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CHAPTER 8

Improvement Healthcare Projects: Meeting Healthcare and Technology Challenges

Shaping approaches to improve the Quality of healthcare solutions

8.1 HEALTHCARE CHALLENGES

Safety, affordability, access, new infectious diseases and prevalent chronic conditions, the complexity of the healthcare environment, the complexity related to the healthcare organization itself, are some challenges of today’s healthcare.

Over time public health’s challenges have changed: rapid identification, triage, and treatment of acutely sick and injured patients in cases like influenza (Influenza pandemic plan. The role of WHO and Guidelines for National and Regional Planning, World Health Organization, Communicable Disease Surveillance and Response, Geneva, 1999.) and severe acute respiratory syndrome—SARS (Severe acute respiratory syndrome (SARS): Status of the outbreak & lessons for the immediate future, World Health Organization (WHO), Communicable Disease Surveillance and Response, Geneva, 2003.); viral diseases like chikungunya (World Health Organization, 2016. http://www.who.int/mediacentre/factsheets/fs327/en/); the assessment, communication, and mitigation of public health risk; and the provision of assistance to state and local health officials to quickly reestablish healthcare delivery systems and public health infrastructures (The White House, 2006); the management of health effects of “El Niño” climate conditions (El Niño and Health, Global Overview, World Health Organization, Geneva, 2016.), urgent and effective public health services for injured people due to terrorist attacks (Vandentorren S, et al. Syndromic surveillance during the Paris terrorist attacks. The Lancet 387(10021);846–7.) are some of the evidences; the increasing impact on medicine due to the utilization of health technology: artificial organs, robotic prosthetic limbs, etc., which define a complex context for healthcare.
These challenges determine a relevant change in the way we understand health systems, Fig. 8.1 illustrates some obstacles in the case of the biodefense role of public health for example; in this regard Salinsky [1] states, “A transformed public health system is needed to address the demands of emergency preparedness and health protection. . . . The future public health system cannot afford to be dictated by outmoded tools, unworkable structures, and outdated staffing models.”

8.2 TRENDS AND EMERGING TECHNOLOGY

*Mega Trends* are global, sustained, and macro-economic forces of development that impact business, economy, society, cultures, and personal lives thereby defining our future world and its increasing pace of change.

On the top of the “Top 10 Mega Trends to 2020,” eight have significant emerging technology components. Emerging technologies will be the dominant driver of disruptive change for the future [2]. Healthcare systems despite the level of their economic sector should be aligned to the change. See Fig. 8.2A, B:

The Mega Trend number 8: “Health, Wellness & Wellbeing” facilitates the understanding about (1) the increasing level of complexity of the health organization; and (2) the value of the multidisciplinary workforce (physicians, nurses, engineers, managers, biologists, chemists, etc.) capacity to work as a team to be aligned to the current and expected challenges. See Fig. 8.3.

8.3 FACING THE CHANGE IN HEALTH SYSTEMS

The Healthcare trends experimented by developed and developing countries define a relevant change for health systems. An interesting contribution from
Hayes (Emerging business & technology trends, ISACA, 2014.) states that the management of emerging technologies will require transformational changes in some or all of the seven enablers in the healthcare organizations see Fig. 8.4.
The consideration of the enablers contributes to the understanding that the management of technology from an effective and consistent perspective dismisses the link of health technology exclusively with operational and/or technician areas.

**FIGURE 8.3**
Mega Trend 8: “Health, Wellness & Wellbeing.” Frost & Sullivan Manufacturing Leadership Council. Top 10 Mega Trends, New York, 2012.

**FIGURE 8.4**
Managing the change: seven enablers to identify organizational capability areas. Hayes T. ISACA, 2014.
8.3.1 Systems Engineering and Healthcare

Systems Engineering (SE) is a systems approach which focuses on developing solutions aligned to (1) economics; (2) technology; (3) social dynamics; and (4) healthcare policy. This perspective is consistent to high, medium, or small levels of economy. A systems approach involves thinking holistically and work with transdisciplinary teams to develop solutions [3].

The Institute of Medicine—IOM [4] and the National Academy of Engineering—NAE [5] recommended and advocated the widespread application of SE tools to improve healthcare delivery [6]. Despite the differences between the levels of the economic sector, healthcare environments have in common: management, project planning, inventory, logistics, facilities design, process flow analysis, resource synchronization, etc. This framework aims on improving the analysis and results expected.

Kopach-Konrad [7] emphasizes that the application of SE requires medical professionals and managers understand and appreciate the power that SE concepts and tools can bring to (1) redesigning, and (2) improving healthcare environments and practices.

8.3.1.1 Definitions

SE focuses on the design, control, and orchestration of system activities to meet performance objectives. A System is a set of possibly diverse entities (patients, nurses, physicians, etc.), each performing some set of functions. The interaction of these entities as they perform their various functions gives rise to a global System Behavior.

8.3.1.2 Healthcare Improvement Project Management: SE Model

Fig. 8.5 illustrates the steps oriented to manage a healthcare improvement project according to SE model [7].

SE approach is pertinent to the growth, operation, and synchronization of many information-rich and technologically complex economic sectors, as described above health related to developed and developing countries is certainly an interesting sector to SE’s application. The following is one of the examples:

8.3.1.3 Improving the Effectiveness and Efficiency of an Intensive Care Unit

Applied Physics Laboratory—APL and Johns Hopkins Medicine—JHM [8] applied successfully SE to achieve effectiveness and efficiency objectives in the intensive care unit—ICU (Project funded by the Johns Hopkins University Whiting School of Engineering Systems Institute—WSE-SI to study integration and interoperability opportunities and challenges in the ICU,
emphasizing the role of the patient and family in their own care within the ICU, USA, 2011–2012.). The objective was on identifying where and how integration and interoperability could improve clinical situational awareness and command and control.

The new ICU system has an information display system based on a common Integrated Clinical Picture—ICP user interface. ICP is designed for rapid, intuitive information integration, assimilation, and sense-making. The ICU system also provides the ability to control the state of clinical systems (infusion pumps, ventilators, and other medical devices) and nonclinical systems (lighting, heating, ventilation, television controls, etc.).

Fig. 8.6 presents the interactions analyzed by APL-JHM team in order to formulate a systems approach to innovations oriented to improve patient outcomes at the ICU.

The process included the development of measures of effectiveness and measures of performance that quantitatively and qualitatively provided...
guideposts to improve safety and quality in healthcare delivery. Below the “V-model,” sequence of system development, test & evaluation, and fielding utilized by the team, see Fig. 8.7.

**FIGURE 8.6**
Analysis of interactions to improve patient outcomes. Ravitz A, et al. Systems approach and systems engineering applied to healthcare: improving patient safety and healthcare delivery. Johns Hopkins APL Tech Dig 2013;354(31):4.

**FIGURE 8.7**
System development life cycle. Ravitz A, et al. Systems approach and systems engineering applied to healthcare: improving patient safety and healthcare delivery. Johns Hopkins APL Tech Dig 2013;354(31):4.
By using V-model health workforce team adheres to SE’s best practice of maintaining a comprehensive set of technology, documents, execution of reviews and analyses. V-model that enables the system requirements may be traced through the design and evaluation phases, ensuring delivery of a system that meets stated objectives. Government, Regulations, and policies influence the Test and Evaluation activities.

V-model is useful in healthcare for device and system development efforts, development of new clinical protocols, the integration of devices, protocols, etc.

### 8.3.2 Management Perspective to Improve Quality of Care

IOM defines Quality of Care as: “the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge” [9].

Some reasons for low quality in health services are inadequate provision of care, limited resources, and the rising costs by inappropriate care. In this regard, a relevant number of evidences around the world, developed and developing economies included, indicate the value and need of including a Management perspective in the elaboration of solutions, the alignment is not achieved as expected yet [10]. Healthcare quality improvement nowadays requires the expansion from the traditional interpretation of structure to include broader perspectives from (1) the organizational framework; and (2) clinical/biomedical engineering (BME), healthcare technology planning and management.

The achievement of quality care results is increasable complex in 2001 IOM report, “Crossing the Quality Chasm,” concluded that fundamental changes in the healthcare sector are needed to ensure high quality of care for patients with chronic conditions and recommends evidence-based planned care and re-organization of practices with the goal to become organizations that meet patients’ needs, since then there is a remarkable progress at the same time the goals still required to be achieved [11].

Although over the last years healthcare quality has improved, the adverse events occurred around the world are one of the evidences about the need to improve quality in healthcare. Patients can be harmed by transfusion errors, adverse drug events, wrong-site surgery, surgical injuries, treatment-related infections, falls, wrong utilization of healthcare technology, lack of knowledge/training related to clinical guidelines, etc.

A study of Classen et al. (“Global trigger tool” shows that adverse events in hospitals may be ten times greater than previously measured. Health affairs
2011;30(4):581–9.) determined that in US healthcare system, adverse events occurred in one-third of hospital admissions, even in hospitals that had instituted advanced patient safety programs. According to the WHO (http://www.who.int/patientsafety/en/), based on the incidence of adverse events worldwide, the chance of being harmed in healthcare is 1 in 10; 43 million of patient safety incidents occurred around the world; the risk is distinctively higher in developing countries.

Additionally, although the Evidence-based Clinical Practice Guidelines are aimed to improve quality of care for specific clinical cases, the adherence from the physicians is still insufficient [12]; the situation has a relevant impact in the quality of service in countries like United States [13] and is one of the factors which drive the low quality of healthcare in developing countries [14].

Aligned to the perspective of linking Evidence-based Medicine to Evidence-based Management to improve quality of care, Frolich [15] states a model on which the quality of care is defined according to the level in the healthcare system at which it is assessed.

The author presents Determinants of Quality of Care as features developed to improve quality of care, see Fig. 8.8.

Determinants can be implemented at one or more organizational levels: macro, meso, or micro level depending on the design of the determinant. See the following definitions proposed by the author:

1. **At the Macro level of countries and organizations**, Frolich defines quality of care based on frameworks with dimensions characterizing areas of care. National and large organizational frameworks assessing quality of care generally include measurements in the following dimensions:
   1. Access; 2. Effectiveness & Appropriateness; 3. Responsiveness; 4. Safety; and 5. Equity.

2. **At the Meso level of organizations**, the quality of care and the definitions are more focused, the dimensions include: 1. Effectiveness of care; 2. Compliance with clinical guidelines; 3. Patient-related quality (e.g., quality of life, patient satisfaction); and 4. Organizational Quality (e.g., safety, rate of re-hospitalization, average length of stay). The quality of care can also be defined in relation to specific technologies, such as care management practices.

3. The **Micro level** includes 1. Measures related to patients (quality of life, patient satisfaction); and 2. Providers (job satisfaction).

Fig. 8.9 summarizes the three organizational levels and their respective dimensions in the healthcare system.
Some of the limitations of the management perspective are: the quality determinants at high-performing sites depend on the context; the mechanism of operation and the effect on quality of care of financial and disclosure incentives are complex and depend on shape, content, and design of the incentive.

The definition of the dimensions requires analyzing the health organization considering the strategic and operational aspects; certainly this framework contributes to the quality of the healthcare project.
Healthcare technology requires a systems approach as medical devices become connected to the Information Technology—IT network for interchanging data with the Electronic Health Records—EHR and other medical devices. In United States there is limited amount of appropriate curriculum and hands-on laboratory resources among the 87 US university-based BME programs to manage medical device interoperability \[16\].

Sloane \[17\] remarks that for the past decade, few medical devices were designed to operate in a vacuum. Most have one or more embedded computer and communication chips/modules that allow the devices to connect to other devices, hospital information systems—HIS, and/or specialized systems like Laboratory Information Systems—LIS and Radiology Information System—RIS.

Medical devices, HIS, LIS, and RIS products are now being designed to allow or even promote device-system integration and interoperability as the author states, as a consequence the devices must be safely and reliably perform their primary design function(s), but they also now send and receive data and patient information to other devices and the HIS. This context establishes the need of an appropriate education, training, and credentials (http://www.who.int/ehealth/en/). Figs. 8.10 and 8.11 show the recommendations for Education and Training on Skills in Management and Leadership according to Sloane.
1. General Project Management, including Agile Methodologies.
2. Software and Systems Development Life Cycle (SDLC) Methodologies.
3. Software and System Engineering, including System of Systems Engineering, aka Complex Systems Engineering, including concepts of interdependencies, modeling and simulation, Software Quality Assurance, including Verification and Validation, including the "V-Model" process and system engineering approach, and Concurrent Engineering.
4. Human factors engineering, including human-system engineering.
5. Life cycle cost analysis (or Total Cost of Ownership for information and communication technologies—ICT).
6. Lean/six-sigma quality methods.
7. Risk management and risk mitigation (ISO 80001 et al.)
8. HTM Maturity Models, including the current HIMSS ERM Maturity Model.
9. Business process engineering/re-engineering and management of change.
10. Contract negotiation.

FIGURE 8.10
Management skills required improving healthcare. Sloane E, Welsh J, Judd T. New opportunities for biomedical engineers—BE/Clinical Engineers—CE Health Information Technology Education, 2014.

1. Recruitment, training, and retention of ICT professionals
2. Cross-training and team building for customer service
3. Job descriptions and careers that include analysts, trainers, implementers, etc.
4. Human capital management
5. Problem/conflict resolution, mediation

FIGURE 8.11
Leadership skills to improve healthcare. Sloane E, Welsh J, Judd T. New opportunities for biomedical engineers—BE/Clinical Engineers—CE Health Information Technology Education, 2014.
The System approach applied to Healthcare contributes to better understand and even to predict health needs also improve the elaboration of solutions. In the case of the increasing emerging Health-related technologies we observe an opportunity to improve patient outcomes; it is recommended though to consider the investment on several factors as education and training to be aligned to the requirements.

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