MODELING AND MANAGEMENT OF VARIATION IN THE OPERATING ROOMS HELPS TO IMPROVE PATIENT OUTCOME

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Background

Operating rooms (OR) are relatively costly for a hospital nevertheless the health care system. Increases in the efficiency of use of the ORs results in more production. As more cases are performed within the maximum margins of the available OR time without overstepping those boundaries frequently, efficiency will eventually increase and therefore also the contribution margin for the hospital. When looking at an operating room (OR) both in an era in which both cost-containment and quality of health care are considered of prime importance, hospitals simply have to utilize ORs effectively and efficiently. Often we see the opposite in ORs. Next examples will illustrate this. Due to poor case scheduling, OR staff is forced to stand around idly, and expensive nursing, anesthesia and support staff are wasted on some of the days. On other days, the OR staff works beyond regular working hours to finish the workload on that day. Surgeons/anesthesiologists arrive too early or too late in the OR and teams are not always ready at the scheduled time. Capacity in the OR is sometimes insufficient for patients who arrive in the emergency department, which causes scheduled patients to be denied surgery that day, or for staff to work late. Such situations frequently result in nurses, doctors, management and patients becoming extremely frustrated. As this paper will demonstrate, a fundamental understanding of the variation and proper control in the OR makes it possible to improve its efficiency and effectiveness, and therefore also improve the quality of care provided to the patients.

In its influential ‘Crossing the quality chasm’, the Institute of Medicine (IoM) identifies six quality dimensions of health care, among which are efficiency and timeliness (1). The IoM described many problems in the quality of the United States health care delivery system. The report suggests that: “Health care should be:

– safe: avoiding injuries to patients from the care that is intended to help them;
– effective: providing services based on scientific knowledge to all who could benefit, and refraining from providing services to those not likely to benefit (avoiding underuse and overuse, respectively);
– patient-centered: providing care that is respectful of and responsive to individual patient preferences, needs, and values, and ensuring that patient values guide all clinical decisions;
– timely: reducing waits and sometimes harmful delays for both those who receive and those who give care;
– efficient: avoiding waste, including waste of equipment, supplies, ideas, and energy;
– equitable: providing care that does not vary in quality because of personal characteristics such as gender, ethnicity, geographic location, and socioeconomic status”.

The view the IoM has on quality is has some similarities to the view expressed in the 1991
Polish Health Care Institutions Act (2). It affirmed for example the right to good quality services. Article 68 of the Constitution of the Republic of Poland commits the public authorities to ensure that all citizens have equal access to health services, irrespective of their ability to pay. This means that the state is responsible for the health protection of its citizens, and thus for ensuring equal access to and quality of health services. Hence we can conclude that any health care provider has to offer ‘responsible’ care. Responsible care implies care of a high standard, that is appropriate care provided in an effective, efficient and patient-centered way and that meets the patient’s actual needs. To achieve appropriate care, the organizations must demonstrate that there is a planned effort to maintain and improve the quality of care in a systematic way. A systematic way means that at least three steps are to be followed: (a) the quality of care should be measured, for example by means of satisfaction surveys or quality indicators; (b) the results of such measurements are to be evaluated against explicit standards or goals; and (c) based on this evaluation, the organization is required to make the necessary changes in care processes or in their quality policy. Such a quality management approach is intended to provide for a continuous process of quality assessment and improvement of care (3, 4).

The meaning of timelines, efficient and effective health care in the OR

According to the IoM, timely access to care is “reducing waits and sometimes harmful delays for both those who receive and those who give care”. One of the most serious problems has to do with timely access to hospital services. Problems involving access to care manifest themselves in a variety of forms, including rejection of patients seeking services. For instance, when a patient accesses the hospital, he or she is likely to encounter waits, delays, and cancellations. If the patient requires surgery, it is not uncommon to experience waits due to stacking of cases in the OR, or to be delayed by more than one day, even on the day of surgery itself. The start of the surgery schedule in the morning is often delayed, putting pressure on the timeliness of the surgeries of the scheduled patients, more so when non scheduled patients arrive from the Emergency Department. As a result, OR staff may need to work overtime. Having to work frequently beyond regularly scheduled hours due to badly scheduled ORs can lead to both overtime costs and intangible costs, the latter resulting from dissatisfaction and reduced motivation on the part of the staff (6, 7).

Another effect of delay in care delivery in the OR is the extension of a patient’s length of stay this entails. Prolongation of the stay of a patient implies that the occupied bed cannot be given to another patient, and hence fewer patients can be served. Not only do increases in the length of stay therefore result in extra cost and/or loss of revenue, they are also major sources of both patient and provider dissatisfaction with the present care delivery system. The variations caused by the various aforementioned problems has been reported to cause poor patient flow, emergency department overcrowding and hence limited access to care, nurse understaffing/overloading, diminished quality of care and high health care cost (8).

Efficient care “avoids waste, including waste of equipment, supplies, ideas, and energy” (1). For the sake of argument, consider a situation where all patients have the same disease, the same degree of illness, and respond identically to therapy. Let us further assume that all patients are elective patients and all medical practitioners and health care systems are standardized. In this highly stylized situation, 100% efficiency in health care delivery might be attainable. Within the boundaries of knowledge and technology, there would be zero waste (9). In reality, patients vary, have different diseases, and respond differently to therapy, etc. The natural variation influences the delivery process. Controlling the variation can, however, be useful in making the processes more predictable, and hence increasing efficiency.

Effective care “is based on providing services based on scientific knowledge to all who could benefit, and refraining from providing services to those not likely to benefit (avoiding underuse and overuse, respectively)”1. Instruments to achieve organizational and workforce excellence are, for example, lean thinking and Six Sigma. Lean is an important dimension of quality; all work that doesn’t add value for the customer is defined as waste. Six Sigma is a methodology that uses data and statistical analysis to measure analysis and improve a company’s opera-
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The meaning of health care quality and how do achieve it

The Donabedian model (11) of structure-process-outcome is generally used as the basis for much of the work addressing quality and outcomes. Donabedian framed the concept of quality assurance in terms of three types of measures (fig. 1): structure (what do we need to have to be able to achieve quality), process (what do we need to do to achieve quality), and outcomes (what do we need to achieve).

Donabedian notes that any efforts to improve quality need to recognize that health care is embedded in, and greatly influenced by, the larger external environment. Structure relates to static characteristics such as facilities, equipment, and personnel (12). Process consists of activities involved in the process of delivering health care services, including the technical and interpersonal actions of health providers and patients as well as organizational processes within the health care system (13). In other words, process looks at what takes place during care, while outcomes assess the effect on care in regards to a patient’s health. Donabedian suggests that each dimension can be judged independently or in conjunction. Furthermore, he says that if both structure and process are adequate, one can assume the outcome will be positive.

From surgical planning and process to outcome

*Does increased timeliness, and efficient and effective scheduling of surgical cases lead to improved outcomes?*

Surgical delay has been shown to be an important determinant of patient satisfaction across the continuum of preoperative-operative-postoperative care (14). Delays in scheduled surgical cases affect patient satisfaction even more than the intraoperative anesthesia experience (15). Delays in surgery resulting from cancellations, bumping of cases and poor scheduling can have a significant impact on quality of care for scheduled cases as well (16). Delays only add to the patient’s inherent anxiety associated with surgery and engenders anger and frustration. The operating room, by its very nature, is an extremely stressful, uncertain, dynamic, and demanding environment where staff members need to manage multiple highly technical tasks, often simultaneously (16, 17). Other factors also impact the system within the OR. Examples are individual, group and organizational performance issues such as team- and time management, interpersonal skills, leadership, workload distribution, dynamic decision making, human machine interface, problem detection, capture of errors (slips, mistakes, fixation bias), loss of situational awareness, high mental and physical workload, fatigue, environmental stress, production pressure and personal life stress (18). Moreover, the dynamics of the OR are complex because they form a point of intersection among multiple groups with their own agendas and requirements. Since ORs are relatively scarce resources, poor scheduling and misuse of ORs can provide opportunities for conflict and competition.

OR staff carry out their sometimes long working days under time pressure. The Joint Commission on the Accreditation of Healthcare Organizations has identified time pressures to start or complete the procedure as one of four contributing factors to increased wrong site surgery (19). Similar to other professions, the undue pressures of time that result from falling behind create stress that can lead to cutting...
corners or inadvertent error. Relative to other hospital settings, errors in the operating room can be catastrophic (i.e. wrong site surgery, retained foreign body, unchecked blood transfusions). In some cases these errors can result in high-profile consequences for the patient, surgeon or hospital (20). In other words, poor scheduling and the subsequent induced variation in processes reduces outcome.

Positioning OR activities within a planning framework

The flow of activities in the OR through surgical case planning, directing, and controlling, and then back to planning again can be formalized by a planning and control cycle. Because there are some differences between industry and service-oriented industries (21-24) a production control framework for hospitals has been developed (21). Characteristic for this framework is that patients, processes and chains are the basis for organizing care and it deals with balancing effective, efficiency and timely care. The framework is based on an analysis of the design requirements for hospital production control systems (25,26) and builds on the production control design concepts developed (27). It is then applied in the context of the OR. In this thesis

Fig. 2. Production control framework (21)
the decisions made on the first four levels of the model are given. The focus of the paper is on the fifth level of the production control framework as applied to the OR. This level concerns the actual scheduling of patients, given planning rules and service requirements for the coming days or weeks. It is concerned with the processes used in facilitating day-to-day activities that need to be performed to deliver timely, effective and efficient care for the patient.

Based on the time required to construct schedules as well as the quality of resulting schedules (28, 29) evidence indicates that case scheduling in practice often is performed poorly (9, 30). Additionally, methods which improve the reliable estimate of surgical cases naturally lead to improved timeliness, efficiency, and effectiveness of OR processes (31-35, 38, 39, 40). As stated earlier, poor surgical case scheduling and the subsequent induced variation in processes reduces outcome. Reasoning along these lines, W. Edwards Deming concluded that the real enemy of quality is variation in processes. A main objective in operations management is therefore to identify sources of variation (10). Though variation exists in every process and always will, controlling the identified variation helps managers and clinicians to improve efficiency by aligning the health service delivery processes towards the desired results (8). Because the OR is a leading source (21) controlling variation of OR schedules and processes has the second order effect of reducing variation and improving quality in subsequent processes throughout in the hospital. Indeed, an OR scheduling process which reduces the census variability of the OR, can improve the flow of surgical patients to downstream inpatient units, resulting in a more even and predictable patient care burden. Furthermore accurate preoperative scheduling of surgical episodes is critical to the effort to minimize variability in the length of the surgical day and maintain on time starts for cases to follow (36).

CONCLUSIONS

Based on the aforementioned reasoning we may conclude that addressing the issue of improving the outcome of healthcare in the OR can be done by modeling and managing variation in medical operations. This will results in an increase in the timeliness, efficiency and effectiveness of health care. This can be realized by using a planning and control-based activity that focuses continuously on controlling variation. The result is twofold: First through the feedback loop in the production control framework it results in a better control of hospital activities (21). Second, it may help to achieve meaningful, sustainable improvement of quality of care in the OR and consequently in the subsequent delivery health care system. Or to put it in the perspective of the process part of Donabedian’s model: this is how to improve the outcome of healthcare.
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