

# The Hospital Tech Laboratory: Quality Innovation in a New Era of Value-Conscious Care

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Advances in medical technology have fueled extraordinary quality improvements in US healthcare. Limitless technological innovation, however, is a primary driver of rising healthcare expenditures.<sup>1-3</sup> This trajectory is no longer sustainable, and incentives in the Affordable Care Act—such as hospital value-based purchasing, readmission reduction, and accountable care organization programs—are prompting hospitals to contemplate a new phase of medical technology. The next generation of diagnostic and therapeutic solutions must simultaneously deliver higher-quality care and lower cost. Hospitals provide a central organizing function where many parts of the delivery system articulate. With the growing emphasis on value, hospitals are ideally positioned at the forefront of an information technology (IT) revolution that favors data synthesis over data generation.

Consider the evolution of medical imaging. The progression from x-ray to advanced modalities, such as computerized tomography (CT), magnetic resonance imaging (MRI), and positron emission tomographic scans, has enabled a more precise view of disease pathology and ultimately yielded better treatment decisions. The focus of an entire era of diagnostic technologies has been to create more and better images. Although successful in many respects, the history of medical imaging has had its trade-offs as well. Additional ionizing radiation from CT scans led to measurable increases in the incidence of various cancers,<sup>4,5</sup> and false positive results necessitated subsequent therapies, often with unclear benefits for patients.<sup>6</sup> Furthermore, the increasingly sophisticated and more abundant scanning techniques have added costs to the healthcare system.<sup>7,8</sup>

Instead of deploying technologies aimed at improving diagnosis through pure information generation, the confluence of current policy incentives, market forces, and technological development has pushed hospitals to invest in tools that facilitate information processing. This new phase in healthcare technology requires synthesizing information from images, medical records, physiological monitoring, and other sources to augment clinical decision making. Stakeholders in medicine have long awaited the productivity

## ABSTRACT

For decades, the healthcare industry has been incentivized to develop new diagnostic technologies, but this limitless progress fueled rapidly growing expenditures. With an emphasis on value, the future will favor information synthesis and processing over pure data generation, and hospitals will play a critical role in developing these systems. A Michigan Medicine, IBM, and AirStrip partnership created a robust streaming analytics platform tasked with creating predictive algorithms for critical care with the potential to support clinical decisions and deliver significant value.

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### TAKEAWAY POINTS

Value-based incentives are influencing development of the next generation of healthcare technology. The features of synthesized and processed data may yield useful clinical decision support tools capable of improving quality and reducing costs. Hospitals are crucial development partners and we advocate several approaches to help them navigate this transformation:

- ▶ Refine and accelerate the accessibility of internal information that management needs to make informed investment decisions.
- ▶ Engage nontraditional industry partners with clear ethical policies in place.
- ▶ Embrace disruption to a traditionally stable business model.

surges that are now commonplace in other industries. Retailers, for instance, optimized access to goods both online and in stores by tracking purchases and anticipating future demand. They currently use machine learning, a type of artificial intelligence capable of adjusting when exposed to new information, to create a personalized shopping experience with the ability to suggest what shoppers might want to buy next.

In healthcare, revenue incentives have disproportionately influenced strategic investment in shiny new scanners. From 1999 to 2014, the number of CT scanners per million individuals in the United States increased from 25 to 41, and the number of MRI units per million individuals more than doubled from 15 to 38.<sup>9</sup> Healthcare IT, on the other hand, was synonymous with electronic health records (EHRs) and was viewed far less favorably. Investment was essentially mandated in costly systems that frustrated clinicians who were comfortable with existing practice patterns. Appearing on the horizon are advanced computing and analytic tools for data processing that have the potential to go far beyond the initial stage of healthcare IT and increase value—not just costs.

#### Michigan Medicine Clinical Decision Support Pilot

Michigan Medicine, the health system affiliated with the University of Michigan, provides a useful illustration of an organization confronting this technological transition. The academic medical center is located in Ann Arbor, Michigan, and receives referrals from across the Midwest. Combining the University Hospital, Women's Hospital, and Children's Hospital accounts for 1000 staffed beds, and the system provides a full range of services, resulting in approximately 48,000 discharges, 2.1 million outpatient visits, and 101,000 emergency department visits each year.

Like many academic institutions, Michigan Medicine functions on a modest operating margin and must carefully weigh investment decisions that further the tripartite mission of patient care, education, and research. In October 2014, Michigan Medicine announced an innovative partnership with tech giant IBM and mobile analytics developer AirStrip (San Antonio, Texas) to pursue a novel approach to predictive medicine. The goal of the collaboration is to develop tools capable of earlier identification of clinical

deterioration in patients with critical illness or injury, and thereby enable course correction at an earlier time. The platform (Figure) collects and processes data from hospitalized patients, mines the data for patterns or features that can be developed into rules, and applies adaptive algorithms capable of learning and making clinical predictions. These predictions are shared with providers when significant clinical changes are anticipated.

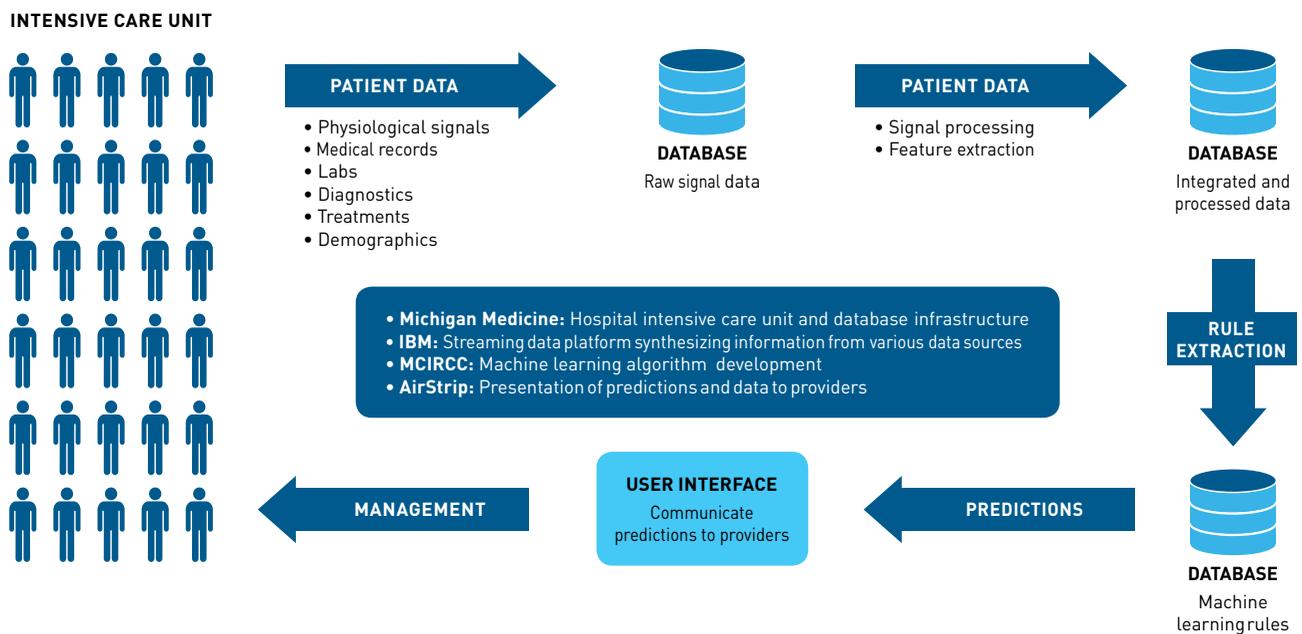
The types of data inputs are diverse, sourced from patient monitors, the EHR, nursing notes, and other health system databases. If successful, the same approach to prediction could be applied in other disease states, such as chronic obstructive pulmonary disease, diabetes, and congestive heart failure.

Each of the partners—Michigan Medicine, IBM, and AirStrip—brings uniquely valuable and synergistic elements to the collaboration. Michigan Medicine provides the care environment and IT infrastructure required to combine data from various sources within the hospitals. IBM provides streaming analytics technology capable of handling millions of events per second from thousands of real-time sources. Researchers at the Michigan Center for Integrative Research in Critical Care are mining the data streams and developing adaptive learning algorithms in an attempt to capture new vital signs capable of providing more and different information than traditional measures, such as temperature, heart rate, and blood pressure. Information is delivered to clinicians on mobile devices via the AirStrip ONE platform. The IBM technology assimilates vast amounts of data and provides real-time analytics, and AirStrip provides the mobile interoperability required to present clinical information.

The platform has the potential to improve quality, increase revenue, and reduce costs for hospitals. Anticipating adverse events, even seconds earlier in the setting of critical illness, has the potential to improve health outcomes and, thereby, quality of care. The potential for earlier discharge means less exposure to risks associated with hospitalization. In terms of revenue, hospital beds are a fixed resource and Michigan Medicine hospitals perpetually operate near capacity. Increasing turnover frees space for additional admissions and drives revenue. Finally, the majority of hospital costs are associated with buildings, equipment, and personnel. Each of these categories represents a relatively fixed cost. By increasing turnover, the platform spreads overhead across more discharges, thereby moderating fixed costs on a per-patient basis.

Michigan Medicine's experience suggests that hospitals have the opportunity to be the laboratory for development, validation, and implementation of many new approaches in healthcare. Conceptually, predictive algorithms already exist in medicine; examples include the Framingham risk score (to assess cardiovascular risk), CHADS2 score (to measure atrial fibrillation stroke risk),

**FIGURE.** Clinical Decision Support Platform



MCIRCC indicates Michigan Center for Integrative Research in Critical Care.  
Source: Michigan Medicine

and Ranson’s criteria (to determine the severity of pancreatitis). Unfortunately, the development of such tools is a lengthy and expensive process, and we can do more with the data we already collect and use on a daily basis in the hospital setting. The underlying technology required to accelerate algorithm development is commonplace in other industries and prepared for analysis. Hospitals are best positioned to deploy new technology and comprehensively monitor patients during periods of care, enabling the necessary careful calibration of predictive algorithms.

Other collaborations between industry and academic medical centers have pursued similar objectives. IBM has partnered with the Cleveland Clinic, MD Andersen Cancer Center, and Memorial Sloan Kettering Cancer Center to utilize its Watson technology for personalized cancer treatments and clinical decision-support tools. IBM also partnered with Mayo Clinic to develop programs for rapid clinical trial matching. Various organizations, including those already mentioned, have innovation arms or business engagement offices that coordinate partnerships with outside companies, or help license and spin out technologies developed in the hospital. Unique to the Michigan Medicine partnership is the strategic infrastructure investment and flexibility provided by the hospital. The process for collecting and analyzing real-time patient information is a new approach, and the objective is to develop tools with broad potential application, rather than just for specific disease states.

### New Technologies

Technologies developed in the acute care setting eventually should have the potential for outpatient expansion. Already, an explosion of wearable sensors attempts to monitor an array of health markers and vital signs—from the number of steps taken in a day, to heart rate and rhythm. Many of these home monitoring technologies, however, fall short because having more data is not always better. They flood family members and clinicians with additional information to monitor and interpret, often creating more work and questionable value. Adaptive learning algorithms have the potential to close the proverbial loop by synthesizing and interpreting vast amounts of data, yielding valuable predictions to those providing care.

### Discussion

Although the vision for the partnership is clear and the possibilities are exciting, launching the initiative was not easy. Because this project interfaces with hospital operations and the research enterprise, it was not obvious where the significant start-up capital should come from. In an increasingly intersectional healthcare environment, the source of funding and allocation of future potential revenue can become points of negotiation. Even within the same organization, incentives do not clearly align; further, in this and similar projects, clinicians may question the utility of disruptive new programs. To build consensus and succeed, the value must be specifically delineated for all potential stakeholders.

## TRENDS FROM THE FIELD

Moving forward, the pressure facing hospitals to improve value will only grow. We advocate several approaches for optimizing these efforts. First, refine and accelerate accessibility of internal information that management needs to make informed investment decisions. Processes and procedures impacted by a new technology can be evaluated in the context of an organization's payer mix and expense structure. Financial metrics, such as contribution margin (revenue minus variable costs), and quality metrics, such as readmission rate and length of stay, are both worthy of consideration. A comprehensive formula for capital allocation decisions should capture the financial reality, operational aspirations, and guiding mission of the organization. Second, with clear ethical policies and procedures in place, hospitals can form strategic collaborations with industry partners to develop the next generation of technology. The analytics platform at Michigan Medicine would not be possible without complementary industry partners. Third, hospitals that embrace disruption to a traditionally stable business model will likely be better positioned for the future. As short-term losses are almost assured, a certain amount of risk tolerance is essential in the setting of careful planning.

The hospital industry is at a tipping point, and the shift away from the emphasis on traditional diagnostic and therapeutic technologies requires a parallel shift in thinking for most organizations. These technologies flourished in a fee-for-service environment, but the emphasis on value will force organizations to adopt technology that makes better use of existing information.

### Conclusions

Technology improvement has propelled extraordinary advances in medicine, but the growth of expenditures is unsustainable. Incentives are pushing innovation in a new direction, and collaborations between healthcare and industry partners have the potential to reap significant benefits for the next generation of technology development. The transition will take time, but as healthcare costs increase, so too does the urgency for change. The most successful hospitals will likely be flexible, as the delivery

landscape evolves, and prepared to play a central role in creating an optimally effective healthcare system of the future. ■

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