Staffing and case scheduling for anesthesia in geographically dispersed locations outside of operating rooms

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Purpose of review

Scheduling and staffing for anesthetics outside of the operating room that are geographically dispersed is different than for operating room cases. Whereas methods to predict how long such cases take were published recently, this article reviews staffing and case scheduling.

Recent findings

Methods have been developed based on the assumption that physicians doing procedures requiring anesthesia are provided open access to anesthesia time within a reasonable number of days (e.g., 2 weeks) or on any future workday. The latter is commonly used in operating rooms. Outside of operating rooms, the former is more practical economically. Statistical forecasting of anesthesia staffing months ahead is conducted by using billing data with the objective of maximizing the efficiency of use of anesthesia time. Calculations assume that anesthesia time that would otherwise be underutilized is released for use by services that would otherwise work in overutilized anesthesia time. Forecasting is different for services with many patients hospitalized preoperatively (e.g., electroconvulsive therapy). Implementation encourages longer-term changes benefiting the anesthesia group (e.g., services choose to work longer hours for fewer days of the week).

Summary

Plan staffing based on providing open access to anesthesia time within a reasonable number of days (e.g., 2 weeks). Schedule cases and release allocated time based on reducing overutilized anesthesia time.

Keywords

forecasting, management: anesthesia group, operating room, operations research, scheduling, staffing

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Abbreviations

ECT electroconvulsive therapy
MRI magnetic resonance imaging

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Introduction

During the past decade, much has been learned regarding how to increase the productivity of anesthetists. A crucial step is to plan the correct hours of staffing for each service on each weekday.

For example, two cases each lasting 2 h are scheduled into operating room #1, with operating room nurses and an anesthesiologist scheduled to work an 8-h day. The matching of workload to staffing has been so poor that little can be done on the day of surgery to increase the efficiency of use [1] of the nurses and anesthesiologists. Interventions such as waking the patients more quickly or reducing the turnover time will not compensate for management's poor initial choice of staffing for operating room #1 or how the cases were scheduled into operating room #1.

For example, on the same day as in the preceding example, operating room #2 has three cases scheduled into its 8-h workday. The first two cases are done by one surgeon and last 7 h. The third case is scheduled by another surgeon to take 3 h. It was not scheduled into operating room #1, because operating room #1 was allocated to a different service. Staffing should be planned so that rarely would a service fill its allocated time and yet have another case to schedule [2,3]. Still, when it happens, it is crucial to release another service's allocated but otherwise underutilized anesthesia time.

Conceptually, these methods can be applied to anesthetists assigned to work outside of the operating room setting in geographically dispersed locations, such as interventional radiology, magnetic resonance imaging (MRI), and electroconvulsive therapy (ECT) suite. Cases outside the operating room, however, have three fundamentally different management characteristics than do operating room cases:

(1) Anesthetizing locations outside of operating rooms are not as interchangeable as operating rooms. When

allocated time is full for the day and a service wants to schedule another case, the allocated time of another service on the same day often cannot be released safely. For example, a pediatric electrophysiologist cannot split and perform his other case inside a computerized tomography machine.

(2) When operating room staffing (i.e., short-term operating room allocations) is based on departments with many surgeons, variations in operating room workload from week to week are driven by variations in numbers of patients requesting to be scheduled for surgery [4]. In contrast, non-operating room services (e.g., interventional radiology) are often small, representing one or two physicians. Depending on how time is allocated and cases are scheduled, variation in workload at each location on any one workday will be larger [4], reflecting vacations and meetings.

(3) Turnover times for operating rooms are often 20–30 min. In contrast, turnover times outside of operating rooms can be 1 h or more when switching from one geographical location to another: transporting a patient to the postanesthesia care unit through halls and elevators, returning to the initial location to collect equipment, and moving the equipment to a separate location. Whereas a medically directing anesthesiologist may do a preanesthesia evaluation on his operating room's next patient during the current case, this is not possible if the next case will be done at a separate location (e.g., interventional radiology followed by MRI). There is a financial benefit to anesthesia groups of having its anesthesia teams do consecutive cases at the same location.

As a result of these three differences, staffing and case scheduling for anesthesia outside of operating rooms needs to differ from that of operating rooms, lest otherwise anesthesia staffing costs are unsustainably large. For elective anesthetics outside of operating rooms, we assume open access within a reasonable number of weeks [5].

This article considers a limited set of topics. Cases that need to be done within 3 days are not reviewed. Such cases would characteristically be scheduled and performed as for operating room cases, with open access provided on any workday or day, depending on medical acuity [1–3,5]. The assignment of personnel (e.g., a postanesthesia care unit nurse) to increase anesthesia providers' productivity (e.g., by reducing turnover times) outside of operating rooms has not been reported in sufficient detail for a review. Finally, methods to predict how long each such case takes are considered separately [6••].

Allocating anesthesia time outside of operating rooms for a service's elective cases

We suggest that if the anesthesia department normally plans 10-h workdays (from 7 a.m. to 5 p.m.) for their anesthetists, then a service (e.g., interventional radiology) requesting anesthesia coverage should receive a block of allocated time provided they average at least 10 h of cases including turnovers every 2 weeks [5,6••,7]. The threshold of 10 h is set high to ensure that the allocated time remains filled [7,8]. A 2-week period is a reasonable number of days from the perspective of patient expectations of waiting times.

Any additional cases that cannot be placed in the allocated time are then scheduled into the overflow anesthesia time (i.e., first come first scheduled 'unblocked' time). Cases are scheduled to reduce anesthesia providers' underutilized time, while fulfilling the service guarantee that anesthesia will be provided for the case within the reasonable (i.e., 2-week) period [5].

There are five important advantages to providing open access (in a reasonable number of weeks) to anesthesia care outside of operating rooms:

(1) A service guarantee of a maximum patient waiting time [5,8] removes the argument that the anesthesia department is causing patients to wait unnecessarily long. The service guarantee is not a particular amount (e.g., 10 h) of allocated anesthesia coverage but that the case will be done within 2 weeks.

(2) Open access makes money for the hospital and anesthesia group, by letting professional practices grow. For virtually every specialty in the US, revenue exceeds the variable costs [9,10], although this profitability incentive may not exist in public healthcare systems.

(3) Future staffing is more accurate, because the total hours of anesthesia time performed in the past can then be an accurate forecast of the hours of the anesthesia time in the future [7,10,11]. Without open access, prior workload can underestimate future workload, because prior workload excluded patients who received care at other hospitals because the wait was too long or no appointment could practically be made.

(4) The cost of inaccuracy in future forecasts is reduced, as anesthesia time that would otherwise be underutilized is instead used by different services that would otherwise have overutilized time [10]. Open access is the foundation for the method of releasing allocated time [3,7,12], which is crucially important for good tactical decision making [10] regarding anesthesia coverage of growing services.

(5) Open access serves as a motivation for rational tactical decision-making (below).

For example, an anesthesia department was requested to provide 10 h of staffing each week for each of two adjacent electrophysiology rooms (e.g., one certified registered nurse anesthetist, one anesthesiology resident, and one faculty anesthesiologist). Start and end times of cases were obtained from hospital billing data. The electrophysiologists averaged 36 h of cases, including turnovers, every 2 weeks, with a standard deviation of 9 h. The allocation choices [5] were 30 h or 40 h every 2 weeks. A 40-h allocation was made because of the following four reasons:

(1) An allocation choice of 30 h had the disadvantage of losing the potential for one anesthesiologist to medically direct two rooms simultaneously.
(2) The electrophysiologists' data were room times, whereas anesthesia times would be longer.
(3) When aiming to care for patients within a reasonable number of weeks, relatively more time needs to be allocated to services with relatively large variations in workload [5]. Large variations in workload among weeks and rooms will result from there being long cases that cannot be 'packed' well [5,13]. Electrophysiology has many such cases. For a normal distribution with mean 36 h and standard deviation of 9 h, allocation of 30-h results in an average of 1.3 h of underutilized anesthesia time and 7.5 h of overutilized anesthesia time every other week. An allocation of 40 h results in 5.9 h of underutilized anesthesia time and 2.0 h of overutilized anesthesia time. As each hour of overutilized anesthesia time was considered to be twice the cost of an hour of underutilized time, the efficiency of use of anesthesia time was higher with an allocation of 40 h instead of 30 h.
(4) The relative cost of an hour of overutilized time was considered to be twice the cost of a scheduled hour. This implies that the ratio of days finishing early to finishing late should be 2 : 1, or equivalently that staffing should be planned for two thirds of days. Assuming a normal distribution, the 66th percentile for workload every 2 weeks was 39.9 h, close to 40 h [11].

These calculations are predicated on a series of mathematical assumptions. The assumptions are considered in the following five examples of this section.

The calculations are predicated on a case not being scheduled into overutilized anesthesia time one day if the case can be done in what would otherwise be the service's underutilized time on the same day [2,3,5,7].

For example, a clinical electrophysiologist (Dr A) has scheduled a case from 7 a.m. to 10.30 a.m. Dr B has scheduled one case from 7 a.m. to 11.30 a.m., and a second case from 12 noon to 3 p.m. Dr B wants to schedule a 3-h case to start at 3.30 p.m. Dr B would not be offered anesthesia services starting at 3.30 p.m., because overutilized anesthesia time would be expected. For case scheduling based on reducing overutilized anesthesia time [2], the case can be scheduled to be performed by Dr A starting at 11 a.m. or performed on another day. The anesthesia department's service guarantee is care within 2 weeks. Staffing calculations were based on the workload of clinical electrophysiology, not Dr A alone or Dr B alone. As the allocation was for electrophysiology, the cases are scheduled by electrophysiology, not by Dr A or by Dr B. A service should not schedule a case in overutilized time if the service has allocated but unscheduled time within 2 weeks [2,5]. The drawback of doing otherwise would be not just the immediate overutilized anesthesia time. If the staffing planned originally for each 2-week period were an accurate forecast, on a subsequent day there may be underutilized anesthesia time that the case would have filled.

The above calculations of anesthesia staffing are predicated on cases being scheduled sequentially [2], until all the cases to be done that day have been scheduled [14].

For example, a 10-h period is allocated for therapeutic radiology each week. Three weeks ahead, one case is scheduled from 7 a.m. to 11.30 a.m. Two weeks ahead, they ask to schedule another case from 12.45 p.m. to 3 p.m., providing a lunch break. A delay cannot be scheduled for the anesthesia team (i.e., anesthetics are scheduled sequentially), as otherwise there is no way of knowing how much staffing should be planned [2,7]. The staffing is calculated from the total hours of anesthetics including turnovers [5,11], not the total hours of anesthetics, turnovers, and whatever delays a service may choose to have. Methods to monitor delays in the middle of the workday were recently described [15••].

The above calculations of anesthesia staffing are predicated on cases not being performed in overutilized anesthesia time if they can be performed in what would otherwise by underutilized anesthesia time on another day within 2 weeks [2,5,7,12].

For example, a service is allocated time for anesthesia coverage from 7 a.m. to 5 p.m. weekly, based on a service guarantee of a maximum 2-week wait. Cases have been scheduled to 4 p.m. Although time is available the next week, the service asks to schedule a 2-h case this week to follow the case scheduled to end at 4 p.m. This is not an acceptable option. The reason is that the allocated time was calculated using the service's average historical total hours of cases including turnovers every 2 weeks [5,7,11]. Not only would overutilized anesthesia time be expected this week, but underutilized anesthesia time next week.

The above calculations are predicated on a service not scheduling a case into another service's operating room time if the case can be completed within its own allocated operating room time [2], since the allocations are calculated based on expected workload of each service during each 2-week period [7,11].

For example, pediatric cardiology is allocated three 10-h periods every 2 weeks. They have time for a 3-h case in 7 days in their allocated time. Nevertheless, they want to do the case, instead, in 8 days in overflow, 'unblocked', time [7]. If pediatric cardiology prefers not to do the case in 7 days, they should swap the days of their allocated time with another service.

Finally, the above calculations are useful only if services trust that they have open access to anesthesia time, be it on any future workday or within a reasonable 2-week period [5,7,8].

For example, a service has an out of the operating room case to schedule that requires anesthesia, but there is insufficient time within its allocated time to finish the case by 5 p.m. within 2 weeks. There is also insufficient time within the overflow [7] or spillover time to finish the case by 5 p.m. within 2 weeks. The time would be released of whatever service has the most unused time sufficient for the case to be completed within the next 1 week [7]. If that still does not provide enough anesthesia time, the anesthesia group either needs to add another team or have an existing team work past 5 p.m. to complete the case. The service guarantee needs to be satisfied.

Achieve organizational change by releasing allocated anesthesia time

One anesthesia team was assigned daily to an office-based operating room suite. On the infrequent days when the team finished late, they were relieved by other anesthesia providers who were on call. This was inconvenient, however, because the office was a 10-min walk from the main hospital surgical suite. As such, the cost of 1 h of overutilized time in the office was considered to be at least twice the cost of a scheduled hour. This implies that the ratio of days finishing early to finishing late should be 2 : 1, or equivalently that staffing should be planned for two thirds of days. From anesthesia billing data, the 66th percentiles for hours per day were 7.5 h, 5.9 h, 7.4 h, 6.4 h, and 5.9 h on Monday through Friday, respectively. As these values were less than the 9-h workday planned for Monday and Tuesday and the 10-h workday on Wednesday through Friday, the need for relief was infrequent. Rather, the bigger problem was the substantial underutilized operating room time in the office surgical suite.

Two options were available to reduce the underutilized operating room time

One option was to reduce the number of days with anesthesia staffing from 5 to 4 days a week, while continuing to care for all patients within a reasonable period. This approach was preferred by the anesthesia department, but was rejected initially by the office-based surgeons.

The other option was to release the allocated time when another service had filled its allocated time and had another case to schedule [3,12]. The disadvantage of this approach was that having the anesthesia team travel from one location to another took time. The advantage was that the service guarantee became to care for the patients, not to staff an operating room.

To initiate the latter option, the anesthesia scheduler set up on-going communication with the office manager. The manager e-mailed five workdays ahead with the remaining time each day, and repeated that process each workday up to the working day before anesthesia. The anesthesia providers were released to go to another location (e.g., to do a computerized tomography scan), whenever another service had filled its available anesthesia time and had another case to schedule.

Within a month, the surgeons suggested switching the anesthesia coverage to 4 days a week. Over the subsequent 5 months, the mean weekly total anesthetic time including turnovers increased from 26.8 h per week to 30.2 h per week. The 66th percentiles on each day of the week were 8.2 h, 8.0 h, 9.3 h, and 9.9 h, respectively.

The example shows that use of an evidence-based release policy [3,12] not only serves to increase the efficiency of use of anesthesia teams, but can serve as a catalyst for longer-term tactical change.

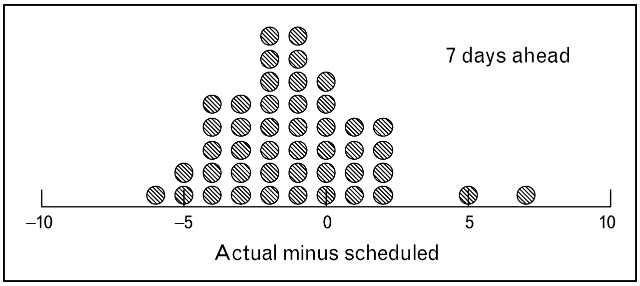
Lack of use of operating room information systems

Operating room cases typically are scheduled with operating room information systems. Cases requiring anesthesia outside of the operating room often are not.

An office may use paper or a calendar. The data are then typed into the operating room information system the working day before anesthesia. To obtain information on expected demand for anesthesia, a web site with e-mail reminders can be used.

For example, since ECT patients are often hospitalized or require prompt care, psychiatrists are provided open access to anesthesia time on 3 days each week. Each ECT workday, a psychiatric nurse uses a website to enter how many ECTs have been scheduled for each of the next three ECT sessions (1 week). Specific patients continue to be scheduled into the operating room information system on the working day before ECTs. Once the data are entered, software calculates a short-term forecast [16]

Figure 1 Difference between count of electroconvulsive therapy cases actually performed and those scheduled 7 days ahead



Electroconvulsive therapy (ECT) cases shown are those performed between Wednesday September 29, 2004 and Friday January 28, 2005, excluding US Federal holidays. There were 45 days of data, as ECTs are performed on Mondays, Wednesdays, and Fridays. When the value was positive, more ECTs were performed than were scheduled. Each circle represents one day. One-sided distribution-free conservative upper 95% confidence bounds were calculated for the 60th and 80th percentiles. These upper confidence bounds were calculated by finding the smallest number of observations that could be included within the percentile while the Blyth–Still–Casella upper 95% confidence bound for the proportion covered exceeded 0.60 or 0.80, respectively [16]. The 60th percentile of the difference equals −1 ECT (95% upper confidence bound 0 ECTs). The 80th percentile of the difference equals 0 ECTs (95% upper confidence bound two ECTs). The statistical assumptions of the 95% upper confidence bounds for the percentiles were not violated. The successive differences were random (runs test $P = 0.33$). The differences were not correlated to increase in the number of cases scheduled since the preceding workday (Kendall's τ $P = 0.31$).

(Fig. 1) of the number of ECTs to plan on that day, after which the anesthesia providers can be scheduled elsewhere. The result is sent by e-mail to the schedulers responsible for assigning anesthetists. The e-mail contains instructions on how to use the information.

A hospital may schedule its anesthetics outside of operating rooms using the institution's enterprise-wide scheduling system. When deciding whether this is an advantage or a concern, focus on cancellations.

For example, a child is scheduled for three successive appointments on the same day: oncology clinic appointment, anesthetic for MRI, and finally a visit with her pediatric neurosurgeon. If the parent calls to cancel that appointment, will the anesthetic be cancelled? The enterprise-wide information system considers the primary visit to be the oncology appointment. All other linked appointments will be cancelled too. If the anesthetic were scheduled using the operating room information system, however, the clerk in the oncology clinic who takes the phone call to cancel the oncology appointment may not know that there is an anesthetic scheduled for the MRI. Even if he or she knows, the clerk may not know how to cancel the anesthetic. Unless the operating room information system appointment is linked electronically to the clinic appointments and the MRI, cancellations and rescheduling may not reliably get passed to the anesthesia department. If the institution goes to enterprise-wide scheduling, this will not be solvable with meetings or educating clerks, as the point of enterprise-wide information systems is that humans do not manage the multiple linked appointments.

Future research will likely be in how best to use information systems on the working day before and on the day of procedures to coordinate patients and anesthesia providers when operating in geographically dispersed locations throughout a hospital.

Conclusion

Anesthesia departments can facilitate growth in caseload outside of operating rooms. Ideally anesthesia staffing and workload are well matched so there is neither underutilized nor overutilized anesthesia time. We have outlined the key principles in our experience with staffing and case scheduling for anesthesia outside of the operating room. Establish from the start that the premise is to care for patients within a reasonable number of days (e.g., 2 week), not to provide care on whatever future workday the surgeon chooses and not to provide a certain number of providers. Doing so reduces the underutilized and overutilized anesthesia time. Good statistical forecasts can be made for staffing, cases can be scheduled to reduce overutilized anesthesia time (e.g., without scheduled delays), and allocated time can be released.

References and recommended reading

Papers of particular interest, published within the annual period of review, have been highlighted as:
• of special interest
•• of outstanding interest
Additional references related to this topic can also be found in the Current World Literature section in this issue (p. 468).

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