CHAPTER

3

HEALTH PROFESSIONS, PATIENTS, AND DECISIONS

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Learning Objectives

After reading this chapter, you should be able to do the following:

- Understand the structure and importance of the role of the health professions in society.
- Explain how advanced information technology changes the role of the health professions but does not diminish it.
- Conceptualize clinical decision support systems that enable judgment and experiential knowledge to be applied to clinical decision making.

Key Concepts

- Professional versus individual autonomy
- Evidence-based clinical practice
- Clinical decision process and decision support
- Decision types and contexts
- Actor–network theory
- Team decision processes

Introduction

Will the traditional role of the health professions survive, or will it be transformed, diminished, or enhanced in an information technology (IT)–driven world? This chapter explores the privileges afforded to health professionals and their clinical obligations to society. The role of the health professions is viewed through advances and transformation in clinical decision making. Clinical decision making and coordination of work are grounded in the long-standing values and behavior of highly trained and dedicated health professionals. Their

Professional Versus Individual Autonomy

There's a difference between professional and individual autonomy. *Professional autonomy* is the freedom of the profession itself (as opposed to policymakers, organizational boards, financial managers, and others) to develop and implement guidelines and protocols for all of the professionals in a specific field. *Individual autonomy*, on the other hand, is the freedom of the individual professional to use or follow the guidelines. Important here is the degree of autonomy: At one extreme, a professional has the discretion to deviate from the guideline if he or she believes a patient's condition merits a different approach. At the other extreme, the clinician has the discretion not to use the established guidelines and protocols at all.

role changes over time, in part because of a rapid increase in basic and clinical sciences, many of which are in themselves transformational. Changes in the basic sciences includes breakthroughs in the biological sciences, the rapid development of genetic sciences, and the growing importance of engineering sciences. Information science provides the architecture for transforming the structure of clinical decision making and the clinical process.

The traditional, independent role of health professionals in society has defined how (1) health professionals are trained, (2) healthcare organizations are structured and managed, (3) services are financed, (4) policies are set, and (5) systems are evaluated. Health systems informatics fundamentally changes the structures of these systems, including the logic of their design and the basis on which they are evaluated. In a well-designed and well-managed system, there will be a loss of *individual* decision control as decisions are increasingly based on collaboration and informed by accumulated clinical evidence. There need not be a loss of *professional* control or flexibility, even though it might look and feel that way to individual professionals if the system is not well designed and managed. One could argue that a loss of professional control will occur as patients increasingly participate in the decision-making process, but engaging patients is part of the professional's role. It is the professional's reason for being. A new environment might be characterized as a team structure, drawing on the best scientific evidence with full participation of the patient.

The new challenge of the health system is to collect the latest and best evidence available, within a distributed decision-making structure, and use it to inform decisions. There is extensive literature on decision making that has not been applied to clinical decisions. The types of decisions in the healthcare sector may be different from those in other disciplines, but they are based on the same science. The types of decisions made across the clinical spectrum and the ways they are informed are discussed here.

Transformation of the Clinical Function

Customizing healthcare services to patient and family conditions has traditionally been carried out by individual health professionals, which is their role in society. This expectation does not suggest that in a transformed health system, it will be business as usual for health professionals. Redesigning or transforming the health system requires transforming the clinical function. Thus, in an information-driven health system, the challenge is preserving the role of the professions while transforming the clinical function.

Health Professionals

The structure of clinical decision making and of the clinical process requires an understanding of the nature of professions in society. The label *professional* has been inappropriately adopted by many occupations; it is a privileged social role that carries with it a high moral obligation and certain freedoms. Professions are institutions created by society and thus vary from society to society and change over time (Muzio and Kirkpatrick 2011). Professionals have "specialized training and knowledge, ethicality, and importance to society" (Friedson 1994, 19). This training and knowledge give them special privileges and responsibilities, as well as power and legitimacy. Their role changes in response to society's changing values, demographics, economics, and technology.

The role of health professionals is reflected in their oath to society and patients, which recognizes medicine as a calling. The modern Hippocratic oath is as follows (Tyson 2001):

> I will remember that there is art to medicine as well as science, and that warmth, sympathy, and understanding may outweigh the surgeon's knife or the chemist's drug. . . . I will remember that I do not treat a fever chart, a cancerous growth, but a sick human being, whose illness may affect the person's family and economic stability. My responsibility includes these related problems, if I am to care adequately for the sick.

Likewise, the nursing profession abides by an oath known as the Nightingale Pledge (ANA 2012):

> I will do all in my power to maintain and elevate the standard of my profession, and will hold in confidence all personal matters committed to my keeping and all family affairs coming to my knowledge in the practice of my calling.

These oaths state the commitment of professionals to their patients, who have varying physical and medical conditions, socioeconomic statuses, beliefs, values, and traditions. This orientation requires professionals to retain some autonomy—the freedom and flexibility to tailor their response according to their own clinical judgment as well as the patient's health, desires, social conditions, and values. Working independently and relying on their knowledge base and available information to make clinical decisions characterize the culture of health professionals.

The role of physicians does not only start when they obtain admitting privileges in hospitals; it begins once they are accepted into medical school and continues throughout their training. Medical faculty are granted considerable autonomy in universities to set standards, select and admit students, define the curriculum, and assess student performance. Personal values, attitudes, and behaviors are just as important as clinical knowledge and skills in the medical education process. Changing how physicians make decisions, collaborate within and across specialties, work in teams, and share decision making with patients, starts upon admission to medical school. This change is not easy; as Calvin Coolidge once said, "Changing a curriculum is like moving a graveyard." This is particularly true in highly professionalized fields.

Clinicians are expected to be not only innovative but also responsive to advances in medical knowledge, information technology, and cultural values—a challenge given the speed of change in the field and society. Carle-Illinois College of Medicine (https://medicine.illinois.edu), for example, has caused a disruptive innovation in physician education by adding engineering science, to complement biological and clinical sciences, to its curriculum. Engineering science includes bioengineering science, precision medicine, and clinical medicine systems engineering (Khayal and Farid 2017), which have been increasingly contributing to medicine.

Clinical Decision Process and Decision Support

Studies have found that clinical guidelines, based on scientific evidence, result in outcomes improvement—although most are focused on the clinical service (even clinical specialty) and not the decision support design, making generalization difficult (Hoomans et al. 2011; Latoszek-Berendsen et al. 2010). There is evidence that clinical decision support tools have had a positive effect on clinical outcomes, and students should critically review this vast and varied collection of studies. We explore the literature here as a framework for understanding the relationship between decision process and outcome. Much attention has been paid to the quality of clinical evidence reported in guidelines, physicians' acceptance of the evidence, and the evidence's effect on quality (Alonso-Coello et al. 2010; Tricoci et al. 2009). The acceptance of a clinical decision support system (CDSS) depends on the level of science and evidence supporting the guideline it presents, such as closed clinical trials. What is not regularly reported is the structure of the clinical decision process within which the guideline was developed and tested (Bates, Kuperman, and Wang 2003).

A CDSS sometimes conforms to—and sometimes transforms—the structure of the clinical decision process. Thus, more attention must be paid to the process itself. Such studies require testing different decision models for exploring new approaches to nonlinear interaction among health professionals. Studies should carefully identify the context and process as well as the outcome (Brenner et al. 2016).

Clinical decision processes are becoming increasingly complex, involving multiprofessional teams. Hafferty and Levinson (2008) suggest that complexity science could be used to recast health professionals, organizations, and systems to be interactive, adaptive, and interdependent. Complexity science is a systems concept based on agility of thought, creativity, risk taking, and the value of diversity (Brainard and Hunter 2016). Current guidelines only report decisions and outcomes but do not report or measure context. This practice is problematic in a highly professionalized field such as healthcare and increases the risk of guidelines becoming too mechanistic. The science should inform the process as well as the decision.

The logic of health systems informatics is based on a transformed clinical decision process and system design. Transformed organizations have been referred to as learning or knowledge organizations, are self-organizing, and are able to capture and use a range of knowledge, including tacit knowledge. They are purposeful systems in which individuals work together toward common goals to achieve extraordinary performance. Hierarchical structures and decision processes are as outmoded as the traditional role of professionals. Under the logic of an integrated clinical function, leaders must collaborate to redesign work processes. Physicians, nurses, and other clinicians must work in integrated teams and be jointly accountable for clinical outcomes. Working together requires flexible and adaptive systems that are "less bounded" but not "boundaryless" (Friedson 2001). Such systems operate with a degree of standardization—of both the clinical processes and the clinical outcomes. Standardization is an inherent condition of structured work processes and is a departure from the traditional independent or autonomous role of health professionals. Standardized measures and information systems do not mean mechanistic decision processes but rather information and decision support that transcend individual practitioners and institutions. Clinical decisions are structured around clinical work processes that include health professionals who have knowledge relevant to a treatment process. Leadership can be shared by professionals who have the dominant knowledge of the case at a given point in the clinical process and not be assumed by the traditional coterie of physicians. Such approaches are evidence based, drawing on engineering, behavioral, and social sciences.

Health professionals recognize the value of information and knowledge embedded within a CDSS and are increasingly structuring clinical decision making around its logic. They understand the power of IT and integrated teams, which require them to fundamentally redesign the structure of many clinical functions. Such a redesign requires new types of healthcare organizations and new perspectives on clinical decision making. It calls for a needed transformation of the organization itself (McGuinness 2014). Most healthcare facilities have implemented evidence-based decision making, but they have done so within the traditional role of clinicians and the traditional structure of organizations. Small hospitals and clinics lag in this transformation because of shortage of funds, resistive cultures, and lack of time or capacity. Failing to change will put at risk their ability to position themselves strategically and even their very survival.

Effective Clinical Decision Support Systems

Many studies that report positive outcomes from using CDSSs lack sufficient rigor because they do not recognize the nature of the clinical decision process. They demonstrate incremental improvements but seldom recognize the outcomes of the overall process and the essential tenets of a CDSS. These limitations are, in part, the result of the way these studies are conducted. Most studies are run by individuals who have considerable knowledge about clinical care but not about the science of decision making or the types of decisions and CDSSs being studied; they do not seem to understand that not all clinical decisions are equal. As a result, their findings tend to apply to specific clinical decisions and are not generalizable to other decision types, situations, or settings. In addition, they frequently refer to decision science concepts that they do not understand. For example, they use a term such as *intuition* but do not explain its intuitive decision-making basis or application. The lack of conceptual rigor in many studies limits the accumulated knowledge available for clinical decision making, which imposes a constraint on the design of effective CDSSs. Although such research provides evidence to inform clinical decisions, it does so without context.

The healthcare field has thus not been able to draw on what is known about designing effective CDSSs or to contribute to the body of decision science. Healthcare leaders and system designers must be critical readers of published research on CDSSs and use the findings to design evidence-based clinical processes. Designing CDSSs is a complex process and requires skills and time that go beyond what clinicians and organizational leaders possess. They must, however, be critical consumers and not assume that IT vendors or consultants serve their best interests. It is the function of researchers, IT companies, and policymakers to develop and test effective CDSS tools. The challenge is to gain an understanding of the types of clinical decisions being addressed as well as to design and test CDSSs that are consistent with those types of decisions, because different decision types require different mechanisms. Information system interfaces and information exchange are essential qualities of effective CDSSs.

The Science of Clinical Decision Making

The Institute for Technology Assessment (2018) identified the need to apply decision science to the complex and competing functions in clinical practice and public health. **Decision science** is the systematic analysis of the complexity and dynamic nature of decision making, applied here within clinical and organizational contexts. It recognizes that contextual factors must be explicitly examined so that decision-making processes enable a thorough but analytically appropriate method of achieving optimal outcomes. Decision science that is applied to healthcare includes quantitative analyses and supporting evidence for clinical decisions and clinical processes. Decision science in healthcare incorporates the clinical sciences as well as engineering, organization, and systems theory to achieve optimal clinical outcomes and system performance. Historically, clinical decision making was based primarily on a single decision model with a focus on individual clinical decisions, but systems-based clinical decision broadens the focus of clinical decision making and adds the range of organizational, behavioral, and engineering sciences. This section focuses on clinical decision making and its context by type of clinical decision. (Chapter 5 focuses on the organization and system context.)

Decision science Systematic analysis of the complexity and dynamic nature of decision making

Decision science applied to clinical decisions recognizes that different types of decisions follow different rules, each of which has a distinct logic and scientific basis (see exhibit 3.1). The design and use of CDSSs are defined by and serve the *inherent* and *essential properties* of specific decision types and decision processes. The decision process and the type of evidence needed to support the decision are determined by the properties of the decision being made. Evidence is used to frame the decision process and inform the decision. The decision itself and its context are both dependent variables, making health informatics independent as a transformational science.

Clinical decision making consists of several interactive components: (1) knowledge of a patient's condition; (2) effective treatment options based on accumulated evidence; (3) the patient's perspective; and (4) contextual factors, such as decision timeliness and urgency. Treatment options refer to the evidence supporting the decision and the associated composition and structure of the clinical team. Complete knowledge of a patient's condition is

EXHIBIT 3.1 Decision Types and Logic

Type	Logic	Basis
Evidence-based decisions—Computational	Mechanistic	Facts are known
Evidence-based decisions—Judgment	Expert and probabilistic reasoning	Factual basis but where sufficient facts are not known
Intuitive	Subconscious	Holistic thought
Affective	Normative	Values

never achieved or needed as a basis for making a diagnosis, primarily because continued search might compromise the timeliness, quality, and acceptability of the decision. Knowledge includes both descriptive information and scientific evidence to support an accurate diagnosis and treatment. As various diagnostic iterations are completed, alternative treatment options—based on accumulated evidence—are considered. While the dimensions of the clinical problem are framed, based on iterations of the diagnostic process, a solution strategy is developed by searching a memory set to bring to bear the collected evidence and knowledge. Other factors, such as cost and reimbursement mechanism, also influence clinical decision making but are considered clinical support factors and are addressed throughout the book.

Types of Clinical Decisions

Clinical knowledge is being generated at a fast rate but is difficult to access, synthesize, analyze, and report. IT has the power to locate, access, accumulate, analyze, and present information and knowledge in a usable form for clinical decision making. The manner in which this process is carried out depends on the type and context of the decision being considered; this is particularly true in decision making in professional domains such as healthcare. The design of a CDSS relies on decision type and context as well.

Evidence-Based Decisions

Evidence-based decisions are either mechanistic/computational in nature or probabilistic, based on judgment and expert reasoning. Computational decisions in clinical practice are constrained in health systems by limited access to large databases. In addition, most clinical decisions are inherently not mechanistic in nature and thus not appropriate for computational solutions. Probabilistic decisions have a factual basis, drawing on the best clinical evidence, but recognize that clinical judgment is required. This might be true because only limited clinical evidence is available, which is enhanced by experiential knowledge and/or the inclusion of patient preferences. These multiple bases for decision making are represented by the shaded areas in exhibit 3.1, making the science of clinical decision making very complex. In general, most if not all clinical decisions are informed by facts, but the factual basis might not be the ultimate logic on which the decision is made.

Computational Decisions

Computational clinical decisions represent the highest level of evidence-based decision making and are mechanistic and factual in nature. They are based on a massive amount of data and knowledge as well as rapid processing speed, using technologies such as artificial intelligence (AI) or machine learning. These decisions are justified in that they are superior to decisions that involve human judgment. (Computational decision technologies are introduced in chapter 2 and further discussed in chapter 5.)

More sophisticated decision support tools are being developed to inform clinicians, enabled by ever-increasing clinical repositories and processing speed. However, judgment in clinical decision making can never be replaced by computational decision making because of the inherent requirement to incorporate other dimensions of decision making into the clinical decision process. Thus, such decisions cannot be appropriately made using AI, simply because they are not mechanistic in nature.

In addition to clinical decision support, smart systems will be increasingly deployed to carry out many operational functions in the health system, such as supply chain (supply robots) and other mechanistic functions. For example, new engineering technologies—such as medical drones—are being deployed to respond to alerts to access and rapidly transport urgently needed supplies, such as blood, to the emergency department (ED), reducing the transport of patients from rural hospitals to medical centers (Mayo Clinic 2017). These technologies are transformational, but the focus of this book focuses on clinical decision making.

Judgment-Based Decisions

Judgment-based decisions by clinicians depend on accumulated clinical evidence as well as knowledge derived from training and experiences of the decision makers. Judgment is methodical, deliberative, and deployed when the evidence is overridden by experiential learning or when adequate decision support tools are not available at the point of decision making. Judgment-based decisions draw on the best available clinical evidence but enable the logic of intuitive and/or affective decision making (represented as the shaded sections of exhibit 3.1).

Experiential knowledge draws on individual judgment and *heuristic reasoning*. Heuristic reasoning is not fully consistent with mathematical representation and cannot be easily standardized. It is considered a structured way of thinking and includes introspection, conceptualization, and insight, which lead to problem solving that is interrupted and discontinuous. How and when, then, is heuristic reasoning applied, and how does it incorporate clinical evidence? Heuristics provides rigor to decisions that are not probabilistic and thus not programmable. It reflects how clinicians make decisions and should be incorporated into the design of CDSSs. Evidence suggests that probabilistic decisions are best made by highly trained domain experts with clinical experience, using the science of expert reasoning. Normative decision is superior to descriptive decision because it is based on producing outcomes.

Using judgment in decision making is important when time does not permit the decision maker to engage in a more deliberate process, including using available decision support tools. Use of judgment cannot be justified by understaffing or the ineffectiveness or faultiness of a CDSS; such excuses are made in organizations that follow business rules or prioritize financial incentives instead of appropriately staffing to achieve optimal outcomes. Imposing operational restrictions or standards on clinicians is an inherent danger of organizational practice. Evidence suggests that a degree of uncertainty characterizes most clinical decisions and that this uncertainty cannot be eliminated for most types of clinical decisions, although it can be reduced by CDSSs. Judgment is an important element, but only when it builds on the best available evidence from a CDSS. In this way, judgment-based decisions are still evidence based and include probabilistic elements.

Recognition of judgment in clinical decision making raises critical issues regarding monitoring decisions and imposing sanctions on deviations from evidence-based clinical guidelines. Judgment might be exercised in the absence of evidence and, in some cases, to override the available evidence. Healthcare organizations and systems must appropriately monitor and hold clinicians accountable for how evidence is used. Such information might provide a basis for guideline modification or continuing education for the clinician. Enabling the ability to retrospectively review cases related to the clinical decision is a value-added contribution of CDSSs. The use of guidelines and retrospective review (modified medical rounds) provide valuable information and serve the best interests of the patient. If negative sanctions are rigidly imposed when deviations from the stated guidelines are made, there is risk that clinicians will be compelled to comply with the guidelines but will not exercise their best, informed clinical judgment on behalf of the patient. Such actions violate the oath of professionals and the moral obligations of the organization.

Judgment in decision making draws on the traditional role of health professionals to always act in the best interest of their patients. Clinical judgment can be defended only when it builds on the best scientific evidence presented by the case. Statements such as “I have always done it this way” or “This is how I was taught” are not defensible. The use of judgment in decision making in medicine, nursing, and other health professions supports the tradition of educating professionals in mental processing that characterizes these forms of decision making. Such conditions can be programmed into patient simulation using mannequins, which are found in all quality medical and nursing schools (Patel and Kannampallil 2015). Use of judgment also logically supports its linkage to more evidence-based simulation in professional and continuing education. Clinicians should welcome a retrospective review of decisions that have been tested against the evidence, because these can serve as an effective basis for continuing education for those who are relatively new in practice and those who have been in practice for decades (Harteis et al. 2012).

Intuitive Decision

Although intuition is a frequently misused concept, it is a legitimate decision process dominated by the decision maker’s subconscious mind (Ruhe and Wang

2007). Labeling decision contexts without drawing on recognized principles limits learning and informed application. Intuitive decisions are based on innate qualities of the decision maker, which are acquired but do not constitute reasoning or learning. These decisions do not replace or negate the importance of evidence but may use evidence to augment or justify the decisions. The decision itself, however, is holistic—drawing from evidence, facts, and the subconscious—and cannot be justified in the absence of an evidence-based decision support tool. Intuitive decision making views the information being processed in parallel rather than in sequence; that is, the quality of the outcome is dependent on intuition, facts, and evidence working together. Clinical decisions based on intuition must demonstrate superior outcomes.

Affective Decision

Affective decisions are based primarily on values—presumably of the patient, not the professional—including emotion, feeling, and mood. Affective decisions are assumed to be thoughtful and deliberate and to incorporate evidence about the disease and treatment options. They are most notably made in clinical areas such as palliative care and are becoming increasingly important as patients and families become more involved in chronic and acute care decisions (National Academies of Sciences, Engineering, and Medicine 2017). Proxy decision makers represent the patient's values and desires (Rolland, Emanuel, and Torke 2017). Beliefs and values can override but do not replace the best available science. Value-based decision making is not unique to healthcare and is considered a strength, not a weakness, of a well-conceived CDSS. Such CDSSs might include the patient's social, cultural, religious, and family characteristics as well as clinical findings to frame decisions that are value based. Social information in medical records does not replace patient involvement but has been found to increase the appreciation and empathy for the particular social conditions of patients (Kotay et al. 2016).

Context of Clinical Decisions

Decision context serves as the basis for designing CDSSs. At the most basic level are single-encounter decisions made by individual health professionals meeting with a patient for an acute episodic illness. Although this might be a single encounter with the medical system, it includes a continuous process of health maintenance. This decision context—not necessarily the decision—is relatively simple: The physician gathers relevant information, draws on available clinical decision support tools, makes a diagnosis, and prescribes treatment for an individual patient. Current CDSSs have been primarily designed with this basic context. As CDSSs developed, their design has frequently included a systematic search of the evidence on the decision but not on the clinical context and broader clinical process. The level of evidence and quality of the decision making have improved, but the decision context has remained the same.

> **Opportunity for Interprofessional Education**
>
> An elderly patient is at risk of falling. Her condition is characterized by a nexus of problems—urinary incontinence, diabetes, musculoskeletal weakness, depression, and osteoarthritis. Describe a clinical team of "health professionals working in collaboration with others, transcending specialties, professions, departments, and . . . organizations" that has been tasked to make decisions about the care for this patient. How would you devise a simulation of such a decision-making process with fellow students—in this class and in others?

The episodic clinical encounter is giving way to a continuous process of health maintenance and wellness for chronic diseases. Such a process is informed by multiple consultations, patient networks, sensors, and self-diagnostic algorithms, making the process more complex. The clinical decision process thus increasingly involves the patient and family, extending the logic of the decision-making process and thus the design and use of decision support tools. Current information systems that allow patients to make appointments or access information on test results and clinical progress are not regarded as patient involvement in decision making.

In addition, the context of clinical decision making has changed in the way clinical teams are now conceptualized as decision-making units. Clinical decisions are increasingly made by health professionals working in collaboration and transcend specialties, professions, departments, and even organizations. A CDSS for this integrated clinical decision process requires a reconfiguration or different logic to include organizational design, management strategy, finance, and policymaking. All components must be aligned and inextricably linked, drawing on engineering and social sciences that transcend but are essential for evidence-based medicine.

An Institute of Medicine study has found considerable variation in clinical decision-making behavior and outcomes, including how scientific evidence informs the decision process (Kaplan and Frosch 2005). Examining what constitutes knowledge and how it is acquired, transmitted, and applied in decision making is an age-old philosophical pursuit. A growing body of research is available to inform the development of effective CDSSs, but more needs to be done to test a range of clinical decisions and their context. There is evidence based on the science and art of clinical decision making for how decision support tools can be applied to improve clinical outcomes and patient satisfaction. What is lacking is an exploration of the different types of decision processes, tested within different clinical structures and using different combinations of professionals. Researchers have not adequately addressed the fundamental transformation of the health system enabled by the logic and power of health systems informatics. In this regard, it is not an overstatement to say we are still in the process of automating obsolescence. A common response by clinicians and health leaders is that "it works better than what we had before." This is not a high bar for the science of decision making.

Types of Decision Context

Research and practice add to our understanding of different types of decision context exhibiting different decision support requirements. Clinical decision support tools must be tailored to the type of decision context, resulting in better science, less variation, and improved outcomes. There will continue to be variation, requiring professional judgment, but it can be reduced where appropriate so that quality is improved. These differences can serve as a basis for developing more effective CDSSs, which will be better received by clinicians because, even though they result in change, they are based on the logic of clinical decision processes and not the structure of organizations or IT systems. CDSSs can stimulate and guide changes in the structure of clinical decision processes based on evidence and the type of decision.

Team Decision Context

Clinical knowledge is structured around clinical specialties, resulting in "domain-specific guidelines, checklists and protocols to improve decision making" (Weinberger et al. 2015), which are essentially silos of decision making. Domain-specific CDSSs are considered inadequate for responding to most clinical cases, particularly complex cases. Improving guidelines using traditional logic will not unleash the potential of CDSSs because the logic, not the science, is what needs to be changed. The design of domain-specific guidelines assumes the logic of cognitive informatics, whereas health systems informatics guides the decision process and thus the logic.

More and more clinical decisions are made by teams, an important development that promotes the redesign of the traditional, individual approach into a systems model. Team CDSSs, particularly in specialized areas such as the intensive care unit (ICU), have been analyzed. One study found that traditional CDSSs in ICUs have caused uncertainty, vagueness, and inconsistent standards of care, threatening patient safety and quality of care (Hawryluck, Bouali, and Meth 2011). Such findings do not suggest that decision support recommendations were not followed but rather that they were not structured to manage complex cases by teams of caregivers. CDSSs designed and tested for multiprofessional decision making were found to produce better clinical decisions, better coordination of care, and improved outcomes (Weinberger et al. 2015). The complexity of clinical cases in hospitals and the greater focus on the patient and wellness suggest that CDSSs of the future must enable teams of health professionals to engage in shared decision making.

Shared access to an electronic medical record (EMR) system is not sufficient as team decision support. Decision support tools that are designed around teams might first appear to be a relatively simple information exchange but in reality are built on evidence-based, shared decision-making models. The entire clinical milieu provides the context in which the decision-making process takes place. *Actor–network theory* includes the entire clinical setting in developing clinical guidelines and protocols, including tacit knowledge generated through group interaction (McDougall et al. 2016; McMurtry, Rohse, and Kilgore 2016). This theory posits that, instead of a defined team leader and structure, the combination of professionals (actors) is the power behind superior outcomes. Team composition and interaction, culture, professional language, decision support, and the care setting all affect decision making and contribute to improved outcomes.

Clinical teams themselves need to develop guidelines based on the best available evidence and the team's collective knowledge and experience. Team-designed guidelines can improve the decision process by using the best science applied to high-performing teams. Educational institutions are paying more attention to team-based competencies in training health professionals (Rajamani et al. 2015), introducing interventions such as collaborative curriculum, team competency practicum, collaborative team environment, and team-based CDSS development and testing.

Evidence indicates that team CDSSs are effective in a range of clinical areas, but more research is needed to guide the design, testing, and use of team decision models and CDSSs. Healthcare organizations have not been oriented toward clinical teams but instead are characterized by functional hierarchies, personnel functions based on individual jobs and rewards, and dysfunctional financial incentives (Sullivan et al. 2016). The singular focus on improving CDSSs based on individual decision making is suboptimal and lacks the essential systems perspective.

Patient Involvement Context

IT enables caregiving teams to redefine the concept of patient-centered care, including patients' communication with providers, online access to a breadth of information, content communities, and wearable sensors and self-diagnostics. More sophisticated systems allow patients to track their medical history and monitor their health. For example, the University of Missouri Health Care (2018) has developed a smartphone application that lets patients with depression enter their moods and symptoms into a log and share data with their psychiatrists. The Internet has opened a new level of patient interaction and access to clinical information, and greater change will occur in the decision process, depending on the demographics and cultural experience of patients and the involvement of clinical teams. The quality of electronic information is enhanced by health portals where both human and nonhuman actors are important (Foroutani, Iahad, and Rahman 2013). The interaction of teams involved in the decision process with patients draws on actor–network theory as well. Changes in the clinical decision process go beyond the clinical encounter to include the entire clinical continuum, which requires transformation of the health system itself. The phrase "the patient will see you now" reflects the likely direction of the health system of the future (Topol 2012). The question is how patient involvement will change, enabled by the type and use of CDSSs.

For many years, clinicians and hospitals have marketed themselves as patient centered. However, only in the past few years have most hospitals and clinics enabled patients to access the electronic health record, allowing them to make or change appointments and review certain clinical information, such as laboratory results and ranges as well as medication lists and dosages. This level of access and involvement raises issues of privacy and security of private and sensitive information (see chapter 16). Giving patients access to test outcomes and other medical data has resulted in a more informed patient but has not substantially altered the decision process or used more than a fraction of the power of IT. One could argue that this type of access is not really patient centered.

Giving patients access to the electronic health record system is based on the traditional model of the doctor–patient relationship, where the patient plays a passive role. Health systems informatics can transform how patients access and use health information and how they collaborate as co-producers with health professionals in the decision process (Butcher 2013). Patient participation in decision making introduces a complex set of dynamics, including the patient's and family's values and beliefs. As discussed earlier, values-based decision making is known as affective decision making. Affective decisions by patients do not negate the essential nature of evidence-based decision support tools, which patients also access, but patient values might override the science in some instances. This situation is frequently experienced in palliative care, where probabilistic evidence is available and accessible but ultimately defers to personal feelings, emotions, and values.

Information systems that support patient participation provide access to not only evidence-based solutions but also relevant information posted on social media or websites. Knowledgeable and involved consumers are active online, creating multimedia content, coordinating support groups, running chat sessions, or maintaining disease-specific or health-related blogs. Providing access to informed consumer support alters the clinician–patient relationship, enabling patients to ask questions, compare treatments, learn, and share advice or experiences (see chapter 8) from and with people other than their clinicians. Defenders of television advertising of prescription drugs—a $5 billion industry allowed in only two countries in the world (the United States and New Zealand)—argue that these commercials provide information about illnesses and their effective treatment. However, studies consistently report that most of these advertisements are misleading or false, although the ads may be of benefit to some patients (Faerber and Kreling 2014). One could argue that the pharmaceutical industry is not in the business of patient education but financial return and, along with insurance companies that reimburse for these medications, likely contributes to the fact that the United States has the highest-cost health system in the world. At a minimum, prescription drug advertising is not an effective means of communicating information to patients.

The danger in planning for patient participation in the clinical decision process is making generalizations about populations and their beliefs, practices, and values. For example, it is easy to assume that all patients desire to be fully informed and to have an active role in considering options and selecting a course of treatment. However, many patients prefer their physicians to make the clinical decisions in certain situations. On the other hand, some patient populations do share certain values and beliefs even though each individual in those populations is unique. Older patients and those with severe illnesses, for example, have been found to place greater relative value on clinical judgment than on clinical evidence (Mira et al. 2014). This is not to say that these patients should not be informed about medication interactions, possible complications, and risks as part of the decision process. In addition, how patients and families are informed is important. Research indicates that patients involved in an evidence-based process have more confidence in and are more satisfied with the final decision. The ability to recognize values-related issues when they arise in practice is an essential competence for clinicians (Scherer et al. 2015).

Urgent Decision Context

Urgent situations that characterize many decisions are not unique to healthcare, but the urgency in healthcare is different from that in other industries. Judgment-based decisions might be the main or initial source of knowledge in certain decision contexts, such as emergency care. When the urgency of the situation allows only limited clinical decision support—because time is lacking or the case or setting is complex—professional judgment by the clinician is required to make a rapid assessment and arrive at a course of action as soon as possible. For emergency care, whether in an ambulance or the ED, the appropriateness of decisions might depend in part on the speed at which assessment and treatment decisions are made, thus limiting the use of CDSSs (Hall 2002). Training in simulated settings, along with experience, sharpens clinical judgment, an essential knowledge base, and is part of the role of the health profession. Even in emergency care, patient-monitoring data should be quickly integrated with the patient record and appropriate decision support tools. The ability to accomplish this electronically in an emergency environment demonstrates the obsolescence of paper records or institution-specific medical records.

What role might CDSSs play in urgent care? There are models for how IT can be engaged immediately to collect, monitor, and report vital information for urgent patients, but there is limited assessment of how quickly and effectively such information can be analyzed and presented to improve clinical decision making. The use of CDSSs has considerable potential given the advanced communication systems in ambulances, local EDs, and tertiary centers. Staff should be able to immediately access an electronic patient record, transcending institutional and regional delivery systems, providing important patient information, and further informing urgent care decisions. The limited ability to rapidly access patient information across disparate organizations and systems highlights a system failure perpetuated by the faulty design of EMRs and CDSSs. The timeliness and progression of integrated information and knowledge are essential for decisions to be knowledge based.

Decision models in the emergency or urgent care context have the potential to outperform individual or group decisions. In an inpatient setting, these models can be employed for repetitive and complex decisions. Decisions to call a rapid-response team in hospitals, for example, are based on multiple and interrelated indicators of change in a patient's condition and typically are made by experienced nurses. Learning occurs as experience increases. Repetitive events generate considerable data on multiple and complex clinical factors exhibited by a patient. Research has found that nurses—using a computational decision model (see chapter 5), which collects vital information and calculates complex interrelationships using large databases—activated the rapid-response team earlier and with fewer false positives than was possible with judgment-based or intuitive decisions. The results were fewer deaths and greater efficiency (Parker 2014). Such decision models can rapidly gather and process immense amounts of data, sometimes looking for obscure pattern relationships, and provide timely alerts.

Conclusion

Much of the complexity of health systems management is in structuring a system that allows authorized clinicians universal access to individual patient records, presents the latest and best available evidence to inform clinical decision making, and gives individuals the freedom and flexibility (when appropriate) to make judgment-based clinical decisions. The logic of such a system defines how hospitals and clinics and their information systems are structured and managed and what their strategic vision will be. Healthcare services finance will be aligned to reward quality and efficiency, not the number of patients seen or procedures performed. Bundled payment is a start, but it is still procedure oriented and just one step on a long journey.

Health systems informatics can be the basis for evaluating health system performance and for establishing institutional and national policies. Policy decisions will be informed by collected evidence, available resources, and values. The logic of IT will define the structure and function of clinical services, hospitals and clinics, regional systems, financing, and health policies. Healthcare has paid little attention to the study of organizational and system design, financing, and policymaking based on the assumptions of a clinical function enabled by advanced IT. The clinical process will be fundamentally altered when IT is used as an organizing principle and is tailored to each clinical encounter. The concept of mass customization is used in marketing to denote a high level of flexibility and personalization of custom-made products that are produced in a large, high-volume system that is knowledge driven. The health system needs to extend this concept by drawing on collected knowledge to tailor services to individuals.

Health systems informatics provides the architecture for the fundamental redesign of the clinical decision-making process, as well as of organizational structure and strategy, financing, and policymaking. Desired change can occur only with the leadership of health professionals, educators, state licensing boards, financing agencies, policymakers, and executives throughout the US health system. Without such transformational change, we will continue to use IT to automate obsolescence.

Chapter Discussion Questions

1. How has the role of health professionals changed but not been diminished in an information-driven health system?
2. How does the assumption of evidence-based clinical decision making change the role of the health professions?
3. Give examples of the difference between a clinical decision and the decision process.
4. Should intuitive decisions include evidence from a clinical trial?
5. Make a case for and against public advertising of prescription drugs as a patient information strategy.

Case Study — Redesigning Futures: The First-Ever Engineering-Driven College of Medicine

Phyllis M. Wise

One of society's greatest challenges today is to improve healthcare for more people at lower cost. To meet this challenge, physicians cannot continue to be trained in the same way they have been trained in the past. Instead, biomedical scientists, engineers, physical scientists, innovators, and physicians—nontraditional partners—must come together to develop dramatically different models of medical education. This collaboration will lead to the modernization of medical education and to higher-quality education, which in turn will lead to better healthcare.

During the 1980s and 1990s, few new medical schools were established in the United States. In 2006, growing concern over physician shortages led the American Medical Association to issue a statement calling for a 30 percent increase in medical school enrollment. Since then, more than 20 new medical schools have been founded. These new medical schools have addressed the need for more physicians, but none of them has considered the proposition that a different kind of physician will be required to solve the challenges of our global healthcare needs.

The University of Illinois at Urbana–Champaign, in partnership with the Carle Health System, has addressed that set of needs by instituting a distinctive, groundbreaking, engineering-driven college of medicine that redesigns the education of doctors and thus the delivery of healthcare. The new college brings together seemingly different disciplines and partners in ways that have not been possible in a traditional medical school environment.

The bold and innovative vision of the new Carle-Illinois College of Medicine is to establish the first research-intensive college of medicine to focus expressly on the convergence of engineering, technology, Big Data, and healthcare. Because this was not a retrofit or add-on to an existing enterprise, it integrated these elements from the beginning.

Both the university and the system were at critical junctures in their strategic plans that made the creation of a new college appropriate at this time in their respective histories. The university is a member of the prestigious Association of American Universities, a society of public and private research universities. One-third of the faculty in the university's internationally respected College of Engineering were already involved in biomedical and systems engineering research. Many bioengineers were not actually in the department of bioengineering but spread out in different departments in different colleges across the campus.

The system—comprising the Carle Foundation Hospital, Carle Physician Group, and Health Alliance Medical Plan—is a vertically integrated healthcare delivery system. It is in the middle of a major recruitment campaign, hiring 150 physicians and physician-scientists, many of whom are involved in the Carle-Illinois College of Medicine. The hospital is ranked in the top 10 percent of hospitals in Illinois. In 2016, its combined outpatient and inpatient visits ranked among the highest volumes in the state.

(continued)

The university and the system are the largest and second-largest employers, respectively, in the micro-urban town of Urbana–Champaign. The establishment of Carle-Illinois College of Medicine was the result of a comprehensive and collaborative process. It was a thorough, extensive, consultative, and thoughtful planning process that involved hundreds of university faculty members, system physicians, and external consultants as well as many community leaders in Urbana and Champaign.

The first goal is to transform the education of physicians by providing graduates with a distinctive degree in medicine. An inaugural class has been admitted for fall 2018. The university and the system had the opportunity to design a new paradigm for medical education, research, and the delivery of care from the ground up. Faculty and physicians designed a totally new medical curriculum. Each course was developed and will be taught by a team of faculty that includes basic scientists, physicians, and engineers. The new curriculum infuses principles of engineering, technology, Big Data, and innovation into all courses as a road map to the future of medicine. The curriculum emphasizes analytical thinking and problem solving and will include clinical immersion in all four years. This is being done, in part, through interdisciplinary, team-based, innovative approaches to achieving improved healthcare outcomes. One of the most important aspects of the curriculum is that students will be introduced to the clinical environment from the beginning. Principles of engineering will be introduced into all cases and the treatment of disease. The future physician-discoverers, physician-innovators, and physician-engineers who will train in the college of medicine will be encouraged to cocreate new devices, medications, technologies, and more with faculty mentors while they are students. Thus, this collaboration will create a new culture in medical education and practice. The future professionals will advance care delivery far beyond what can currently be imagined. Not only will their patients benefit, but the impact they make will also extend to countless others who will be healthier as a result of their medical discoveries.

The second goal is to redesign healthcare, taking full advantage of current and future discoveries in engineering, technology, and Big Data. Advances in these areas are driving medical breakthroughs. The future of precision medicine lies in discovering new sensors, materials, and devices as well as new uses for robotics, miniaturized imaging, Big Data, and remote monitoring and then applying these innovations to medicine and healthcare. The complex system for delivering healthcare services will draw on medical systems engineering. Graduates will advance patient care and develop dramatic technologies to deliver higher-quality healthcare to more people at lower cost.

Case Study Discussion Questions

1. Research the Flexner Report. How did this report transform medical school in the early 1900s, and how did existing medical schools respond? How did the change in curriculum requirements affect the profession of medicine?
2. Why did the American Medical Association not call for a new type of medical school and curriculum in 2006, instead of just a 20 percent increase in numbers?
3. Discuss the conflicts that might arise if a change in curriculum design were proposed in an existing and well-established medical school.
4. Consider a range of existing medical schools and assess their relative strategic positions if engineering is added as a new translational science.
5. What arguments can be made for preparing physicians with competencies in engineering? Against?
6. The curriculum at Carle-Illinois College of Medicine is designed around "interdisciplinary, team-based, innovative approaches to achieving improved healthcare outcomes." How are nurses and other health professionals engaged in this new model?

Additional Resources

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