Both Bias and Lack of Knowledge Influence Organizational Focus on First Case of the Day Starts

Elisabeth U. Dexter, MD, FACS*

Franklin Dexter, MD, PhD†

Danielle Masursky, PhD‡

Michael P. Garver, MSEE§

Nancy A. Nussmeier, MD‡

BACKGROUND: The economic costs of reducing first case delays are often high, because efforts need to be applied to multiple operating rooms (ORs) simultaneously. Nevertheless, delays in starting first cases of the day are a common topic in OR committee meetings.

METHODS: We added three scientific questions to a 24 question online, anonymous survey performed before the implementation of a new OR information system. The 57 respondents cared sufficiently about OR management at the United States teaching hospital to complete all questions.

RESULTS: The survey revealed reasons why personnel may focus on the small reductions in nonoperative time achievable by reducing tardiness in first cases of the day. (A) Respondents lacked knowledge about principles in reducing over-utilized OR time to increase OR efficiency, based on their answering the relevant question correctly at a rate no different from guessing at random. Those results differed from prior findings of responses at a rate worse than random, resulting from a bias on the day of surgery of making decisions that increase clinical work per unit time. (B) Most respondents falsely believed that a 10 min delay at the start of the day causes subsequent cases to start at least 10 min late ($P < 0.0001$ versus random chance). (C) Most respondents did not know that cases often take less time than scheduled ($P = 0.008$ versus chance). No one who demonstrated knowledge (C) about cases sometimes taking less time than scheduled applied that information to their response to (B) regarding cases starting late ($P = 0.0002$).

CONCLUSIONS: Knowledge of OR efficiency was low among the respondents working in ORs. Nevertheless, the apparent absence of bias shows that education may influence behavior. In contrast, presence of bias on matters of tardiness of start times shows that education may be of no benefit. As the latter results match findings of previous studies of scheduling decisions, interventions to reduce patient and surgeon waiting from start times may depend principally on the application of automation to guide decision-making.

(Anesth Analg 2009;108:1257–61)

Delays in starting first cases of the day are a common topic in operating room (OR) committee meetings. Multiple prior studies have evaluated proposed strategies[1–5] to reduce the percentages of first cases starting late. The direct economic benefit of reducing such first case delays is often small (see companion article).[6–9] Not only are the time reductions in each OR often limited, but the costs of reducing the delays can be high because efforts need to be applied to multiple ORs simultaneously. Our survey at a hospital revealed some reasons why personnel working in ORs may focus on small reductions in nonoperative time.

From the *Section of General Thoracic Surgery, Department of Surgery, State University of New York [SUNY] Upstate Medical University, Syracuse, New York; †Division of Management Consulting, Departments of Anesthesia and Health Management and Policy, University of Iowa, Iowa; ‡Department of Anesthesiology, SUNY Upstate; and §Materials Management, SUNY Upstate, New York.

Accepted for publication December 15, 2008.

Franklin Dexter is Section Editor of Economics, Education, and Policy for the Journal. This manuscript was handled by Steven L. Shafer, Editor-in-Chief, and Dr. Dexter was not involved in any way with the editorial process or decision.

Address correspondence and reprint requests to Franklin Dexter, MD, PhD, Division of Management Consulting, Department of Anesthesia, University of Iowa, Iowa City, IA 52242. Address e-mail to Franklin-Dexter@UIowa.edu or web site www.FranklinDexter.net.

DOI: 10.1213/ane.0b013e31819a6dd4

METHODS

After obtaining exemption status from the University's Institutional Review Board of Human Subjects Studies, an e-mail inviting participation in the survey was sent to the nursing staff and administration, surgeons, and anesthesia providers working at the hospital's 16 ORs. Respondents accessed the secure web site (WebSurveyor, Herndon, VA) by clicking on a hyperlink in the e-mail or by typing in the URL. They read the consent form, selected that they agreed to participate, and attested both that they work at the study hospital and had not completed the survey previously.

Our objective was to learn about perceptions of OR personnel who cared sufficiently about OR management that they completed a 27 question process improvement survey. We also wanted not to influence responses, since issues of time and delays are emotionally charged.[10–12] To address both objectives, we inserted three questions regarding OR operations research into the hospital's 24 question survey of ways to improve its handling of surgeon preference cards. The survey was performed while the hospital was implementing its new OR information system incorporating a new format for creating and updating surgeon preference cards. For example, the survey asked whether patient positioning should be added to the new preference cards.

The 57 respondents included 23 registered nurses or surgical technologists, 20 attending or resident surgeons, and 14 "others" including 7 anesthesiologists. The same hyperlink was used for all respondents to emphasize anonymity. Nothing else is known about respondents. Respondents had to answer all questions to submit the survey.

In deliberate contrast to our previous psychological studies of OR management decision-making at different hospitals,[13–15] no education was provided as part of the study. We are aware of no education in OR management at the hospital before the survey other than one 45 min Grand Rounds guest lecture "OR management decision-making to maximize OR efficiency" given in the Anesthesiology department 34 mo previously.

Question #1

We previously showed that most anesthesiologists, OR nurses, and housekeepers make decisions on the day of surgery with the bias of trying to increase their work performed during the time they are assigned to work clinically.[13,14] In meetings at the hospital about regular workdays, the word "efficiency" was often used by clinicians and administrators as synonymous with clinical work per unit time (i.e., working quickly). Although some individuals seemed to demonstrate understanding of principles of operations research when asked, their common conversation nonetheless conceptualized "efficiency" principally as working quickly. Therefore, we hypothesized that the bias seen for decision-making on the day of surgery was also being applied during group discussions, resulting in attention being focused disproportionately on interventions that would reduce first case start delays, time in the OR, etc.

Question #1: "A good example of OR efficiency is finishing six[6] scheduled hours of cases in only five[5] hours."

Respondents were given a five point scale of "Strongly disagree," "Disagree," "Neither disagree nor agree," "Agree," and "Strongly agree."

Long after staff scheduling has been completed, and especially after case scheduling has been completed, the cost of an hour of under-utilized OR time is negligible relative to the cost of an hour of over-utilized OR time (i.e., costs are fixed).[8,13,14,16–18] Consequently, OR efficiency* can be increased on the day of surgery only by reducing over-utilized time.[8,14,16,17] Question #1 considered a scenario wherein there would to be no over-utilized time under any reasonable circumstance, because both 6 h and 5 h are much <8 h, the shortest workday at the hospital. Therefore, in answer to Question #1, OR efficiency cannot be increased. So, "Strongly disagree" is the most correct answer, but "Disagree" was also considered correct for this analysis (see Results).

We expected respondents to answer less accurately than random chance, as found at the previously studied hospital.[14] The 95% confidence interval for the percentage respondents answering correctly was calculated using StatXact 8 (Cytel, Cambridge, MA). All *P* values and confidence intervals were calculated using exact methods.

To confirm that Question #1 was suitable for the study hospital, we analyzed the hospital's OR information system data from January 1, 2004 through December 31, 2006. The data were analyzed through 2006, because the survey was performed in December 2006. The hospital staffed 16 ORs throughout the 752 studied workdays. We checked that there were routinely some OR-day combinations with 6.0 h or fewer hours of scheduled cases.

Question #2

Previously, we showed that even when schedulers learn that cases often start earlier than scheduled, they do not apply that knowledge when scheduling events or when giving patients instructions for fasting.[15] In meetings, hospital staff repeatedly emphasized their desire to start on time, especially first cases of the day. This perception, that starting even a little late contributes substantially to each subsequent case running late, seemed to persist even when OR management data suggested otherwise. Multiple staff seemed both i) to embrace the axiom that starting the first case late "cascaded," causing all subsequent cases to be late, and ii) did not know how the scheduled start times of cases were chosen. We hypothesized that the bias that cases do not start early, as previously observed for case scheduling,[15] was also present when individuals think about small delays in starting first cases of the

*Let the *OR workload* for a specialty on a day be its total hours of OR and turnover times on the day.[8] Let the *allocated OR time* be the hours of specialty-specific OR time into which the cases were effectively scheduled. Let the *under-utilized OR time* = (allocated OR time) − (OR workload) if the difference is positive, and 0 h if the difference is negative.[8,18] Let the *over-utilized* OR time = (OR workload) − (allocated OR time) if the difference is positive, and 0 h if the difference is negative.[8,18] Let the *inefficiency of use of OR time* = (cost per hour of under-utilized OR time) × (under-utilized OR time) + (cost per hour of over-utilized OR time) × (over-utilized OR time).[8,18]

day. Consequently, the respondents would expect that each increase in the minutes of delayed entrance of the first case of the day would result in an equivalent increase in the tardiness of start of subsequent cases in the same OR:

Question #2: "Starting the first case in a room ten[10] minutes late because of missing supplies likely causes each following case to start at least ten[10] minutes late."

Respondents were given a five point scale from "Strongly disagree" to "Strongly agree." Although "Strongly disagree" is the most correct answer, both "Strongly disagree" and "Disagree" were considered correct.

To confirm that Question #2 was suitable for the study hospital, we again used the hospital's OR information system data. Standard errors were calculated by batching the 3 yr of data into 39 four-week periods and then calculating the standard deviation among $n = 39$ batches.[8,19] We calculated the percentage of first cases of the day starting at least 10 min late. We calculated the percentage of cases that were not first cases of the day and that were in ORs for which the first case of the day started 5 min to 15 min late. We also calculated the corresponding results using mean tardiness as the end-point. Tardiness was defined as the difference between the actual and scheduled room entry time, with the value set to 0 if the case entered the OR early. For example, if a case was scheduled to start at 7:15 AM, and the patient entered the OR at 7:20 AM, the tardiness was 5 min. If the patient entered the OR at 7:14 AM, the tardiness was 0.

Question #3

Although tardiness can be reduced by the moving of cases, most of the scheduled cases had started by 4 h into the workday (mean ± SE = 64.2% ± 0.3%).[20] Thus, the principal reason why starting a first case of the day 10 min late affected overall tardiness by <10 min per case (i.e., Question #2 is "Strongly disagree") was because most cases took less time than scheduled:

Question #3: "What is your closest estimate (guess) of the percentage of surgical cases where you work that last longer than scheduled, due to any cause, including incomplete preference cards."

Any integer could be entered between 0% and 100%.

Provided the duration of staffing for each OR was chosen appropriately months before individual cases were scheduled, each case should be scheduled into the OR time using an unbiased estimator for the case's contribution to the total workload that was used to plan the staffing.[16,21–23] Because the logarithms of OR times for specified combinations of surgeon and scheduled procedure(s) follow Student *t*-distributions, more than half of cases take less time than the mean.[16,22,24] Therefore, we considered any response <50% to be correct.

Previously, we found that schedulers learned that to-follow cases can start early, but ignored that information when scheduling.[15] Therefore, we expected that those respondents to this survey who know that most cases take their scheduled time or less (i.e., answer Question #3 correctly) would not apply that knowledge to answer Question #2 correctly.

RESULTS

No respondent answered all three questions correctly (0 of 57, 95% CI 0%–5%).

Question #1 focused on OR efficiency. There was a 2 of 5 (40%) chance to guess the correct answer and 21 of 57 (37%) did so (two-sided $P = 0.73$). If only "Strongly disagree" were considered correct, then 10 of 57 (17%) answered correctly, not differing from the random rate of 1 of 5 (20%) ($P = 0.79$).† These findings are consistent with lack of knowledge. Our hypothesis of a bias to increase clinical work per unit time was not supported, in contrast to findings of studies of decision-making on the day of surgery.[13,14]

Question #2 considered late starts. There was a 2 of 5 (40%) chance to guess the correct answer, but only 7 of 57 (12%) did so ($P < 0.0001$). If only "Strongly disagree" were considered correct, then 1 of 57 (2%) answered correctly, also significantly less than the random rate (20%) ($P < 0.0001$). These findings of worse than random chance are consistent with our prediction that staff have a bias that cases start on time or late (i.e., do not start early) (see Methods).[15]

Question #3 evaluated the incidence of knowledge that fewer than half of cases last longer than scheduled. The knowledge was low, being as only 18 of 57 (32%) answered correctly, which was less than the random rate of 50% ($P = 0.008$). More importantly, none of the 18 with this knowledge applied it to answer Question #2 correctly ($P = 0.0002$) (Fig. 1). This finding of lack of application of knowledge is consistent with staff having a bias that cases do not start early.

The remaining results are secondary analyses of data from the studied hospital for validation of the questions and our interpretation of their implications.

Correct answers to Question #1 did not differ among types of providers (χ^2 test $P = 0.52$). Although each OR was staffed for at least 8 h, 50% of the OR-day combinations had 6.0 h or fewer of scheduled cases.

Correct answers to Question #2 did not differ among types of providers ($P = 0.21$). Among first cases of the day, 46% ± 1% started at least 10 min late, so the value of 10 min in the question was realistic. Among cases that were not first cases of the day, 50% ± 1% started <10 min late. If the first case in the OR started 5–15 min late, the percentage of cases starting <10 min late was not 0% as in the question, but 40% ± 1%. The results can also be considered in terms of tardiness. The tardiness was 14.2 ± 0.3 min among the 5110 first case of the day starts with

†For Question #1, there were also 12 "Neither agree nor disagree," 21 "Agree," and 3 "Strongly agree." For Question #2, the corresponding counts were 6, 29, and 15, respectively.

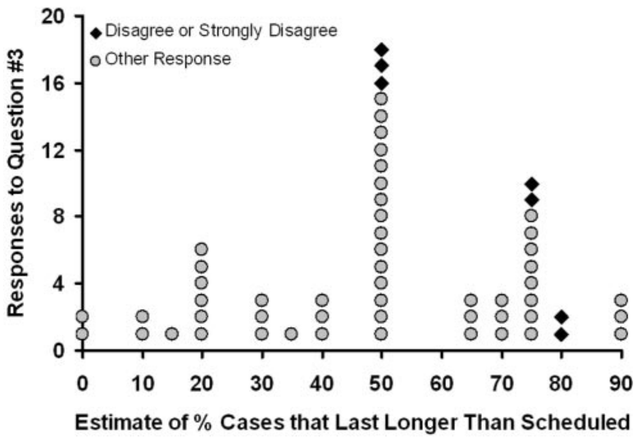

Figure 1. Lack of application of knowledge that fewer than half of cases last longer than scheduled from Question #3 to Question #2 about start times. The text along the horizontal axis is an abbreviation of the full Question #3: "What is your closest estimate (guess) of the percentage of surgical cases where you work that last longer than scheduled, due to any cause, including incomplete preference cards?" The responses to Question #3 could be any number from 0 to 100. The wording of Question #2 was "Starting the first case in a room ten (10) minutes late because of missing supplies likely causes each following case to start at least ten (10) minutes late." Responses to Question #2 were "Strongly Disagree," "Disagree," "Neither Agree nor Disagree," "Agree," or "Strongly Agree." One respondent (who answered 80% to Question #3) strongly disagreed to Question #2. Six respondents "disagreed" to Question #2. The other incorrect responses are displayed as circles. The important finding is that 0 of 18 respondents with knowledge about case duration scheduling then applied that knowledge to start times. This finding of lack of application of knowledge to guide start times matches that found previously in an experimental study of case scheduling.[15]

tardiness 4 h or less, such that the value of 10 min in the question was realistic. The tardiness was 34.1 ± 0.6 min among the 21,024 scheduled cases that were not first cases of the day and started no more than 4 h late. If the first case in the OR started 5–15 min late, the pairwise increase in tardiness was not 10 min, but only 1.1 ± 1.0 min.

Correct answers to Question #3 did not differ significantly among types of providers ($P = 0.08$). The $P = 0.08$ may suggest a trend, and if present it was for more knowledge among the anesthesiologists and "Others." However, that would be practically irrelevant since none of the 18 with the knowledge applied it. Among the 26,295 scheduled cases, far fewer than half of the cases (35.5% ± 0.4%) took longer than scheduled. Findings of Question #3 are supported by 15 of 57 (26%) under-estimating the actual value versus 42 of 57 (74%) over-estimating it, not a symmetric 50%:50% relationship ($P = 0.0005$).

DISCUSSION

Unlike for our prior study of decision-making on the day of surgery,[13,14] survey respondents seem to lack knowledge. Knowledge of OR efficiency appears not to have been learned "on the job" by working in ORs. Also unlike for decision making on the day of surgery,[13,14] respondents appear not to be applying a bias of increasing clinical work per unit time. Together, education may influence behavior. That is not to say that education is simple. Question #1 was designed with a deliberately over-simplified example. Realistic scenarios are more complicated, because sometimes reducing delays in first case of the day starts does reduce over-utilized time.[8] In our companion article,[25] we develop a process to make it feasible for analysts to educate with examples created in meetings.

Matching prior experimental[15] studies of case scheduling, respondents seem to have a bias that cases do not start early, even though more than half of cases actually do start early. In the current survey, none (0%) of the respondents with the necessary factual knowledge (that fewer than half of cases take longer than scheduled) applied that knowledge to the question regarding the impact on cases that follow a late starting first case of the day (Fig. 1). Likewise, in our prior study of case scheduling, even though this knowledge had to be learned in order to proceed with scheduling, few participants then applied the knowledge.[15] The implication of the new and prior findings is that education on principles of tardiness may be of no benefit. Reducing waiting times of patients and surgeons without simply adding[26] more first case of the day starts (ORs) likely will require automation of choice of patient ready times and scheduled case start times. For example, the day before surgery, start times are adjusted to be the best possible at reducing patient and surgeon waiting without increasing over-utilized time.[15,17,27,28]

Our survey did not inquire about reduction in conflict with surgeons as a motivation for group focus on first case of the day starts. Qualitative observation showed that nurses and anesthesiologists who run OR control desks make decisions on the day of surgery based on reducing conflict.[29] Nevertheless, even though efforts to reduce delays in first case of the day starts may reduce surgeon complaints, reduction in surgeon complaints cannot be the root cause of most group actions, based on two observations. First, if reductions in complaints were the goal, most clinicians would know how scheduled start times are chosen, since the start times affect to-follow surgeons, but most clinicians do not. Second, if reductions in surgeon complaints were the goal of actions, then that objective would be applied also in the late afternoons and weekends, even though in practice it is not.[13] Cases would not be queued, even though they are.[13,14,17]

Our results are limited by the study design, in four ways. First, the design involved a single survey at a single site. Second, our findings for Question #1 were that bias was absent. That result differed from our previous observations for decision-making on the day of surgery.[13,14] The findings may differ simply because the current survey did not study decisions made on the day of surgery.[14] Third, we know that the respondents took the time to complete a survey of preference cards, and had to answer all 27 questions, but we do not know whether these respondents were the same people who are the most vocal about needs to improve local OR management. Fourth, we do not know how many people could have responded, but think that the response rate was around 25%. This is why we focused on comparing responses to those expected based on random chance and among questions. Hopefully, these limitations will motivate future research in behavioral operations of OR management.

In summary, knowledge of OR efficiency relevant to first case of the day starts was low among respondents even though they work in ORs. However, because of the apparent absence of bias, education may be effective at influencing behavior. In contrast, education on principles of tardiness of start times may be of no benefit, just as found previously for scheduling decisions. As the latter results match findings of previous studies of scheduling decisions, interventions to reduce patient and surgeon waiting from start times likely will depend on the application of automation to guide decision-making.

REFERENCES

1. Overdyk FJ, Harvey SC, Fishman RL, Shippey F. Successful strategies for improving operating room efficiency at academic institutions. Anesth Analg 1998;86:896–906
2. Lapierre SD, Batson C, McCaskey S. Improving on-time performance in health care organizations: a case study. Health Care Manag Sci 1999;2:27–34
3. Shelver SR, Winston L. Improving surgical on-time starts through common goals. AORN J 2001;74:506–13
4. St Jacques PJ, Patel N, Higgins MS. Improving anesthesiologist performance through profiling and incentives. J Clin Anesth 2004;16:523–8
5. Eappen S, Flanagan H, Lithman R, Bhattacharyya N. The addition of a regional block team to the orthopedic operating rooms does not improve anesthesia-controlled times and turnover time in the setting of long turnover times. J Clin Anesth 2007;19:85–91
6. Macario A, Dexter F. Effect of compensation and patient scheduling on operating room labor costs. AORN J 2000;71:860–9
7. Dexter F, Macario A, Manberg PJ, Lubarsky DA. Computer simulation to determine how rapid anesthetic recovery protocols to decrease the time for emergence or increase the phase I post anesthesia care unit bypass rate affect staffing of an ambulatory surgery center. Anesth Analg 1999;88:1053–63
8. McIntosh C, Dexter F, Epstein RH. Impact of service-specific staffing, case scheduling, turnovers, and first-case starts on anesthesia group and operating room productivity: tutorial using data from an Australian hospital. Anesth Analg 2006;103:1499–516
9. Dexter F, Weih LS, Gustafson RK, Stegura LF, Oldenkamp MJ, Wachtel RE. Observational study of operating room times for knee and hip replacement surgery at nine US community hospitals. Health Care Manag Sci 2006;9:325–39
10. Espin SL, Lingard LA. Time as a catalyst for tension in neurosurgeon communication. AORN J 2001;74:672–82
11. Riley R, Manias E. Governing time in operating rooms. J Clin Nurs 2006;15:546–53
12. Lingard L, Garwood S, Poenaru D. Tensions influencing operating room team function: does institutional context make a difference? Med Educ 2004;37:691–9
13. Dexter F, Lee JD, Dow AJ, Lubarsky DA. A psychological basis for anesthesiologists' operating room managerial decision-making on the day of surgery. Anesth Analg 2007;105:430–4
14. Dexter F, Willemsen-Dunlap A, Lee JD. Operating room managerial decision-making on the day of surgery with and without computer recommendations and status displays. Anesth Analg 2007;105:419–29
15. Dexter F, Xiao Y, Dow AJ, Strader MM, Ho D, Wachtel RE. Coordination of appointments for anesthesia care outside of operating rooms using an enterprise-wide scheduling system. Anesth Analg 2007;105:1701–10
16. Dexter F, Traub RD. How to schedule elective surgical cases into specific operating rooms to maximize the efficiency of use of operating room time. Anesth Analg 2002;94:933–42
17. Dexter F, Epstein RD, Traub RD, Xiao Y. Making management decisions on the day of surgery based on operating room efficiency and patient waiting times. Anesthesiology 2004;101:1444–53
18. Strum DP, Vargas LG, May JH. Surgical subspecialty block utilization and capacity planning. A minimal cost analysis model. Anesthesiology 1999;90:1176–85
19. Dexter F, Macario A, Qian F, Traub RD. Forecasting surgical groups' total hours of elective cases for allocation of block time. Application of time series analysis to operating room management. Anesthesiology 1999;91:1501–8
20. Dexter F, Epstein RH, Marcon E, Ledolter J. Estimating the incidence of prolonged turnover times and delays by time of day. Anesthesiology 2005;102:1242–8
21. Dexter F, Macario A, Epstein RH, Ledolter J. Validity and usefulness of a method to monitor surgical services' average bias in scheduled case durations. Can J Anaesth 2005;52:935–9
22. Dexter F, Ledolter J. Bayesian prediction bounds and comparisons of operating room times even for procedures with few or no historical data. Anesthesiology 2005;103:1259–67
23. Dexter F, Macario A, Ledolter J. Identification of systematic under-estimation (bias) of case durations during case scheduling would not markedly reduce over-utilized operating room time. J Clin Anesth 2007;19:198–203
24. Strum DP, May JH, Vargas LG. Modeling the uncertainty of surgical procedure times: comparison of the log-normal and normal models. Anesthesiology 2000;92:1160–7
25. Dexter F, Epstein RH. Economics of organizational focus on first case of the day starts. Anesth Analg 2009;108:579–82
26. Dexter F, Birchansky L, Bernstein JM, Wachtel RE. Case scheduling preferences of one surgeon's cataract surgery patients. Anesth Analg 2009;108:579–82
27. Wachtel RE, Dexter F. Simple method for deciding what time patients should be ready on the day of surgery without procedure-specific data. Anesth Analg 2007;105:127–40
28. Denton B, Viapiano J, Vogl A. Optimization of surgery sequencing and scheduling decisions under uncertainty. Health Care Manag Sci 2007;10:13–24
29. Xiao Y, Kiesler S, Mackenzie CF, Kobayashi M, Plasters C, Seagull FJ, Fussell S. Negotiation and conflict in large scale collaboration: a preliminary field study. Cogn Tech Work 2007;9:171–6

