Medical Technology Innovation

Key Takeaways:
- Advances in medical technology can be broadly categorized into two clusters: (1) innovation in diagnosis and treatment and (2) innovation in information technology that analyzes large data sets
- Healthcare technology is driven by the need to meet the demands of patients, payers, and policymakers to achieve better results, in less time and for less money
- Healthcare technology is expensive to develop; estimates are that 40-50 percent of the growth in medical expenditures are linked to technology. These are not always cost-effective, and there are significant costs associated with marketing and implementation
- Researchers are exploring ways by which artificial intelligence can be used to reduce manual burdens, increase precision, and reduce cost; however, some are concerned that robot technology could make certain professions obsolete
- Telemedicine is creating new opportunities for improving access to care for patients, expanding the capacity of medical staff and enhancing efficiency of care
- Human Centered Design and Co-Creation models may be valuable exemplars offering best practices for how to develop successful patient-informed healthcare innovations at lower costs.

Background
There is broad agreement among experts that, in the future, technology will profoundly change the way medicine is practiced, administered, and paid for. Yet there is no consensus regarding what these changes might be or how and when they might roll out. Some see these changes as being almost universally positive; others caution that the force and pace of technological disruption may harm patients, providers, and the system as a whole.

What’s Driving Innovation in Healthcare?
In the United States, healthcare innovation is being driven by the need for the industry to meet the competing demands of patients, payers, and policymakers who want better
The traditional healthcare delivery model is quickly becoming overwhelmed with such demands, particularly given that the US population is rapidly aging and presenting at healthcare facilities with chronic diseases and comorbidities which are expensive to treat. (Tinker, A) Additionally, many – but not all – believe that there is a provider shortage in primary and specialty care, with one study estimating a shortfall of between 14,800 and 49,300 primary care physicians and between 33,800 and 72,700 in non-primary care specialty physicians by 2030. (Association of American Medical Colleges) The physician shortage is compounded by decreasing rates of productivity in the healthcare industry, which have dropped by 0.8 percent annually between 1990 and 2007 while other sectors like the computer and semiconductor industry experienced a 7.6 percent annual growth in productivity. (Houghom) The high demand for services and low supply of providers is one of many factors that contribute the high cost of care, which is impacting patients on an individual level as well as creating a burden on the overall US budget. (Haughom, J) Medical technology innovation has been proposed by researchers and policymakers alike as a promising strategy for mitigating these issues. New models of care, payment, and practice are being piloted by healthcare entities each year with the aim of reducing cost, enhancing quality of care, and improving population health. Evaluating these models and identifying relevant successes and challenges will provide the field with insight on best practices for creating medical technology that meets diverse needs.

Reflecting on the Past and Looking Ahead: How Technology has and is Predicted to Change Healthcare

Patterns of the Past

Past healthcare technology innovation has primarily emerged from the Life Sciences field and focused on the research and development of new therapies, drugs, medical devices and diagnostic procedures. These advances represent areas in which the US has excelled and helped to improve pharmaceutical agents (e.g. stents) as well as develop more precise diagnostic scanners and surgical robotic techniques. While these innovations have made a significant impact on healthcare outcomes and economic growth, they have been
incremental, and are too narrowly focused to solve the issues that the field currently faces. (Haughom, J)

**Predictions for the Future**

As the healthcare industry considers the challenges of today and the future, a shift in the focus on innovation is needed to produce necessary change. The field is considering a variety of opportunities to innovate and is casting its eyes on areas including: prevention; tailored and personalized care for genetic profile needs; efficient and proactive tech-enabled care models; and integrated delivery design and virtual options for effective healthcare engagement within and between provider and patient groups. (Haughom, J)

Certain predictions have been made about how the pace and focus of technology-enabled innovation is likely to change, given the exponentially growing role that technology can play in improving quality of and access to care. The International Data Association predicted that in order to improve consumer experience, healthcare would leverage technology and develop omni-channel strategies to transition 65 percent of consumer transactions with its organizations to web, mobile, and telephonic platforms by 2018. Additionally, given the need to manage cohorts of patients with chronic illnesses, the Association estimated that 70 percent of healthcare organizations would invest in consumer-facing mobile applications, wearable devices, remote modeling tools and virtual tools. This trend could result in an overall increase in demand for data and analysis for improved population health management. (Haughom, J)

**Optimism and Concerns about Innovation**

Though innovation in healthcare is often viewed in an optimistic light, there can be negative consequences to technology advances in any industry and it is important to consider potential harms that new and emerging drugs, devices, and practices can have on patients, providers and the health system at large. There is an ongoing debate between healthcare experts, some of whom encourage innovation as a positive evolution towards optimal health, and others who are cautious if not wary of the rapid pace of systems change.
Arguments on both sides of the debate are valid and should be thoroughly considered and applied when determining whether new technology is beneficial or harmful to the field. There are a wide range of examples of how technology has advanced and complicated service delivery and information access as well as the efficiency and precision of medical care.

Service Delivery and Closing the Provider Gap

Technology has expanded the way that care can be delivered to patients, enhanced medical teams’ ability to communicate and improved integration of care within and across healthcare facilities. Mobile and web technology has enabled patients to access care and communicate with their medical team more conveniently and efficiently. Healthcare systems are investing in the development of virtual systems that afford patients the ability to receive world-class medical treatment without having to physically visit a facility. For example, The University of Southern California has a system called the Virtual Care Clinic that has “digital communication and cloud-based data storage [which] allows for a completely different model of healthcare that does not depend on patient visits to a brick-and-mortar health care facility and, therefore, can provide the greatest advantage for patients for whom such visits are physically or financially challenging.” The model has been uplifted by USC medical staff as an important unifying construct “because it represents a health care model in which the patient drives the health care interaction and digital technologies are used to continuously provide information and integration of services.” (Peden, C) Additionally, virtual technology has been adopted as a strategy for addressing issues related to the physician shortage. Such technology can be applied to increase the capacity of primary care practices to meet patient demand by reallocating clinical responsibilities to telemedicine platforms, non-physician team members, or even the patient, when self-care is appropriate. (Health Affairs)

“The health care solutions of the future will be patient-facing and directed toward patient education, self-management, and on-demand diagnostics and service; therefore, medical care should become more of a continuous experience that patients can access when and where they need it.”

-Carol J. Peden, MD, USC, Keck School of Medicine
Though technology can enable patients to access care remotely, engaging in virtual platforms presents challenges to some populations as some may not have the skills to use applications nor the knowledge to fully understand the information well enough to manage their condition. (Thimbleby H) Given this challenge, technology advancements that allow access to mobile healthcare may also require cultural solutions and substantial patient and provider education efforts in order to be successfully used by diverse population groups. (Thimbleby H)

**Big Data and Information Access**

Technological advancements have also been made in healthcare data systems and have enabled the field to unlock large datasets which have the potential to inform epidemiological studies and scientific discoveries. Large amounts of patient information can be collected through patient records and efficiently stored in electronic health records. The quantity and quality of this information is expected to increase significantly due to genomics and personalized medicine and this will allow for more advancements in the healthcare field. (Thimbleby H)

In addition to electronic health records, enterprise data warehouse technology is being adopted to help overcome current limitations in relying on one set of information or claims data. Enterprise data warehouse technology can aggregate data from multiple systems to provide data related to both individual patient information as well as the broader population landscape. (Tinker A) Facilities such as Texas Children’s Hospital are leveraging this technology to enable multiple providers to share information to better understand their patients’ medical history and make appropriate and aligned care recommendations. (Bickmore AM) On the broader population level, enterprise data warehouse technology can be used to help understand targeted populations, stratify by prevalence of how often individual conditions appear together and enable clinical teams to develop best practices for population health. (Tinker A)
Though Big Data presents promising avenues for discovery in terms of epidemiologic research and best practices, it presents both challenges and concerns about security and privacy. As collecting biomedical and other personal medical identifiers becomes easier and more common, gathering data for state security may happen as a consequence, eroding the current norms of patient confidentiality in a way that could be out of the realm of providers’ control. Additionally, there is concern that as data becomes larger it distances the manager of the data from the patients it serves, opening opportunities for diluting the obligation and accountability for using patient information appropriately and keeping it secure. (Thimbleby H)

**Precision and Robotic Care**

Technology has also advanced the healthcare field in terms of precision. Diseases and treatments can be diagnosed and administered in ways that are more targeted, require fewer resources and less recovery time. Precision medicine for example, “allows healthcare interventions to be tailored to groups of patients based on their disease susceptibility, diagnostic or prognostic information, or treatment response.” (Love-Koh, J) Some speculate that this field will be accelerated “firstly by the complexity and uncertainty around delivering therapies that use biomarker data and, secondly, by the innovative, evolutionary nature of AI-based technologies.” (Love-Koh, J). In addition to precision medicine, healthcare has improved through the adoption of robotic surgery, which allows doctors to perform “complex procedures with more precision, flexibility and control than is possible with conventional techniques”. (Mayo Clinic Robotic Surgery) Some argue that in the future robot technology will be superior to human ability. Ajan Reginald, CEO of Celixir, contends that “AI will further remove the speed, complexity and precision limitations inherent in a human being driving the robotic arm” and that “[a]utomation should provide a higher quality of care, broader access and lower cost for patients.” (Stark, H)
Though robotic technology has generated excitement among providers and patients alike, some are concerned that robots may become so advanced that they could make providers’ jobs obsolete. Robots have already been tested to complete the work of some types of clinical providers; psychology experts and artificial intelligence enthusiasts at Stanford University developed a chatbot known as Woebot, that could function as a cognitive behavioral therapist by making use of artificial intelligence algorithms to track patients’ mood, understand their psyche over time, make productive conversation and offer valuable suggestions for reducing psychological problems. (Stark, H). As artificial intelligence becomes more advanced, other medical professional duties may be able to be accomplished effectively by robots. However, many argue that “face-to-face patient-physician encounters will always be a part of healthcare” as some patients prefer human interaction and find it an important aspect of the care experience. (Lagasse, J)

Weighing the Cost of Healthcare Technology

In addition to concerns about quality, accessibility, efficiency, precision and data security, it is also important to consider the economic impact of healthcare technology. There are circumstances in which technology can be leveraged as a way to generate cost savings that benefit the individual patient as well as the overarching healthcare budget. However, healthcare innovation cannot be achieved without expense and in some cases, technology can drive a level of spending that is not cost effective considering the size of the population being served and the incremental benefit of the product. Some researchers are working specifically on cost saving technology. For example, at the 2018 World Medical Innovation Forum, researchers presented technology solutions for “reducing the high costs and negative patient experiences that stem from treatment uncertainty, trial-and-error medicine, and an inability to access meaningful insights at the point of care”. One participant showcased his work on “a natural language processing (NLP) platform that enables automated, real-time querying of electronic health records”. The platform, which uses Smart Rx software, can “understand the context and extract information from structured and unstructured fields” and could eventually be used to reduce the manual burdens and costs of creating patient registries. (Bresnick, J)
However, the cost of researching, developing and marking technology is expensive. Studies show that “the cost of medical technology is not declining and its increasing use contributes to the spiraling healthcare costs”. (Kumar, RK) In the United States, new medical tech is responsible for 40-50 percent in annual cost increases. (Clemens, M) Given this trend, it is imperative that healthcare innovation is considered both in terms of potential population health benefits and overall healthcare costs.

Models for Consideration
If healthcare innovation is to be successful, it not only needs to meet high standards for cost effectiveness and quality, but it also should be designed with human experience in mind. Human Centered Design and Co-Creation models can be applied with the objective of creating technology that is developed with patient input.

Conclusion
Healthcare innovation is driven out of a need for more efficient, effective, and accessible care, however the process of innovating challenges the capacity of national budgets and industry norms. It is difficult to understand the possibilities that healthcare technology will unlock, but the field can benefit from evaluating patterns from past developments to work to ensure that new products, drugs and devices that are created in the coming years create more benefits than harms. Healthcare leaders will need to collaborate with experts across different sectors and thoughtfully engage with patients to develop technology that works to advance the triple aim of reduced costs, enhanced quality of care and improved population health.
References


