



Original Contribution

At most hospitals in the state of Iowa, most surgeons' daily lists of elective cases include only 1 or 2 cases: Individual surgeons' percentage operating room utilization is a consistently unreliable metric



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ABSTRACT

Study objective: Percentage utilization of operating room (OR) time is not an appropriate endpoint for planning additional OR time for surgeons with high caseloads, and cannot be measured accurately for surgeons with low caseloads. Nonetheless, many OR directors claim that their hospitals make decisions based on individual surgeons' OR utilizations. This incongruity could be explained by the OR managers considering the earlier mathematical studies, performed using data from a few large teaching hospitals, as irrelevant to their hospitals. The important mathematical parameter for the prior observations is the percentage of surgeon lists of elective cases that include 1 or 2 cases; "list" meaning a combination of surgeon, hospital, and date. We measure the incidence among many hospitals.

Design: Observational cohort study.

Setting: 117 hospitals in Iowa from July 2013 through September 2015.

Subjects: Surgeons with same identifier among hospitals.

Measurements: Surgeon lists of cases including at least one outpatient surgical case, so that Relative Value Units (RVU's) could be measured.

Main results: Averaging among hospitals in Iowa, more than half of the surgeons' lists included 1 or 2 cases (77%; $P < 0.00001$ vs. 50%). Approximately half had 1 case (54%; $P = 0.0012$ vs. 50%). These percentages exceeded 50% even though nearly all the surgeons operated at just 1 hospital on days with at least 1 case (97.74%; $P < 0.00001$ vs. 50%). The cases were not of long durations; among the 82,928 lists with 1 case, the median was 6 intraoperative RVUs (e.g., adult inguinal herniorrhaphy).

Conclusions: Accurate confidence intervals for raw or adjusted utilizations are so wide for individual surgeons that decisions based on utilization are equivalent to decisions based on random error. The implication of the current study is generalizability of that finding from the largest teaching hospital in the state to the other hospitals in the state.

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1. Introduction

Percentage utilization of operating room (OR) time is not an appropriate endpoint for planning additional OR time for surgeons with high caseloads [1–8], and cannot be measured accurately for surgeons with low caseloads [9–11]. Nonetheless, many OR directors claim that their hospitals measure and make decisions based on individual surgeons' OR utilizations [12–14]. This incongruity may reflect a combination of lack of scientific knowledge of OR management science, reliance on

hospital committees for decision-making involving mathematics, and ineffective communication with suitable experts [15–17].

A course that includes this topic of surgeon-specific OR utilization and suitable alternatives [1–11] was designed [18–23] to improve these processes of evidence-based OR management decision-making [15–17]. The lectures and cases are publically available online, including one about service-specific staffing and another about calculating surgeon block time [24–27]. However, such an educational program would be an ineffective strategy for increasing OR productivity nationwide if the OR managers think that the results do not apply to their hospitals (i.e., do not apply outside the realm of the studied hospitals).

The earlier mathematical studies [9,10] relied on data principally from one large teaching hospital [7,9,10,28,29]. Thus, it is possible that the studies' results [9,10] are of limited generalizability to the >90% of

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hospitals nationwide that are not large teaching hospitals [29,30]. Potentially, the majority of hospitals can measure each of their surgeon's adjusted or raw utilizations (i.e., with or without turnover times) sufficiently accurately for quality decisions. In the current study, we assess the generalizability of the previous studies related to OR utilization [9, 10].

The important mathematical parameter, that would influence the generalizability of the lack of accuracy in measuring utilization by surgeon, is the percentage of hospitals can measure each of their surgeon's adjusted or raw utilizations (i.e., with or without turnover times) sufficiently accurately for quality decisions. In the current study, we assess the generalizability of the previous studies related to OR utilization [9, 10].

At large teaching hospitals [29], lists including 1 or 2 cases are common. For example, we studied reducing the hours that anesthesiologists and nurse anesthetists worked late [7], at a large teaching hospital with long work hours [29,31,32]. At the outpatient surgery center of the hospital, over the studied year [7], only 3% of surgeons (2/65) had enough workload to fill 1 OR for 8 h every week. There were just 1 or 2 cases for 62% of the surgeon-day combinations with at least 1 case. At the hospital's main surgical suite, only 28% of its surgeons (59/211) had enough workload to fill 1 OR every week. There were 1 or 2 cases for 59% of the 7247 surgeon-days. These percentages of 1 or 2 cases both exceed 50%; $P < 0.00001$. Consequently, hospital-specific policies involving optimization of block time utilization would, by definition, not be applicable to most surgeons, because the utilization cannot be measured accurately. The small caseloads resulted in most surgeons (i.e., $>50\%$; $P < 0.00001$) having coefficients of variation of scheduled hours and turnover times, among the days with at least 1 scheduled case, that were large ($>30\%$) compared with the coefficients of variations of the specialties [3].

The specific question studied in the current paper is whether the typical (i.e., not a large teaching) hospital in a large region also has most ($>50\%$) surgeon lists with just 1 or 2 cases. If this tested hypothesis were accepted (i.e., average percentage $> 50\%$), then the earlier findings – that OR utilization of individual surgeons cannot be measured accurately for most surgeons [9,10] – would apply to smaller, non-teaching hospitals as well. To quantify the average percentage of lists with 1 or 2 cases, we used data for all elective surgical cases at all 117 non-federal hospitals in the state of Iowa, of which only 3 are large teaching hospitals [29,33].

2. Methods

The data studied were from the Iowa Hospital Association's (IHA) inpatient and outpatient data sets of all encounters at hospitals in the state of Iowa, excluding behavioral health and HIV. The patient data were edited prior to release for integrity and to comply with Health Insurance Portability and Accountability Act (HIPAA) regulations. The University of Iowa Institutional Review Board determined that the project did not meet the regulatory definition of human subjects research. We studied combinations of surgeon, hospital, and date (i.e., "lists" of cases) performed at the 117 hospitals in Iowa from July 1, 2013 through September 30, 2015 [34].

2.1. Data analyzed

Table 1 shows, in detail, the steps that were followed to obtain the analyzed data. The following text describes the context.

Each of the studied lists of cases included at least one of the 4159 surgical Current Procedural Terminology (CPT) codes with non-zero corresponding intraoperative work Relative Value Units (RVU's) [35] and with non-zero corresponding American Society of Anesthesiologists' anesthesia base and time units [36]. We studied the lists that

Table 1 Methods to obtain the studied 175,751 combinations of surgeon, hospital, and date (i.e., "lists" of cases) from the Iowa Hospital Association Revenue File, Outpatient Database, and Inpatient Database.

# Cases	Revenue records	Description
61,871,243	Iowa Hospital Association's Outpatient Revenue Records with service date from July 1, 2013 through September 30, 2105	
– 60,447,792	Each revenue file record contains one Healthcare Common Procedure Coding System (HCPCS) code. Excluded all records with HCPCS not a surgical Current Procedural Terminology (CPT) code (i.e., excluded codes not 10,000 through 69,999)	
936,722	1,423,451	All outpatient visits involving a surgical procedure
– 956,882	CPT Codes with 0 intraoperative work Relative Value Units (RVU) or 0 American Society of Anesthesiologists' anesthesia base units	
381,689	466,569	Revenue records, with > 0 intraoperative work RVU and > 0 anesthesia base units
– 1302	Surgeon missing (0.3%), with surgeon defined as the National Provider Identifier "of the physician with primary responsibility for performing the principal surgical procedure." The actual surgeon codes were all blinded for analysis.	
– 6933	Case performed on a weekend	
373,454	Outpatient cases analyzed	
36,032	Iowa Hospital Association Inpatient Database searched for the surgeon having had 1 or more elective inpatient admissions at the hospital on the date. An admission was considered to represent elective surgery if both (1) the type of admission code was Elective and (2) the date of the principal procedure was the date of admission.	
409,756	Elective surgical cases studied among the 117 state of Iowa Hospitals performed in an outpatient facility or in a hospital on the same day of admission	

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