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Short communications

Mean operating room times differ by 50% among hospitals in different countries for laparoscopic cholecystectomy and lung lobectomy

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Abstract
We explored whether there were large differences in operating room (OR) times for two common procedures performed by multiple surgeons at each of several hospitals thousands of miles apart. Mean OR time, "wheels in" to "wheels out," for ten consecutive cases of each of laparoscopic cholecystectomy and lung lobectomy were obtained for each of ten hospitals in eight countries from their OR logs. After log transformation, the OR times were analyzed by analysis of variance. Mean OR times differed significantly among hospitals ($P = 0.006$, laparoscopic cholecystectomy; $P < 0.001$, lung lobectomy). The second longest average OR time was 50% longer than the second shortest average OR time for both laparoscopic cholecystectomy and lung lobectomy. Differences in OR times among the hospitals we studied were large enough to affect the productivity of OR nurses and anesthesia providers. Thus, international benchmarking studies to understand differences in OR times worldwide may be beneficial.

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During the next 20 years, increasing numbers of elderly patients will result in large (e.g., 35% to 48%) [1,2] increases in surgical caseloads. However, the expansion of outpatient surgery centers has reduced operating room (OR) productivity, as the workday is usually far less than 8 h [2]. Change is needed now to increase provider productivity [3]. This can be accomplished in four ways: change the provider mix [3], reduce hours that are scheduled but idle (underutilized) [4], reduce hours worked late (overutilized) [5,6], and reduce OR times per case [7,8]. Progress has been made in understanding how to improve on the first three items, and how to estimate the impact of reductions in OR times on productivity [7,8]. Consequently, scientific work can and should focus on OR times. A limitation is that productivity is generally unchanged by small (≤15%) reductions in OR times [7,8]. We explored whether there were large differences in OR times for two common procedures performed by multiple surgeons at each of several hospitals thousands of miles apart. If there were large differences in OR times, then comparison of practices among hospitals resulting in the differences may reveal strategies to increase provider productivity through reductions in OR times. We

simultaneously examined potential relationships between OR time and the use of additional personnel, induction rooms, anesthesia bays, and/or regional block rooms.

Two common procedures performed with general anesthesia were studied: laparoscopic cholecystectomy and lung lobectomy. The precise definitions used were those corresponding to the *International Classification of Diseases Version 9 Clinical Modification* procedure codes 51.23 and 32.4, respectively. Each author described the most common staffing for these procedures at his or her hospital in December 2004. Author, county, academic affiliation, and hospital name are listed at the start of the article. Mean OR time, "wheels in" to "wheels out," for ten consecutive cases of each of the study procedures performed alone were obtained for each hospital from their OR logs.

Power analysis for the study design was based on OR times following log normal distributions [9]. The natural logarithm of the SD of the OR times in hours equaled 0.351 for both laparoscopic cholecystectomy and lung lobectomy at the Midwestern United States hospital. From the properties of log normal distributions [10], the chosen sample size of ten cases was predicted to provide mean SEs of 11% of the true mean.

After log transformation, the OR times were analyzed by analysis of variance. Relationships between the anesthetic practice at each hospital and the mean OR time were explored by two-sided Wilcoxon-Mann-Whitney test.

The quantitative differences in OR times among hospitals was studied using the second shortest and longest times to eliminate the outliers.

We found that OR times differed significantly among the ten hospitals in eight countries (Table 1; $P = 0.006$, cholecystectomy; Table 2, $P < 0.001$, lung lobectomy). The second longest average OR time was 50% longer than the second shortest average OR time for laparoscopic cholecystectomy and 51% longer for lung lobectomy.

Exploratory analysis identified that the presence of additional personnel may explain some of the variation ($P = 0.03$), but not the use of block rooms, induction rooms, and/or bays. Although such locations were used widely at the studied hospitals, they were not used for induction of general anesthesia for the studied procedures.

The observed 50% differences in mean OR times among the hospitals we studied were large enough to affect the productivity of OR nurses and anesthesia providers (see Abstract). These preliminary, yet provocative results, suggest that performing studies to quantify and understand differences in OR times among academic hospitals *worldwide* may be beneficial.

Table 1. Mean OR times for ten laparoscopic cholecystectomy cases at each hospital

	Australia	Canada	Finland	France	Japan	Sri Lanka	Switzerland	US East Coast	US Midwest	US West Coast
Mean time in the OR ("wheels in" to "wheels out") where laparoscopic cholecystectomy is performed (h)	1.6	1.8	1.9	1.9	2.1	1.4	1.8	2.8	2.4	2.0
Standard error of mean (h)	0.2	0.1	0.2	0.1	0.3	0.2	0.2	0.5	0.4	0.2
Will an ASA 1 patient undergoing laparoscopic cholecystectomy likely be intubated before entering the OR where surgery will be done?	No	No	No	No	No	No	Yes	No	No	No
If an anesthesiologist serves as the primary anesthesia provider for a patient undergoing laparoscopic cholecystectomy, will a dedicated assistant be available?	Yes	No	Yes	No	No	Yes	Yes	No	No	No

Table 2. Mean OR times for ten lung lobectomy cases at each hospital

	Australia	Canada	Finland	France	Japan	Switzerland	US East Coast	US Midwest	US West Coast
Mean time in the OR ("wheels in" to "wheels out") where lung lobectomy is performed (h)	1.8	4.0	3.9	3.4	2.7	3.1	4.7	3.9	2.8
Standard error of mean (h)	0.1	0.3	0.2	0.2	0.3	0.4	0.5	0.3	0.2
Will a patient likely be intubated before enteringthe OR where surgery with be done?	No	No	No	No	No	No	No	No	No
Would placement of thoracic epidural for lung lobectomy likely be done *before* patient enters OR where surgery is done?	Yes	No	Yes	No	No	Yes	No	Yes	No

The hospital in Sri Lanka is absent from Table 2, as thoracic surgery is not performed at that hospital

Differences in OR times may reflect differences in how procedures are performed and may result in differences in patient outcomes. For example, differences in OR times for lung lobectomy may be influenced by the degree of lymph node dissection and by whether frozen sections were obtained to assure a negative margin. Benchmarking studies of OR times need to study, simultaneously, precisely what is being done in the OR and the resulting influence on patient outcome. Our experience has shown that organizations are hesitant to embark on such expensive observational studies without knowing, a priori, that there are, in fact, very large differences in OR times. This was the authors' objective when working by e-mail, meeting during the American Society of Anesthesiologists' meeting in 2004, and then performing the current work.

By design, we were not detecting academic versus nonacademic differences. Large (71%) differences in OR time have been reported as the learning curve for laparoscopic cholecystectomy [11]. Overall 18% differences in OR time have been observed in a comparison of four academic hospitals in the United States to the nationwide average [12]. We avoided the academic—nonacademic issue.

Single-hospital studies have found that the principal determinant of OR time for a procedure is the surgeon [12,13], and the second most important determinant is the type of anesthesia [13]. In the present study, the latter was the same for all patients (general). Thus, the anesthesia issues that we evaluated were the use of assistants, induction rooms, and regional analgesia placement outside the OR [14,15]. Our findings match those of the previous studies. First, international benchmarking should focus on differences in surgical processes among hospitals, even when the listed procedure is the same. Second, the number of anesthesiologists present per anesthetizing location and their activities are important too [16–18].

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