The Need for Systems Integration in Health Care

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PROGRESS IN PATIENT SAFETY AND QUALITY HAS BEEN slow, despite increasing recognition of risk across the health care system. Efforts to reduce harm to patients or to improve quality of care often focus on a single, local intervention or a collection of local interventions, usually seeking to improve a single care process. Although valuable, this approach is incremental, resulting in modest, though needed, improvements. Most quality improvement efforts miss a larger opportunity to improve and redesign the fabric of health care. It appears that a systems-integration approach that incorporates the fundamental building blocks of health care, from equipment and technology to clinical insight and workflow processes, is needed to take the next major leap in improving quality and safety. More specifically, a systems integrator in health care, the equivalent of Boeing in aviation, is needed to make significant progress.

Modern-day intensive care units (ICUs) and operating rooms (ORs) each can contain easily 50 to more than 100 different pieces of electronic equipment. Yet, this equipment and these technologies do not communicate or work efficiently in an integrated fashion, posing a safety risk. These limitations also reduce the ability of new technology to improve productivity and to reduce cost in medicine.[1] Additionally, clinicians often feel burdened rather than supported by technology, as if vendors' needs are setting the agenda. As a result, workarounds are common and solutions meant to help often directly conflict with one another.

The lack of an integrated system results in diagnostic errors, failures to identify deteriorating patients, communication errors, and inefficient work, all of which contribute to worker stress and burnout. For example, despite the increasing understanding that clinicians routinely ignore alarms due to noise fatigue and their perceived nuisance,[2] most vendors of monitoring equipment have responded by making their alarms louder or more irksome, hoping to outcompete related equipment by ensuring their alarm gets attention. Yet equipment alarms are not equally important and there is currently no system that prioritizes disparate alarms. Additionally, there is no incentive for a given vendor to work with its peers on this problem. The result is an "arms race" mentality that is fundamentally detrimental to the quality of patient care.

Although there are promising efforts, such as Health Level Seven (HL7),[3] to support interoperability and standardization of equipment, true integration of disparate data streams and clinical workflows into a single smart system, although technically possible, does not exist. Accordingly, clinicians are presented with ever-increasing amounts of raw data, often in chaotic environments, with the expectation of filtering data, prioritizing risks, and making informed treatment decisions. Consequently, safety has not improved. Ironically, the overall signal-to-noise ratio in complex health care settings may be worsening despite advances in technology and computing power.

The broader fragmentation of medicine extends to hospital units and even to individual patient rooms. Industry vendors depend on and promote this fragmentation with each vendor working alone trying to maximize market share. Although single-solution equipment providers exist, they still reside within isolated domains (eg, radiology and imaging, physician-order entry, and electronic patient record) and do not integrate with other technologies. Hospitals have largely stood on the sidelines in shaping the landscape of technology, equipment, and infrastructure in health care. They are perceived as the battleground in which vendors claim victories and admit defeats, but not as a driving force behind integration to which the market responds. This needs to change.

As is frequently the case, the health care industry can learn from the experience of the aviation industry. When a major airline wants an aircraft for its fleet, it does not painstakingly assemble it by deciding which seats, control systems, engines, communications, oxygen masks, and other components to use. The airline does not try to

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determine the best way for these and hundreds of other components to fit together; rather, it relies on an industry integrator (such as Boeing) to build a low-cost, high-quality aircraft that is safe and meets the needs of its end users. The result is a lower-cost, higher-quality airplane with components that work together. Health care needs a similar systems-integration approach.

Why are clinicians, who do not necessarily have a background in technology or human factors engineering, painstakingly deciding and purchasing which pieces of equipment should be cobbled together in an emergency department, an ICU, or an OR? Why are clinicians from individual hospitals trying to negotiate the lowest prices for individual pieces of equipment? Why are clinicians also responsible for ensuring that these systems communicate and work concurrently when there was no forethought by equipment manufacturers to help meet these goals? Clinicians and administrators are trying to build hospitals piecemeal, buying technologies one by one, hoping to make equipment and technology talk to each other. Yet in so doing, they are increasing health care costs and reducing health care quality. Health care needs a systems approach to integrate the insight and workflows of clinicians with the increasing amount of health care technology and equipment.

With the US health care construction market set to increase from $45 billion in 2010 to $70 billion by 2014,[4] and the medical device market valued already at nearly $100 billion in 2010,[5] there is a huge opportunity to shape the infrastructure of health care in a way that is both quality conscious and cost-effective.

If a systems integrator in health care would be so beneficial, why has such an entity not emerged? Largely because it requires collaboration between health care professionals, administrators, researchers, human factors and systems engineers, and industry; it requires a learning laboratory. University-based academic medical centers, with schools of public health and engineering, make the ideal conveners for such an entity. For example, an approach being taken at the Johns Hopkins Medicine Learning Laboratory seeks to reduce harm to patients through innovative partnership with industry. The Learning Laboratory brings together multiple industry partners, clinicians and researchers, and human factors and systems engineers to conduct robust usability testing and to evaluate the effectiveness and efficiency of technologies. The goal is to create ORs, ICUs, or hospitals that have the best technologies at the lowest cost that are fully integrated. For efforts such as these to succeed, health care stakeholders must foster and embrace their interdependence. No one stakeholder can do it alone; industry and academic medicine must collaborate and provide a protected space for discovery.

Academic institutions are natural platforms for this type of activity and can serve as the incubators for integration projects. To be certain, both individual and organizational conflicts of interest will need to be managed. Yet these risks pale in comparison with risks to the patient and with the economic costs of health care's failure to integrate technologies and systems. Although the technology is available to create an integrated OR, ICU, or hospital, the leadership to create the needed partnerships has not emerged. It will take leadership in academic medicine and private industry to convert early successes from partnerships into mass-market solutions that meet clinicians' needs, improve safety, and reduce costs of care.

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