records technicians
- medical transcriptionists
- nursing assistants (CNAs)
- orderlies
- personal care aides
- registered nurses (RNs)[19,20]

Both home health aides and personal care attendants provide clients in-home support with daily tasks such as laundry, food preparation, and toileting, as well as with the performance of certain rehabilitative exercises. Home health aides usually have specific training and perhaps have earned a qualification or certification in the delivery of simple health care services. Personal care attendants generally do not need formal certification and are especially likely to be a friend or relative of the client.[21]

While we did not initially intend to exclude any care settings, we found that the most pressing concerns around technological change are in hospitals, surgical centers, and in-home care. In part, this reflects increasing demands from patients to get routine and ongoing care at home: in fact, technological change has allowed these demands to be met, and has elevated the importance of the home health agencies that link aides to clients and administer the flow of payments from public and private payers into workers' pay.

The report does not consider issues involving the manufacture of such medical devices as artificial hips or stents, unless changes in these devices have consequences for front-line care delivery processes. Likewise, we do not dig deeply into issues involving health insurance. Thus, while it is impossible to completely sequester health care delivery from health care financing, we will not be focusing, for example, on the ways insurers deploy robotic processes or cognitive automation to streamline the claims process or balance their risk pools. Nonetheless, the sector's structural separation between the financing and the delivery of care has implications for the sorts of technologies that front-line workers and their patients will confront at home, in hospitals, and in other care settings.

We also chose to focus on technological change and its implications for the sector over the next five to10 years, i.e., the short and medium runs. In this way, we can distinguish this report from those analyses that predict massive technological change and proportionally large labor market impacts at some point in the undefined but distant future. We find those predictions wildly unreliable and lacking in credibility. Even more important, we think what eventually transpires in two decades hinges on the decisions that policymakers, health care administrators, and others make over the next five to10 years.

Plan for This Report

The late health economist Uwe Reinhardt quipped that no health policy expert would ever intentionally design a health care system like the one we have in the United States.[22] In fact, it bears little resemblance to the industrial organization of any other part of the economy. Thus, Section 2 of this report offers a primer on the ways we finance and deliver health care. Aside from proffering a set of objectives for the sector, we zero in on the workforce charged with front-line care delivery, counting workers by occupation and such subsequent dimensions as sex, race, age, and educational attainment.

We also reviewed differences in earnings, injury rates, and access to employer-provided health care benefits, three aspects of job quality, and we share projections for future employment. Our findings follow, turning first to the factors that drive technology adoption in health care. We offer what we found to be the contextual drivers—increasing access to health care, consolidating and coordinating health care delivery, facilitating chronic disease prevention and management, and responding to demographic trends.

In Section 4, we present the three technological responses to the aforementioned contextual drivers that emerged from our fieldwork—digital communications and telepresence, semi-autonomous service robots, and artificial intelligence. Having presented the sectoral context and the emergent technological response, Section 5 returns us to the initial question regarding technology's driving factors. However, now we can consider the choice points available to policymakers and health care administrators/managers. That is, in responding to the four imperatives, what key questions should be considered to predict how technological change ultimately will affect worker outcomes?

This analysis paves the way for Section 6, where we tackle how new technologies, when filtered through the aforementioned imperatives and choices, will likely influence labor market outcomes. We do this first by laying out the default path—the road we are on. Then, we suggest a realistic, high-road alternative requiring strategic and proactive decision-making on the part of policymakers, managers, and unions. We wrap up by suggesting the sorts of public policies that would pave the high road.

SECTION TWO
Health Care Delivery in the United States: A Primer

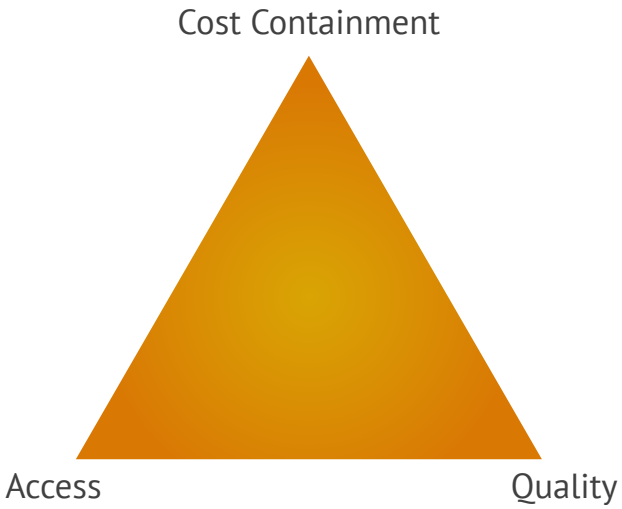
The health care sector may be the single most important source of jobs in the U.S. economy. The nation's annual health care bill was $3.5 trillion in 2017, accounting for 17.9% of GDP.[23] The sector includes nearly 13% of all private-sector workers[24] and more than 16% of union members.[25] As noted above, most of the nation's fastest-growing jobs reside in the sector. Moreover, health care did not contract during the Great Recession, whereas every other sector did.[26]

At the same time, the United States spends more money per capita on health care—nearly double the next closest country—to achieve outcomes ranging from average to poor relative to this same comparative set. Even after passage of the 2010 Patient Protection and Affordable Care Act (ACA)—intended to make health insurance nearly universal—about 9% of Americans still report having no coverage at all. This is a sticking point for many citizens, as this sector presents many with a moral obligation that extends to just a few other markets, namely food and housing.

More than 25 years ago, physician and professor William Kissick suggested we consider three objectives in designing, administering, and regulating our health care system—quality, cost containment, and accessibility, which became the three vertices of his Iron Triangle of Health care.[27] (See Figure 1.) In a world without economic constraints, we would want everybody to have access to the highest quality of care at the lowest possible cost. In reality, however, when policymakers or others decide to emphasize one factor, the other two are likely to suffer. For example, when we focus on cutting costs, we are likely to sacrifice patients' access to care as well as the quality of care they receive. Conversely, where the ACA aimed to increase access to care, critics reasonably responded with concerns over increasing costs, and to a lesser extent, deteriorating or inconsistent quality.

FIGURE 1

The Iron Triangle of Health Care



Source: William L. Kissick, *Medicine's Dilemmas: Infinite Needs Versus Finite Resources* (New Haven: Yale, 1994).

Prevailing attitudes even before COVID-19 held that the U.S. health care system could perform better on all three fronts, and that new technologies would be part of whatever progress to come in increasing access, reducing costs, and improving quality. What remains unresolved is how to prioritize the three goals and the ways in which we might use new technologies to attain them.

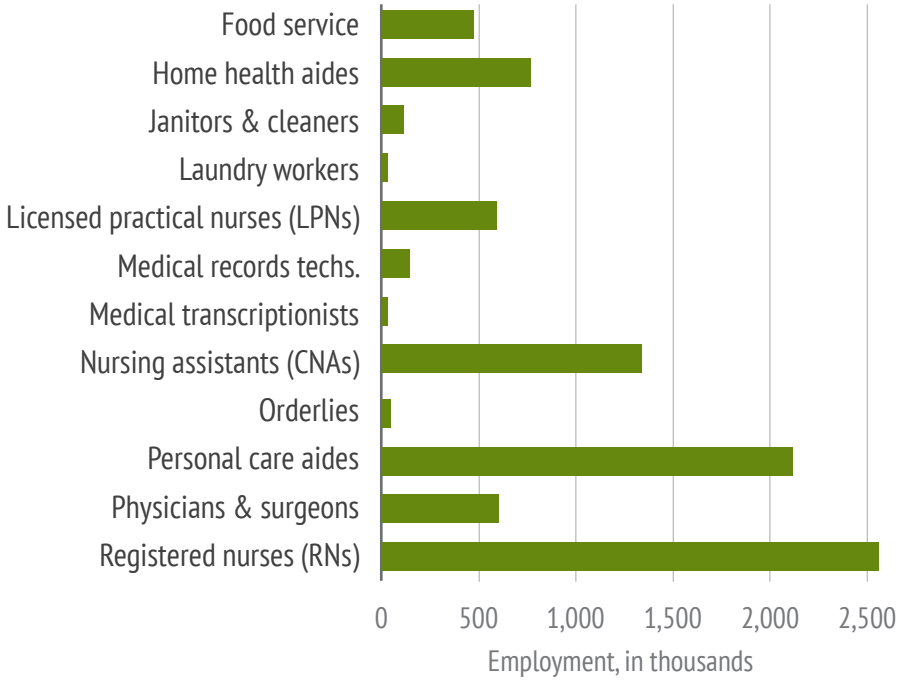
The Health Care Workforce in the United States

Employment Totals and Composition in Selected Occupations

Total employment in the United States sat at 152 million workers as 2020 began—with health care making up about 12%.[28] Whereas home health aides and RNs, for example, work almost exclusively in health care per se, laundry workers and janitors work across nearly every sector. Food service work essentially falls in a sector of its own, though many of these workers also cross into many other sectors.

As shown in Figure 2, of the occupations we analyze, nurses are the largest as about 2.6 million of them presently work in the sector. This bodes well for the industry. Aside from physicians and surgeons, whom we include here and elsewhere purely for comparative purposes, RNs are the most highly skilled and highly paid jobs we examine. Note also there are nearly 2.1 million personal care aides, who have fewer skills and receive much lower pay. The totals for food service workers, janitors, and laundry workers include only those employed in the health care sector.

FIGURE 2
Employment in Selected Occupations



Source: BLS Occupational Employment Statistics, May 2018.

Note: For home health aides, nursing assistants, and personal care aides, we have included those in the "social assistance" subsector. However, health care sector employment excludes the "social assistance" subsector. Food service captures the Food Preparation and Serving-Related Occupations major occupational category Standard Occupational Classi ication (SOC).

Relative to the economy at large, women and people of color are overrepresented in health care, as shown in Table 1. Women comprise 48.3% of employment across all occupations in the United States; relative to that baseline, women are overrepresented in all but two of the occupations we analyze—janitors and cleaners and orderlies.[29]

The table illustrates a similar trend with respect to race. Black workers represent 11.7% of the workforce across all occupations; they are overrepresented in every one of the occupations shown in the table except for medical transcriptionists and RNs. Latinos make up 16% of workers across all occupations,[30] but who are overrepresented in three of the lowest-paying occupations in Table 1. Finally, note that Asian workers, who make up 8.7% of all U.S. workers, are overrepresented in the health care sector compared to the rest of the economy. The physicians and surgeons category—not shown in the figure—accounts for some of this. However, Asian workers also make up a disproportionate share of home health and personal care aides as well as RNs.

We conclude that technological change in the health care sector will likely have an outsized effect on women and people of color. This report will help determine whether, when, and for whom those effects will be positive or negative.

TABLE 1

Sex and Racial Composition for Selected Occupations

Occupation	Sex		Race			
	Female	Male	White	Black	Latino	Asian & Other
All U.S. occupations	**48.3%**	**51.7%**	**63.6%**	**11.7%**	**16.0%**	**8.7%**
Entire health care sector	**77.7%**	**22.3%**	**62.7%**	**15.7%**	**11.8%**	**9.8%**
Food service	83.1%	16.9%	51.3%	26.0%	14.2%	8.5%
Home health aides	89.9%	10.1%	35.0%	32.7%	22.7%	9.6%
Janitors & cleaners	28.5%	71.5%	49.8%	23.1%	19.4%	7.7%
Laundry workers	82.4%	17.6%	51.7%	25.9%	16.5%	5.9%
Licensed practical nurses (LPNs)	88.5%	11.5%	57.2%	24.5%	11.0%	7.2%
Medical records technicians	90.6%	9.4%	64.8%	13.9%	12.8%	8.5%
Medical transcriptionists	85.9%	14.1%	75.0%	6.7%	7.4%	10.9%
Nursing assistants (CNAs)	89.1%	10.9%	47.0%	31.6%	12.8%	8.6%
Orderlies	40.9%	59.1%	41.6%	34.1%	14.6%	9.7%
Personal care aides	84.1%	15.9%	44.0%	25.1%	19.1%	11.8%
Registered nurses (RNs)	89.3%	10.7%	71.7%	10.5%	6.4%	11.5%

Source: U.S. Census Bureau, 2014-2018 American Community Survey.

Notes: Numbers may not sum to 100 due to rounding. The all U.S. category incorporates every sector of the economy. The entire health care sector includes 2017 industry Census codes 7290-8290, inclusive. For home health aides, orderlies, and personal care aides, we also include the "social assistance" subsector, 2017 industry Census codes 8370-8470, inclusive. The definitions of each of these industries appear in the appendix. For the remaining occupations, we only consider those working in the health care sector, as we have defined it. Food service includes 2018 Census occupation codes 4000-4160, inclusive.

Tables 2 and 3 provide compositional information on the age and educational attainment of the health care workforce, respectively. Overall, health care workers skew older than the broader labor force. Across the economy, about a quarter of the workforce is 55 or older. Aside from CNAs and orderlies, every health care profession finds this age group overrepresented. That suggests that shortages, where they already exist, are likely to worsen, which would lead to favoring technology solutions for jobs that may be difficult to automate.

Workers in the health care sector have completed more education, on average, than workers economywide. More than one-third of the U.S. workforce has a high school diploma (or equivalent) or less, whereas just less than one-quarter (22.7%) of health care workers report that level of education. In fact, 60.1% of RNs have earned a bachelor's degree or more. Nonetheless, five of the occupations we analyze are majority populated by those without any tertiary education. Nearly half of home health and personal care aides, in particular, report having a high school education or less.

TABLE 2

Age Composition for Selected Occupations

Occupation	Age					
	16-24 Years	25-34 Years	35-44 Years	45-54 Years	55-64 Years	65+ Years
All U.S. occupations	**14.9%**	**21.1%**	**19.2%**	**19.4%**	**16.9%**	**8.5%**
Entire health care sector	**8.5%**	**23.0%**	**20.7%**	**20.3%**	**18.8%**	**8.8%**
Food service	25.5%	17.6%	12.7%	17.4%	18.8%	7.9%
Home health aides	7.7%	18.7%	18.7%	22.1%	21.8%	11.0%
Janitors & cleaners	9.5%	14.2%	14.7%	22.3%	26.8%	12.5%
Laundry workers	6.2%	13.0%	12.0%	25.0%	28.3%	15.6%
Licensed practical nurses (LPNs)	8.4%	21.9%	20.9%	20.6%	19.4%	8.8%
Medical records technicians	4.1%	16.4%	21.6%	21.5%	25.5%	11.0%
Medical transcriptionists	21.5%	15.5%	7.6%	14.0%	23.5%	17.8%
Nursing assistants (CNAs)	18.8%	25.1%	18.3%	17.3%	14.5%	5.9%
Orderlies	19.9%	24.8%	15.2%	14.8%	17.0%	8.1%
Personal care aides	14.7%	20.4%	17.1%	18.6%	19.0%	10.3%
Registered nurses (RNs)	4.0%	24.0%	22.3%	20.6%	20.6%	8.5%

Source: U.S. Census Bureau, 2014-2018 American Community Survey.

Notes: Numbers may not sum to 100 due to rounding. The all U.S. category incorporates every sector of the economy. The entire health care sector includes 2017 industry Census codes 7290-8290, inclusive. For home health aides, orderlies, and personal care aides, we also include the "social assistance" subsector, 2017 industry Census codes 8370-8470, inclusive. The definitions of each of these industries appear in the appendix. For the remaining occupations, we only consider those working in the health care sector, as we have defined it. Food service includes 2018 Census occupation codes 4000-4160, inclusive.

TABLE 3

Educational Attainment Composition for Selected Occupations

Occupation	Educational attainment				
	Less than high school	High school	Some college	Bachelor's degree	Graduate degree
All U.S. occupations	**10.5%**	**25.3%**	**32.2%**	**20.1%**	**11.7%**
Entire health care sector	**4.7%**	**18.0%**	**38.4%**	**21.4%**	**17.5%**
Food service	19.7%	42.6%	32.5%	4.5%	0.7%
Home health aides	18.8%	38.8%	31.7%	8.5%	2.2%
Janitors & cleaners	21.5%	46.5%	26.8%	4.1%	1.1%
Laundry workers	29.2%	51.4%	17.3%	1.7%	0.4%
Licensed practical nurses (LPNs)	1.7%	23.5%	70.1%	3.6%	1.0%
Medical records technicians	1.2%	19.5%	59.0%	16.8%	3.4%
Medical transcriptionists	1.0%	16.7%	49.8%	28.6%	3.9%
Nursing assistants (CNAs)	10.9%	35.1%	45.4%	6.8%	1.7%
Orderlies	7.2%	31.1%	45.8%	12.5%	3.4%
Personal care aides	15.7%	34.7%	37.3%	9.6%	2.8%
Registered nurses (RNs)	0.4%	1.2%	38.3%	49.4%	10.7%

Source: U.S. Census Bureau, 2014-2018 American Community Survey.

Notes: Numbers may not sum to 100 due to rounding. The all U.S. category incorporates every sector of the economy. The entire health care sector includes 2017 industry Census codes 7290-8290, inclusive. For home health aides, orderlies, and personal care aides, we also include the "social assistance" subsector, 2017 industry Census codes 8370-8470, inclusive. The definitions of each of these industries appear in the appendix. For the remaining occupations, we only consider those working in the health care sector, as we have defined it. Food service includes 2018 Census occupation codes 4000-4160, inclusive.

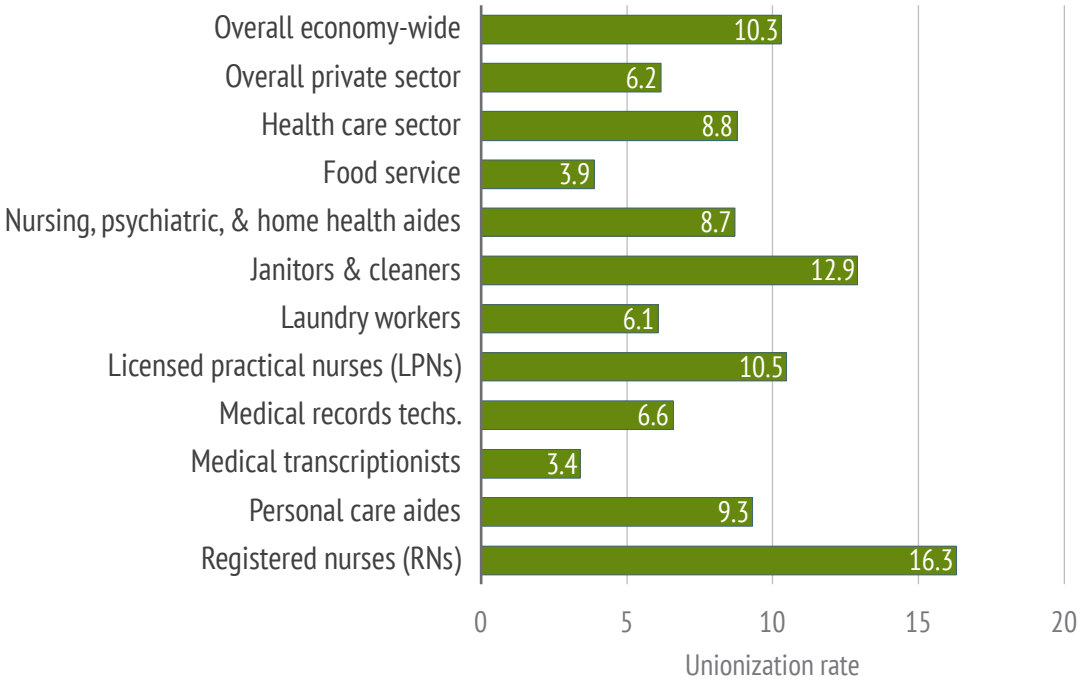
The sectoral demographics—majority women and people of color, many of whom have less formal education—will influence our three focal questions. That said, workers joining together in unions, which remain the foremost institutions for leveling the labor market playing field, deserve our attention. Collective bargaining continues to thrive in the health care sector.

Figure 3 provides comparative data on union density. Overall private-sector union density currently sits at 6.2%, but sectoral density is some 40% greater (8.8%). While these data are

broken down slightly differently than the data underpinning Tables 1–3, three occupational categories shown here, including LPNs and RNs, have densities greater than the economywide average of 10%.

FIGURE 3

Unionization Rates for Selected Occupations in 2019



Source: BLS data compiled by Barry T. Hirsch and David A. Macpherson as described in "Union Membership and Coverage Database from the Current Population Survey: Note." *Industrial and Labor Relations Review* 56, no. 2 (2003): 349-54.

Note: Health care sector unionization was calculated after removing the narrow "social assistance" subsector from the Health Care and Social Assistance major sectoral category. The "nursing, psychiatric, and home health aides" category includes nursing assistants and orderlies, as these data cannot be disaggregated any further. Food service includes 2018 Census occupation codes 4000-4150, inclusive.

Wages and Job Quality in Selected Occupations

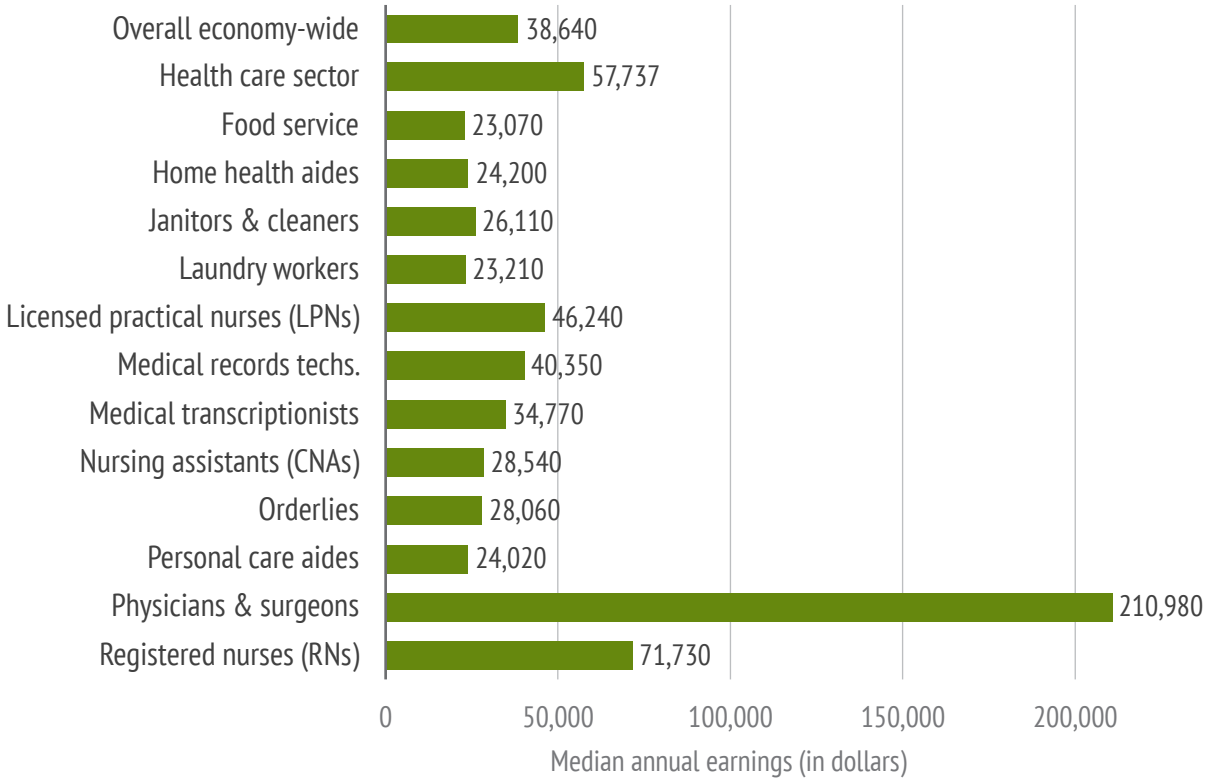
Job quality—specifically wages—figures as well into our analysis. Figure 4 shows median annual earnings, first for all U.S. workers, then for the entire health care sector, and finally for the occupations that we consider. Once again, while not our focus, we also have included for comparative purposes the wages for physicians and surgeons.

At first glance, sectoral pay appears to exceed that for all occupations economywide—an appearance driven mostly by salaries for physicians and surgeons. Note that of the occupations on which we focus, LPNs, medical records technicians, and RNs earn more than the median worker economywide. RNs, in particular, make 86% more than the median worker economywide.

However, many jobs earn less than the national median, including home health aides and personal care aides. Laundry workers make the least of any of the occupations in Figure 4, 40% less than the median U.S. earner. Janitors and cleaners are not paid much better. In the case of laundry workers, and janitors and cleaners, wages are less likely to be buoyed by health care sector-specific wage norms, since so many of these incumbents do not work in the health care sector at all. And, even those that may visibly appear to work in health care settings often work for contractors, further driving down their wages relative to those they work alongside.[31]

FIGURE 4

Median Annual Earnings for Selected Occupations in 2018



Source: BLS Occupational Employment Statistics May 2018.

Note: Health care sector employment excludes the "social assistance" subsector. Food service captures the Food Preparation and Serving-Related Occupations major occupational category Standard Occupational Classification (SOC). The figure provided for physicians & surgeons is actually the mean as BLS does not provide median earnings data for the most highly-compensated occupations.

While we can hardly overstate the importance of wages, they are but one measure of job quality. As we will detail later, U.S. employers—not the government—serve as the primary conduit for health care access. Employers are motivated both economically and normatively to provide workers quality health insurance, sometimes directly and other times through union health plans. Thus, access to employer- or union-provided health insurance, while becoming more rare, remains a principal attribute of a "good" job.[32]

Table 4 shows the rates for employer- or union-provided health insurance and injury rates for the same set of occupations examined in previous figures. Perhaps owing in part to their high union density, 83.2% of RNs report such access to employer-provided health care, more than any other listed occupation. However, the entire sector reports access to health insurance at a rate that is 12% greater than the economy at large. Just two occupations offer workers insurance less than 40% of the time—home health aides (33.4%), and personal care aides (39%). As we will see, direct care workers generally work for cash-strapped, private home care agencies, making these employees poorly compensated and presenting a challenge for them to join together to form a union.

Finally, given the physical nature of health care work, we might assess job quality on the basis of workplace injuries or illnesses. The injury data in Table 4 aid us in this effort. As depicted, the likelihood of incurring an injury or illness in health care varies a great deal by occupation. Those occupations that are less hands-on and more focused on recordkeeping incur substantially fewer injuries and illnesses than the economywide average. Others, namely CNAs and orderlies, incur substantially more injuries and illnesses, explaining why both score so poorly on this facet of job quality.

Broad Projections for the Sector and Its Workers

By any measure, demand for health care will grow for the foreseeable future—certainly for the short and medium runs that concern us here. According to the Centers for Medicare and Medicaid Services (CMS), national health spending will grow at an average annualized rate of 5.5% per year over the next 10 years, reaching nearly $6.0 trillion by 2027. That is 0.8 percentage points faster than GDP, meaning the health care share of total production will increase from 17.9% to 19.4%.[33]

This long-term, structural increase in demand for health care—what economists call "scale effects"—has material consequences for understanding the impact of technological change on work. (See Box 2.) Growth in "final" demand for health care will mitigate some of the negative employment effects arising from technological change. Unfortunately, many widely publicized projections do very little to account for final demand or scale effects more broadly or even consider sector-specific drivers of technological change and their workforce impact. They also tend to focus on jobs lost without adequately considering the types of new jobs created by technology adoption.

TABLE 4

Access to Employer- or Union-Provided Health Insurance Overall and Incidence Rates for Nonfatal Occupational Injuries and Illnesses Involving Days Away From Work for Selected Occupations

Occupation	Access to health insurance		Injuries incidence rate
	% Yes	% No	
All U.S. occupations	**63.1%**	**36.9%**	**89.7**
Entire health care sector	**70.4%**	**29.6%**	**106.0**
Food service	57.9%	42.1%	75.2
Home health aides	33.4%	66.6%	96.9
Janitors & cleaners	58.8%	41.2%	137.1
Laundry workers	50.8%	49.2%	106.7
Licensed practical nurses (LPNs)	66.8%	33.2%	85.6
Medical records technicians	77.8%	22.2%	22.7
Medical transcriptionists	68.7%	31.3%	9.1
Nursing assistants (CNAs)	58.3%	41.7%	255.7
Orderlies	69.0%	31.0%	283.3
Personal care aides	39.0%	61.0%	73.0
Registered nurses (RNs)	83.2%	16.8%	88.4

Source: The insurance data come from U.S. Census Bureau, 2014-2018 American Community Survey. Note that this only reflects access to health insurance for those in work. The injury data come from the BLS Survey of Occupational Injuries and Illnesses, 2018.

Notes: With respect to health insurance, numbers may not sum to 100 due to rounding. The all U.S. category incorporates every sector of the economy. The entire health care sector includes 2017 industry Census codes 7290-8290, inclusive. For home health aides, orderlies, and personal care aides, we also include the social assistance subsector, 2017 industry Census codes 8370-8470, inclusive. The definitions of each of these industries appear in the appendix. For the remaining occupations, we only consider those working in the health care sector, as we have defined it. Food service includes 2018 Census occupation codes 4000-4160, inclusive. With respect to injuries, incidence rates represent the number of injuries and illnesses per 10,000 full-time workers and were calculated as (N/EH) x 20,000,000, where N = number of injuries and illnesses, EH = total hours worked by all employees during the calendar year, 20,000,000 = base for 10,000 equivalent full-time workers (working 40 hours per week, 50 weeks per year). Injuries and illnesses include sprains, strains, tears, fractures, cuts, bruises, burns, carpal tunnel syndrome, and tendonitis. The injury data includes both health care and social assistance as there is no easy way to further disaggregate them.

BOX 2

Labor Market and Workplace Impact of Technological Change: Scale Effects vs. Substitution Effects

In analyzing and then diagnosing the labor market impact of technological change, economists discern between *substitution* and *scale* effects. By default, those concerned with technological displacement tend to focus on the former: if the cost of technology falls relative to the cost of labor, i.e., wages, then employers will want to shift their resources from labor to capital, thereby making production or service delivery more capital-intensive and less labor-intensive. Consequently, demand for labor would fall, eroding employment, wages, and job quality writ large. This technological substitution, which for some workers might lead to technological unemployment, has become the dominant upshot of the more apocalyptic, often less sectorally grounded treatments of the impact of technological change.

Fortunately for workers, technological change drives a second effect: by reducing the overall costs of production or service delivery, it also allows the employer to produce more than he or she had been. This scale effect will lead to increased use of all production inputs, including labor. As a result, in this case, the positive scale effects resulting from technological advances will *at least partially* offset the negative substitution effects arising from those same advances. Which effect dominates—and therefore, whether workers benefit or suffer, in the net—thus becomes an empirical question, one that cannot be answered by textbook theory alone. Indeed, this theoretical ambiguity is what calls for studies like this one that examine a single sector or specific technologies in depth.

In the wake of potentially impactful technological advances, health care offers workers another cushion—the likelihood of a long-term, limitless structural increase in the demand for care. As we will discuss, a number of factors lead us to anticipate increased demand for health care services, fueling the very scale effects that could mitigate and potentially overcome many of the negative effects arising from substitution.

Scholars, the media, and policymakers focus on studies adopting a task-replacement approach, in part because they provide easily understood takeaways.[34] From a methodological standpoint, task replacement originated with Autor, Levy, and Murnane's[35] analysis of the impact of computers on the demand for skills. They argued that computers would be used to substitute for workers performing routine tasks predicated on explicit rules, irrespective of whether those tasks were manual or cognitive, and would be used to complement the labor of those undertaking nonroutine problem solving and complex communications tasks.

Since then, investigators have extended this approach to technologies that can do more than simply carry out explicit rules, including AI-infused robotics. Most notably, Acemoglu and Restrepo extend existing thinking by unpacking the "task content" of technological change.[36] They envision technological change in multiple stages—initially displacing labor through automation, but then reinstating some workers into a broader range of tasks, thereby offsetting at least some of the initial, negative effects on labor demand. The practitioner community also has weighed in, most notably McKinsey & Company. Though they lack the theoretical foundation underpinning the academic studies, they have offered multiple reports predicting—in concrete terms—the extent to which technological change will shape demand for specific sectors and occupations.

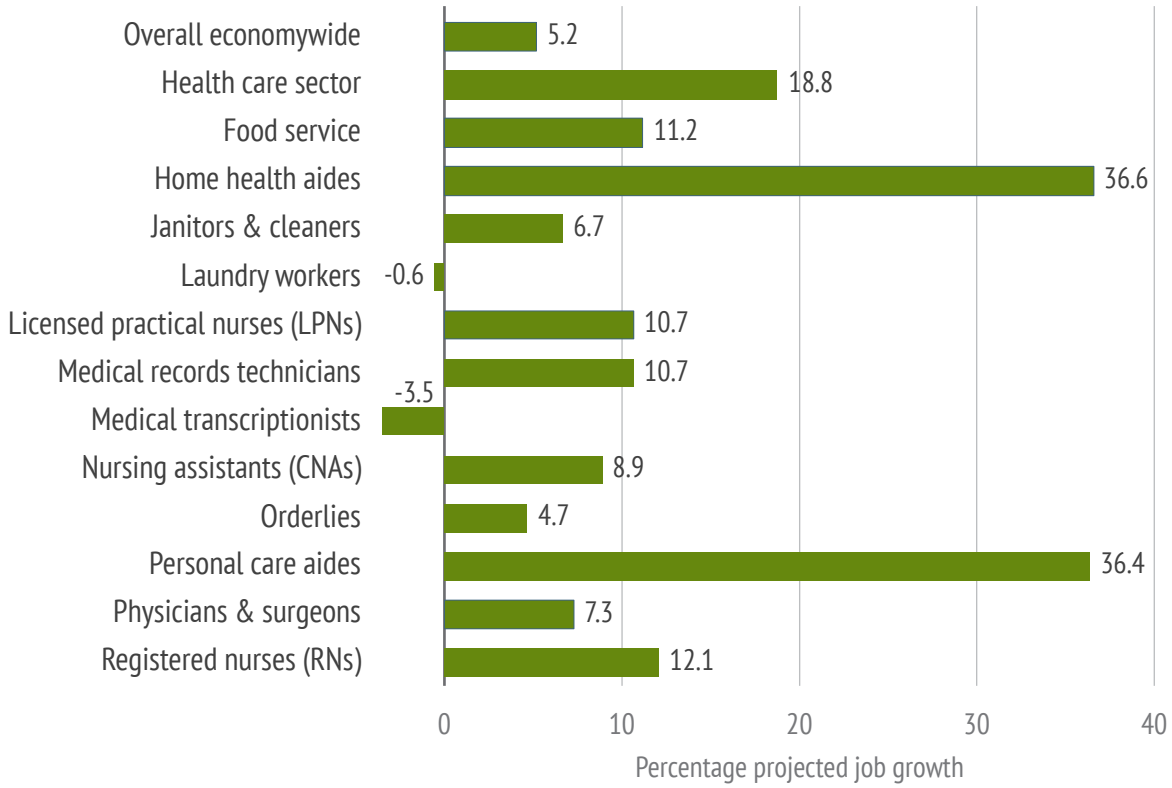
Bureau of Labor Statistics (BLS) data (see Figure 5) provide us with 10-year employment projections and account for growth in final demand at a more granular level. However, even they project future economic behavior on the basis of a continuation of economic relationships that held in the past without closer attention to the likelihood of increased demand for health care. Likewise, the BLS data do not fully account for technologically induced changes in care delivery. Within a given sector, technological innovation counts among seven factors that drive a qualitative analysis of compositional changes in occupational demand. The BLS data does not provide industry studies of each sector to determine which technologies are on the brink of adoption or how each will affect the nature of each occupation and the relative distribution of them.

As it turns out, health care and its associated occupations are expected to account for a large share of new jobs projected through 2028, due in large part to demographic shifts.[37] Overall, fully 40% of the 8.9 million new jobs expected to be created will be in health care and social assistance, increasing the sector's share of overall employment from 12.4% in 2018 to 13.8% in 2028. And, eight of the 30 fastest-growing occupations fall within the sector. By 2028, if not sooner, health care will be the largest major employment sector in the United States.

Turning to specifics, BLS predicts job growth of nearly 18.8% in health care relative to an economywide projection of 5.2%. We see the largest projected job growth for home health aides (36.6% projected job growth), personal care aides (36.4%), and RNs (12.1%)—the last of which is actually the highest paid and most unionized job class analyzed. Unfortunately, both of the direct care jobs anticipating sizable demand increases pay poorly and require, at most, a

FIGURE 5

Employment Projections for Selected Occupations



Source: BLS. 2019. Employment Projections—2018-2028. Washington: U.S. Bureau of Labor Statistics.

Notes: The all U.S. category incorporates every sector of the economy. The entire health care sector includes 2017 Census industry codes 7290-8290, inclusive. The definitions of each of these industries appear in the appendix. It does not include social assistance. For the individual occupations aside from food service, we only consider those working in the same set of 4-digit industries. Food service captures the Food Preparation and Serving-Related Occupations major occupational Standard Occupational Classification (SOC).

high school education. Interestingly, demand for laundry workers in the sector is projected to fall, despite the fact that across-the-board demand for these workers (not shown in the figure) is expected to increase slightly. Medical transcriptionists are the only other occupation we analyze showing negative projected growth over the 10-year time horizon. While speech recognition technology could be a future driver of job decay for this occupation, these numbers probably stem from the transition from paper-based health records to EHRs, into which most practitioners just enter patient data directly.

In short, most analyses of job growth bode reasonably well for the health care sector as a whole, even accounting for technological change. However, we see a fair bit of occupational variation within the sector. And, while each of the aforementioned approaches is founded in rigorous and careful statistical methodology, none accounts for the institutional peculiarities of each sector—the very structures and processes that actually generate the data they analyze. And, the health care sector has no shortage of institutional peculiarities.

The Strange Sectoral Structure: The Separation of Financing from Delivery

The impact of the unique structure of the health care industry must be factored into any analysis of technology utilization.

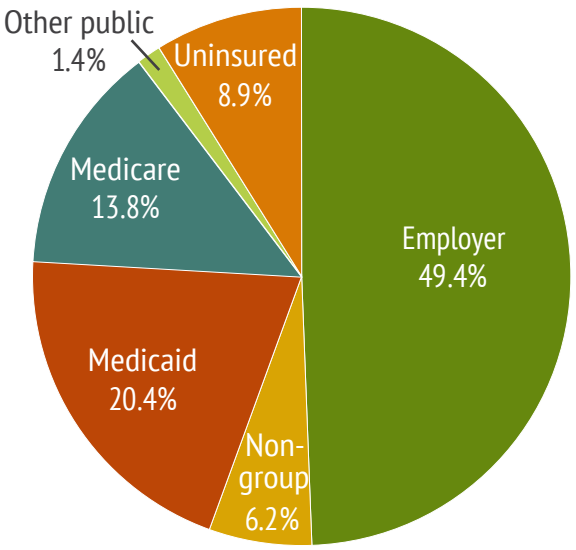
If health care were potatoes and the market was competitive, there would be many customers that wanted potatoes and many sellers seeking to meet their needs. The price of potatoes would rise and fall with changes in supply and demand. Potato growers and sellers would invest in new technologies if they thought the benefit would exceed the cost—whether the candidate technology improved the efficiency with which the farmer could grow his potatoes or perhaps the quality of the potatoes he was able to cultivate and sell. In any case, an affirmative answer to this question would lead the farmer to invest in new machinery.

The U.S. health care market deviates substantially from this model, with serious implications for technology adoption and its impact on work and workers. For starters, Americans don't buy health care; if anything, they buy health *insurance*. When they do so, they often have few choices and lack the information and foresight to predict their own health care needs. And, in actuality, in a given year, rather few Americans ever step up to a health insurance sales window anyway.

Figure 6 shows the sources of health insurance for U.S. residents in 2018. Only 6.2% of Americans actually purchased (or have purchased on their behalf) an individual or family policy directly from an insurer, potentially through one of the regulated health insurance exchanges established as part of the ACA. Almost half of all Americans access their health insurance through an employer—their own, in the case of a policyholder, or the policyholder's, in the case of dependents. The federal government encourages this practice by offering employers tax incentives to provide health insurance to employees.[38] While this form of group insurance reduces the sorts of adverse selection that plague the individual policy market, it presents some serious challenges. In the wake of an economic downturn, millions may suddenly be left without a way to pay for health care. In fact, by one credible account, the immediate economic impact of COVID-19 was separating some 3.5 million people from their health insurance—a particular challenge in a public health emergency.[39]

FIGURE 6

Sources of Health Insurance Coverage for United States Residents in 2018



Source: Henry J. Kaiser Family Foundation using data from the U.S. Census Bureau's American Community Survey (ACS). The U.S. totals exclude Puerto Rico.

Notes: Employer includes those covered through a current or former employer or union, either as policyholder or as dependent. Non-group includes those covered by a policy purchased directly from an insurance company, either as policyholder or as dependent. Medicaid includes those covered by Medicaid, Medical Assistance, Children's Health Insurance Program (CHIP), or any kind of government-assistance plan for those with low incomes or a disability, as well as those who have both Medicaid and another type of coverage, such as "dual eligibles" who are also covered by Medicare. Medicare includes those covered by Medicare, Medicare Advantage, and those who have Medicare and another type of non-Medicaid coverage where Medicare appears to be the primary payer. Excludes seniors who also report employer-sponsored coverage and full-time work and those covered by Medicare and Medicaid, i.e., "dual eligibles." Other Public includes those covered under the military or Veterans Administration. Uninsured includes those without health insurance and those who have coverage under the Indian Health Service only.

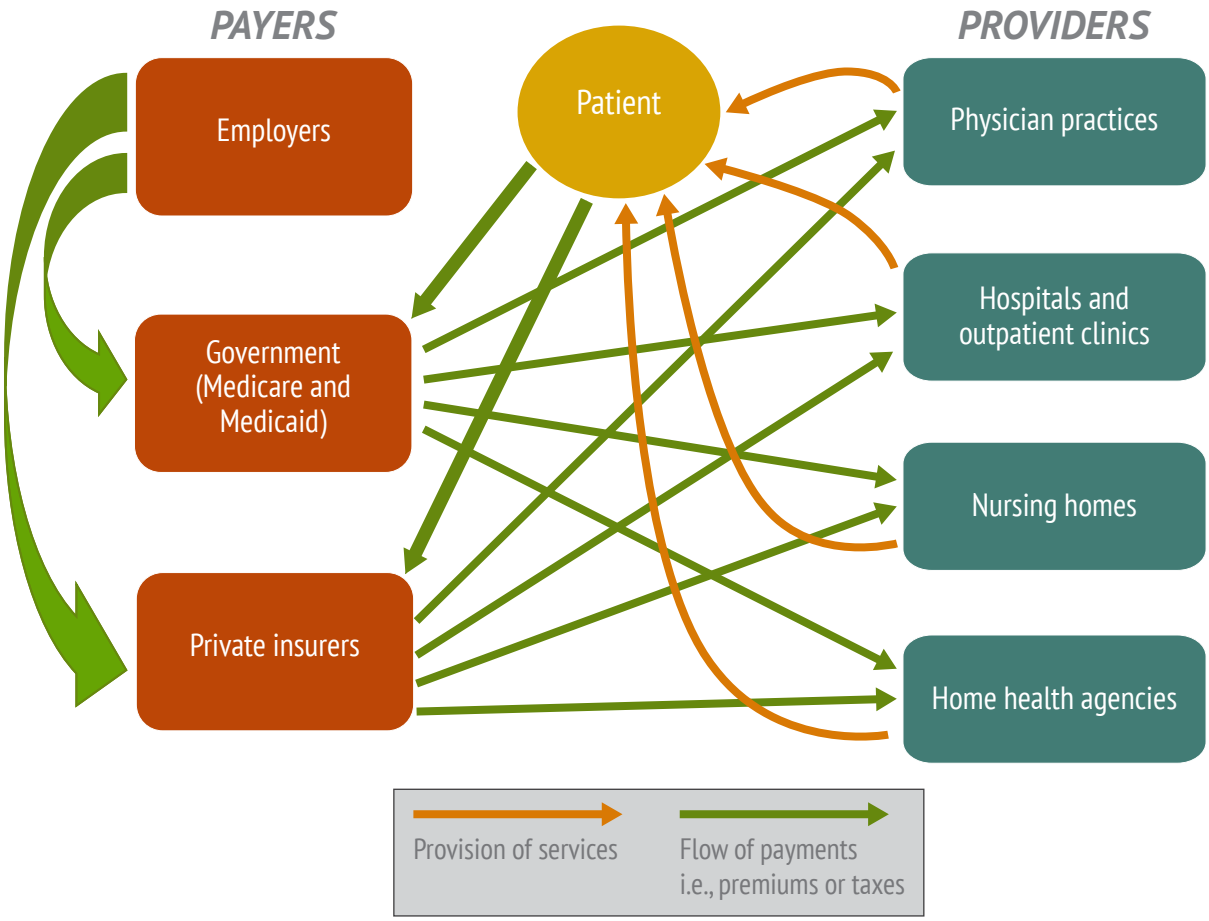
Even during an expansionary period, employer-based health insurance further distances the patient/customer from the marketplace. That is, they are no longer showing up to a health insurance "sales counter," comparing many competing products, and choosing the one that provides the best value to them. Another 34.2% of Americans receive their insurance from the government, mainly from Medicare (13.8%)—the program for those who are elderly or disabled—and from Medicaid (20.4%)—a program for the most indigent Americans. Another 8.9% of Americans have no health insurance at all, despite the explicit individual mandate embodied in the ACA (since hollowed out by the Trump administration and the courts).

Since Americans generally buy health insurance rather than health care, the stage already is set for a structural separation between the financing of care and the delivery of care—a bifurcation to which we will return. Add to this the many avenues by which Americans might access health insurance, and it's clear that any sort of visual representation will be convoluted relative to the one we might use to depict our simplified potato market. Nonetheless, Figure 7 attempts a structural depiction of the U.S. health care system, to clarify the drivers and impact of technological change in the sector.[40] The green and red arrows represent flows of money and services, respectively.

Notice that the patient ("customer") in this market sits between the insurers ("payers") and the providers. Nearly all care is provided in one of the four settings on the right—physician practices or medical offices, hospitals or outpatient clinics, nursing homes, or in the patient's home via a home health agency. Not only is there overlap in the services provided, but they employ many of the same occupations, including RNs, LPNs, and home health and personal care aides.

FIGURE 7

Simplified Map of the U.S. Health Care System



In general, insured patients do not pay the bill directly. Rather, patients pay their employers via foregone wages, the government via taxation, and private insurers via conventional monthly premiums. Employers also pay taxes and premiums to private insurers, from which the payers—namely Medicare, Medicaid, and private insurance—pay the providers.

The specific arrangements under which payers actually compensate providers generally fall into one of two payment models. Under the conventional fee-for-service (FFS) model, the health plan, i.e., the insurer, pays the provider on a claim-by-claim basis according to prenegotiated rules regarding what procedures are covered and at what rate. The provider then pockets the difference between what it collects from the payer (plus co-payments or co-insurance from the patient) and the cost of providing the care. Consequently, providers benefit from providing the services of each claim as efficiently as possible and from generating as many reimbursable claims as possible, with an emphasis on those treatments that leave more claims revenue in excess of costs.

Alternatively, rather than paying providers on the basis of individual claims, insurers can contract to reimburse providers on a capitated basis, usually per-member-per-month (PMPM). Under this model, often labeled "value-based care" (VBC), the provider internalizes the risk of its patient population, effectively assuming the role of health care insurer or health plan in addition to its role as health care provider. The provider must finance all necessary care from the capitated payment (once again, plus co-payments or co-insurance from the patient), leaving the residual revenue after costs of care delivery as its profit.

In reality, most health plans marketed today contain some elements of the VBC model. Government policies promote this model, and insurers, who have long seen value in it, have become increasingly able to sell it to employers and policyholders as a more efficient form of care delivery.

Aside from influencing providers' incentives to adopt new technologies, payment models constrain the behavior of provider organizations as employers. Historically, the FFS model left providers relatively flush with cash, as plans placed few limits on the number and nature of claims providers could submit to insurers. This increased the overall size of the pie available for dividing between provider organizations and their employees. On the other hand, the VBC model forces providers to be more cost conscious, since the amount of monthly income is fixed. In other words, the VBC model yields a smaller pie, suggesting greater constraints to wage-setting for those providers operating chiefly under the VBC model.

SECTION THREE
Drivers of Change in Health Care Delivery: Four Sectoral Imperatives

Once we accept the underlying premise of the Iron Triangle of access to care, cost containment, and quality, we can step closer to identifying the actual technologies most likely to play a role in the technological change process. The first question focuses on the factors or forces driving technology adoption.

Our research leads us to answer that question in two separate ways and in two separate parts of this report. In this section, we outline the four, overarching imperatives that respondents consistently identified as critical—in other words, what was leading sectoral actors to adopt new technologies? Or, where technology is viewed as (perhaps part of) a "solution," what was the problem? As such, these imperatives emerged as the drivers of technology adoption in the health care sector. Once we identify specific technologies, we will consider key choices that policymakers and managers face when responding to these imperatives.

Increasing Access

In simplest terms, increasing access to care amounts to increasing the share of the U.S. population with health insurance. The Affordable Care Act took direct aim at this issue, and did reduce the uninsured share of the population to below 10%, as shown in Figure 6. The Department of Health and Human Services (DHS) has a number of other objective measures of access it aims to boost. For example, DHS hopes to increase the proportion of the population with coverage for clinical preventive services as well as the share of the population with a "usual primary care provider." Following this, the agency also recognizes the relative shortage of primary care providers and has developed a set of sub-goals for addressing this issue as a means of increasing access.[41] And, as the lack of access disproportionately impacts people of color, it may help explain the disproportionate toll that COVID-19 has taken on minority communities.

More so than any other imperative, increasing access almost certainly requires policy solutions along the lines of the ACA. However, new forms of technology that facilitate patients' access to medical services, particularly once these services are covered by public or private payers, may also help along these lines. Increasing access almost assuredly increases costs—but using technology can mitigate these higher costs, particularly if its use facilitates increases in access that do not necessitate increased staffing.

Consolidating and Coordinating

Sectoral consolidation has been the structural response to runaway costs. And, technological developments have both facilitated and themselves been hastened by this restructuring. Consolidation generally takes the form of a merger of two to three community hospitals, sometimes under the umbrella of a large hospital chain. Aside from creating more opportunities for hospitals to leverage scale economies, these mergers imbue inpatient providers with more bargaining power vis-à-vis the insurers with whom they must negotiate. This same bargaining power brought about by horizontal integration may also translate into monopolization of the product market, with all of the usual pitfalls for "customers"—patients, in this case.

Increases in organizational scope—like those in size—also have become more apparent over the last decade. Vertical integration—incorporating multiple parts of the production or service-delivery process under a single organization's control—is usually considered in a manufacturing context, but it works in the health care sector also. A single health care provider organization can coordinate across one or more hospitals, a host of primary care and specialist physician medical offices, outpatient care or surgical centers, skilled nursing facilities, and home health agencies. Doing so could facilitate transitions from one care setting to another as well as improve coordination of care more broadly. To the extent the ACA and other institutions have promoted a shift from FFS to VBC, this coordination can deliver the sorts of cost reductions and quality improvements that create value that providers can actually appropriate. And, if providers can capture at least some of that value, they are likely to invest in technologies that can help them do so.

Facilitating Chronic Disease Prevention and Management

Consolidation and increased coordination of care delivery, when engendered by changes in payment models, also puts responsibility on providers for such costly chronic conditions as diabetes and congestive heart failure, thus encouraging investments in population health management and chronic disease prevention. It also focuses providers' efforts on reducing what otherwise amounts to a substantial portion of the nation's $3.3 trillion annual health care bill.

That a clearly defined entity bears financial responsibility for chronic conditions paves the way for the transition away from what some derisively label a "sick care" system as opposed to a health care one.[42] However, this transition also necessitates a complete switch from the episodic

treatment of acute health conditions to the management and ideally prevention of chronic, debilitating, and often terminal ones—physical or mental conditions that last more than a year and cause functional restrictions or require ongoing monitoring and treatment. Fully 60% of adults in the United States have one or more of these conditions, inclusive of hypertension, lipid disorders, diabetes, asthma, osteoarthritis, and mood and anxiety disorders.[43] Whereas *treatment* requires waiting for the onset of symptoms, *prevention* calls for upfront monitoring, health coaching, and patient education. As a number of sources told us, treatment often takes place in a hospital, where care delivery is costly, dangerous, and inefficient; prevention takes place elsewhere, often even in the patient's home. Thus, as one respondent noted, this imperative drives the larger movement to "keep patients away from the hospital."

Like prevention, disease management similarly requires that patients be guided, reminding them to take their medication, to remember to get refills and keep their doctor's appointments, and, more broadly, to engage in health-enhancing behaviors such as exercise and to refrain from health-eroding behaviors, e.g., smoking. Since this requires creating and maintaining regular lines of communication between providers and patients—even when the patient may be relatively asymptomatic,—many of the same technological solutions called on to reduce barriers to access can similarly aid efforts to prevent and manage chronic diseases. Finally, while increased preventive care could not have prevented the spread of the novel coronavirus per se, it could have made those with asthma, diabetes, and other COVID-19 risk factors—again, disproportionately the poor and people of color—more resilient.

Responding to Demographic Trends

Life expectancy in the United States has risen slowly but steadily since 1960—from 54.6 to 74.3 years for women and from 50.7 to 70.0 years for men.[44] Add to this the arrival of the baby boomer generation into retirement, several decades of declining birth rates, and restrictive immigration policies, and the implications start to take shape. While we welcome improvements in the treatment and prevention of life-shortening medical conditions, we also must recognize the challenges of an aging population from a health policy perspective—namely, increased prevalence of chronic and co-morbid conditions and thus, a swelling of unmet demand for long-term care that will continue into the foreseeable future. The shortage of direct care providers will be even more pronounced in rural areas, which have higher proportions of elderly, disabled, and impoverished residents, implying elevated levels of Medicare and Medicaid eligibility and enrollment.[45]

The elderly and the otherwise infirm often require regular, ongoing care, and understandably, generally prefer to receive that care at home. In many ways, the desire to age in place, while originating with the patient, also allows for the most cost-effective method and location of care delivery. However, it also necessitates the mobilization of an entire sub-sector of direct home care workers—namely home health aides and personal care attendants. And, as Paul Osterman has documented, the haphazard way in which the sector has been allowed to evolve appears unsustainable.[46]

SECTION FOUR
Technological Responses to Sectoral Imperatives

We now turn to the discussion of which sorts of technologies the sector has turned as it responds to the four imperatives outlined above? Those we spoke to offered up dozens of specific manifestations and applications of new technologies just now beginning to diffuse across the sector. Our research identified three patterns of technology "families," as we refer to them, as listed on the left side of Table 5. Along the top of the table are the four imperatives we outlined in the previous section.

Digital Communications and Telepresence

Without significant advances in digital communications and telepresence, there would be no need for this report. In simplest terms, this category includes one's smartphone and internet-connected computer. In their first incarnation, these devices provided patients with a wealth of information of inconsistent quality that could be used to self-diagnose, self-treat, or perhaps to better understand information provided to them by their physician.[47,48] However, respondents made clear that as bandwidth and processing power become cheaper, providers increasingly embrace these technologies in ways that respond to the four sectoral imperatives.

Digital communications and telepresence facilitate keeping patients away from the physical facility—ideally, at home—thereby increasing access and reducing costs, and appears to be doing so without a decrease in quality.

While the shift from paper-based records to integrated EHRs is now largely finished in the both the hospital and medical office settings, nearly all of our respondents referenced it, usually to

TABLE 5

Emerging and Potentially Impactful Technologies for Addressing Sectoral Imperatives in Health Care Delivery

Technology	Trend / Imperative			
	Increasing access	Consolidating & coordinating	Facilitating chronic disease prevention & management	Responding to demographic trends
Digital communications & telepresence	• Viritual hospitals and health centers • Telemedicine/ telehealth	• Optimization of electronic health records (EHR) systems	• Telemedicine/ telehealth • Mobile medical/ health apps	• Electronic visit verification (EVV) • Smartphone as the "locus of care"/ augmented home health
Semi-autonomous service robots	• Pick-up and delivery robots	• Pick-up and delivery robots		
Artificial intelligence/ machine learning/ natural language processing	• Artificial intelligence (AI)-enabled chatbots • Professionally-mediated clinical decision support	• AI-enhanced EHR systems	• Machine learning (ML)-enabled diagnosis • AI-powered personal health assistants	• AI-enabled virtual assistants

point out the initial acceptance and use of digital communications technologies in the health care space. Multiple respondents also noted that EHRs, firmly ensconced in care-delivery routines, now are being optimized toward care coordination, particularly across large, multiple setting care delivery systems. In this sense, digital communications technology responds directly to the consolidation and coordination imperative.

> **"When we first implemented EHRs, we were just hoping to successfully replicate what we used to do with paper. Now, we've recognized not only that computers are bad at replicating paper, but that EHRs can allow us to do much more than we ever could with paper."**
>
> **—a hospital administrator**

Interestingly, in the course of discussing the initial deployment and subsequent optimization of EHR systems, some interviewees also recounted unpleasant memories of the transition from paper. The legacy of organizational and technological hiccups seems to have weighed on the minds of providers, suggesting why they are just now starting to push the bounds of the technology in ways that paper-based systems or even nonintegrated digital systems simply did not allow.[49,50] As a result, increasing comfort with and use of these technologies facilitates the growth of hospitals and health delivery systems both in terms of their size and the range of services they can offer and coordinate across. Notwithstanding the negatives of concentrated market power, larger hospital systems theoretically could increase access for patients. Similarly, we learned that digital communications technologies can further extend the reach of a health system by allowing for "virtual hospitals," in which specialists care for patients at a distance. While the COVID-19 pandemic has brought renewed attention to digitally enabled, remotely provided care, the concept is by no means new or untested. Mercy Virtual Care Center (MVCC) in suburban St. Louis offers a living example of a virtual hospital functioning long before the exigencies of the pandemic:

> **"...doctors and nurses sit at carrels in front of monitors that include camera-eye views of the patients and their rooms, graphs of their blood chemicals and images of their lungs and limbs, and lists of problems that computer programs tell them to look out for. The nurses wear scrubs, but the scrubs are very, very clean. The patients are elsewhere."[51]**
>
> **—Arthur Allen, "A Hospital Without Patients," 2017**

MVCC cares for patients along two separate paths. First, it provides specialist care remotely through a hospital at home model, whereby providers at MVCC can check vital signs, record notes, respond to alarms, issue orders, undertake exams, and talk with patients. Providers can even track patients with wireless devices, getting pinged if a sensor detects a fall or a sudden change in blood pressure or body temperature. Typically, these chronically ill patients are in bed in their own homes, benefitting from that location rather than being admitted to the hospital—especially one far from where they live. When a patient's condition worsens or they undergo an acute episode, virtual providers will prompt them to take an ambulance to the nearest hospital.

Otherwise, MVCC can keep the sickest patients "out of the hospital, where their care runs up enormous bills and is laced with dangers to the patient."[51] As we noted earlier, keeping patients at home pleases both providers and patients. As the current pandemic has demonstrated, keeping contagious patients, in particular, in their homes benefits us all.

MVCC also provides virtual care to patients who have been admitted to conventional hospitals' intensive care units (ICUs). These smaller hospitals are generally within MVCC's network, but often are located in distant, rural areas. In this case, physicians and nurses based at MVCC monitor patients and digest vast streams of data generated through the conventional hospital's EHR system, freeing up the minds of onsite providers to "pay more attention to the patients and less to the machines."[52] Managers and administrators say this spatial division of labor and innovative use of multiple data streams facilitates the diagnosis of sepsis or the onset of a stroke, for example, to a degree that busy, onsite providers generally cannot match.

MVCC may be on the cutting edge in terms of the breadth of services it offers in this manner, but it is not unique. We learned that improved capability and reliability of internet-enabled devices has paved the way for telehealth, defined broadly as the distribution of health-related services and information via IT. Included under telehealth are endless sub-categories capturing the provision of different health care services, including telepharmacy, telepsychiatry and, most commonly, telemedicine.

Even prior to the pandemic, telemedicine—which typically denotes the provision of remote clinical services, including diagnosis and monitoring—presented what we see as among the most compelling threats to existing models of care delivery. Entirely new companies have sprung up to provide routine, ambulatory care to patients via their computers, smartphones, and tablets. MD Live, whose online patient interface we show in Figure 8, typifies the new players in this space. The company currently offers virtual urgent care and behavioral health services in all 50 states. A small part of their business is direct-to-consumer or direct-to-patient services, where the patient pays a per-appointment fee regardless of their insurance status. The majority of their business, however, comes through contracts with health plans or with large, self-insured employers, who pay a capitated, per-member-per-month (PMPM) or per-employee-per-month (PEPM) fee, and then a discounted per-visit fee. And, depending on the terms of the patient's policy, he or she also will be charged a co-payment or co-insurance fee, much like for a conventional office visit.

Our research shows that most of the concerns practitioners, payers, and patients have expressed regarding the virtualization of health care seem to have been overblown, or they are at least easily mitigated.[53,54,55,56,57] There is no evidence that patients are overconsuming health care, nor is there reason to think patients are receiving a lower quality of care. Primary care physicians, already strapped due to a shortage in their ranks, seem to appreciate that some of their patients have an alternative avenue for receiving routine care quickly and efficiently. Those developing these technologies reminded us that clinicians essentially have been providing uncompensated telemedicine services for years, in the form of answering quick questions or returning and

FIGURE 8

Simulated Portal for an MD Live Virtual Appointment

Source: MD Live promotional and marketing materials.

explaining lab results, for example. Thus, they report, the redirection allows primary care physicians (PCPs) to focus on cases for which they actually can bill: those they deliver in person, that are less routine and less clear-cut, and thus, more in need of their expert judgement.

MD Live and other startups like it also provide virtual monitoring and management of such chronic diseases as diabetes and hypertension, similar to the care that MVCC offers its patients. In 2020 terms, this could prove helpful in caring for those who think they may have been exposed to or are suffering from COVID-19. A number of innovators have taken virtual patient monitoring and disease management one step further, removing the physician or other provider from the interaction altogether by embedding specialist knowledge in mobile apps. These apps prompt the patient to enter information at regular intervals and sometimes accept information more passively from activity trackers, glucometers, or other devices. They then process this information to provide the patient with alerts and reminders based on accepted treatment protocols and best practices.

We challenged developers and proponents of telemedicine technology on the effectiveness of a virtual visit—let alone one on an unmonitored personal health app—relative to a traditional encounter in which the provider can see and touch the patient. In general, they responded

that is not the correct comparison. Too often, those with chronic conditions forgo regular appointments for monitoring and disease management, seeing them as too bothersome or inconvenient. Recall that the structural shortage of primary care providers presents at least one hurdle for these patients, suggesting that telemedicine could offer a technological means for addressing the sectoral imperative to increase access to the system. Consequently, when considering the potential effectiveness of a virtual appointment or a smartphone app for disease management, the more appropriate comparison should probably be to a complete absence of disease management, which is, of course, much more likely to result in an expensive and injurious acute condition.

Aside from leveraging telepresence toward telemedicine to keep patients at home, in California, in particular, we are starting to see these same technologies deployed for use in the home, but not for virtual visits per se. Instead, large providers might have physicians supervise LPNs remotely, allowing the latter to intake patient data in the patient's home in preparation for diagnosis and treatment by the offsite physician. At present, these arrangements seem to be working effectively for managing post-operative care as well as for the treatment of wounds and minor burns. However, licensing boards largely have proven an obstacle to more wide-scale adoption.

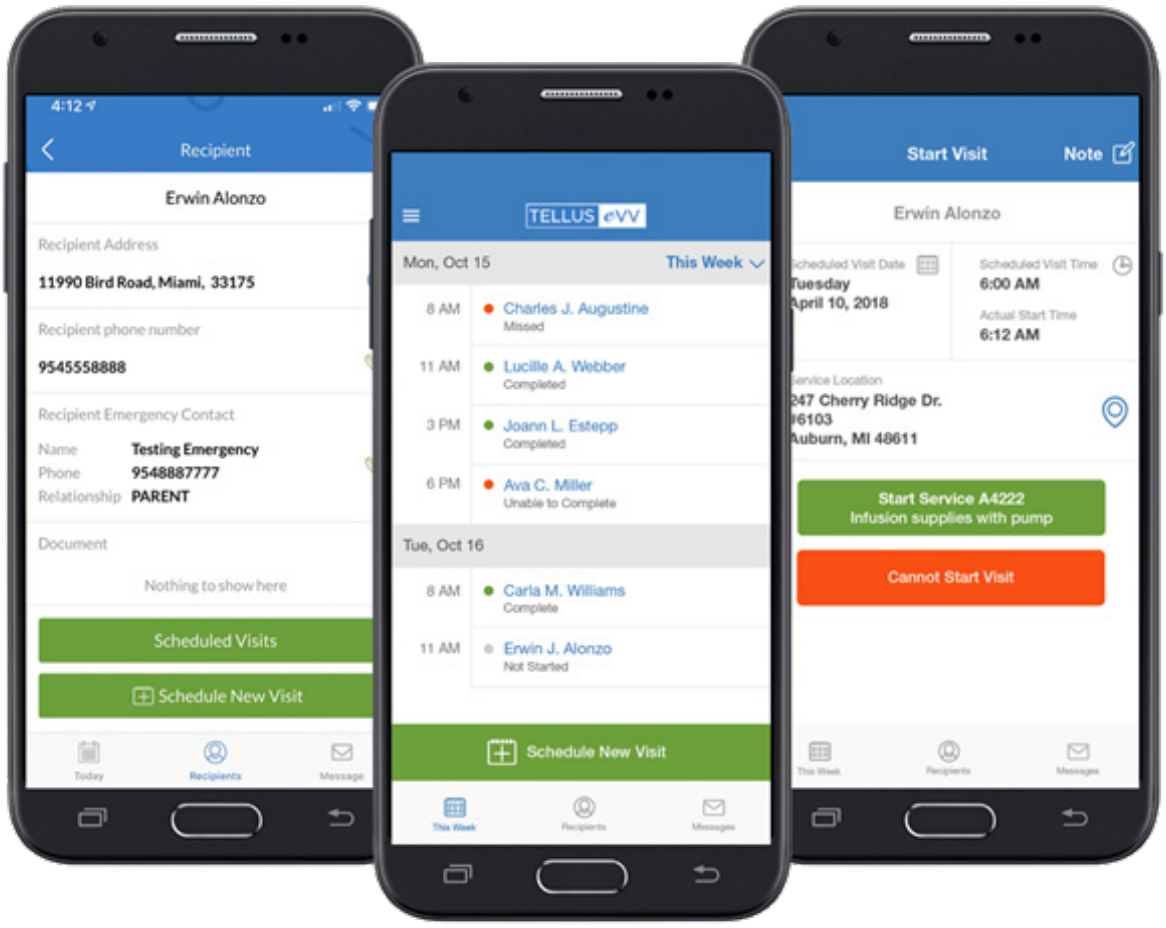
We've previously noted the aging U.S. population will require a greater amount of chronic disease management as well as long-term care. Such care can be provided at home via a combination of humans and technology in a variety of ways. Labor representatives, in particular, favor the use smartphones and tablets to provide support for the caregiver, be it substantive (in the form of up-to-date clinical information on the patient/client or best practice protocols) or social and emotional (in the form of easily accessible and well-developed caregiver networks). However, these sorts of technologies that raise the profile of the home care worker—rendering him or her the "locus" of care delivery—have not been widely disseminated or tested. Still, early indications are that augmented home health—in which an aide takes on the role of care coordinator for their client—using the smartphone not simply for clocking in and clocking out, but for connecting the home health or personal care aide to the rest of the care team, can bring positive results as part of broader interventions that reconsider the role of home health and personal care aides.[58]

What we did see demonstrated at trade shows was a much more widely adopted application of digital communications to address the demographic shifts driving the ever-expanding demand for home care. Examples of electronic visit verification (EVV) apps appear in Figures 9 and 10. These technologies track and verify the labor provided by caregivers to Medicaid recipients and their families, essentially serving as way for direct care workers to clock in and clock out. Figure 9 illustrates this by showing one vendor's aide-directed smartphone app, which the aide would use (usually on their personal phone) to maintain and manage her schedule; her agency would use it to track her progress in real time. Figure 10 shows the specific, dedicated smartphone-like devices that the Ohio Department of Developmental Disabilities recently distributed to its

Medicaid beneficiaries. In this case, clients themselves would hold onto the devices, and the home health or personal care aide would use it when they were working with that specific client.

Developers have convinced policymakers that EVV streamlines the efficiency with which personal care and home health services are delivered. On its face, EVV is intended to ensure that when a caregiver bills for services, he or she actually has provided them. As a result, lawmakers aiming to thwart fraud against those receiving care and those funding it—taxpayers—essentially have mandated the use of EVV by making Medicaid payments dependent on its use. However, as with any online service, punching in and out digitally allows for the collection of all sorts of additional data and opportunities for micromanagement, including location information. The technology has other implications for home care work, to which we will return in the next section.

FIGURE 9
Simulated Aide-Directed Portal for Tellus Electronic Visit Verification Solution



Source: Tellus corporate website: https://4tellus.com/electronic-visit-verification/.

Of course, the other two technology families that surfaced from our interviews—semi-autonomous service robots and AI—cannot be considered fully distinct from the technology family we just treated. After all, neither could exist in its present form were it not for the advent and diffusion of digital communications and telepresence. Nonetheless, respondents tended to speak about each uniquely, and indeed each responds to the sectoral imperatives in distinct ways.

FIGURE 10

CAT-Manufactured Dedicated EVV Device Distributed by the Ohio Department of Medicaid to Patients/Clients Needing Home Care Services

Source: Agency website for Ohio Department of Developmental Disabilities: http://prodhomedefault.secprod.dodd.ohio.gov/IndividualFamilies/Pages/Supporting-Families.aspx.

Semi-Autonomous Service Robots

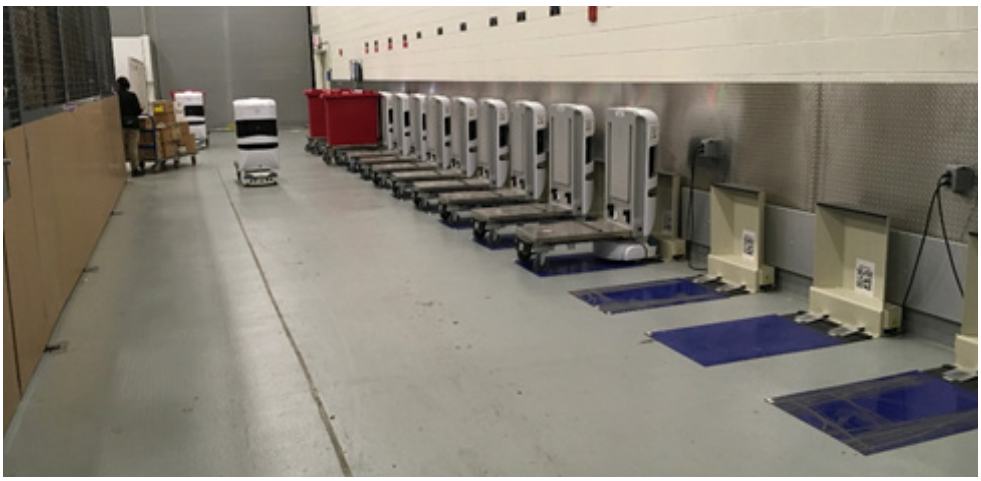
Perhaps no image better conjures up fears of workplace technological change than that of a robot, particularly a "humanoid" one that resembles an actual worker in appearance, behavior, or cognition. The International Foundation of Robotics (IFR) measures the use of robots in the workplace as the number of robots employed in production and service delivery per 1,000 full-time equivalent workers. Their data show that in the United States over the period 2009–2017, robot exposure more than doubled, from .75 to 1.81.[59] Other economywide research using similar data has shown that increased use of robots reduces both wages and employment.[60] Were that not enough, workplace robots have long since matured beyond the imprecise, dangerous, and heavy machines once kept tightly caged away from errant or glassy-eyed assembly workers on the industrial shop floor.

Today's robots are agile, sensitive to their surroundings, and much less dangerous to co-workers, at least in a physical sense, than earlier iterations. More important, modern workplace robots can undertake far more than a static, predetermined sequence of movements and other actions. Many instead operate semi-autonomously—accepting external commands from users as well as maneuvering and operating on their own by taking in, processing, and reacting to information absorbed through sensors. Indeed, respondents made clear that these semi-autonomous robots—much more so than the aforementioned surgical robotics systems—appear likely to disrupt health care labor markets and health care work over the next five to 10 years. We committed to visit a particularly technologically inclined hospital on the basis of the great concern of one group of union leaders on behalf of their rank-and-file members.

Where patients still must receive their care in a traditional manner, i.e., onsite, semi-autonomous service robots can assume many of the tasks once dependent on human workers.

FIGURE 11

A Row of Charging Stations for TUG Autonomous Mobile Robot Manufactured by Aethon Corporation



Source: Photograph taken by the researcher.

Our guided walk about the hospital showed us how this technology operates in practice. In addition to navigating providers and patients in the hallway, we encountered semi-autonomous robots in the form of "smart carts" that deliver meals and pick up dirty trays, deliver clean linens and take away the soiled ones, pick up and remove rubbish as well as hazardous medical waste, deliver clean medical supplies, and transport prescriptions to nursing stations. They are, in a sense, more courteous and more agile than any of the humans in the hallway. They rely on

FIGURE 12

TUG Semi-Autonomous Mobile Robot Manufactured by Aethon Corporation

Panel A

TUG Exiting Hospital Cafeteria to Deliver Meals to Patients on the Floors above

Panel B

TUG Moving Bio-waste from Patient Rooms to Biohazard Waste Removal Area

Source: Photographs taken by the researcher.

overlapping laser, sonar, and infrared sensors to traverse the halls to their destination while avoiding human and nonhuman obstacles.

We learned that we were observing the TUG robot produced by Aethon, a prototypical example of this technology. It can run for about 10 hours on a single charge and can make its own way to its charging station when it needs such a jolt, as shown in Figure 11. In between charges, it undertakes tasks on a scheduled basis as well as on demand. It cards in and out of secure areas, the same as human staff, opening doors and calling the elevator as needed. The carts, shown in action in Figure 12, are essentially interchangeable, carrying a meal from dietary services in the basement up to a patient room, and then stopping to pick up and remove dirty linens for delivery to the laundry facility. Only the carts used for biowaste are "dedicated," that is, not used for any other sort of cargo. Extremely sensitive cargo such as narcotic drugs remain secure, only accessible via fingerprint sensor. In many cases, workers are pinged on their smartphones when a requested delivery is on its way. According to Aethon, these robots are not presently creating and operating under their own rule sets. However, they (and others) have developed that technology and are in the process of commercializing it.

In general, these robots are used by employers to reduce costs and make more efficient use of relatively expensive labor. Employers even may argue their deployment increases access; this is an argument that soon will be testable empirically. Hospitals and other facilities also can reasonably claim that the use of robots facilitates growth in the scale and scope of their organizations and facilities, thereby helping organizations respond to the imperative that they consolidate and better coordinate care delivery. Often, designers account for the use of semi-autonomous robots in their sketching out of new facilities, providing the technology with its own travel lanes or even a dedicated "robots only" elevator bank. In fact, developers market their services as a way of getting more use out of costly investments in additional square footage.

> **"Often, building a second lab or pharmacy for a new tower would be nuts. So, robots can provide facilities with help in meeting growing demand while maintaining costs. That is, they can facilitate expansion and construction."**
>
> **—a developer of semi-autonomous robots**

While we did not hear of or witness the widespread use of robots for cleaning and disinfection, we see few obstacles to their adoption for this purpose. For starters, a great number of hospitals have outsourced their cleaning, and outsourcing generally serves as a layover on the flight to complete automation.[61] Second, despite the apparent, nonroutine nature of cleaning, the improved ability for robots to sense and respond to their surroundings renders this challenge moot. Likewise, changes in how we disinfect—for example, the use of high-energy ultraviolet

light, as opposed to old-school "rubbing and scrubbing"—may be more amenable to robotic as opposed to actual workers.[62] The COVID-19 pandemic brought news coverage of robots used in this way. However, it also suggested limited use of "robot nurses"—a label that was too generous in its implications for these robots' abilities and usefulness.[63]

Before moving onto the third form of technology making an impact in the health care space, we should pause to note the sort of robotic technology that *does not* appear ready to disrupt the sector or its labor market: "home care" service robots. Our research provided no evidence that robots are anywhere near ready to step in to fill the anticipated growing need for home care workers, consistent with sociologist Jerry Jacobs's answer to the question, "Will the Robots Take Care of Grandma?" He answers his own question with an emphatic *no*, noting that "Robots do not provide physical care for the elderly, not even in Japan."[64] Nothing we observed and no one we spoke to offered information to contradict this statement, including union members and their leaders. As Jacobs and some of our interviewees pointed out, there are technologies that can make staying at home easier, such as those that vacuum a rug or order food when the refrigerator runs low on milk or eggs. Simply stated, semi-autonomous robots cannot navigate houses or apartments with the same apparent ease and manageable cost as they can a hospital or other large institution. Even union-side respondents clarified that the prospect of home care robots diffusing any time in the near future did not keep them up at night. As a result, we strained to find ways that this particular technology could respond to the chronic disease prevention or changing demographic trends imperatives detailed above.

Artificial Intelligence

AI supercharges digital telecommunications technology, making it more powerful as a tool to treat and manage patients from their homes.

On the one hand, AI is similar to semi-autonomous robots in that both have digital communications technologies, the first of our technology families, subsumed within them. On the other hand, semi-autonomous robots already traverse hospital hallways, whereas the adoption and diffusion of AI in the health care sector has only just begun. So, why is it on the minds of nearly every single person we interviewed? We have concluded that much of what we heard was—perhaps well-founded—fear of the unknown. Workers, developers, and others can easily picture their own smartphone when prompted to consider digital communications technology. Likewise, semi-autonomous robots already have assumed some work that humans once undertook. While developers may know AI's capabilities, neither managers nor workers have a solid grasp of what it can and cannot do, let alone what it might look like. In fact, in the wake of the pandemic, much of what was lauded as the futuristic application of artificial intelligence to fight COVID-19 seemed more like the effective use of well-programmed digital communications technologies.[65] Most people

seem to understand that AI can tackle some errands more efficiently and more thoroughly than humans, and that it can assume tasks that human workers could not even conceive of, let alone undertake.

AI can complement the work of professionals with the right mix of medical understanding, technological skill, and compassion, thereby allowing for in-office care to be delivered more efficiently without sacrificing care quality.

Until recently, the most useful workplace technologies were those that could reliably execute repetitive tasks—that is, tasks that were routine, predictable, and amenable to programming. And, as long as a task could be reduced to simple, static steps—whether physical or cognitive—the worker assigned to the job rightfully could fear technological displacement.[66,67] At least symbolically, this rule of thumb regarding programmability was dispatched in January 2011 when IBM's AI-infused computing system, IBM Watson, bested two previous champions in a televised set of "Jeopardy!" games. That win set the stage for the application of AI as machines, software, and algorithms that act intelligently by recognizing and responding to their environment[68] to all sorts of practical problems in a range of industries and sectors, including health care. In fact, its developers targeted utilization management decisions in lung cancer treatment as Watson's first commercial application, partnering with a renowned cancer center and a large insurer in 2013.[69]

What makes AI so useful is its ability to "learn" by crunching or absorbing vast amounts of information and data—a particular form of AI called "machine learning" (ML). Increasingly, AI also can process unstructured textual or spoken inputs, using natural language processing (NLP) to translate free text into standardized or structured data. ML, with the help of NLP, allows the application or the machine to uncover associations and correlations that can serve as the basis for future decision rules. This ability contrasts with its aforementioned predecessor workplace technologies that required manual programming by human beings, leaving it to humans alone to determine the most effective ways to undertake a task or work through a complex issue, and then program those "best practices" into the machine.

The media and the public historically have overstated the capabilities of AI, only to be disappointed. The computer science community long ago abandoned attempts to develop and commercialize "general AI," what data journalist Meredith Broussard jokingly labels the "Hollywood" version of AI, replete with robot butlers and the like.[70] Today, however, serious researchers focus more modestly on applying machine learning in more specific domains, i.e., "narrow AI," and have achieved modest successes in doing so.

Our visit to one particular conference of health care technologists made clear that developers and investors see great possibilities for AI-enabled chatbots—software that can conduct a conversation verbally, either by auditory language or textual display—in particular, in many aspects or subspecialties of care delivery. For example, the use of AI can expand access if patients seeking primary care or mental health services could receive them through an app on their smartphones. In the language of the Iron Triangle, this increase in access could come at relatively low cost, too, explaining why so much venture capital has gravitated toward these technologies. Much as we discussed above with respect to telemedicine and telehealth, some of this increased access will benefit patients who might not have sought an actual office visit, and others would be utilizing the chatbot in place of a conventional appointment. What remains unclear is the overall quality of care one might receive from a chatbot relative to that given by a conventional, in-person provider or even from a less conventional teleprovider.

Respondents also think advances in AI will boost access to care through professionally mediated clinical decision support (CDS) systems. CDS systems link health or patient observations with health knowledge to influence health choices by clinicians for improved health care.[71] They have long been embedded in most EHR systems; however, prior to the advent and incorporation of AI into these systems, all of the rules and their associated alerts needed to be manually entered into the system explicitly and regularly updated. So, for example, if a particular drug combination were newly found to be contraindicated, then onsite information systems personnel or vendor-employed programmers (by pushing system updates) could add the appropriate alert to the system. However, there was no easy way to regularly determine the latest research-based protocols. Likewise, there was no easy way to search for associations between fields unless they were explicitly sought, and even then this excluded the use of unstructured data living in the medical record. With ML, software now can analyze vast amounts of historical patient data in the context of established best practices and cutting-edge, peer-reviewed research to generate its own decision rules. It can crunch millions of case histories to develop a probable diagnosis and to suggest the most predictably effective treatment associated with it. It could even uncover links between published studies that human readers—especially those from disparate medical specialties—would have missed.

As we learned from our interviews, similar technology could aid organizational efforts to consolidate and to improve coordination. In part due to policy incentives, the diffusion of EHR systems has finally picked up pace. Once information has been converted from paper to bits, it can feed AI that can warn clinicians a patient is at high risk for a particular iatrogenic condition such as sepsis. AI can also render these systems more user-friendly: NLP, for example, allows the use of digital technologies to extract, structure, and compose clinical notes simply from listening to providers' natural conversations with their patients. The same data also can power ML to facilitate earlier diagnoses of chronic diseases, allowing for more precise direction of preventive care and for earlier treatments and, thus, improved prognoses. One also can imagine technologies that use AI in a way that bypasses clinicians altogether. In a limited sense, our

smartphones already serve as personal health assistants, tracking our steps. A growing number of patients also use their phones to track vital signs and even blood sugar. Once we address well-founded privacy concerns, we can link these data to the data in our personal medical records and then to the aforementioned information resources living in the cloud. Then, AI will make it much easier for patients with chronic diseases to monitor and manage their conditions without frequent visits to a hospital or medical office.

Just as we saw with the previous two tech "families"—telepresence and robots—there are few obvious ways in which AI will fundamentally address demographic challenges. Home care clients already use AI-infused devices in all sorts of small ways that enrich and facilitate their daily lives, potentially interacting with or substituting for some functions of direct care workers. That Siri can dial 911 and Alexa can adjust the thermostat have no doubt made aging at home easier—but the use of such AI-enabled virtual assistants does not fulfill the fundamental need for onsite caregivers to undertake the wide variation of physical and cognitive demands engendered by this work.

These three tech families substantially overlap in the real world. In fact, the true power of any of them to disrupt health care delivery comes from combining them. As noted above, AI-infused chatbots, for example—dependent on digital communication and telepresence, allowing them to tap the cloud as a means of continuously updating their knowledge by leveraging ML—are among the most coveted targets for venture capital in the health care space. Our fieldwork identified that enterprising developers have already worked to provide this dual technology a physical presence, effectively yielding a cloud-connected, AI-augmented, semi-autonomous robot. Nonetheless, our research also makes clear that our three aforementioned technology families are those that health care administrators and providers call upon to address the four imperatives and that the examples we cite above are those most likely to reshape work in the health care sector. Just how these technologies will alter work depends on a number of choices we make regarding how to respond to the four imperatives. This is the issue to which we now turn.

SECTION FIVE
Policy and Managerial Choice Points

Section 3 drew from our research to lay out the four imperatives to which the health care sector must respond immediately—what we labeled the drivers of technological change in the sector. Section 4 detailed the three technology families that our interviewees said they were most likely to leverage (or see leveraged) toward this response. This section and the next consider *how* the technologies in Section 4 might be used to respond to the imperatives of Section 3. The present section puts forth the key choice points—actions within the control of policymakers or managers—that will determine *how* the sector uses digital communications and telepresence, robots, and AI to respond to the four imperatives.

Active public policy would aid these responses. Active policy around technology adoption may be thorny in most sectors; this is less likely with health care. As we noted at the start, unlike most other sectors, health care carries a certain moral obligation that transcends simple economic arguments—a reality only reinforced by the COVID-19 pandemic. A number of other sectoral quirks make it difficult to argue that it can or should operate the same way as the competitive markets that underpin rudimentary economic analyses. We note three, in particular.

First, as we have pointed out, most of the anticipated job growth in health care will be in occupations that—at least prior to COVID-19—were traditionally considered low skill and low status, jobs most often filled by women and people of color. Policy thus could promote the deployment and use of new technologies in ways that improve the quality of these jobs and increase the productivity and wages of those who hold them. Therefore, policies promoting high-road adoption strategies not only optimize across access, cost, and quality, but do so in ways that bolster labor market outcomes, too.

Second, the health care sector in the U.S. receives almost incalculable levels of economic subsidization, much in the form of specialized tax treatment. Anyone selling a product would prefer that customers be able to purchase it pretax or that the government create incentives for

bulk purchases. Since policymakers do not afford most of us this luxury, citizens and taxpayers have the right to demand certain conditions be attached to these government-conferred market advantages. For example, policy could require health care employers contribute to a training fund for those who otherwise might be technologically displaced or require that extra protections for worker organizing be put in place. In short, if the government is going to prop up an entire sector as it presently does, it is only reasonable to demand that the government giveaways be shared widely. Economic benefits will not trickle down on their own from employers to workers, particularly when workers are not covered by a collective bargaining agreement.

Finally, we can justify active health care policy on the basis of employers' ability to compete. From a labor supply perspective, a nation's health care sector forms a critical part of its economic and social infrastructure, promoting a labor force that thrives both physically and mentally and is therefore able to apply itself fully not only to its work, but to investments in its own human capital. Thus, just as the government must ensure the reliable and continuous flow of electricity, it also must work to maintain a flourishing health care system. From the standpoint of national economic competitiveness, asking U.S. employers to compete while mandating that they purchase employee health insurance in an underperforming market puts them at a distinct disadvantage relative to their international rivals. On this basis, one should support policies aimed at promoting the application of new technologies in ways that improve the efficiency and performance of the health care sector.

Having justified the need for active measures to direct technological change in the sector, we point to three, specific choice points for policymakers and managers:

1. Which payment model will policymakers encourage, fee-for-service or value-based care?
2. How open to experimentation will policymakers and managers, e.g., practice and hospital administrators, be?
3. Which approach will policymakers and managers embrace for technology adoption and deployment—a *work-centered* approach or a *technology-centered* approach?

We expect the largest, most broad-based benefits to arise from health care technologies when they are deployed toward the fulfillment of VBC; under the auspices of policymakers and managers open to experimentation; and by those who adopt a work-centered approach. By broad-based, we mean for the full range of stakeholders, including front-line care delivery workers. While we will unpack the differences between work-centered and technology-centered approaches, note that the former privileges the elevation rather than the replacement of workers and recognizes the realties and limitations of new technologies.

Leverage the Power of Payment Models

The organizational and institutional wedge between those who finance care and those who provide it presents a level of complexity absent in studies of technological change in nearly any other sector. In most sectors, employer-owner-producers adopt new technologies when the marginal benefits to doing so exceed the marginal costs. While that same dynamic applies to health care providers, their calculation of marginal benefit and marginal cost hinges entirely on the structures and rules connecting them to payers. Thus, if a given technology improves the optimal mix of access, cost, and quality without allowing any of that benefit to accrue to the provider, we have a classic economic externality. Our fieldwork, particularly conversations with health care industry consultants, made clear that the discrepancy between the social benefit of technology adoption and the private benefit to the party expected to pay for it systematically curbs investment in new technology.

The most common illustration of this phenomenon relates to technologies that improve the quality of care delivered. A given hospital or medical office may be convinced that a new machine or device provides more precise or more reliable results than legacy technology. However, under the conventional FFS model, the owners of the facility cannot appropriate the incremental benefits arising from the use of this technology. Thus, they will not purchase it. This dynamic explains why health maintenance organizations (HMOs) and other such integrated health care provider/payers as Kaiser Permanente and Health Partners were the first to adopt EHRs, technologies that ultimately influenced outcomes for medical records technicians and transcriptionists, among others. It also explains the adoption proclivities for smaller-scale, more specific technologies.

> The separation between those organizations that finance and those that actually deliver health care complicates the incentives for technology adoption: whether or not a given technology is adopted and used at the point of care hinges on the structures linking the payers to the providers.

We witnessed a prime example of this at one of the hospitals we visited. The chief financial officer explained that despite its production of a clearer and more detailed digital image, the hospital only recently had invested in tomosynthesis—three-dimensional (3D) breast imaging. Tomosynthesis combines X-rays taken from multiple angles, yielding fewer false positives, identifying more cancers, and doing so earlier than traditional 2D mammography. Unfortunately, the machines also cost substantially more than those used for traditional mammography. With the reimbursement from payers set at a single level for breast imaging no matter how providers capture the images, this hospital, and presumably many others, simply would not make the purchase.

Conversely, if administrators spot a technology that can increase the efficiency with which their hospital can undertake a particular procedure or perhaps the number of these procedures it can perform annually, then the facility may well take the plunge and make the investment. In this case, the technology appears to be able to increase access and lower costs, and even the traditional FFS model would allow the hospital to appropriate the gains arising from the investment. This shrinks the discrepancy between the private and social benefits attendant to this technology.

Hospital use of semi-autonomous robots exemplifies this flavor of technological investment. Facilities do not expect payers to increase their rates simply because robots, rather than human beings, transport food and linens around the hospital. Rather, both service robot developers and administrators tell us that despite their high upfront costs and regular maintenance fees, robots will generate efficiencies through cost savings relative to the continued use of labor to undertake these tasks. If they are correct,[72] then the use of robots in this manner should provide both private net benefits to the hospital and social ones to a broader range of stakeholders—with the possible exception of those whose work is directly affected by the deployment of robots, like hospital orderlies. Just how the deployment affects orderlies hinges on the specific decisions managers make around how potentially displaced workers will be treated in the course of the deployment of new technologies.

Clearly, the separation between financing and delivery occasions market failures that impinge upon technology adoption in the sector. If we agree as a society that we want to improve quality, the organizations that would invest in quality-enhancing technologies must be able to benefit from improved quality. If our aim is to improve access, then the system must reward providers for being able to serve more patients. Only then will they invest in technologies that help them achieve these goals. Obviously, the same principle applies to cost reduction, the third vertex of the Iron Triangle.

Policymakers must acknowledge the buying power of Medicare and Medicaid can translate into a meaningful institutional force favoring specific technology adoption paths.

Policymakers have a number of options regarding payment rules. They can acknowledge the institutional power of Medicare and Medicaid to drive the use of the right technologies and in the right manner. As one hospital administrator told us, "As CMS goes, so go the private payers." Though not uniformly the case, private payers often follow the lead of the Centers for Medicare & Medicaid Services (CMS) when deciding which services to cover and at what rate—a recent example being the many manifestations of value-based care, including accountable care organizations (ACOs) and bundled payments. Therefore, if Medicare and Medicaid take a more favorable view of telehealth—as they did in their response to the pandemic—or of new forms of care coordination and care delivery that elevate the role of home care workers or that promote

new forms of telehealth or AI-infused care delivery, private payers are likely to follow suit. Of course, this domino effect will occur more quickly once researchers demonstrate the efficacy of these high-road strategies for optimizing across access, cost, and quality.

Additionally, hastening the shift in payment models from those resembling fee-for-service toward those encouraging value-based care would make providing organizations responsible for the quality of care delivered—making it in their best interest to provide high-quality care, ideally but arguably without restricting access or increasing costs. This in turn would encourage more technology adoption. In fact, this trend is well under way, as elements of VBC appear in an increasing share of health plans and health reform ideas. The ACA encouraged the creation of ACOs and Medicare has made increasing use of bundled payments, both aimed at urging providers to be entrepreneurial in their quest to deliver care that optimizes across access, cost, and quality.

Continuing and hastening the transition from fee-for-service to value-based care will likely encourage the adoption of new technologies that bolster care quality.

Private insurers recognized long ago that price-conscious health plan customers—be they employers or individuals—gravitate toward HMOs and other plans with aspects of cost containment attendant to VBC. Thus, instead of paying providers based on the quantity of care they provide and then forcing them to comply with rigid treatment protocols, policymakers can incentivize value in the system and then afford providers' independence toward achieving their goals. Some will adopt new technologies and some will not, but they will make these choices based on their own ground-level knowledge of whether new technologies will help them better serve patients.

More specifically, policymakers' doubling down on VBC also encourages the adoption and use of new technologies as part of a response to the four sectoral imperatives. Clearly, value exists in the economies of scale and scope that derive from organizational consolidation and coordination, suggesting one can work right down the respective column from Table 5. That is, further encouragement of VBC will drive organizations to leverage digital technologies and telepresence toward the optimization of EHRs—eventually, even enhanced or augmented with AI capabilities—and the increased use of pick-up and delivery robots in hospital settings. Likewise, providers are likely to take steps on their own to invest in telemedicine and telehealth and to develop or purchase access to mobile medical and health apps—again, some infused with AI—on behalf of their patients. In doing so, they will be responding to the imperative that they prevent and manage chronic diseases on behalf of (and in partnership with) their patients. One can make analogous arguments regarding the other two sectoral imperatives, increasing access and responding to demographic trends.

So, why hasn't there already been a tipping point with respect to the transition from FFS to VBC? The transition from FFS to VBC has been slow, largely because those with vested interests in the FFS model have lobbied to slow the changeover. Investors and consultants we spoke to pointed out that a decade earlier, nearly all of the talk around health care technology centered around the shift in payment models. As an Austin, Texas-based venture capitalist put it, "We were all thinking in big, systemic terms. There was so much hope." This year, the demonstration floor at the same conference featured almost nothing predicated specifically on a shift from FFS to VBC, though one certainly can imagine much of what was on display being deployed toward such a broad-based, sectoral transition.

Health care policymakers must continue their openness to experimentation and should encourage the same in those managing and administering provider organizations.

Encourage Experimentation with Novel Uses of Technology

With respect to health care, policymakers and managers long have demonstrated a relative openness toward experimentation, perhaps best exemplified by the gradual emergence of HMOs in the 20th century and by the establishment and expansion of ACOs in the 21st. Now, they must decide just how experimental they are willing to be as they respond to the four sectoral imperatives. Based on our interviews, their first area of deliberation should be payment and reimbursement rules.

Existing reimbursement rules dampen the anticipated usefulness and effectiveness of many new technologies.

Restrictive reimbursement rules retard the adoption of new technologies within provider organizations, limiting the flexibility to embrace technology as part of a response to the four imperatives. Telemedicine offers a case in point. As an RN told us, doctors and nurses have been providing "low-tech" telemedicine for decades—calling patients to report test results or responding to patients' descriptions of their symptoms by writing a prescription. However, regulations previously prohibited providers from billing for these services delivered via phone—and in fact, generally still do, but for the changes engendered by COVID-19. As part of the larger effort to redirect low acuity patients away from doctors' offices and emergency rooms, CMS and Congress temporarily relaxed restrictions limiting provider reimbursements for telehealth.

There are a number of explanations for policymakers' reluctance to loosen regulations and why it now is only temporary. Many doctors have concerns that telemedicine will undermine their business, leading patients to see "virtualists" from their home rather than PCPs in their office. Likewise, payers worry that providing coverage for telemedicine will lead patients to "overconsume" the service and physicians and others to "overprovide" it, potentially trying to bill insurers for all of the telephonic work they had been performing gratis for so long.

When early, pre-COVID-19 experience suggested these concerns were overblown, CMS responded by ever-so-slightly loosening the rules that prevented Medicare reimbursement for telehealth services. Those elderly and disabled citizens relying on government insurance, in some cases, now can apply these benefits toward virtual office visits, psychotherapy, consultations, and certain other medical or health services. As a result, we were likely to see more providers turning to digital communications and telepresence to increase access, even had we not been confronted with a pandemic. Whether forced experimentation brought forth by COVID-19 will lead to lasting regulatory changes regarding telehealth remains unclear.

Policymakers should consider relaxing restrictions that prohibit the use of certain technologies or that constrain the sorts of organizational and work structural adjustments required to use these technologies optimally.

In our view, policymakers should not stop there. They also should revisit rules that constrain the optimal use of new technologies. As an extreme example, rules requiring that providers be licensed separately in each of the 50 states place severe limits on the use of telehealth—any entrepreneur interested in providing telehealth services must develop services state by state. As one such telemedicine executive explained, calls come in 24 hours a day and can come from any of the 50 states. But it is often the case that no virtual PCP licensed in the patient's state is available and online. As it turns out, COVID-19 pointed out that the challenges state-based licensing poses to telehealth technology developers have larger consequences, too.[73] State-based licensing hindered the ability for policymakers and health systems to move licensed caregivers to the neediest places when they were across state lines. Clearly, state-by-state licensing exists for a number of reasons, some only historical and others that continue to make sense even in today's connected world. So, these rules should not be repealed hastily, but should be revisited in light of new ways that could allow technology to better serve patients providing immediate benefits with respect to access and cost.

Aside from rethinking the state-based licensing regime, policymakers could nudge licensing boards to experiment with scope-of-practice rules that presently constrain the effectiveness of new technologies. For example, we noted above that California, in particular, has allowed limited use of LPNs in the home, using point-of-care technologies that effectively extend the reach of physician providers. In general, if technology could facilitate shifting of responsibilities down the

skill chain, from RNs to LPNs, for example, for low-acuity patients, then it could effectively boost access and lower costs. However, this would require LPNs be granted broader authority and authorized to administer a wider range of low-risk drugs. Policymakers should pay close attention and consider these proof-of-concept studies, encouraging licensing boards to allow their scope to expand in both geographic and functional terms when they appear to be working.

Perhaps more feasible than the experimental loosening of the medical licensing regime would be a relaxing and possibly harmonizing of federal and state reimbursement rules and requirements for scope of practice. While we should not do this hurriedly, we should consider the ways that new technologies—when used by people with the right skills—allow for the delegation of tasks to those closer to the patient. Likewise, we should take a "blue sky" approach to constructing new health care occupations that take advantage of new technologies, including AI, and connect them to patients in ways that make patients, providers, and payers better off without making anyone worse off.

Ideally, managers will follow policymakers' lead by opening their own organizations up to experimentation. In fact, there is a very fine line separating the work of policymakers from that of managers when it comes to managing the politics of technological change. The concerns that physicians raise with respect to telemedicine hint at the larger political obstacles hindering technology adoption—many of which transpire in organizations themselves.

Approaches that tackle intraorganizational power struggles and broader political battles to encourage the delegation of tasks, e.g., from physicians to RNs or from RNs to LPNs, provide opportunities for increased productivity, and technology materially facilitates these shifts.

One of the great benefits of digital technologies is their ability to decentralize knowledge by disseminating up-to-date information to providers at the point of care. However, as our interviews made clear, it was never simply a "lack of information" that prevented RNs from taking on the work of physicians, for example. Rather, concrete scope-of-practice regulations—at the policy level—clarify the nature of the tasks that each licensed role in a state can undertake, either with or without supervision. For unlicensed roles, the limitations generally are spelled out by employers, usually in the collective bargaining agreement itself (where one is in place). Consequently, in order to deploy technology toward addressing the four sectoral imperatives, states must update their existing regulations to allow for new work structures that devolve more responsibility to the front lines. Likewise, managers and high-status providers, namely physicians and surgeons, must allow these adjustments to take place at the point of care. Practice administrators, for example, can do this by demonstrating to those with high occupational

status the ways in which new uses of technology can scrub what they probably consider time-wasting, low-value activities from their daily schedules, freeing them up to undertake more complex and more lucrative work for themselves. Our research underlined the notion that RNs, LPNs, and CNAs, among others, would welcome the opportunity to work closer to their full scope, something their employers have clamored for for years.

> **"The best estimates are that our RNs spend a quarter of their time on nonpatient care. So…using telemedicine or some new AI technologies to allow RNs and LPNs more time for patient care…would alleviate a huge administrative burden, which would benefit our folks, their employers, and their patients."**
>
> **—a health care union representative**

Finally and relatedly, home care provides fertile ground for experimentation involving the application of emerging technologies toward expanded care delivery responsibilities. Conversations with union leaders illuminate the obstacles to the high-road use of technology that elevates home care workers into onsite care coordinators. Multiple union representative told us that home health and personal care aides are often not comfortable using new technology. Even when workers are technically adept, smartphones and tablets are prohibitively expensive, and maintaining a regular data plan will prove especially financially challenging on home care workers' wages. Consequently, the home health agency that employs the aide would need to purchase the device and the app and to invest in the necessary training. Unfortunately, under the present reimbursement model, the agency does not have much of an incentive to do this, nor do they have the bargaining power vis-à-vis the states to compel more public funding. This suggests a lost opportunity to improve care quality and to reduce overall costs by shifting work to less expensive, underutilized home care aides. More critically, it precludes the use of technology to improve the quality of these jobs by boosting skill levels and wages—what many believe to be the only way to attract more people to the field of home care.

Prioritize the Work, *Not* the Technology

Researchers have documented the efficiency benefits to providing front-line workers a voice in the technology deployment process. Workers possess tacit and explicit knowledge of the care delivery process, and gaining their support would be key in this endeavor. Employers realize they should value and leverage workers' information and respect those who are providing it, even if they are not quite sure how to go about doing that. As a result, not a single employer or manager volunteered to us headcount reduction to justify their technological inclinations.

Instead, they point to issues of cost or quality, generally using "enabling" language detailing the more constructive, patient-directed ways in which front-line health care workers could allocate their time were new technologies available to remove less-skilled, perhaps even mind-numbing work.

Yet, by default and perhaps unwittingly, most employers use a *technology-centered* approach. Apparent tautology aside, this involves employers or managers aiming to employ technology to undertake any task that it can capably assume, predicated of course on the calculus of marginal benefits vs. marginal costs. Having shifted whatever tasks that reasonably can be moved from labor to capital, the residual tasks remain the province of human labor. We label the alternative approach *work-centered*. In this case, managers begin the process by asking, "What are my people really good at?" From that, they seek the technology that best exploits these capabilities, in part by undertaking the tasks that workers do not enjoy or excel at. In manufacturing and historically, these tech-advantaged tasks typically were those that required great strength or that would put human labor in harm's way. More recently, as we noted above, we consider tech-advantaged tasks to be those that may well be cognitive, but are mind-numbingly repetitive, and thus, easily proceduralized. We also would include tasks requiring workers to process large amounts of information very quickly; workers may not find these tasks monotonous per se, but will likely be more prone to errors than the competing technology. Finally, human beings are not especially good at being "on watch"—monitoring generally copacetic situations, waiting for something questionable or problematic to occur, and then responding reflexively.[74]

Policymakers must inspire and managers should follow and encourage a ***work***-centered approach—not a ***tech***-centered one—to technology adoption and deployment.

So, what are health care workers especially good at? Workers themselves likely know the answer best, which is one reason employers should afford them a say in decision-making around new technologies. In general, workers can undertake a wide variety of inconsistent and often unpredictable tasks. Many of these tasks require judgement and an acute sensitivity to the subtleties of patient emotion. Perhaps most critically, front-line health care workers offer patients true empathy and emotional support. When managers take a work-centered approach, they recognize these realities.

BOX 3

What Is a *Work*-Centered Approach to Technology Adoption?

The notion of a *work-centered* approach to technology adoption comes from the distinction technologists have long made between *technology-centered* and *human-centered* automation. The former represents the dominant and default paradigm in which developers strive as best they can to minimize the role of humans in the production or service delivery process. In other words, they automate as many functions as possible, leaving the residual functions to human workers.

Technology-centeredness derives from an assumption that people are clumsy and error-prone relative to the machines that could replace them.[75] Engineering programs perhaps unintentionally reinforce this doctrine by depriving students of training in anything related to "human factors."

We all know inept humans. However, tech-centeredness ignores the fact that technology itself remains fallible. And, when a computer misfires or malfunctions, it will require a human being to step in to correct the problem and to undertake the tasks designers had intended the machine to do. What happens, however, when those few remaining people who had those skills find they have atrophied? Even more problematic, in a hospital setting, even those whose skills have yet to go stale still may lack the situational awareness to step directly into a dire situation that calls for immediate action.

Human-centered automation begins not with an evaluation of the technology's capabilities, but rather with "careful evaluation of the strengths and limitations of the people who will be operating or otherwise interacting with the machine."[76] In fact, human-centered automation forms the core of our notion of a work-centered approach to technology adoption. Aside from starting with the employer's evaluation of their people rather than with the technology vendor's attempt to minimize the need for labor, it also calls for greater worker involvement in how the technology is configured and deployed. If necessary, one can justify this technology-related manifestation of worker voice entirely on efficiency grounds, as it will leverage front-line workers' deep knowledge of the care delivery process while helping employers achieve necessary buy-in.

Take the sectoral imperative of changing demographics, which manifests itself most outwardly in home care. Add to that the subsector's apparent chronic shortage of workers and predictions for its exponential growth in demand, and it practically begs for a an immediate and highly effective answer. Yet, no credible health care expert sees one on the horizon.

Semi-autonomous robots, for example, cannot assume the work of personal care and home health aides, easing the labor shortage that bedevils policymakers. The variety and inconsistency of tasks performed by home care workers, not to mention the broad swath of homes in which they perform them, render it incredibly difficult for anyone to develop something along the lines of a semi-autonomous robot like those that hospitals now deploy. Even telehealth-inspired virtual home care aides might be able to check up on a client, but they wouldn't be able to do the laundry, make the beds, and drive the client to their many other appointments. This suggests that the implications of technological change for home health and personal care aides could differ substantially from those of hospital orderlies.

While concerns over home care, in particular, beg for high-tech solutions, work structures preclude immediate technological solutions.

For evidence of technology's limits, a variety of respondents repeatedly mentioned two competing companies—Homehero and Hometeam. Both aimed to disrupt the direct care market and were backed by tens of millions of dollars in venture capital. What is more, they were not looking to create a semi-autonomous, robotic home care provider. They each rather modestly aimed to develop an app for connecting home care workers to would-be clients. In other words, clients and providers could find one another using the app, and then continue using the app to schedule care and manage payments.

The technology generally worked; the hang-up was the value proposition. For private payers, the developer could charge a premium price, from which it would pay the provider and keep the proceeds as profits. It also could negotiate bonuses from private insurance company payers. For Medicaid patients, it could extract some of what would be the providers' hourly pay to keep for themselves. Yet, both companies failed in their effort to become the "Uber of home care," lacking appreciation for home care's idiosyncratic payment model and Medicaid's bargain basement reimbursement levels. Even in hindsight, Homehero CEO Kyle Hill still thought the technology was the toughest nut to crack. In an article on Vox, he noted, "To break away with enough escape velocity in home care, a company needs to effectively leverage technology to deliver a faster and better experience at a drastically lower price."[77]

In no way are we suggesting that technology cannot be *part* of a solution for addressing the impact of changing demographics on the demand for home care. Technology can facilitate communication and coordination between home care workers and other health care and social

service personnel, including physicians, nurses, and case workers. A visit to an appliance or home improvement store makes clear that smart refrigerators are available commercially, and they can order milk and other staples for you without your even having to ask. Likewise, we all already carry a digitally enabled emergency response system embedded in our smartphones; many of these are already augmented with apps that can detect when we have been sedentary for too long or may have experienced an injurious fall. In fact, SEIU 775 Benefits Group, affiliated with SEIU's Seattle local, has had success with a limited version of a technology very similar to that which Hometeam and Homehero failed to monetize. As the group's executive director explained to us, the organization has developed and rolled out a web-based application to upskill its direct care worker-members and to match them with clients needing home health and personal care aides. Of course, SEIU 775 Benefits Group intends to serve its members, but otherwise has no profit motive.

No technological version of compassion can truly substitute for human empathy.

Along similar lines, despite news stories about "therapeutic robots," the health care consultants we spoke with are resigned to the reality that no robot or app will ever be able to provide true empathy to a patient or client. This leaves those of us charged with arranging care for others to decide whether we are comfortable allowing our loved ones to be duped by the faux compassion of an AI-infused app or even a humanoid robot. But, before patients and their families can even face this decision, policymakers and managers need to decide the extent to which we should even be permitted to do so. That is, should public and private payers allow patients to settle for the apparent empathy of a robot, thereby rendering true human compassion a luxury good available only to those who pay out of pocket?[78] Or, should they recognize and acknowledge this particular limitation of technology by preserving standards for the provision of true human empathy?

While home care provides the most salient examples of technology's limits, what rings true for home care applies across the sector. There are limits to technology's automation potential, some of which we may soon transcend and some of which we will not. The inability of technology to provide true—not just apparent—empathy and compassion falls into the latter category. And, a key choice for policymakers and those leading organizations is the extent to which they will accept these limitations and preserve certain care delivery roles for human beings. In short, the impact of new technologies in home care—or, more precisely, how policymakers and home care agencies deploy new technology toward addressing demographic changes—turns on an important realization—technology will not solve the home care problem by reducing the demand for home care workers. Instead, it must be used to mitigate the shortage of people willing to do this work by making the work of personal care and home health aides more interesting, more lucrative, and less onerous.

While one could argue for a work-centered approach on moral grounds, we focus here on dollars and cents. Very rational managers, understandably concerned with the bottom line, may gravitate toward the Marxist path described in Box 1. They will want to deploy technology to simplify work, in part because it facilitates deskilling that softens wages and should ease the search for qualified workers. This strategy aligns with technology-centered approaches. And, while none of our interviewees described this avenue so philosophically, many imagined managers and administrators in the sector being tempted to take this path. However, a number of industry-specialized consultants pointed out there would be many challenges to doing so, particularly in a sector that predicts structural increases in demand for the foreseeable future.

First, these demand increases imply that organizations will be hiring on a nearly continuous basis henceforth. Thus, they will have to compete with other employers along reputational lines. Facing these steady increases in demand, providers also want to retain incumbent workers whom they know they can trust, even if that requires upskilling them. We would add to this longstanding evidence, largely from manufacturing, that underlines the importance of offering incumbent employees upskilling and job and wage security in the wake of a technological reconfiguring of the production or service delivery process.[79] Thus, managers would be wise to at least reconsider deployment plans that denigrate workers.

Even casting aside moral or normative arguments, approaches that elevate workers make pure economic sense.

Central to their thinking should be nearly universal sentiment regarding scope-of-practice concerns. When pressed for ways to improve the efficiency of care delivery, nearly everyone—labor representatives, managers, or consultants—highlights the importance of having every member of the care team operate at their full scope of practice. Leaders of nurses' unions, for example, want their RNs doing the work of RNs, not LPNs. Not only do their members prefer to undertake this more skills-dependent work, but it makes it easier for negotiators to justify relatively high pay. One union representative also highlighted that top-of-license work structures reduce the frequency of grievances related to job titles and duties. Likewise, managers often cite the inefficiency of having doctors do work that nurses can do or nurses doing work that CNAs can do—an opinion with which consultants concur. Consequently, even before relaxing existing scope-of-practice constraints, we should highlight the ways in which the effective use of digital technologies, service robots, and AI encourage full scope-of-practice work structures.

Despite all of these reasons, the single most important reason to focus on scope-of-practice issues when promoting high-road technological solutions may well be widespread concerns around worker "shortages." As we argue above, many of these supposed shortages probably can be explained by the low pay, poor working conditions, and overall low quality of certain health care jobs. The shortage of home care workers, in particular, could be so acute, and

the possibilities for a full-service home care robot so slim, that policymakers and home care agencies will have little choice but to use technology in ways that raise the quality of home care work—workers would be paid more, which necessitates that they be trained to take on and then trusted to undertake additional responsibilities, all of which can be facilitated by digital technologies that connect them to the rest of the care team. In that capacity they will be spatially and temporally advantaged—spending more time than any other provider with the client, and doing so onsite where the client spends most of their time—to take on a care coordinating role. Therefore, to the extent technology can be used to stretch aides' scope of practice, high-road strategies with respect to technological advancement can begin to tackle the impending critical shortage of people willing to undertake this work.

Using technology to lift workers up—providing upskilling alongside job and wage security—makes good business sense in a sector that will face growing demand for its services for the foreseeable future.

As managers turn to digital telecommunications, semi-autonomous robots, and AI to undertake many of the tasks currently performed by labor, they will do so in an environment of increasing demand for care. Therefore, they will require more and more workers able to undertake the residual or complementary tasks that technology cannot assume. At this point, human workers still hold a sizable advantage in their ability to provide emotional support and compassionate care to patients. The ability to respond to patients empathetically seems difficult to automate, implying enduring demand for human workers that can do this. And, this ability rests at the core of every occupation involved in health care delivery. That is, employers will require more workers to take on the emotional and compassionate work that we may never want machines to do for us. Likewise, consultants underlined for us the increased value of tacit and institutional knowledge embedded in the minds of front-line workers: as they cede their responsibility for replicable, proceduralizable tasks, demand for this knowledge of the organization and its service delivery process will grow. Historically, no sector has rewarded compassion and empathy very well. Nonetheless, the more technology can assume certain tasks, the more demand it will create for this emotional labor—the very sort of work that probably drew many people into front-line care delivery in the first place. All told, we think employers have little choice but to put workers at the center of their technology deployment plans.

SECTION SIX
Two Roads Diverging: Examining Technological Change Paths

Having laid out four imperatives and three key choice points, we now can examine the possible ways in which new technology could influence worker-related outcomes over the next five to 10 years. We'll do this first by assuming we remain on our present path. Then, we'll offer a competing narrative that takes us along what we call the "high road," thus illustrating the ways in which proactive decision-making on the part of public policymakers and managers could yield more broadly rewarding outcomes. We also will consider the role health care unions will likely play under each scenario.

The Status Quo: Progressing Down the Default Path

An oft-cited but apocryphal Taoist aphorism tells us "If you do not change direction, you may end up where you are heading." For our purposes, what happens if we do nothing to intentionally and strategically change paths—where will technological changes take the health care sector? Let's imagine this scenario in which we remain on the present or default path. How must policymakers and managers have adjudicated the three choice points?

- ***They have maintained the lumbering transition from fee-for-service to value-based care, maintaining for now the awkward mix of the two payment paradigms.*** In general, some elements of VBC continue to be embodied in most health plans. However, plenty of providers, particularly specialists, continue to be reimbursed procedure by procedure rather than on a capitated basis. As a result, technologies that build volume are advantaged over those that promote care quality. CMS, the agency that administers

Medicare and coordinates with state governments to administer Medicaid, does not act to counter this market failure beyond the work it already has done via the promotion of bundled payments and the like.

- ***They have maintained but not expanded their relative openness toward experimentation.*** As noted above, the default path sees Medicare and Medicaid, not to mention health care organizations and licensing boards, maintaining their existing openness to experimentation. Thus, HMOs and, to a much lesser extent, ACOs remain part of the health care landscape. However, both the regulatory and normative barriers to increased use of telehealth remain, including the state-based licensing regime for providers. This also would imply that policymakers eventually rescinded some of the emergency measures taken to facilitate the management of COVID-19.
- ***They have taken a technology-centered rather than a work-centered approach toward adoption and deployment, allowing technology to take on every task it can and leaving the remaining tasks for the remaining workers.*** Hoping that technology might prove to be a silver bullet solution for any number of issues, including supposed labor shortages, they have allocated more capital and attention to technology per se than to workforce challenges arising from technological change.

Continuing along this imagined path, if we have stayed with the status quo, we also can determine what actions health care unions must have taken. Those unions, particularly on the hospital side, would not have been opposed to technological change. Instead, many union members will have leveraged their strength at the bargaining table to mitigate the adverse effects of new technology, and to attain any possible benefits from technological change at the least possible cost.[80] They also will have worked to ensure the gains of technology-induced productivity materialize in wage and employment guarantees for front-line workers.

Note that these imagined actions on the part of unions would prove invaluable to the rank and file. They would also disproportionately benefit those workers typically most in need of economic protections—women, people of color, and those with less formal education. To the extent that unions encourage their risk-averse employers to hasten their adoption of new technology, they may well be bolstering care quality, too. In fact, research shows that union nurses, in particular, were effective at speeding their employers' transition from paper-based health records to EHRs.[81]

Along our imagined, default path, union members have continued to bargain for front-line worker involvement in technology-related decisions and in the technology deployment process. However, managers will have maintained a top-down approach with respect to the introduction of new technologies, constraining unions' role in this process. Unions nevertheless will have fought to protect their existing role in designing and delivering the training necessitated by new technology—as one union leader put it, mitigating against employers' tendency to see

technology's impact on front-line workers "as a mere afterthought." Likewise, unions will have continued to back and to garner their managements' support for joint training funds. These funds will devote the bulk of their attention and resources to retooling technologically displaced workers for the front-line care delivery jobs that remain.

At the strategic level, we imagine unions will continue to fight against the deployment of technologies that erode job quality, namely EVV. They also will continue to deploy innovative methods to improve job prospects for home care workers, albeit within the confines of the present structure of the labor market. Thus, entities like the SEIU 775 Benefits Group likely will have expanded the use of existing technology to facilitate training and job-matching in the home care sector.

With respect to the four sectoral imperatives, policymakers on the present path will have continued to make vague statements favoring increased access to the system, and the ACA—in place, but hobbled—will remain as the primary regulatory force encouraging near universal coverage. Costs will continue to increase faster than broad-based inflation, and managers will respond by looking for ways to restructure their organizations both vertically and horizontally as a means of countering and beating back this economic pressure. However, only those providers goaded by elements of VBC actively will have shifted their attention and resources away from treatment and toward the prevention and management of chronic diseases. The exigencies arising from changing demographics, left largely unaddressed technologically or otherwise, will have understandably continued along their unsustainable path.

Even under the default path, we expect hospital use of semi-autonomous service robots and home care agency use of electronic visit verification to mushroom.

Along this imagined, default path, we see only minimal additional diffusion of telehealth care delivery, including virtual hospitals and health centers, as payment models, reimbursement rules, and licensing practices do not adjust to encourage these sorts of innovations. AI-enabled chatbots will proliferate; we will all have access to them via our smartphones. Likewise, providers may well have access to them in the form of clinical decision support systems that will be woven seamlessly into EHRs. However, health systems will be unlikely to adopt chatbots for the actual, outward-facing provision of patient care, since they will not be able to bill for services provided virtually. Even on this default path, there are two exemplar technologies that we expect providers to adopt with gusto—semi-autonomous service robots in the case of hospitals and health centers and EVV in the case of home health agencies.

What makes robots so attractive even on the default path is that their use is not predicated on a change in financing or care delivery models. To the extent that robots can take on tasks formerly undertaken by humans—particularly where they can achieve scale—they should be able to do so at lower cost and at a more consistent level of quality. And, if costs fall without decreasing quality, increased use of robots should translate into increased access to care. Their use would also support and facilitate the spatial growth arising from consolidation.

These imagined adjustments in service delivery would come with growing pains. Seeing that robots can transport supplies, waste, and soon even patients, managers and hospital administrators might be inclined to reduce employment rolls at the same time they deploy their new technology, laying workers off despite realizing increased, unmet demand for some tasks robots remain ill-equipped to undertake. In fact, early adopters, including El Camino Hospital—with facilities in Los Gatos and Mountain View, California—made explicit claims that their purchase of 19 TUG smart carts allowed for the firing of 140 workers.[82] Yet, empirical research makes clear that technological rollouts undertaken in this way and explicitly for the purpose of reducing headcount rarely work: at least some tasks will remain for human workers, who will need to be motivated not only to undertake these tasks, but to collaborate constructively with their new robot colleagues. At Kaiser Permanente, for example, the effective deployment and then optimal use of its EHR system required the efforts of Kaiser employees, prompting Kaiser—with a push from its unions—to offer employment and wage security to those whose work would be affected by the new system.[83,84]

Recall the employment projections that appear in Figure 4 in Section 2, which we think of as those pertaining to the default path—the same one we're imagining here. These projections show just one occupation aside from medical transcriptionists with negative projected growth—laundry workers at -0.6%. We are not surprised, since we found that semi-autonomous service robots have already assumed many of the tasks formerly undertaken by these workers. Therefore, these projections suggest, with respect to this particular classification's status along the default path, the negative substitution effects associated with new technologies may be larger relative to the positive anticipated growth attributed to scale effects.

In our interviews, developers in particular extolled another labor market benefit arising from the deployment of service robots. That is, they require programmers, designers, maintenance and repair teams, and even builders and tradespeople to retrofit existing spaces for increased robot use. Undeniably, the widespread adoption of robots and other technologies do generate these sorts of labor market spillover effects, and many of these jobs pay well and probably achieve higher levels of subjective job quality than the roles this technology will displace. Still, when thinking about the jobs for those who service a hospital's semi-autonomous service robots, one realizes two things. First, these employees will work not for the hospital, but for the robot vendor. Second, there may be fewer of these jobs created than will be wiped out by the hospital's investment in robotic technology. For some workers, the possibility of job loss is real, particularly where employers take a putative tech-centered approach to deployment.

When imagining the default path, aside from the diffusion of semi-autonomous robots in inpatient settings, we expect home care agencies' adoption of EVV to skyrocket, underlining our point about the power of payment models to drive technology adoption behavior. Technically, the 21st Century Cures Act, signed by President Obama shortly before he left office, does not "mandate" the use of EVV. However, by requiring home care agencies that provide personal care services to have this technology in place or risk having their Medicaid claims forfeited, reduced, or denied, the federal government essentially "picked a winner." We expect this technology to have grave consequences for direct care labor as it essentially breaks these jobs into narrow tasks and removes what little autonomy once existed in these roles. This further erosion of job quality cannot bode well for addressing the shortage of workers willing to undertake this work. Even when the economy cools, employers likely will struggle to keep up with hiring demands, blaming apparent shortages for their inability to land workers. This phenomenon rings especially true for patient-facing jobs requiring the demonstration of compassion and empathy.

Hospital adoption of semi-autonomous service robots will generate positive, cumulative employment effects for programmers, designers, and repairers. However, these may pale in comparison to the number of jobs lost.

Even under this default path scenario, long-term, structural increases in the demand for care—scale effects—likely will temper the worst labor market substitution effects arising from technological change. Government projections, which implicitly assume the default path, show that the sector will grow in absolute terms as well as in its share of GDP. Thus, along the present path, with the few occupational exceptions we mentioned above, new technologies will not erode employment in the health care sector.

With few occupational exceptions, new technologies will not erode overall employment in the health care sector.

As we showed in Section 2, while most jobs in health care delivery will see employment increases in excess of the economywide average, some jobs are composed largely of tasks that prove to be especially automatable with the technologies we have today—namely medical transcription. Demand for medical transcriptionists has been declining for a long time and will continue to do so. As is often the case with technological change, organizations first found a way to break off this work from the rest of the production process, using digital technologies like those we discuss, to offshore that work to cheaper labor overseas. However, that offshoring was just a one step on the way to complete automation, whereby the same digital technologies once used only to transmit the data, now enhanced with AI and ML, can undertake the actual transcription work.[85] Depending on their employment arrangements and their ability and interest in developing new skills, these workers could well find themselves unemployed.

Nonetheless, recall from Figure 5 that medical transcriptionists are the exception and not the rule. Aside from medical transcriptionists, only laundry workers and orderlies see projected employment growth below the economywide projection of 5.2%. In fact, projected employment growth for home health aides and personal care aides, both more than 36%, far exceeds the economywide average. Yet, herein lies the challenge.

On the one hand, as shown in Table 1, women disproportionately populate both of these direct care roles, even within a sector in which more than three-quarters of workers are women. Furthermore, a solid majority of home health aides and personal care attendants identify as other than White. Add to this that more than half of direct care workers report having a secondary school education or less, as shown in Table 3, and the health care sector's robust job growth is poised to benefit many of the workers most in need. On the other hand, both categories of direct care workers earn substantially less than the median occupation in the economy, as shown in Figure 4. Similarly, while 70.4% of health care workers report access to health insurance through their employer or their union, the analogous numbers for home health and personal care aides are 33.4% and 39.0%, respectively, as shown in Table 4. Moreover, the anticipated impact of EVV technology on the day-to-day quality of these jobs, and it becomes clear that the most vigorous job growth characterizes some of the least desirable jobs. Consequently, we must temper the sector's overall positive employment outlook with material concerns over the nature of the jobs that will be in abundance.

That the sector's projected job growth is concentrated in direct care work is a double-edged sword. On the one hand, these workers are disproportionately women workers of color with a high school degree or less, a group in desperate need of employment opportunities. On the other hand, direct care workers make among the least of anyone in the sector and are less likely to access health insurance through their employer than any other jobs we analyzed.

With respect to the default path, one additional occupation deserves consideration. Of all of the occupations we analyze, nursing emerges as the largest with respect to total employment (see Figure 2). RNs also make more money than any of the other occupations except physicians and surgeons (see Figure 4), and are the most likely to report access to employer- or union-provided health care (see Table 4). This stands to reason, since Figure 3 shows that RNs are also the most likely to join together in unions. In our view, what proves must unfortunate for RNs along the default path is their relative inability to transition from conventional nursing roles into less

physically onerous virtual ones as a means of extending their careers. Interviewees told us of numerous situations where the opportunity to transition from a conventional role to a virtual one extended the careers of those leaning toward retirement. One can imagine reaching a point in their career when they no longer want to run around the hospital: for RNs, the ability to transition to a telehospital role could allow them to continue doing the work for which they were trained. Conversely, an aging dietary worker may enjoy the time they spend with patients, but feel they are no longer equipped to push food carts up and down the hospital hallways. In the latter case, their employer's adoption of semi-autonomous robots could allow them to shed the more physically onerous tasks that once were part of their job, allowing them to prolong their careers. Under the default path, RNs lose out where dietary workers do not. It seems the default path casts aside some who would be willing to continue working and whose services likely would be valued by patients, a genuine waste of precious human resources.

The default path engenders a missed opportunity to preserve value in the system—without enough opportunities to provide virtual care, experienced workers looking to transition into virtual roles at the end of their careers are more likely to opt for outright retirement.

Taking the High Road

Nothing obligates us to stay on the path we are on, especially if we determine the destination unremarkable. However, shifting from the default path to the high road requires bold decision-making on the part of policymakers and managers. The COVID-19 pandemic may bring about such a process, though it is unclear whether emergency policy changes will become permanent.

In this subsection, we consider an alternative future in which we take proactive steps to address the four sectoral imperatives in a way that not only balances access, cost containment, and care quality, but does so without exacting unnecessary costs on the health care workforce. In fact, we think relative to remaining on the default path, taking the high road could bolster all three vertices of the Iron Triangle at the same time it engenders wide benefits for health care workers. Just as we did for the previous scenario, if we find ourselves on the high road, we can reverse engineer policymaker and managerial actions on the key choice points from Section 5.

- ***They have accelerated the transition from FFS to VBC, perhaps even eliminating a la carte payment models altogether from both public and private insurance plans.*** Consequently, economies of both scale and scope characterize the service delivery process, favoring technologies that enable care coordination and quality as well as those that facilitate volume.

- ***They have created a policy regime to encourage experimentation with innovative models for both the financing and delivery of care.*** Public policy encourages individual payers and providers to develop provisional structures or alliances for providing and paying for care and to take careful account of how stakeholders fare with respect to the three vertices of the Iron Triangle. Those structures that succeed as pilot programs are encouraged to scale up, and those that fail are dissected to find out why. Similarly, state- and occupation-specific licensing boards show a willingness to experiment, particularly to the extent that the loosening of existing rules allows for increasing the scope of practice defined by their certification.
- ***They have taken a work-centered rather than a technology-centered approach toward adoption and deployment, accepting technology's limitations and embracing human workers' unique abilities.*** Rather than asking what technology can do and then leaving workers to do the rest, providers prioritize identifying where workers excel, and then seek technologies that exploit these capabilities while filling gaps in the care delivery process. They assume from the start that technology will not provide an immediate solution to any of their most pressing problems, including so-called labor shortages. They recognize that workers' default reaction to the introduction of new technologies would be defensiveness; thus, employers make manifest investments in workers concomitant to their investments in technology.

Unions will be able to play a stronger role along this imagined, high road path, compared with the default path. Union members will have more leverage at the bargaining table and can use it to help their employers prepare for technology adoption and to mitigate potential negative impacts.

Health care unions' most salient efforts likely will involve countering employers' and policymakers' near-instinctive tendency toward technology- rather than work-centered approaches. In the wake of sectoral consolidation, union members should be well-poised to do this: where employers exhibit structural market power, collective bargaining will be a better force than markets for leveling the competitive playing field and promoting care quality and service to patients. At the workplace level, union power could manifest itself in the realization of work-centered deployment methods that tap workers' implicit and explicit knowledge of front-line service delivery processes. Not only would this engender necessary worker buy-in to technology decisions, it could improve the speed of deployment and the effectiveness of the technology once installed. Moreover, by educating management on the downstream performance benefits attendant to work-centeredness, union members can forestall the erosion of skill and job quality. In so doing, employers may need front-line workers to develop greater skills and take on more responsibilities. This justifies a parallel push to negotiate increased employer support for joint training programs along the lines of 1199SEIU's Training and Educational Funds and the Health Care Career Advancement Program's many training programs.

We might also see unions take a broader approach in their lobbying efforts at the state and national levels. For starters, union members could join with management and licensing boards to urge for the relaxation of laws and regulations that inhibit the diffusion of telehealth, in particular. They could initiate this effort now, jointly asking policymakers to maintain the pandemic-induced steps lawmakers recently have taken on this front. They also could push for the expansion of programs like SEIU 775 Benefits Group's e-hiring hall, in part by pointing to the important role that union-run hiring halls have played in other sectors. They may even be able to have the use of these institutions *de facto* mandated by regulation if they are able to link the establishment and issuing of new home care certifications to the use of these hiring halls. This could effectively redefine home care work, in particular, allowing for material improvements in job quality. In fact, unions could argue that changes like those they are seeking may be the only real solution to structural worker shortages. By doing this, they will also be making a tacit argument for the elimination of EVV. Therefore, they can claim that they are helping patients (or clients) at the same time they are addressing the realities of the labor market for home care workers.

With respect to the four sectoral imperatives along this imagined path, access would remain a critical issue. However, an easing of cost and quality pressures would allow for increased public investment to facilitate access to care. Sectoral consolidation would continue apace: it would be driven by and itself drive the shifting of organizational resources from treatment to the prevention and management of chronic diseases. There would continue to be excess demand for labor across the sector, largely due to structural increases in demand for health care services arising, in part, from an aging population.

Even along the high road, the shift from FFS to VBC would squeeze employers and constrain worker pay. Unions would have to lobby for increased insurance payments for employers and bargain for a greater share of those payments.

We see a far wider variety of technology and its applications along the high road than we do along the default path. Aside from providers deploying technology to facilitate volume, they would do so in ways that target care quality. They would be rewarded not only for consolidation as they were on the default path, but improved coordination between providers aids quality improvement, for which VBC payment models reward them. Much of this increase in care quality would come from proactive behavior by providers recognizing that prevention is cost effective and better for patients. Furthermore, home care agencies, free from the yolk of EVV, could instead use technology in ways that improve the quality of home care work, simultaneously addressing dire issues in the direct care labor market while improving the efficiency of home care delivered. AI would

magnify the utility of nearly all of these technologies. Not only would it remain embedded in provider-facing CDS systems and EHRs, it would improve the effectiveness of patient-directed chatbots and app-based personal health assistants.

So much of this apparent panacea would arise from the shift in payment models from FFS to VBC—which would bring a greater challenge for both employers and workers. As noted previously, the VBC payment model, with its fixed, upfront, or bundled payments, pushes employers to reorient their relations with workers. Under VBC, provider organizations face tighter budget constraints, which will influence pay and employment issues more broadly. Collective bargaining can serve as a doubly useful institution under these circumstances. Aside from workers negotiating for a larger share of payments as pay, labor and management could recognize a shared interest in generous or at least fair payment rules. Thus, union members could effectively increase the size of the entire pie before securing a larger slice.

Notwithstanding these new constraints, the possibilities for digital communications and telepresence along the high road and their resulting, beneficial labor market impact abound. Despite our initial fears that telemedicine or telehealth might leave front-line providers missing patient interaction, we have found—somewhat ironically—that telehealth actually engenders *more* patient-provider intimacy than does conventional care delivery. Instead of seeing a given patient once every three months in the office, providers actually get to know them even better through day-to-day video interactions. In a sense, they see themselves resurrecting the notion of a house call, seeing patients in their natural environments, building a connection not only to the patient, but to his or her spouse, children, and even pets.

Providers often find virtual interactions of higher quality than in-person ones.

Aside from these intrinsic benefits, providers of telehealth—telehospital care, in particular—also work more comfortably than their peers toiling in conventional hospitals. Politico described the work environment in one particular telehospital by contrasting it to the loud, fluorescently lit, bleach-smelling facilities that typically come to mind when we think about hospitals:

> **"Instead of bright fluorescent lighting, beeping alarms and the smell of chlorine, Mercy Virtual Care has striped soft rugs, muted conversation and a fountain that spills out one drop a minute. The mess and the noise are on screens, visible in the hospital rooms the staffers peer into by video—in intensive care units far away...."[86]**
>
> **—Arthur Allen, "A Hospital Without Patients," 2017**

Consequently, by making work more comfortable in this way, telehealth can also extend careers, a key issue for occupations for which employers claim a shortage. An aging or injured nurse, for example, still can work in front of a bank of computer screens. Likewise, the pressure that telehealth can take off of onsite nurses likely reduces their rates of burnout and turnover as well. The CMO of a telemedicine provider told us explicitly that their company recruits providers on this very basis:

> **"These are the doctors, usually 65 or older, who have had a great career, but they can't do it anymore. They just don't want to trudge and do the 40-hour workweek anymore, but they still want to be doctors. And we give them an opportunity to spent 10, 20 hours a week being the great doctors they are but not feeling overwhelmed with all this paperwork and the busyness of the day that they'd have to do as a full-time doctor."**
>
> **—a Chief Medical Officer, telemedicine provider**

Finally, recall the limited ways in which California, in particular, has allowed for the use of digital communications technologies—telepresence—in the home not by patients, but by LPNs working with a physician remotely. We can expect these arrangements to become more permissible and thus more prevalent. Not only will we witness the application of technology in this way across the states, but we will see it applied to a growing set of symptoms and conditions. Aside from the benefits to patients in terms of access and cost, this use of telepresence should increase demand for LPNs, while boosting their pay and their job quality more broadly.

Digital communications technology, when deployed along the high road, also can yield positive effects for home care workers. Electronic visit verification, the default-path use for digital communications technologies in home care, provides just one example of how advancements in digital communications and telepresence can be embedded in hardware and software—a smartphone and its associated apps, in this case—to affect the jobs of health care workers. An alternative, high-road strategy would be one in which the core technology allows for better optimization across the vertices of the Iron Triangle without pushing the costs of these improvements off onto other stakeholders, namely workers, employers, or taxpayers. We referred to this earlier as "augmented home health"—in which an aide takes on the role of care coordinator for their client—using the smartphone not simply for clocking in and clocking out, but for connecting the home health or personal care aide to the rest of the care team. 1199SEIU Training & Employment Funds (TEF) has a number of pilot programs under way along these lines, one of which involves a company called eCaring. In this case, the home health aide signs into an iPad app to access a client-customized care plan developed by a nurse care planner. The aide

can then follow the care plan, including step-by-step instructions where necessary, and can enter behavioral, clinical, and medication-related information directly into the interface. He or she can also provide additional information on the client's emotional state or their living environment. An RN then can review the information in real time or asynchronously, and communicate instructions back to the aide.[87]

In our high-road example, EVV—essentially mandated by law—would be absent. Instead, we'd imagine a provision along the lines of H.R. 3461, sponsored by Rep. Matt Cartwright (D-Pa.). While his bill makes no mention of technology whatsoever, its goal of training direct care workers to take on deeper clinical responsibilities carries an implicit technology imperative—one that is consistent with the high-road outcomes laid out here.

Augmented home health just as easily could have been incorporated into law as electronic visit verification, and that could encourage a more work-centered use of digital communications by home care workers.

We think augmented home health not only exemplifies the high-road, work-centered approach to bringing more technology to home care, but may well be the only realistic path for home care over the next five to 10 years. While we heard many ways in which technology can be deployed to improve efficiency at the edges, we found no silver bullet—not even the futuristic elder care robots that some imagine to be on the horizon. Home care clients already use AI-infused devices to enrich and facilitate their daily lives, but not in ways that have material implications for home health and personal care aides. Thus, we have come to think only by enacting fixes that are both structural and technological in nature will the demand for direct care workers be met. What we envision on this high road has the added benefit of boosting wages and working conditions, too, for these occupations.

Where do semi-autonomous service robots figure along the high road? We expect their diffusion to continue apace in the hospital setting, though we see big differences in how they are deployed. Under the work-centered approach that characterizes the high road, rather than viewing the use of robots as a way to relieve themselves of labor, employers would instead consider how robots could assume some of the less enjoyable, lower-valued-added tasks for which workers long have been responsible. As one developer of hospital robots put it, "With robotics like [ours], dietary workers can spend more time helping patients get the ketchup packet opened and less time running up and down the hallways and going up and down on the elevator." Glibness aside, he correctly notes that service robots do not provide compassionate care in the same way humans can, and patient perceptions of genuine empathy now contribute materially to hospital performance metrics.

Along the high road, employers would embrace the notion that robots can relieve workers of some tasks while enhancing their ability to take on others. As we have noted, automating some tasks complements or supports workers in their performance of higher-value-added, less-automatable tasks.

Robots can just as easily improve work as they can displace it. Their deployment could turn orderlies into "transporter and telehealth techs" and dietary clerks into "healthy foods ambassadors."

In their own analysis, 1199 SEIU TEF provided two specific examples of what we would label the high-road response to the robotization of front-line care delivery:[88] Orderlies, whom the collective bargaining agreement refers to as "patient transporters," presently move both patients and supplies around the hospital. In many hospitals, robots already are assuming much of the responsibility for moving supplies, and there are few technological barriers, at least, to robots taking on patient transport.

Along the high road, once patient transporters are relieved of their responsibility for moving supplies, they could leverage their unique ability to interact with patients as well as their knowledge of the facility and the campus to transport and set up new telehealth carts and to prepare patients for their telehealth interactions. They could also devote more time and effort to the discharge process, which research has shown plays an outsized role on patients' overall satisfaction with their hospital stay. For example, they could take steps to ensure the patient has a safe and reliable ride home, as well as to their next scheduled doctor's appointment.

This enhanced role, which 1199 SEIU TEF calls "transporter and telehealth tech"—would require an additional modicum of technical skill and perhaps even some incremental training on patient interaction. However, in this new role, patient transporters would be relatively safe from technological displacement and would be undertaking a more high-value-added set of workplace tasks.

The same report also offers up a high-road plan for dietary clerks, a second job service robots could soon displace. Dietary clerks/workers would prepare meals based on clinician instructions, dietary and treatment guidelines, and individual patient needs and preferences, and then deliver those meals to patients. Robots already have assumed much of the responsibility for food delivery and are poised to take on even more. However, they have yet to take on responsibility for the preparation of meals, nor will they soon be equipped to facilitate patient coaching and socialization.

Once dietary clerks/workers cede their delivery responsibilities to semi-autonomous service robots, they would have more time to discuss dietary alternatives with patients. They could also help patients download and familiarize themselves with smartphone and tablet apps for

in-hospital use for meal selection as well as those that will help them maintain the appropriate diet once they are discharged. They could also supply the patient with other educational materials, as needed, and could follow up with the patient after discharge.

Once again, this new role—that of a "healthy foods ambassador"—would demand more from the worker in terms of technical, domain, and customer service expertise. However, it would also lead these workers to allocate more of their time toward high-value-added patient interactions that will largely remain the province of workers rather than robots. Note that in both cases, technological change would benefit workers by boosting their job security. These managerial decisions around implementation, endorsed by the union, also would also boost workers' skill levels, increasing the likelihood of increased wages and job quality. Thus, investments in new technology—semi-autonomous service robots, in this case—would generate value not only for patients, providers, policymakers, and citizens looking to optimize across the three vertices of the Iron Triangle, but also for the health care workforce working alongside them.

Finally, AI would likely be embedded in nearly all of the technologies we have discussed, particularly when they are deployed along the high road. To the extent that AI helps providers capture the value associated with care quality, they are more likely to invest in it. Furthermore, openness to experimentation would allow providers to use it as a means of delivering more care at lower cost, making great inroads with respect to increasing access. The question is, would this AI displace front-line workers, either entirely or in a way that drives down their wages and erodes job quality?

AI could well be unleashed to improve patient access to care. Done in a work-centered way, it could engender entirely new occupations that pay well.

While we cannot claim to have seen it in action yet, our research suggests that AI could be deployed alongside rearrangements in work structures to tackle the deficit of primary care providers in the United States. Rather than endeavor to apply AI in a science fiction-like attempt to replace physicians or nurses, we could instead use it to equip a new generation and new classification of caregivers filling the void left by physicians turning to more lucrative specialty care. In a plan most clearly propounded by technological futurist Martin Ford,[89] we could insert AI into the exam room for use by a newly designated health care occupation. We would train these new practitioners to be adept at both interacting with and examining patients *and* interfacing with a standardized diagnostic and treatment system, the latter powered by AI and ML. In its initial incarnation, the machine would sit physically in the exam room alongside the practitioner and the patient. Later on, the machine instead could be used by teleproviders providing care remotely.

Used in this way, AI would allow us to substitute lower-cost practitioners for more expensive ones in the disposition of routine cases. These same "bridging" practitioners could aid in handling the surge of patients needing help with the management of their chronic diseases. While patients requiring more specialized care still could be directed to physicians or specialists, the vast number of patients not requiring this expensive, and sometimes all-too-scarce expertise could receive their services more quickly and less expensively.

What makes this a high-road application of technology? Aside from helping us optimize across the vertices of the Iron Triangle, according to Ford, it does so while establishing and then sustaining demand for a new kind of health care professional, educated to the bachelor's or master's level. And, given the shortage of primary care providers, the use of these new practitioners need not come at the expense of jobs for existing practitioners. Instead, these positions could help to fill an existing gap in the system, one that is even more acute in rural areas. Furthermore, and most important from a labor market perspective, "College graduates would benefit significantly from the availability of a compelling new career path, especially as intelligent software increasingly erodes opportunities in other sectors of the job market."[90]

SECTION SEVEN
Conclusion

This report set out to address three questions regarding health care delivery in the United States over the next five to 10 years.

- What factors will drive which technologies are actually adopted and how will they be implemented in the workplace? How might public policy mediate the relationship between adoption and labor market impact?
- What are the new technologies in the health care delivery space that have the potential to influence wages, skill requirements, and the organization of work?
- What are the likely impact scenarios for specific occupations and wage levels, and how might those effects vary by race, ethnicity, gender, age, and educational attainment?

Our fieldwork points to the following answers:

- In general, the health care sector should optimize across three goals: access, quality, and cost containment. In doing so, provider organizations must confront four overarching imperatives: increasing access to health care and reducing the cost of care; consolidating and coordinating health care delivery; facilitating chronic disease prevention and management; and responding to demographic trends. Technology adoption will be part of the sector's response to these imperatives. Or, put another way, these factors will impel technology adoption. Just how organizations deploy technology and how those choices will affect workers depends on policymakers' and health care administrators'/managers' adjudication of three choice points and, importantly, the role that workers have in the process. Just how open will the sector be to experimentation with new models for financing and delivering care? To what extent will value-based care further supplant the fee-for-service model? And, will provider organizations actively espouse and maintain a work-centered approach over a technology-centered one to technology adoption?

- Three technology families emerged from our fieldwork as those most likely to be called upon by sectoral actors to address employment, wages, skill requirements, and the organization of work in the health care sector in the near and medium terms: digital communications and telepresence, semi-autonomous service robots, and artificial intelligence. The first is readily apparent in hospitals and home care, and the second is becoming increasingly prevalent in hospitals and health centers. AI, however, has thus far proven more elusive, in part because it does not have an obvious physical embodiment and because organizations are just starting to consider all of the ways they might use it.

- Our findings point to two possible scenarios moving forward—following the current (default) path and charting a high-road scenario. Even if we stay on the present path, increases in projected demand for health care services will easily dominate the negative substitution effects otherwise wrought upon workers by new technology adoption. But, pursuing the default path also would leave unaddressed the considerable shortage of home care workers, meaning that increased demand for health care services would go unmet and that workers who might otherwise benefit from increased demand from health care services will be left on the sidelines. That these excluded workers tend to be women, people of color, and less educated makes this possibility even more profligate. Thus, we suggest ways that policymakers and managers can take the high road and promote adoption of the three technologies as a response to the four imperatives, in ways that better address patient needs while more widely distributing technology's economic benefits.

- Along the default path, health care unions, particularly on the hospital side, leverage their strength at the bargaining table to demand frontline worker involvement with respect to workplace technological change. They also seek wage and employment guarantees, invaluable to the rank-and-file. However, we envision a more proactive role for unions along the high road. They could involve themselves earlier and more deeply in technology adoption efforts, countering employers' near-instinctive tendency to use technology-centered over work-centered approaches. They also could unite with management to lobby for regulatory changes that facilitate the diffusion of new technologies—telehealth, in particular—and that create certifications for home care workers. This likely would improve the quality of these jobs, which we think is the only sensible way to ease the structural shortage of workers willing to undertake them. These changes incidentally pave the way for replacing restrictive technologies such as EVV with more enabling ones that serve the proposed, expanded role for certified home care workers.

- While we conceived of and conducted this research in a pre-pandemic world, COVID-19 has shone a light on the need to leverage technology toward more efficient use of the health care workforce. Anecdotal evidence points to an increased use of semi-autonomous robots in intensive care settings, though there is no evidence of their

efficacy or staying power. Telehealth, however, took off once policymakers *temporarily* lifted restrictions on its use as a way of alleviating the strapped system of low-acuity patients. Lawmakers also recognized the obstacle that state-based occupational licensing regimes posed to the rapid, reallocation of front-line workers to where they were most needed across state lines. Consequently, while not exactly voluntary, the pandemic has occasioned the sorts of experimentation that we call for along the high road.

As this report shows, predictions that "the robots are coming" for health care jobs ignore the deeper sources of change in the sector, the technologies at our disposal, and the political and institutional forces determining which technology is adopted and how. The default path sees employment increasing, not decreasing. In fact, demand will outstrip supply for some jobs, particularly in home care. However, our high-road prescription, which requires action on the part of policymakers, employees, and unions offers a nobler way—one that better meets the needs of patients, providers, and taxpayers while addressing labor market constraints and frontline worker appeals.

APPENDIX
Additional Information on Data

When assessing industries or sectors, the Bureau of Labor Statistics combines "Health Care and Social Assistance" under a single, two-digit NAICS code, as shown in Table A.1. For most of our analyses, we *exclude* the Social Assistance subsector. However, we include it in our analyses of home health aides, nursing assistants, and personal care aides, as many Medicaid-funded nonprofits likely reside in Social Assistance. Thus, for these three job classifications only, we include residential care facilities, individual and family services, community food and housing, emergency services, vocational rehabilitation services, and child day care services.

TABLE A.1
Census, NAICS, and Occupation Codes

Industry description	2017 Census code(s)	2017 NAICS code(s)
Health care and social assistance	7970-8470	62
Offices of physicians	7970	6211
Offices of dentists	7980	6212
Offices of chiropractors	7990	62131
Offices of optometrists	8070	62132
Offices of other health practitioners	8080	6213 exc. 62131, 62132
Outpatient care centers	8090	6214
Home health care services	8170	6216
Other health care services	8180	6215, 6219
General medical and surgical hospitals, and specialty (except psychiatric and substance abuse) hospitals	8191	6221, 6223

Industry description	2017 Census code(s)	2017 NAICS code(s)
Psychiatric and substance abuse hospitals	8192	6222
Nursing care facilities (skilled nursing facilities)	8270	6231
Residential care facilities, except skilled nursing facilities	8290	6232, 6233, 6239
Individual and family services	8370	6241
Community food and housing, and emergency services	8380	6242
Vocational rehabilitation services	8390	6243
Child day care services	8470	6244

Occupation description	2018 Occupation code(s)
Food service	4000-4160, inclusive
Chefs and head cooks	4000
First-line supervisors of food preparation and serving workers	4010
Cooks	4020
Food preparation workers	4030
Bartenders	4040
Fast food and counter workers	4055
Waiters and waitresses	4110
Food servers, nonrestaurant	4120
Dining room and cafeteria attendants and bartender helpers	4130
Dishwashers	4140
Hosts and hostesses, restaurant, lounge, and coffee shop	4150
Food preparation and serving related workers, all other	4160
Home health aides	3601
Janitors & cleaners	4220

Occupation description	2018 Occupation code(s)
Laundry workers	8300
Licensed practical nurses (LPNs)	3500
Medical records technicians	3515
Medical transcriptionists	3646
Nursing assistants (CNAs)	3603
Orderlies	3605
Personal care aides	3602
Physicians & surgeons	3090, 3100
Registered nurses (RNs)	3255

With respect to occupations, we rely on 2018 occupation codes, also shown in Table A.1. For most of the classifications we analyze, there is a one-to-one mapping into an occupational code. Our physicians and surgeons category draws from two distinct occupational codes. Likewise, food service incorporates 12 distinct occupations, all of which we list in the table.

We further clarify these issues in the notes accompanying each of the tables and figures.

Endnotes

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20 When we turned to U.S. government data, we found the health care sector often includes "social assistance occupations" such as child care and vocational rehabilitation services. Thus, for some analyses, we excised these occupational subcategories from our aggregate sectoral data. *See* the Appendix for more information on the industry and occupations codes included in our analyses.

21 According to SEIU Local 2015, one of two unions that represent such workers in California, nearly two-thirds of in-home supportive services (IHSS) workers—the state's label for what we refer to as personal care aides—support a family member or someone they live with.

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