

Patient safety: Technology and design can help

We can prevent many errors by improving information technology infrastructure and designing equipment and systems that compensate for human limitations.

ABSTRACT: Improving patient safety involves analyzing and learning from adverse events and developing or adapting systems to reduce reliance on individual vigilance. Taking advantage of advances in computers and networking can aid clinical decision support and provide better information flow within and between systems. Strategic equipment design can prevent or mitigate harm to patients. Technology in health care, along with organizational culture change, promises to be an extremely effective safeguard against human fallibility.

Improving the performance of skilled medical professionals is unlikely to be achieved by exhorting them to work better, faster, or more cheaply. They are already making decisions, planning their time, remembering key information, and preventing adverse events as well as the limits of human ability will allow. Further advances will require some form of assistance. Investing in technology to improve safety, as the automotive, aviation, and nuclear industries have done, is the next logical step. It will be critical to have information technology infrastructure in health care that not only supports the standardized identification, reporting, and tracking of patient data, but that also reduces and, where plausible, prevents errors.¹ In addition, strategic design of the equipment and systems that govern our work will be needed to minimize the risk of harm to patients.

To improve safety, we must begin by measuring and evaluating risk to patients. As we do not routinely identify and collect information on errors, this is currently not possible. A Canadian study shows that in one hospital, half of 10 life-threatening complications and half of all fatal ones were not reported.² To learn from our errors, we need to develop national standards for defining and classifying events. Often

health care workers are uncertain whether and how to identify and report errors. They fear revealing “incriminating” information. A change in emphasis from “assigning blame” to “improving quality,” and iterations of reporting, educating, and measuring must take place to ameliorate the situation.

Information technology infrastructure

Emerging technology will play a vital role in improving active reporting of errors and in routine collecting of accurate outcomes data against which the quality of the health care we deliver can be judged. In British Columbia, a provincial incident management and reporting information system project is in the process of selecting an electronic incident reporting system. This pioneering initiative will be rolled out across the province to promote a common language for reports, investigations, follow-up, and trend analysis of all incidents, as well as for near misses and patient feedback.

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Electronic systems for reporting and analyzing events are just one small part of improving patient safety—errors must be prevented in the first place.³ To aid with decision mak-

functions, improving communication, and decreasing reliance on human vigilance, information technology offers opportunities to reduce error that are not provided by a paper-based sys-

tem. technology will be in engineering patient safety. Systems need to be designed and built that not only report about harm to patients and provide decision support for the clinician, but that also compensate for the human limitations of the clinician and others.

Organizations around the world are now using design to great effect to develop solutions that meet the needs and desires of people in all walks of life. These organizations have achieved what seemed impossible by making the complex systems people need in order to get on with their lives into something simple and intuitive that is a delight to use. The same design thinking can also be used to improve safety. For instance, cars are complex machines driven by error-prone, risk-taking humans, and used within a complex environment—the road network. Within the automotive industry, designing for safety has become a key way to differentiate products and to add value. Car designers have built a reputation for safety by considering the latent needs of road users and delivering pioneering innovations such as the safety cage, air bags, and ABS brakes.

Well-designed packaging, clear communications, and safe environments can reduce the incidence of errors within health care. But design responses need not be limited to these more obvious areas. We may be able to prevent some of the most common medical errors and make it far more difficult for mistakes to trigger specific types of preventable harm to patients. Without a doubt, the best solution to any safety hazard is to engineer a solution to prevent the hazard or mitigate the injury. For example, between April 2000 and March 2003, nearly 2000 individuals aged 65 and older suffered an in-hospital hip fracture in Canada, making hip fractures much more common than having a foreign object, such as a sponge or instrument, left in a

The ultimate challenge for technology will be in engineering patient safety.

ing, information systems must provide immediate access to a patient's history, reports, and test results. Information systems must also be used to implement current research using clinical guidelines or timely information, and to assist in further clinical research. Practical examples of combining information to prevent errors might include combining electronic patient records with clinical prescribing information to prevent the prescription of a drug with a known contraindication; combining prescribing information with patient laboratory results to prevent inappropriate drug prescription; or ensuring that abnormal pathology results are followed up or tests are repeated.

Technology facilitates the building of a stronger information infrastructure.⁴ Without it, our health care system will deteriorate in terms of safety and quality.⁵ By simplifying work processes, reducing reliance on memory, improving access to information, using constraints and forcing

tem.⁶

Medical error reduction is fundamentally an information problem.⁷ Failure to convey information about patients can compromise quality of care and lead to patient injuries caused by failure to follow up on positive diagnostic results or to transfer health-related information to other care providers. Information about patients, their clinical condition, and prescribed therapies needs to be transmitted quickly, completely, and clearly between clinicians. Electronic patient records, better communication among clinicians, and better communication technologies are needed to reduce the incidence of incomplete or inaccurate information transfer, which can result in poor coordination of care and adverse events.

Safety by design

Poor design of equipment and the systems, structures, and processes that govern our work in health care invite mistakes.⁸ The ultimate challenge for

body cavity after a procedure.⁹ This number of fractures could be reduced by attaching cot sides to hospital beds and educating staff on ways to identify high-risk patients, and injuries could be mitigated by lowering the height of hospital beds and providing high-risk patients with hip pads.

Improving safety by design will extend from building ergonomic working environments to automating drug prescription and delivery, providing clinical decision support, and improving the design of medical devices.

Conclusion

Technology is critical to patient safety management, but for optimal results it should also be part of an organization-wide strategy that includes infrastructure redesign. Reducing errors requires organizational culture change along with changes to clinical process and selective implementation of technology. Systems can be integrated and processes automated without solving the problem. Traditional systems must be re-evaluated to harness technology and assist in information capture, flow, analysis, transmission, and tracking of trends.

It is vitally important to realize that technology cannot act independently of people to improve patient safety. There is little doubt that technology may itself result in patient harm,¹⁰ especially if it is outdated, inappropriately used, or inadequately maintained.

Appropriate increases in the use of technology in health care, especially the introduction of design safety, clinical decision support, and better information flow within and between systems, can result in substantial improvement in patient safety. The success of such a strategy will depend on a thorough understanding of the health care system and how patients and professionals behave within it, which can

be very different from how they are expected to behave. It will also involve knowing how patients and professionals can benefit from, and interact with, the equipment, medications, environments, and information that they come across in the health service.

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5. Morgan MW. In pursuit of a safe Canadian health care system. *Healthc Pap* 2004; 5:10-26.
6. Spath PL (ed). *Error Reduction in Health Care: A Systems Approach to Improving Patient Safety*. San Francisco, CA.

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Competing interests

None declared.

References

1. National Steering Committee on Patient Safety. Building a safer system: A national integrated strategy for improving patient safety in Canadian health care. http://rcpsc.medical.org/publications/building_a_safer_system_e.pdf (accessed 13 June 2005).
2. Wanzel KR, Jamieson CG, Bohnen JM. Complications on a general surgery service: Incidence and reporting [comment]. *Can J Surg* 2000;43:113-117.
3. Aspden P, Corrigan JM, Wolcott J, et al. (eds). *Patient safety: Achieving a new standard for care*. Washington, DC: National Academies Press; 2004.
4. Ball MJ, Garets DE, Handler TJ, et al. Leveraging IT to improve patient safety. In: *Quality of Healthcare: Improving Informatics*. Edmonton, AB. International Medical Informatics Association; 2003:

Jossey-Bass; 2000:199-234.

7. O'Leary D. Focus on reducing medical errors. Statement of the Joint Commission on Accreditation of Health Care Organizations. www.jointcommission.org/ (accessed 5 June 2006).
8. Leape LL, Bates DW, Cullen DJ, et al. Systems analysis of adverse drug events. ADE Prevention Study Group. *JAMA* 1995;274:35-43.
9. Pulcins I, Wan E. In-hospital hip fractures in Canada: Using information to improve patient safety. *Healthc Q* 2004;7:25-27.
10. Ammenwerth T, Shaw NT. Bad health informatics can kill—is evaluation the answer? *Methods Inf Med* 2005;44:1-3.

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