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Efficiency improvement in the operating room

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ABSTRACT

Background: In the changing health care environment, health systems, hospitals, and health care providers must focus on improving efficiency to meet an increasing demand for high-quality, low-cost health care. Much has been written about strategies and efforts to improve efficiency in the perioperative periods, yet the time when the patient is in the operating room—the intraoperative period—has received less attention. Yet, this is the period in which surgeons may have the most influence.

Methods: Systematically review published efforts to improve intraoperative efficiency; assess the outcomes of these efforts, and propose standardized reporting of future studies.

Results: A total of 39 studies were identified that met inclusion criteria. These divided naturally into small (single operative team), medium (multi-operative team), and large (institutional) interventions. Most studies used time or money as their metric for efficiency, though others were used as well.

Conclusions: There is substantial opportunity to enhance operating room efficiency during the intraoperative period. Surgeons may have a particular role in procedural efficiency, which has been relatively unstudied. Common themes were standardizing tasks, collecting and using actionable data, and maintaining effective team communication.

Introduction

Hospitals and health systems must focus on improving efficiency to meet the increasing demands for high-quality, low-cost care. Although much has been written about the need and strategies to improve efficiency of the preoperative and post and/or interoperative periods,[1] the intraoperative period—when the patient is in the operating room (OR)—has received less attention. Yet, the intraoperative period is the primary OR experience, the basis for procedure billing, and the period of time over which surgeons may have the most influence.

Most surgical dollars are spent in the OR,[2] making this a high-priority target for efficiency efforts. As the public becomes more aware of differences in health care spending,[3,4] hospitals may hold surgeons more responsible for controlling variable OR costs.[5,6] Beyond this, surgeons have additional incentives for OR efficiency—time savings may translate to an earlier finish or the opportunity to perform more cases during the same block time. Because surgeons direct and perform surgical care on behalf of their patients, they are in the ideal position to ensure that efficiency improvements do not threaten patient care.

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To raise surgeon awareness of OR efficiency (as has been previously done for quality[7]), this article summarizes currently published studies of intraoperative efficacy improvement, examines the outcomes of these efforts, and proposes standardization of reporting future efforts in the surgical literature.

Methods

Key search terms were determined by background reading on health care and manufacturing efficiency.[8-11] We queried PubMed in April 2015 via the following search: ["operating room" OR "surgery" OR "surgical"] AND ["Efficiency" OR "Lean" OR "Six Sigma" OR "parallel processing" OR "process mapping" OR "process map" OR "value stream mapping" OR "value stream map" OR "total quality improvement"]. We excluded nonrelevant search results and articles not in English and then manually screened the remaining abstracts and their references for appropriate articles.

"Efficiency" is a widely used word in health care with multiple definitions[8]; for this study, we focused on efforts to produce improvements in time, costs, or their proxies. We defined our inclusion criteria as any article describing a method to improve intraoperative efficiency and reporting results of an outcome measure. We defined the intraoperative time period to be that when the patient is in the operating room, including anesthesia time but not patient transport or room changeover time ("interoperative" time). Articles solely reporting preoperative, postoperative, or interoperative efficiency were excluded as were articles solely regarding on-time starts, scheduling, ergonomics, cancellations, training, admissions, room change-overs, room airflow, quality measures, and work-life balance.

Each author independently selected articles based on inclusion criteria, and disagreements were settled with consensus. References of included articles were scanned for additional articles. After this iterative process was exhausted, the resultant articles were surveyed and categorized by focus and methodology. Level of evidence was assigned as a group from these articles based on the Agency for Healthcare Research and Quality National Guideline Clearinghouse guidelines. Two authors (A.F. and A.L.) then abstracted results from these studies and grouped them into the categories presented in the results.

Results

The initial search generated 26,798 results. Of these, 3602 remained after initial screening, and 182 articles and their references were screened individually for relevance. Of these, 37 studies were identified by all authors as meeting inclusion criteria; an additional eight articles were identified by at least one author, and of these, two were added based on consensus review for a total of 39 articles (Table). The PRISMA flowchart and the stratification for focus on intraoperative efficiency are summarized in Figure 1. For explanatory and supportive purposes, we also have cited an additional 49 review, analytical, and nonintervention descriptive articles in this article.

Of the 39 intervention articles, 29 (74%) used time as their metric for efficiency, 9 (23%) used financial measures, and 12 (31%) studies used other metrics such as tool reduction, case number, delays, and steps. Some studies used more than one metric and some included quality metrics as well. The most common factors studied were parallel processing ($n = 7$), lean management ($n = 2$), value stream/process mapping ($n = 5$), checklists ($n = 2$), OR redesign and environment ($n = 2$), six sigma ($n = 2$), and total quality management ($n = 2$). Most articles focused on the OR space or the surgical team and did not examine efficiency of the operative procedure itself.

Interventions were naturally partitioned into three categories based on scale: small (those that could be implemented in a single operating room potentially by a single surgeon or team); medium (those that require a surgical group or floor cooperation); and large (those that require major institutional buy-in, support and change). Common themes across these interventions were standardization, collecting and using actionable data, and maintaining effective communication.

Small-scale efficiency interventions

"Small" interventions can be implemented relatively quickly and can be considered first-line approaches to improving OR efficiency. A single surgeon or small groups of surgeons might initiate these interventions, which include:

Surgical workflow redesign

Attarian used interoperative and intraoperative workflow analysis to make multiple changes in staff behaviors and generate a case increase of 29% for total joint arthroplasties (from 2.35 to 3.04 average cases per OR per day[12]). Krasner standardized setup and introduced parallel task completion to reduce coronary bypass procedure time an average of 22 min (18%), anesthesia time 10 min (38%), and total OR time 67 min (21% of the initial average time of 314 min[13]). Such time savings may allow more cases to be completed if they are shorter (more revenue per OR day) or allow longer cases to be completed within standard shifts to avoid overtime (lower costs per OR day). Bender managed to accomplish both of these goals in a large academic medical center using a six sigma approach that included input from members of the surgical team and administration; cases increased by 9% and overtime decreased from 7% to 4%, resulting in a 14% decrease in personnel costs and a 19% increase in OR revenue.[14]

Three studies applied process-mapping surgical procedures, which outline every step of the case and expected team tasks to decrease staff uncertainty and encourage anticipatory preparation. Chalian reduced operative time by 12% in 21 head and neck cancer resection cases by designating intraoperative pathways and standardizing planned instrumentation.[15] Casaletto reduced operative time by 20% and reduced the number of surgical steps from 66 to 37 in eight carpal tunnel decompression cases.[16] Lee mapped the intraoperative process of deep inferior epigastric perforator flap breast reconstruction and instituted simultaneous flap harvest and breast resection (parallel processing, Fig. 2). This change resulted in an average case length reduction of 16% (8.2 to 6.9 h for unilateral and 12.8 to 10.6 h for bilateral reconstruction) and reduced operative costs by 5%-12%.[17]