

PATIENT SAFETY: STATE-OF-THE-ART IN HEALTH CARE MANAGEMENT AND FUTURE DIRECTIONS

By: [Eric W. Ford](#) and Grant T. Savage

Ford, E. W. and Savage, G. T (2008). Patient Safety: State-of-the-Art in Healthcare Management and Future Directions. *Advances in Healthcare Management*. Volume 7, pp. 1-14.

Made available courtesy of Emerald Publishing Group: <http://www.emeraldinsight.com/>

***** Note: Figures may be missing from this format of the document**

Abstract:

The needs for health system change and improved patient safety have been pointed out by policymakers, researchers, and managers for several decades. Patient safety is now widely accepted as being fundamental to all aspects of health care. The question motivating this special volume on patient safety is: How can the increased emphasis on patient safety among health care managers be more effectively translated into better policy and reduced clinical risk? The 12 contributions in this volume are divided into four sections: (1) theoretical perspectives on managing patient safety; (2) top management perspectives on patient safety; (3) health information technology (HIT) perspectives on patient safety; and (4) organizational behavior and change perspectives on patient safety. Patient safety is a topic that provides a fertile niche for management researchers to test existing theories and develop new ones. For example, the patient safety goals of reducing medical errors while maximizing health outcomes draws upon the tenets of evidence-based medicine (EBM), as well as the managerial theories of human relations, organizational culture, organizational development, organizational learning, organizational structure, quality improvement, and systems thinking. Indeed, these and other managerial theories are drawn upon and applied in different ways by the various contributors. Overall, the authors of this volume demonstrate that the future of patient safety for health care management requires health care professionals and managers who can successfully engage in multi-faceted projects that are socially and technically complex.

Article:

Patient safety is now widely accepted as being fundamental to all aspects of health care. Therefore, professionals in the policy and administration fields need to be even more vigilant to the potential risks in delivering clinical care. It is important for policymakers, administrators, and clinicians to understand a wide variety of system features that must be correctly aligned to ensure successful patient management. Further, developing common mental models among these key stakeholders will facilitate both the sharing of information and the aligning of incentives with desired outcomes.

The overarching question motivating this special volume on patient safety is: How can the increased emphasis on patient safety among health care managers be more effectively translated into better policy and reduced clinical risk? Health care managers are at the fulcrum of balancing policy imperatives and practice practicalities. Therefore, conducting research from the managerial perspective that looks in both directions is necessary. Further, research teams drawn from a wide variety of disciplines should ensure frequent assessment and analysis of their ongoing theoretical and empirical work in relationship to system features that harm patients or create the potential for patient harm. Health management theories and methods will vary depending upon the researchers' areas of expertise and the clinical practice or policy issues being studied.

This special volume presents a collection of health care management articles that look at patient safety change efforts ranging from board room strategies (e.g., Rubino & Chan and Culbertson & Hughes) to discreet patient exchanges on the floor (e.g., Deutsch et al.). In addition, we assess the state-of-the-art and future directions for health care management theory and research on patient safety. We believe the primary benefit to a special

volume is that it goes beyond the sum of its parts. Further, synergistic benefits arise from the questions that are created from papers presented in juxtaposition to one another. Therefore, we frame and pose an initial set of questions for health care management practitioners and researchers to consider as they move forward in making health systems both safer and more effective.

ASSESSING THE STATE-OF-THE-ART IN PATIENT SAFETY RESEARCH

The needs for health system change and improved patient safety have been highlighted by policymakers, researchers, and managers. As early as 1991, the Institute of Medicine (IOM) was calling for the universal adoption of electronic medical records (EMRs) to control cost and provide actionable data for quality improvement (Institute of Medicine, 1991). However, these alarms went largely unnoticed by policymakers and the public until the publication of *To err is human: Building a safer health system* (Kohn, Corrigan, & Donaldson, 1999) and its widespread dissemination of research estimating that 44,000–98,000 avoidable fatalities occurred annually in U.S. hospitals. Since this seminal report, researchers from numerous disciplines have brought their theories, methods, and experiences to bear on the causes of poor quality in health care.

Theories, Models, and Methods for Managing Patient Safety

As an emerging field of research, the relatively recent recognition and interest in patient safety provides a fertile niche for management researchers to test existing theories and develop new ones. An indication of the emerging nature of patient safety is the makeup of the organizations that have formed to address the topic. While the Institute for Health Improvement (www.ihl.org) began relatively early, other organizations such as those at Johns Hopkins, the Center for Innovation and Quality in Patient Care (www.hopkinsquality.com) and Vanderbilt's Center for Better Health (www.mc.vanderbilt.edu/vcbh/) did not begin until 2002 and 2001, respectively. Each of these organizations has a clear agenda related to policy and clinical practice, but it is difficult to discern any discreet programs targeting the improvement of management practices. Taken together, the papers in this volume of *Advances in Health Care Management* are intended to aid management researchers in formulating both individual and collaborative agendas to address the issue of patient safety.

The first chapter in this volume discusses evidence-based medicine (EBM), its application to patient safety, and its limits for improving safety in health service delivery (Savage and Williams). Many initiatives to improve patient safety are based on EBM, without recognition of either its key assumptions, or its inherent limits for improving patient safety. Savage and Williams address three research questions: (1) How does EBM contribute to patient safety? (2) How and why is EBM limited in improving patient safety? and (3) How can patient safety be maximized, given the limitations of EBM? Currently, EBM contributes to patient safety both by educating clinicians on the value and use of empirical evidence for medical practice and via large-scale initiatives to improve care processes. Attempts to apply EBM to individual patient care are limited, in part, because EBM relies on biostatistical and epidemiological reasoning to assess whether a screening, diagnostic, or treatment process produces desired health outcomes for a population – not for an individual. Health care processes that are most amenable to EBM are those that can be standardized or routinized; non-routine processes, such as diagnosing and treating a person with both acute and chronic co-morbidities are cases where EBM has limited applicability. A first step in bridging the gap between EBM and management research is the development of models that help to identify how to fit such work into larger organizational frameworks. For example, to improve patient safety, health care organizations should not rely solely on EBM, but also recognize the need to foster mindfulness within the medical professions and develop patient centric organizational systems and cultures.

The second manuscript presents a model designed to help managers think about the nature of errors (Palmieri et al.). The 'Swiss Cheese' model promotes a systems thinking approach to identifying the multiple causes that underlie the worst errors in health care. In particular, the role of organizational-level policies in retarding and promoting medical errors is critical. In many health care settings the role of policies in outcomes are often ignored because the organizational levels between the top managers and patients is populated with professionals that assume full responsibility for the patient's care. Therefore, when a failure or error occurs, the individuals charged with executing untenable or impracticable policies are blamed. The greatest promise of the 'Swiss

Cheese' model is that it will diminish these types of attribution errors – blaming an individual for a systemic failure – that is the current mode of operation in many health care organizations.

Nurses in particular bear the brunt of fundamental attribution error because they work at the end point of the patient care system. To the extent that it is possible to mitigate ineffective or poor policies, front-line nurse managers take on this task. The separation of policy input, operating authority, and outcome responsibility places these professionals in untenable situations on a daily basis. The third article by Tamuz, Russell, and Thomas describes this phenomenon using a series of case studies. Drawing on interviews with 20 nurse managers from three tertiary care hospitals, their study identifies key exemplars that illustrate how managers monitor nursing errors. The exemplars examine how nurse managers: (1) sent mixed messages to staff nurses about incident reporting, (2) kept two sets of books for recording errors, and (3) developed routines for classifying potentially harmful errors into non-reportable categories. These exemplars highlight two tensions: first, applying bureaucratic rule-based standards to professional tasks; and, second, maintaining accountability for errors while also learning from them. These fundamental tensions influence organizational learning and suggest theoretical and practical research questions. While nurse managers are engaged in important forms of organizational learning to improve patient safety, they cannot address the core issue that many problems have their roots at the other end of the organizational chart – the boardroom.

Top Management Perspectives on Patient Safety

The commitments necessary to build high reliability health organizations that are safe take many forms. For example, the requisite financial investment to bring the latest information technology into the system is typically a significant percentage of an organization's budget. Another common problem is that facilities are often designed in ways that make workflows inefficient and ineffective and they need to be remodeled or replaced. Because the costs of changes to an organization's physical plant are so high, such decisions invariably require the approval of the board of directors. However, simply committing money is not enough. The biggest challenge that health care organization boards face is changing their own cultures and those of their organizations to put safety at the forefront of the care agenda.

The case study by Rubino and Chan details how the Board of Directors at St. Francis Medical Center took on the task of improving patient safety. They provide a set of tools that other boards can adapt to their institutions in order to pursue similar goals. For example, they use a 'Balanced Scorecard' approach that is familiar to many hospital administrators and board members. The use of scorecards reduces an important barrier to adoption by allowing board members to fold their patient safety efforts into existing quality assurance and improvement activities in the hospital. While such incremental steps are valuable, they do not provide a holistic theoretical framework to work from in instituting change or address the role of medical professionals in changing the delivery of care.

The involvement of hospital boards in change processes is critical and there is growing pressure to hold board members accountable for organizational outcomes – including those of a clinical nature. Herein lays a dilemma, as physicians are the profession with the authority and responsibility for directing patient care. To that end, most hospitals rely on physicians to ensure the quality of care delivered. The article by Culbertson and Hughes considers this problem using the organizational structure theory first put forth by Mintzberg (1979), which views the hospital as a case of a professional bureaucracy. Physicians, as professional staff, are thus responsible for standard setting and regulation. However, trustees are now asked to examine reports identifying physician compliance in attaining safety standards without education in the practice supporting those standards. Physician board members, whose numbers have increased in the past decade, are often sought to take the lead on interpretation of patient safety standards and results. The very public nature of patient safety reporting and its reflection on the reputation of the organization for which the trustee is ultimately accountable create a new level of tension and workload that challenges the dominant voluntary model of trusteeship in the U.S. health system. Culbertson and Hughes offer some advice about how board composition and duties might be configured to include physicians, but not exclude them from other policymaking activities.

The roles of nurses, physicians, and boards are undoubtedly critical foci in any fully formed theory related to patient safety; however, they do not, as individual areas of research or even in combination, address the systemic nature of the problem. Health care delivery takes place in a community context. Norms and standards of care have significant regional components that go beyond individual institutions. Many health services purchasers hope to activate these local market forces using tools such as pay-for-performance (P4P) to help improve care and control costs. The nursing shortage has already empowered that professional to activate market forces and negotiate better wage packages. Further nurses are asserting their own professional autonomy to redefine inter-professional relationships with physicians and managers. The power of community action can yield remarkable changes in the way people within organizations behave.

The last article in the Top Management Team section provides an example of a regional effort to change the way care is delivered. The Houston–Galveston region created an aggressive approach to this issue by forming an unusual coalition of business, university, and hospital leaders and using a quality-improvement approach. Batten, Goodman, and Distefano’s findings indicate that shifting the focus away from individual employee behaviors to meaningful management change had a far more profound effect that stretched across an entire community. The project has achieved over 40% participation among hospitals in the 13-county region, and it includes 50 hospitals employing approximately 15,000 registered nurses. The data that have been collected by this collaborative to date suggest that hospitals are taking action to improve outcomes by modifying their key initiatives to address the attributed causes of poor work environments. From 2004 to 2005, executives of top performing hospitals increasingly attributed successful work environment outcomes to an emphasis on management development and executive-driven initiatives, de-emphasizing specific employee behavior, process, and outcome-based initiatives.

The admonition to physicians to ‘heal themselves’ may be one that health care administrators ought to take to heart when launching efforts to improve patient safety. Administrators need develop management systems that do more than create policies and track claims data. Managers need to synthesize information into actionable forms that can be used to redesign work processes at levels that cannot be readily changed through written policies.

Health Information Technology Perspectives on Patient Safety

Health Information Technology (HIT) has been held out as a ‘silver bullet’ solution to all of the problems that make the U.S. system suffer from lapses in patient safety and cause medical errors to occur. In particular, mandatory universal adoption of EMRs has been suggested as a means to document encounters, coordinate care among providers, monitor compliance with clinical guidelines, and provide decision support to physicians. These are ambitious goals and the EMR products currently available in the market-place are a quantum leap away from achieving the level of functionality necessary to realize those goals. Further, even if a particular system possesses such features, it is unclear whether it would be capable of effectively interfacing with another manufacturer’s system.

In recent years there have been significant efforts to make systems interoperable and the U.S. Government formed the Certification Commission for Healthcare Information Technology (CCHIT) to promote and coordinate this goal (Classen, Avery, & Bates, 2007). Beginning in 2006, several products were certified as being interoperable to the HL7 standard. However, even among those products, it is unclear that it is possible to effectively match patients and share medical information from one to the next. Patient identification is particularly important for two reasons. First, it is the clinical imperative to correctly identify the person being treated. In emergency situations, having incorrect medical information such as blood type, allergies, immunizations, and pre-existing conditions can be far worse than having no information at all. The second issue is the consumer’s right to privacy. Fundamental questions around who owns and controls medical information are potentially more problematic than the technological challenges of interoperability and accurate individual identification. Coordinating the safeguarding and sharing of health information is a governance issue. Frequently, a local market’s competitive dynamics make it nearly impossible for organizations to harmonize their policies and procedures in a way that allows for meaningful interchange.

A nationwide effort to assess state and regional stakeholders' views on the issues surrounding health information and privacy was begun in 2005 under the auspices of the Department of Health and Human Services. One goal of the program was to identify current legal and regulatory standards that needed to be harmonized so that patient information sharing within and across communities could occur without the fear of violating laws. Galt and her colleagues examine how the process played out in the state of Nebraska. They conducted an in-depth case study to explore the knowledge, understanding, and awareness of 25 health board/facility oversight managers and 20 health professional association directors about privacy and security issues important to achieving Health Information Exchange (HIE). The case analysis revealed that health board/facility oversight managers were unaware of key elements of the federal agenda; their concerns about privacy encompassed broad definitions both of what constituted a 'health record' and 'regulations centeredness.' Alternatively, health professional association leaders were keenly aware of national initiatives. Despite concerns about HIE, they supported information exchange believing that patient care quality and safety would improve. The analysis also revealed a perceptual disconnect between board/facility oversight managers and professional association leaders; however, both favored HIE.

Licensure and facility boards at the state level are likely to have a major role in the assurance of patient protections through facility oversight and provider behavior. Similarly, professional associations are the major vehicles for post-graduate education of practicing health professionals. Their engagement is essential to maintaining health professions knowledge. States will need to understand and engage both of these key stakeholders to make substantial progress in moving the HIE agenda forward. In addition to the challenges in these efforts, one theme that emerges is the large number and transient nature of the umbrella organizations that are charged with conducting these projects.

The list of acronyms labeling the organizations charged with solving the Gordian Knot-like dilemma of HIT interoperability and exchange is now legion. The American Health Information Community (AHIC) has already come and gone. Its successor, AHIC.2 – a private–public partnership – is still in the formative stages. The contract with the Research Triangle Institute (RTI) to manage the Health Information Security and Privacy Collaboration (HISPC) is near its end – but what has come of it? Will it merely be another set of recommendations that no one has the authority or wherewithal to implement?

Perhaps, the most telling story is that of the Santa Barbara County Data Exchange (Brailer, 2007; Frohlich, Karp, Smith, & Sujansky, 2007; Holmquest, 2007; Miller & Miller, 2007). Although it is not chronicled in this volume, its legacy is inescapable for those hoping to build a national system for sharing patient information. As one of the first and highest profile Regional Health Information Exchanges (RHIOs), the Santa Barbara organization was held out as a model for other communities. Its leader, Dr. David Brailer, became the first National Coordinator for Health Information Technology (ONCHIT). In the end, its peer-to-peer model collapsed because organizations could not interface their data systems and there was no sustainable business plan in place.

One common element to all of the large-scale efforts has been the underlying philosophy that 'if you build it, organizations will come.' The separation of costs and benefits can be profound in information exchanges with the providers and their parent organizations bearing the cost, while the benefits accrue to others (Menachemi & Brooks, 2006). The impact of this misalignment is most keenly felt in smaller organizations that face all the fixed costs of adoption, but lack the economies of scale to make the financing work in their favor.

Physicians in small practices are at the pointy-end of the HIT adoption stick (Ford, Menachemi, & Phillips, 2006). As much as any other group of professionals, it is physicians' workflows and pocketbooks that are likely to feel the major impact of moving to EMR systems. The paper by Bramble and his colleagues describe how physicians characterize these barriers to HIT implementation. Content analysis of qualitative interviews revealed three barrier themes: time, technology, and environment. Interviews also revealed two other major concerns; specifically, the compatibility of the HIT with the physician's patient mix and the physician's own attitude toward the use of HIT. The axiom that 'time is money' and that reduced productivity is a major concern

among physicians when they consider adopting HIT are well illustrated. When the reward systems are not aligned with the policy goals of HIT advocates, the reward system will dominate decision making and the status quo will prevail. Changing individuals and organizations' behaviors is one of the most difficult tasks that managers face and lies at the heart of many patient safety programs.

Organizational Behavior and Change Perspectives on Patient Safety

Efforts to change the organizations' structures, process, and cultures to improve patient safety related outcomes are proliferating rapidly. Health organizations are drawing on LEAN (Manos, Sattler, & Alukal, 2006) and Six Sigma (Lazarus & Novicoff, 2004; Revere & Black, 2003) manufacturing principles to redesign care delivery processes. New facilities are being built to create healing and family-centered environments (Fottler, Ford, Roberts, Ford, & Spears, 2000; Towill & Christopher, 2005). While some companies are achieving amazing results, three out of four reengineering programs fail (Manganelli & Klein, 1994).

Those leading reengineer efforts often make bold promises to transform organizations, but the hard part is taking the theory and putting it into practice. To change conventional thinking and traditional practices pits managers against the status quo. To overcome these barriers, not only is senior management sponsorship essential, the leadership itself needs to be exposed to external change agents and ideas to reshape their views. The article by McAlearney describes a new mechanism to allow organization leaders to gather new ideas and skills – the corporate university.

As McAlearney points out, in other industries, the rise of corporate universities has been steady over the past 20 years (Anonymous, 2005). The corporate university is organized to allow health leaders to stay at their current job while gathering the skills and knowledge to implement innovations. Aside from the human resources motivation for wanting to develop and retain talent, corporate universities allow innovation and change to originate from within the organization. The hope is that the corporate university will foster a culture of change as a shared value among leaders. In health care organizations, OD programs can serve an important institutional function by providing a framework through which patient safety can be emphasized as an organizational priority, and patient safety training can be delivered as part of OD efforts. In addition, organizations committed to creating a patient-focused safety culture can use OD initiatives strategically to support organizational culture change efforts. McAlearney's paper describes different approaches to including patient safety in an OD framework, drawing from both management theory and practice. Findings from three extensive qualitative studies of leadership development and corporate universities in health care provide specific examples of how health care organizations discuss patient safety improvement using this alternative approach.

The article by Deutsch and her colleagues discusses a common operating procedure that is anything but standardized in most health care organizations – the patient handoff. A 'handoff' occurs so that patient-specific medical information can be provided to the medical professional(s) assuming responsibility for that patient. Providing an appropriate summary supports safe, high quality, effective medical care; inadequate or incorrect information may create risk for the patient. A handoff approach was developed to facilitate this process, using the mnemonic S*T*A*R*T (S: situation; T: therapies; A: anticipated course; R: reconciliation; T: transfer). Surveys of handoffs occurring before and after introduction of the S*T*A*R*T system demonstrate that there are several areas with potential for process improvement. Contrasted with the McAlearney paper, which deals with the macro-level of organizational change, Deutsch et al.'s paper takes us to the most finite of organizational activities. Nevertheless, the lack of common techniques for ensuring that vital patient information is effectively communicated from one caregiver to the next is a weak link in the system that often breaks. Indeed, the results of such breaks create the 'holes' in the continuity of care processes described by Palmieri and his colleagues in the first section of this volume.

Nonetheless, there may not be one best way to conduct every handoff, since the intensive care unit (ICU) has different needs than subacute care facilities (SCFs). As van Stralen and his colleagues note, there often are not common standards within the same unit at many such facilities. Specifically, this last chapter in this compendium describes how a nursing home was transformed to a pediatric SCF. The transformation entailed

not only making information flows more effective, but also empowering the personnel to make the SCF a high reliability organization (HRO). To obtain these goals, the health care team implemented change in four behavioral areas: (1) risk awareness and acknowledgement; (2) defining care; (3) thinking and making decisions; and (4) information flow. The team focused on five reliability enhancement issues that emerged from previous research on banking institutions: (1) process auditing; (2) the reward system; (3) quality degradation; (4) risk awareness and acknowledgement; and (5) command and control. Three additional HRO processes also emerged: high trust and building a high reliability culture based on values and on beliefs. The case demonstrates that HRO processes can reduce costs, improve safety, and aid in developing new markets. Key to van Stralen et al.'s findings was that every organization must tailor its processes to fit its own situation. Further, organizations need managers with the skills and training to be flexible and adapt to in applying HRO principles.

CONCLUDING COMMENTS: THE FUTURE OF PATIENT SAFETY

Much of the rhetoric promoting patient safety in the U.S. has focused on technical solutions – such as computer-assisted physician order entry (CPOE) for prescriptions – and over-simplifies the challenges facing health care managers and professionals. The authors of this volume – all of who are from the U.S. – demonstrate that the future of patient safety for health care management requires health care professionals and managers who can successfully engage in multi-faceted projects that are socially and technically complex. These challenges, more often than not, involve changing the social structures and cultures of health care organizations. Improvements in patient safety, thus, require long-term commitments from health care managers and professionals, as well as competencies in managing complexity.

What should health care management researchers do to improve patient safety? Two paths are suggested based on the work published in this volume. First, we believe that health care management researchers can help clinical and managerial practitioners to improve patient safety by engaging in (a) multi-level of analysis research that evaluates organizational change efforts; (b) institutional-level research on inter-organizational and public-private collaborations; and (c) social-technical system evaluations of HIT and other technical implementations. These three general areas of research explore the complex and multi-faceted nature of health care organizations, and will better ensure that research findings inform both policymakers and health care managers and professionals.

Second, and lastly, health care management researchers should look beyond the U.S. and its organizational and institutional landscape to investigate ways to improve patient safety. Efforts underway in Europe, Asia, and other countries represent naturally occurring experiments in patient safety. International comparative research holds the promise of illuminating new facets on the complex challenges of improving patient safety, while hastening the dissemination of best practices throughout the world.

REFERENCES

- Anonymous. (2005). The corporate university: Riding the third wave. *Development and Learning in Organizations*, 19(6), 16.
- Brailer, D. J. (2007). From Santa Barbara to Washington: A person's and a nation's journey toward portable health information. *Health Affairs*, 26(5), w581w588.
- Classen, D. C., Avery, A. J., & Bates, D. W. (2007). Evaluation and certification of computerized provider order entry systems. *Journal of the American Medical Informatics Association*, 14(1), 48–55.
- Ford, E. W., Menachemi, N., & Phillips, M. T. (2006). Predicting the adoption of electronic health records by physicians: When will healthcare be paperless? *Journal of the American Medical Informatics Association*, 13(1), 106112.
- Fottler, M. D., Ford, R. C., Roberts, V., Ford, E. W., & Spears, J. D. (2000). Creating a healing environment: The importance of the service setting in the new consumer-oriented healthcare system/practitioner application. *Journal of Healthcare Management*, 45(2), 91.
- Frohlich, J., Karp, S., Smith, M. D., & Sujansky, W. (2007). Retrospective: Lessons learned from the Santa Barbara project and their implications for health information exchange. *Health Affairs*, 26(5), w589w591.

- Holmquest, D. L. (2007). Another lesson from Santa Barbara. *Health Affairs*, 26(5), w592w594. Institute of Medicine. (1991). *The computer-based patient record: An essential technology for healthcare*. Washington, DC: National Academy Press.
- Kohn, L. T., Corrigan, J. M., & Donaldson, M. S. (Eds). (1999). *To err is human: Building a safer health system*. Washington, DC: National Academy Press.
- Lazarus, I. R., & Novicoff, W. M. (2004). Six Sigma enters the healthcare mainstream. *Managed Healthcare Executive*, 14(1), 26.
- Manganelli, R. L., & Klein, M. M. (1994). A framework for reengineering (Part I). *Management Review*, 83(6), 10.
- Manos, A., Sattler, M., & Alukal, G. (2006). Make healthcare lean. *Quality Progress*, 39(7), 24.
- Menachemi, N., & Brooks, R. G. (2006). Reviewing the benefits and costs of electronic health records and associated patient safety technologies. *Journal of Medical Systems*, 30(3), 159168.
- Miller, R. H., & Miller, B. S. (2007). The Santa Barbara County Care Data Exchange: What happened? *Health Affairs*, 26(5), w568–w580.
- Mintzberg, H. (1979). *The structuring of organizations*. Englewood Cliffs: Prentice-Hall.
- Revere, L., & Black, K. (2003). Integrating six sigma with total quality management: A case example for measuring medication errors. *Journal of Healthcare Management*, 48(6), 377.
- Towill, D. R., & Christopher, M. (2005). An evolutionary approach to the architecture of effective healthcare delivery systems. *Journal of Health Organization and Management*, 19(2), 130.