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Performance Improvement in Health Care Organizations

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Performance Improvement in Health Care Organizations

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ABSTRACT

Performance improvement is an important organizational capability that is essential for health care organizations to achieve excellence on the three components of the Triple Aim: patient experience, health, and cost. In this monograph, we present a framework for performance improvement in health care organizations: the Model of Transformational Performance Improvement. This model takes a system-level approach to performance improvement and comprises six key components: (1) determining and communicating a system-level goal; (2) developing and using system-level performance measures; (3) understanding and managing interdependencies; (4) selecting a portfolio of projects aligned with system-level goals; (5) creating an organizational engine for improvement; and (6) implementing, spreading, and sustaining improvements. In addition to presenting this model, we review the operations management literature on performance improvement with a special focus on operations management tools and principles that may help with successful implementation of these six components. Though work has already been done in these areas, much remains unknown and many opportunities for future research exist. This monograph seeks to inform the research of operations management scholars and to equip clinicians and health care leaders with techniques that may be leveraged to improve performance in health care organizations.

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List of Acronyms

ACO	Accountable care organization
AMI	Acute myocardial infarction
CCHMC	Cincinnati Children's Hospital Medical Center
CMS	Centers for Medicare and Medicaid Services
CPOE	Computerized provider order entry
DMAIC	Define, Measure, Analyze, Improve, and Control
ED	Emergency department
EHR	Electronic health record
FDA	Food and Drug Administration
HCAHPS	Hospital Consumer Assessment of Healthcare Providers and Systems
HITECH	Health Information Technology for Economic and Clinical Health
ICU	Intensive care unit
IHI	Institute for Healthcare Improvement
IT	Information technology
JCAHO	Joint Commission on Accreditation of Health Care Organizations
NCQA	National Committee for Quality Assurance
PACU	Post-anesthesia care unit
PDSA	Plan-Do-Study-Act
RFID	Radio-frequency identification devices
STEMI	ST-segment elevation myocardial infarction
TPI	Transformational Performance Improvement
TQM	Total Quality Management

1

Introduction

Managers of health care organizations are responsible for achieving the "triple aim", which is simultaneous excellence on patient experience, health, and cost (Berwick *et al.*, 2008). Reaching the triple aim requires that organizations improve their patients' experience, improve clinical outcomes for individual patients as well as for a population of patients, and reduce the per capita costs of health care. Rising cost pressures coupled with increased public reporting of clinical outcomes and patient experiences serve to increase competitive pressures on health care organizations (Chou *et al.*, 2014, Moody, 2014, O'Neill, 2015). Therefore, managers must learn how to improve performance across one or more of the three goals of the triple aim.

Performance improvement is one approach that organizations can use to learn how processes can be altered to yield higher quality care, better patient experience, and lower costs. We define performance improvement as a structured approach that uses repeated cycles of hypothesis testing to discover how processes can be modified so that they produce output that meets the performance target. In this monograph, we are particularly interested in *transformational* performance improvement—a change effort that crosses organizational boundaries with the goal of

dramatically improving performance. Transformational improvement often requires fundamental alterations to the underlying business model and processes used to deliver service, such that staff and customers will shape new ways of working together that are more efficient and yield better outcomes.

Successful execution of a transformational performance improvement initiative is challenging. Less successful improvement initiatives may focus on local (e.g., unit-level) performance, overlooking opportunities to improve organizational-level performance. They may also create unanticipated negative effects on downstream departments. Thus, it is important to develop and utilize a comprehensive system-level approach to transformational performance improvement in health care organizations that actively seeks to overcome common barriers to making change in complex organizations.

Framework for Performance Improvement in Health Care Organizations

In this monograph, we review the literature on performance improvement in health care organizations. Based on prior studies, we present a framework that synthesizes the factors associated with successful transformational performance improvement. The model, which we call the Model of Transformational Performance Improvement (TPI), comprises six key components. We describe the model in greater detail in section 2 and list the components below.

1. Determining and communicating a system-level goal
2. Developing and using system-level measures of performance
3. Understanding and managing interdependencies
4. Selecting a portfolio of projects aligned with system-level goals
5. Creating an engine for improvement
6. Implementing, spreading, and sustaining improvements

This monograph is intended for two audiences. First, it informs operations management scholars who conduct research on or teach about improvement in health care organizations. It provides a framework that can be useful for teaching about the subject, as well as a summary of the literature that can aid future research projects. Second, the monograph provides clinicians and health care leaders with knowledge about operations management techniques that can be leveraged to improve performance.

The remainder of the monograph is organized as follows. In this section, we first provide an overview of the U.S. health care system. We then discuss the need for a health care specific framework for improvement. Finally, we provide a brief introduction of key operations management concepts relevant for performance improvement. In section 2, we present the Model of Transformational Performance Improvement. We also review other models for improvement and compare them to our model. In sections 3-8, we present each of the six key components of the model, respectively. We draw on case studies and empirical research to explain the components in more depth and to provide examples of their implementation. We also link each component to relevant operations management literature streams. The literature discussed includes operational focus, health information technology (IT), patient flow, appointment scheduling, Total Quality Management (TQM), Lean, and Six Sigma. In section 9, we discuss common barriers to performance improvement that we hope can be avoided by applying the framework and the operations management principles outlined in this monograph. In sections 10-11, we provide ideas for future research and conclude.

An Overview of the U.S. Health Care System

In this section, we present a brief overview of the U.S. health care system and define key terms and concepts that will be discussed throughout this monograph. Specifically, we describe types of health care organizations, financing, and regulation. Though we frame our discussions within the U.S. health care system, many of the operations management-based

lessons of this monograph are applicable to performance improvement in health care organizations in other countries as well.

Health care in the U.S. is provided by several types of organizations. The two most predominant types of health care delivery organizations are hospitals and physician practices, though there are also nursing facilities, rural health clinics, and others (National Center for Health Statistics, 2016). Of the 4,900 general hospitals in the U.S., approximately 60% are non-profit, 20% are for-profit, and 20% are state or local government-owned (Henry J. Kaiser Family Foundation, 2015). The state or local government-owned hospitals comprise much of the public delivery system that forms the safety net for uninsured individuals and those without the means to pay for care. Hospitals provide services to patients in inpatient units such as medical units, surgical units, and obstetrics units, but also in outpatient units such as emergency departments (EDs) and hospital-based primary care practices. Altogether, hospital care accounts for nearly 40% of personal health care expenditures, which we can see in Figure 1.1 (National Center for Health Statistics, 2016).

Physician practices account for the other predominant site of health care delivery. Figure 1.1 shows that physician and other clinical services account for nearly 25% of personal health care expenditures (National Center for Health Statistics, 2016). As of 2007, the majority of physicians work in group practices, making coordination of care an important aspect of work not only across practices, but also within practices. The number of single-specialty medical groups is increasing, and nearly 60% of the 900,000 professionally active physicians in the U.S. are specialist physicians. As a result, with few integrated care delivery systems across specialties and across the continuum of care, fragmentation of care delivery is a significant and pervasive issue (Burns and Pauly, 2012).

When it comes to financing this health care system, there are three main sources of funding: private insurance plans, government insurance programs, and the patients themselves (see Figure 1.2). Financing is an important and influential factor in thinking about performance improvement in health care organizations, because health care organizations are affected by insurance policies and reimbursement systems. Changes

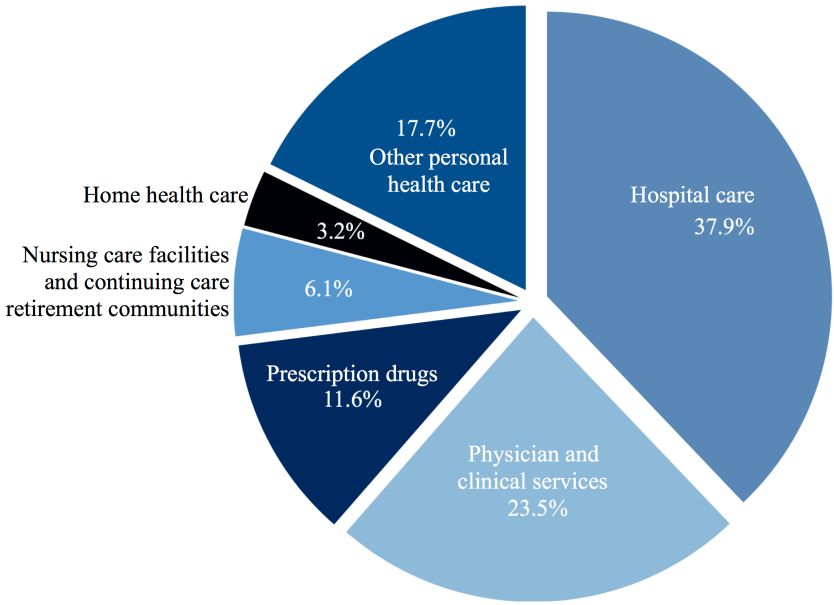

Figure 1.1: Distribution of Personal Health Expenditures by Type of Service, 2014.

Note: Other personal health care includes dental and other professional health services, durable medical equipment, and other nondurable medical products.

Source: Calculations using 2014 National Health Expenditure Accounts data from Centers for Medicare & Medicaid Services, Office of the Actuary, National Health Statistics Group, National Health Expenditure Accounts, National Health Expenditures.

and reforms of these policies shape the financial incentives of health care organizations, which in turn have important implications for health care markets, access to care, and performance improvement initiatives.

Private insurance is purchased from insurance companies, which can be either for-profit or not-for-profit. Most private insurance is purchased by employers and provided to employees as a benefit (employer-sponsored insurance); this is a preferable source of insurance because employers can effectively pool risks in a way that individuals cannot. Nevertheless, individuals may also purchase private health insurance themselves (private non-group insurance). As of 2013, approximately half of the total U.S. population had employer-sponsored insurance and

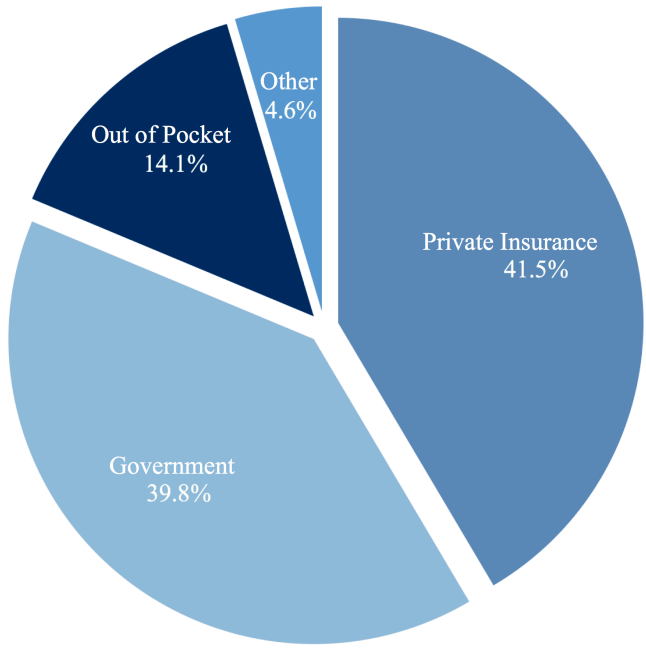

Figure 1.2: Sources of Payment for Health Care, 2012.

Source: Calculations using 2012 Medical Expenditure Panel Survey data from Agency for Healthcare Research and Quality, Center for Financing, Access, and Cost Trends.

6% of the population had private non-group insurance (Henry J. Kaiser Family Foundation, 2015).

Among the government insurance programs, the two largest programs are Medicare and Medicaid. Medicare funds health care for the elderly (aged 65 and above), the permanently disabled with a work history, and individuals with end-stage renal disease. It is comprised of four components: Part A (primarily hospital service coverage; automatic), Part B (outpatient service coverage, including physicians' fees and ED visits; optional with a monthly premium), Part C (Medicare Advantage, or alternative plans including managed care and fee-for-service care plans; optional with a monthly premium), and Part D (prescription drug coverage; optional with a monthly premium). As of 2013, Medi-

care beneficiaries constituted 15% of the total U.S. population and Medicare spending exceeded 20% of national health spending (Henry J. Kaiser Family Foundation, 2015). Medicare is federally funded and largely financed by payroll taxes of current workers and by the optional premiums. It has a relatively narrow scope of coverage and involves deductibles, coinsurance, and coverage ceilings. Almost all hospitals and physicians participate in Medicare.

On the other hand, Medicaid is a program funded jointly by the federal and state governments for low-income families and/or individuals with disabilities. As of 2013, 16% of the total U.S. population had Medicaid, and Medicaid spending constituted 15% of national health spending (Henry J. Kaiser Family Foundation, 2015). The criteria for eligibility are complex with both income and categorical criteria that vary from state to state. The services covered also vary by state, though they are generally broader than those covered by Medicare and involve limited or no cost sharing for enrollees. That said, access to care is a key issue for Medicaid beneficiaries, due to the historically low reimbursement rates to hospitals and physicians that results in a shortage in the supply of health care providers who are willing to accept Medicaid patients (Cunningham and Nichols, 2005).

Health care is a heavily regulated industry, both in terms of how the services are delivered and in terms of the various products and technologies utilized in its delivery (Field, 2007). Table 1.1 summarizes the primary regulatory functions of some of the key health care regulatory agencies and organizations in the United States. The regulations and policies that surround the industry significantly influence health care delivery and often determine what a health care organization can and cannot do. Often times, this means that transformational performance improvement efforts are subject to external regulations and policies. For example, in the United States, health care organizations are required to meet certain standards and guidelines in order to be accredited by bodies including the Joint Commission on Accreditation of Health Care Organizations (JCAHO) and the National Committee for Quality Assurance (NCQA) (Iglehart, 1996). In most states, accreditation is a regulatory requirement, without which health care organizations cannot

Table 1.1: Key Health Care Regulatory Agencies and Organizations.

Type	Agency or Organization	Primary Regulatory Function
Federal	Food and Drug Administration (FDA)	Oversees the safety of food, drugs, vaccines, biopharmaceuticals, medical devices, and cosmetics
	Environmental Protection Agency (EPA)	Regulates the discharge of environmental pollutants
	Occupational Safety and Health Administration (OSHA)	Regulates workplace safety and health
	United States Department of Agriculture (USDA)	Regulates food safety
State	Boards of medicine	Regulates the practice of medicine through the licensure, registration, and certification of physicians
	Boards of other health professions	Regulates the practice of medicine through the licensure, registration, and certification of allied health professionals
Private	Accreditation Council on Graduate Medical Education (ACGME)	Accredits post-graduate medical training programs
	Joint Commission on Accreditation of Healthcare Organizations (JCAHO)	Accredits and certifies hospitals and other kinds of health care facilities
	Medical specialty societies	Certifies physicians as qualified to practice in medical specialties
	National Committee on Quality Assurance (NCQA)	Accredits individual physicians, health plans, and medical groups

Note: Adapted from Field (2007).

operate. To stay accredited by JCAHO and NCQA, organizations may need to continually adopt changes to abide by standards and guidelines set externally. This may influence the portfolio of projects being executed by an organization and the set of performance measures that are being tracked. Another regulatory body in the United States is the U.S. Food and Drug Administration (FDA), which regulates and supervises pharmaceutical drugs, medical devices, vaccines, and other products intended for human use. In delivering care, health care organizations must stay abreast of and adapt to changes in the status of various medical products and new innovations. This may affect the way an organization decides to implement, spread, and sustain previous improvements.

For a more detailed description of the U.S. health care system, we refer the reader to *Jonas and Kovner's Health Care Delivery in the United States* (Kovner and Knickman, 2008) and the brief by National Center for Health Statistics (2016). For a more detailed review of the relationship between health insurance policies, reimbursement systems, and health service providers, we refer the reader to the *Handbook of Health Economics* (Culyer and Newhouse, 2000).

The Need for a Health Care-Specific Framework

Performance improvement has been studied in industries outside of health care, such as manufacturing (Ahire *et al.*, 1995). Although there are differences between the health care context and other industries, prior studies nonetheless provide helpful insights for improvement projects undertaken in health care organizations (Boyer *et al.*, 2012). Several practices are linked with successful performance improvement efforts. These include strong support for improvement from top management; a focus on customer needs; positive, cooperative relationships with suppliers; workforce management; information about quality issues; thoughtful product design; and process management (Kaynak, 2003, Meyer and Collier, 2001, Zu *et al.*, 2008). Some of these practices, such as top management support, provide the infrastructure necessary to launch and sustain improvement projects (Flynn *et al.*, 1995, Kaynak, 2003, Meyer and Collier, 2001, Samson and Terziovski, 1999, Sousa and Voss, 2002). Additional infrastructure is also important, such as

performance measurement systems, which provides guidance about what processes within an organization are inefficient, and on what competitive dimensions (e.g., quality, cost, flexibility, delivery) the organization is falling behind the competition (Neely *et al.*, 1995). Gaps in performance measures often lead managers to set challenging goals, which serve to engage staff members and spur them to invest in improving performance (Linderman *et al.*, 2003, Zu *et al.*, 2008). Vogus *et al.* (2010) describe a model where the infrastructure of an enabling culture supports the enacting practices, which are the problem-solving behaviors that lead to improved outcomes (Boyer *et al.*, 2012). Enabling practices of performance improvement include statistical process control and process flow management (Sousa and Voss, 2002). These in turn are associated with improved quality performance and business performance (Anderson *et al.*, 1995, Flynn *et al.*, 1995).

Key findings from quality improvement studies in manufacturing are that quality is a multi-dimensional outcome and that there is no universal set of improvement practices that lead to high performance. Instead, organizations should tailor their quality practices to achieve high performance on their strategic dimensions of performance (Sousa and Voss, 2002). Although many of the lessons learned in studies of other industries can be applied to health care organizations, health care warrants its own coverage of this topic (Asch *et al.*, 2014, Field *et al.*, 2014, Meyer and Collier, 1998).

There are special conditions present in health care delivery that distinguish it from manufacturing and other similar industries. Successful performance improvement requires attention to these conditions, which we outline in Table 1.2.

First, individual patients with similar underlying medical conditions can have very different biological responses to the same treatment. As a result, there can be greater variability and uncertainty in health care operations than in manufacturing (Bradley *et al.*, 2010a). For example, patients have differently-shaped gallbladders, which requires surgeons to adapt how they remove an infected gallbladder (Gawande, 2007). As a result of uncertainty in exactly what medical care will be needed for a patient, and how she will respond to that treatment, health care

Table 1.2: Characteristics that Distinguish Health Care Organizations from Other Industries.

Characteristic	**Description**	**Implication for Performance Improvement Efforts**
Variation in biological response to treatment by patient	Individual patients with similar underlying medical conditions can have very different biological responses to the same clinical treatment.	There is an inherent level of flexibility that will be required of clinicians to appropriately respond to individual patient differences.
Patient's integral role in the service delivery process	The patient needs to willingly cooperate with the plan of care to achieve the best quality outcomes.	Processes need to be designed to include communication with the patient, and they must be flexible enough to accommodate patient preferences.
Complex relationship between quality improvement and financial performance of health care organization	The goal of health care provision is to maximize health and minimize patient visits. Therefore, improving quality will not necessarily result in high volume of service provision for health care organizations. In health care provision, the person receiving the service (i.e., the patient) is often not paying for the majority of the cost. This leads to a situation in which the "customer" (e.g., insurance company) is not always willing to pay more for higher quality of care. A patient care episode often requires services from various entities (e.g., physicians and the hospital), making it complicated to implement broader changes that affect multiple parties.	To prevent obstacles to the improvement effort, champions of the improvement effort need to make a business case for quality, find funding to support the efforts, and determine how to appropriately allocate costs and benefits of these efforts.

providers must maintain the ability to be flexible with a patient's care plan, even if they are using standardized processes (Gawande, 2009a). Consequently, improvement efforts need to maintain some flexibility in the prescribed health care processes.

Second, the product—health—is the joint output of both the provider(s) and the patient. In other words, patients are not only involved in the production process, but integral to it. Without the cooperation and participation of the patient, it is difficult to achieve a high quality outcome (i.e., good health). This necessitates effective communication between the provider and the patient, which enables individual patient preferences to be taken into consideration when designing her care plan. Consequently, performance improvement efforts are more likely to be successful if the patient is an integral part of the improvement team (Uhlig and Raboin, 2015).

Third, the link between the quality and efficiency of services delivered and the profitability to the organization is less direct for health care organizations than it is for other service industries. The lack of a direct financial reward for improving quality and efficiency of care has been raised as an impediment to performance improvement in health care (Gawande, 2010). This is because, unlike restaurants, hotels, and other experience-based services, the goal for many patients and their health care organizations is to minimize repeat visits (Kocher and Adashi, 2011). As a result, high quality service delivery is not as clearly linked with profitability-driving repeat visits for health care organizations as it is for other service businesses depicted in the Service-Profit Chain (Heskett *et al.*, 1997). In addition, a unique feature of health care is that service is typically at least partially paid for by a third party—such as government agencies, insurance companies, and employers—rather than being paid solely by the customer. The three-party financial relationship weakens the link between customer satisfaction with service quality and willingness to pay higher prices for a higher quality experience (Gawande, 2010, Toussaint *et al.*, 2010). Furthermore, health care delivery for a patient is not conducted by a single entity—even if that care takes place within the same health care organization. Different providers working in the facility may be reimbursed separately (e.g., the physician

versus the hospital, ED versus the surgical department) (Harris, 1977). The financial silos impede the ability to work across boundaries to improve efficiency and quality (Burns and Pauly, 2012, Pham *et al.*, 2014). Additional funding mechanisms may be needed to embark on ambitious performance improvement programs (Gawande, 2010).

Thus, there is a need to study performance improvement in the context of health care organizations. Performance improvement projects in health care would need to maintain flexibility and responsiveness to individual patient needs, involve patients in the effort, consider the impact of these efforts on patient experience, and find alternate funding mechanisms.

Introduction to Key Operations Management Concepts in Performance Improvement

Many operations management concepts provide relevant insights for improving performance in health care organizations. In this section, we introduce four that pertain closely to our model: performance frontiers, queuing theory, capacity management, and the theory of swift, even flow. Below, we define each concept and explicitly state the link between the concept and a component of our model. We also provide a brief overview of the operations management literature on the concept, with particular emphasis on implications for transformational performance improvement in health care organizations. We focus on the literature most closely related to health care settings, but we also draw on other relevant research. We provide an overview of the mapping of operations management topics to the model components and monograph sections in Table 1.3.

Performance Frontiers

The first two components of our model—setting a system-level goal and creating system-level measurements to gauge progress—relate to the concept of performance frontiers. These topics are covered in sections 3 and 4, respectively.

There are multiple dimensions on which an organization can compete, including cost, quality, responsiveness (e.g., short waiting time

Table 1.3: Mapping of Operations Management Concepts on the Components of the Model of Transformational Improvement.

Component of the Model of Transformational Improvement	**Operations Management Concepts**	**Section**
1. Determining and communicating a system-level goal 2. Developing and using system-level measurements of performance	Performance frontiers - Operational focus	Section 3.2: Operational focus Section 4.2: Health information technology
3. Understanding and managing interdependencies	Queuing theory - Pooling	Section 5.2: Patient flow
4. Selecting a portfolio of improvement projects aligned with system-level goals	Capacity management - Appointment scheduling	Section 6.2: Appointment scheduling
5. Creating an engine for improvement	Theory of swift, even flow - Standardization - Experimentation	Section 7.2: Total Quality Management, Lean, and Six Sigma
6. Implementing, spreading, and sustaining improvements	Theory of swift, even flow - Standardization - Experimentation	Section 8.2.1: Organization-related factors that aid spread and sustainability Section 8.2.2: Implementation process-related factors that aid spread and sustainability

for service) and flexibility (Boyer and Lewis, 2002). Achieving excellent performance on one of the four different strategic goals requires aligning the facility's structural elements—such as technology, capacity and layout—and infrastructure elements—such as human resource policies and quality programs—to achieve that goal (Boyer and Lewis, 2002, Butler *et al.*, 1996). Skinner's seminal article from his experience with over 50 manufacturing plants finds that the best performing manufacturing plants produce a narrow range of products that enables alignment of the production system with the strategic objective (Skinner, 1974). Such alignment is called "operational focus".

As a result of the need for operational focus, production facilities that have industry-best performance on one dimension (e.g., low cost) face tradeoffs if they want to improve performance on different dimensions (e.g., delivery speed) (Boyer and Lewis, 2002). To illustrate, a facility that has optimized its processes and product portfolio to have the lowest costs in the industry would likely have to increase its inventory costs to reduce its delivery time.

Graphically, as shown in Figure 1.3, the tradeoff can be depicted by a performance frontier that represents the explicit competitive position of each company on these two dimensions. For example, the x-axis measures performance on inventory costs, while the y-axis measures performance on quality. Values farthest from the origin represent better performance. Best-in-industry companies lie on the outermost curve, which is called the performance frontier. Assuming that the performance frontier stays the same, improving performance on one dimension will result in decreased performance on the second dimension (Hayes and Pisano, 2009, Schmenner and Swink, 1998). However, companies that are *not* best-in-industry on either dimension (e.g., Company A or Company B in Figure 1.3) can adopt existing best practices and improve their performance without decreasing performance on the other dimension (Boyer and Lewis, 2002). Finally, technological and process innovations—such as Lean manufacturing—can push the industry's performance frontier outward because tradeoffs are broken (Hayes and Pisano, 2009, Schmenner and Swink, 1998).

The operations management concepts of performance frontiers and operational focus are directly relevant to performance improvement in health care organizations. A focused organization that is on the performance frontier can improve its performance via new innovations that break tradeoffs. Organizations not on the performance frontier can improve along multiple dimensions by adopting existing technology or processes used by leading organizations (Chandrasekaran *et al.*, 2012, Senot *et al.*, 2016).

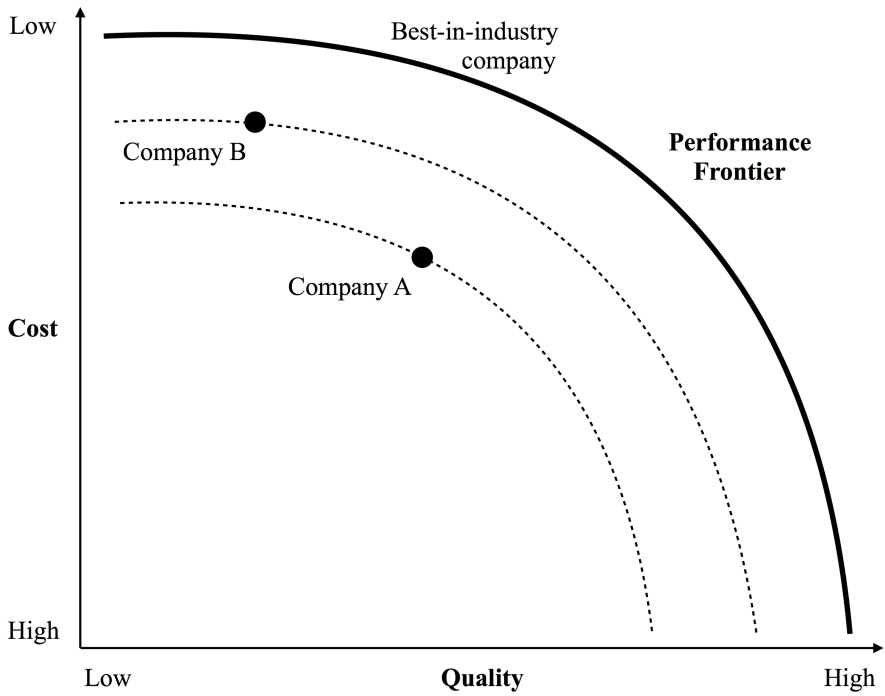

Figure 1.3: Performance Frontier.

The impact of operational focus on performance has been studied in health care. Specialty hospitals, which treat a narrow set of patient conditions—such as cardiac care—are analogous to a focused factory (Barro *et al.*, 2006). In theory, a focused hospital should have better clinical outcomes and lower costs of treatment because it can hone its processes and equipment to meet its patient population's specific needs.

The classic case study of Shouldice Hospital (Heskett, 1983) describes how focusing only on hernia patients enables the center to design its facility and procedures to achieve shorter length of stay and better patient outcomes. The higher volume of homogenous patients should also reduce complexity (Clark and Huckman, 2012) and result in faster rates of individual and organizational learning (KC and Terwiesch, 2011).

Despite the arguments for the benefit of focused hospitals, empirical studies find that specialized hospitals have better performance not because of operational excellence, but because they treat healthier patients than do general hospitals (KC and Terwiesch, 2011). Specialized hospitals also improve care in their region not through their own performance, but by inducing competition among the non-specialty hospitals in their region (Barro *et al.*, 2006). However, there does appear to be a benefit of focus at the unit level (Huckman and Zinner, 2008, KC and Terwiesch, 2011) if there is "related" diversification across units within the hospital. Related diversification is the capability of treating a medical condition that often accompanies the primary diagnosis, such cardiovascular disease (primary focus) and kidney disease (related diversification) (Clark and Huckman, 2012). This literature suggests that managers seeking to use the concept of focus to improve their organization's performance should ensure that the facility has the capability to treat not only the primary targeted medical condition, such as cardiovascular care, but also the most common comorbidities associated with that targeted condition.

Queuing Theory

Queuing theory uses mathematical formulas to approximate the average waiting time for service, given average system parameters, such as arrival rates, processing times, and utilization. Queuing theory can inform efforts to reduce waiting for services and to improve patient flow (see section 5 for a more detailed discussion). Patients often progress through multiple departments, such as the ED to the medical unit, during their health care treatment. Therefore, improving patient flow involves the third component of our model: paying attention to the interdependence

among various departments affected by the improvement project.

Queuing theorists have investigated how to improve patient flow in hospitals. One of the most significant lessons from this body of literature is that managerial decisions, such as day-to-day variation in the number of elective surgery patients, pose a bigger problem for patient flow than does the random nature of health care, such as variation in arrival rates of emergency patients (McManus *et al.*, 2003). Studies have shown that patient flow can be significantly improved by leveling the flow of elective surgery patients to provide a more constant number of patients arriving to inpatient units across the seven days of the week (Haraden and Resar, 2004, Ryckman *et al.*, 2009).

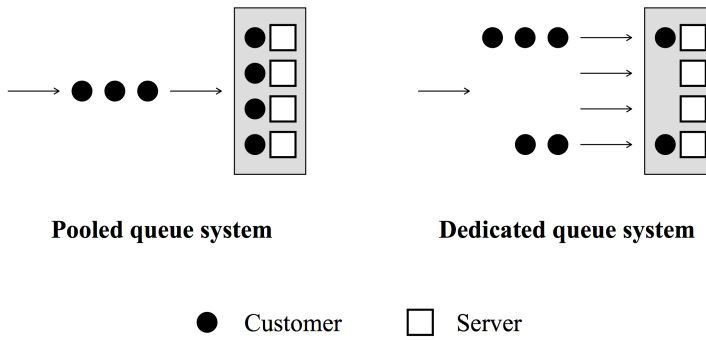

Figure 1.4: Pooled versus Dedicated Queue System.

Pooling similar types of patients (see Figure 1.4) can reduce waiting times by better utilizing available capacity (Best *et al.*, 2015, Saghafian *et al.*, 2012). However, pooling patients is not always beneficial. Patient types with low arrival rates and priority levels may end up with long waits if they are pooled with high priority, high arrival rate patients who have long average lengths of stay (Green and Nguyen, 2001). Pooling can also decrease individual clinicians' motivation to keep waiting times short. One study found that the average length of stay for ED patients is shorter if incoming patients are assigned upon arrival to a specific physician rather than waiting in a (virtual) pooled queue (Song *et al.*, 2015).

Another key lesson from the queuing literature is that high levels

of hospital occupancy result in longer length of stay (Berry Jaeker and Tucker, 2016, KC and Terwiesch, 2012, Kim *et al.*, 2015), higher readmission of patients who are discharged early to make room for incoming patients (Anderson *et al.*, 2012), and worse patient outcomes (Kuntz *et al.*, 2015). A recommendation that emerges from this literature is the importance of using state-dependent criteria for admitting patients to intensive care units (ICUs), particularly when occupancy approaches the threshold where performance worsens (Kim *et al.*, 2015).

Capacity Management

The fourth component of our model, having a portfolio of improvement projects, relates to the operations management concept of capacity management because many different interventions can be implemented to better align demand and capacity of a health care organization (Gupta and Potthoff, 2016, Jack and Powers, 2009). Specifically, section 6 reviews the appointment scheduling literature, which is a subfield of capacity management.

Capacity is a measure of an organization's processing ability, enabled by its prior investments in a variety of processing resources (van Mieghem, 2003). The amounts and locations of various resources dictate how much and what type of services an organization can offer (van Mieghem, 2003). Uncertainty in quantity, timing, type of future demand, and the lag time in creating additional production resources results in mismatches between supply and demand. For health care organizations, the consequences of mismatches are especially severe. If there is not enough capacity, patients may face long delays in receiving necessary treatment, while excess capacity is expensive for the organization (Jack and Powers, 2009).

At least three comprehensive reviews of the literature on demand and capacity management in health care have been conducted. Smith-Daniels *et al.* (1988) review papers published between 1970 and 1986. Jack and Powers (2009) pick up from that study and review the literature from 1986 to 2006. Gupta and Potthoff (2016) highlight the operational challenges, state of practice, current operations management approaches, and future research opportunities with regards to capacity management

in the operating room, ED, and inpatient settings of a hospital.

Demand management identifies causes of demand uncertainty, with the goal of removing or managing the sources of demand uncertainty (Jack and Powers, 2009). The demand management-related topics covered by the first two reviews include demand management strategies such as predicting demand using mathematical models and simulation, health management organizations, vertical and horizontal integration, and multi-hospital systems (Jack and Powers, 2009, Smith-Daniels *et al.*, 1988). Capacity management is the efficient use of internal resources to meet fluctuating demand for services (Gupta and Potthoff, 2016, Jack and Powers, 2009, Smith-Daniels *et al.*, 1988). Topics addressed by the review articles include capacity management strategies, workforce management, utilization, subcontracting, and IT. Key capacity management tactics are having flexible resources (Jack and Powers, 2004) and effective scheduling policies, such as same-day scheduling (Murray and Berwick, 2003). Performance topics include quality of care outcomes, efficiency, and financial performance (Jack and Powers, 2009, Smith-Daniels *et al.*, 1988).

Theory of Swift, Even Flow

The theory of swift, even flow is relevant for the last two components of our model: creating an organizational engine for change (section 7) and implementing, spreading, and sustaining the changes (section 8). The theory of swift, even flow states that "the more swift and even the flow of materials through a process, the more productive that process is" (Schmenner and Swink, 1998, p. 102). The flow of materials through a process can be improved by reducing non-value added work, removing impediments to flow, and reducing variability in processing time and arrival rates (Schmenner and Swink, 1998). This philosophy of management is the foundation for performance improvement programs such as TQM and Lean manufacturing. Both programs utilize frontline employees in efforts to reduce non-value added activities. Doing so first requires training them on scientific methods for problem solving. Experimentation is a key component of these methods. Once an improved method for working is discovered, processes are standardized on the

new method. Despite debate about the applicability of the concepts of swift, even flow to health care (Arndt and Bigelow, 1995), many studies have demonstrated the ability of the principles to improve quality of care and efficiency (Douglas and Fredendall, 2004, Furman and Caplan, 2007, Jimmerson *et al.*, 2005, Shortell *et al.*, 1995). Leadership support and physician involvement are two components of successful implementations in hospital settings (Carman *et al.*, 1996, Douglas and Fredendall, 2004, Harrison *et al.*, 2016).

Summary

In this section, we presented a brief description of the U.S. health care system and outlined conditions that warrant specific study of performance improvement in health care organizations. We also introduced four operations management concepts that inform improvement efforts in health care settings. In the next section, we outline our Model of Transformational Performance Improvement and review other commonly used models of improvement to highlight similarities and differences between our model and others.

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