

ASSIGNING SURGICAL CASES WITH REGIONAL ANESTHETIC BLOCKS TO ANESTHETISTS AND OPERATING ROOMS BASED ON OPERATING ROOM EFFICIENCY

Cormac T. O'Sullivan, CRNA, MSN
Franklin Dexter, MD, PhD
Iowa City, Iowa

The popularity of regional anesthesia blocks for both intraoperative anesthesia and postoperative pain management supports the inclusion of the administration of regional anesthesia into discussions about operating room (OR) efficiency. This article reviews the literature on OR efficiency with a focus on day-of-surgery decision making. Vignettes show regional anesthesia block placement is a variable that can affect the efficiency of use of OR time. Clinical examples highlight OR management issues and staff assignment

decisions on the day of surgery. Regional anesthetic block placement can affect surgical schedules, and thus OR efficiency. When patient safety is unaffected, rearranging OR schedules on the day of surgery to place regional blocks, meet surgeon requests, or move up incision times should generally not be done if doing so results in otherwise unnecessary increases in overutilized OR time.

Key words: Operating room efficiency, operating room management, regional anesthesia, surgical case assignment.

A primary goal of operating room (OR) and anesthesia clinical directors is to complete the scheduled cases. Various issues occur including cancellations, add-on cases, staff illness, delays, limited resources, and emergencies. Still, the scheduled cases are completed.

Operating room and anesthesia clinical directors also maintain a focus on OR efficiency. The popularity of regional anesthesia blocks for both intraoperative anesthesia and postoperative pain management support the inclusion of the administration of regional anesthesia into discussions about OR efficiency. This article reviews the literature on OR efficiency with a focus on day-of-surgery decision making. Vignettes show regional anesthesia block placement is a variable that can affect the efficiency of use of OR time.

Review of the literature

Most of the scientific literature about OR efficiency and day-of-surgery decision making has focused on appropriate surgical case scheduling,^{1,2} decreasing patient and surgeon waiting times,³ moving cases between ORs,⁴ the effects of reducing turnover times on staffing costs,⁵ and increasing efficiency of use of OR time.^{3,6} The use of regional anesthesia for intraoperative and postoperative pain management necessitates the evaluation of how these modalities can be performed to increase, or at least not to reduce, OR efficiency. The decision to perform regional anesthesia is usually based

on patient and surgeon preference and anesthesia provider skills. To make appropriate assignment decisions on the day of surgery, the effect of regional anesthetic block placement on surgical schedules, and thus OR efficiency, also should be considered. To do so, we follow the definitions present in the literature.

Regional anesthetic block refers to any regional block performed by an anesthesia provider for the purpose of intraoperative or postoperative pain management. This includes epidurals and all peripheral nerve blocks. Our paper does not consider blocks being used solely for surgical anesthesia such as subarachnoid (spinal) or Bier blocks.

Surgical service refers to an individual surgeon, group of surgeons, surgical subspecialty, or surgical department that shares allocated OR time.⁵ Cases "added-on" on the day of surgery (eg, fractured humerus repair) are attributed to an *urgent case service*, not the elective service performing the surgery.

Allocated OR time is an interval of OR time with specified start and end times on a specified day of the week that is assigned by the facility to a surgical service for scheduling its cases.⁵

Overutilized OR time is the positive difference between total hours of cases including turnover times performed and the allocated OR time for a given OR.⁶ For example, an OR was allocated and staffed from 7 AM to 3 PM and finished at 5 PM. There were 2 hours of overutilized OR time.

Underutilized OR time is the positive difference between total hours of cases including turnover times performed and the allocated OR time for a given OR.⁶ For example, an OR was allocated and staffed from 7 AM to 3 PM and finished at 1 PM. There were 2 hours of underutilized OR time.

Inefficiency of use of OR time equals the sum of 2 products: hours of underutilized time multiplied by the cost per hour of underutilized OR time plus hours of overutilized OR time multiplied by the cost of overutilized hours.⁶

OR efficiency is the value that has been maximized when the inefficiency of use of OR time has been minimized.⁶

For example, an OR is allocated for 10 hours from 7 AM to 5 PM. Cases are scheduled sequentially. The surgeons always finish between 2:00 PM and 2:30 PM, resulting in 2.5 hours to 3.0 hours of underutilized OR time each day, and never any overutilized OR time. Reducing the OR allocation to 8 hours a day would reduce underutilized OR time and thus increase OR efficiency.

Staff scheduling refers to the scheduling of staff members to cover allocated OR time at a given surgical facility on a specified day of the week with a specified start and end time. For example, Jill works at Metro Hospital next Monday from 7 AM to 3 PM.

Staff assignment refers to a specified staff member assigned to a specified OR for a specified length of time on a specified day. For example, Jim will be circulating in OR 1 from 7 AM to 3 PM today.

Regional anesthesia may produce benefits such as superior pain control, reduced narcotic usage by patients, and reductions in recovery and discharge times.⁷⁻⁹ However, for it to have an effect on OR efficiency, it must reduce the amount of inefficiently used OR time.

OR personnel such as nurses and nurse anesthetists are usually hospital-employed or group-employed professionals, and staffing decisions are made months prior to the day of surgery.³ Unless a facility can adjust or cancel scheduled staff on the day of surgery, their wages are a sunk (unrecoverable) cost to the facility on the day of surgery. If personnel happen to finish cases early on the day of surgery, costs will be negligibly less. In the vignettes, anesthesia and nursing personnel are salaried and paid, whether or not they provide patient care for all scheduled hours on a given day. Nevertheless, results apply equally to facilities that pay employees on an hourly or other basis. Then, the cost of idle personnel can be considered as an opportunity cost. Specifically, those personnel could have been available elsewhere to provide care on a

given day. Either way, on the day of surgery, the incremental labor costs of underutilized OR time is negligible relative to the facility's cost of overutilized OR time. Consequently, the underutilized OR time term can be deleted from the calculation of OR efficiency.²

When surgeries are unexpectedly cancelled or ORs finish early, there is an increase in the hours of underutilized OR time. However, on the day of surgery, the underutilized OR time has a negligible contribution to the inefficiency of use of OR time as compared to overutilized OR time. Finishing early neither increases nor reduces OR efficiency, although it has other advantages such as reducing the likelihood of patient and surgeon waiting past scheduled start times and increasing satisfaction of surgeons and staff.

In contrast, the effect of overutilized OR time is decreased OR efficiency and increased labor costs both before and on the day of surgery. The cost of overutilized OR time includes extra employee compensation, employee loss due to job dissatisfaction, and recruitment costs to replace frustrated employees who left. Overutilized OR time drives decision making on the day of surgery, provided patient safety is unaffected.

Overutilized OR time begins when allocated OR time ends. Therefore, although underutilized OR time does not affect decision making on the day of surgery, the threat of it has large effects months earlier when OR allocations are planned based on OR efficiency.

To allocate OR time correctly, it is not necessary to know the absolute costs of underutilized and overutilized OR time, just the ratio of those costs.⁶ For example, when the cost of an hour of overutilized OR time is twice as expensive as allocated time, costs will be minimized when there is underutilized OR time on two thirds of the days and overutilized OR time on one third of the days. Using a ratio of 1.5 instead of 2.0, the result is that appropriate OR allocations result in 40% of ORs having overutilized OR time. The implication for the day of surgery is striking. Rarely should there be more than half of the ORs finishing late (ie, with overutilized OR time). For regional anesthesia, or any other intervention, to affect OR efficiency, it must reduce the hours of overutilized OR time. On more than half of the occasions when a decision will be made on the day of surgery, the use of regional anesthesia will have no bearing on OR efficiency. The decision's impact will instead be on patient and surgeon waiting from scheduled start times and professional satisfaction of the staff and surgeons.

The remainder of this paper will use vignettes to highlight OR management issues involving regional anesthesia and various surgical procedures. The

vignettes use case times that are known exactly (ie, without error). Unexpected delays are assumed not to occur. This is for simplicity of presentation only, as the same results apply fully in more realistic situations.^{2,3}

Vignette #1

Operating room 1 has been allocated to 3 PM. Operating room 2 has been allocated to 7 PM. Both nursing and anesthesia directors have chosen to schedule staff for OR 1 using one team from 7 AM to 3 PM and for OR 2 using one team from 7 AM to 7 PM.

It is now 2 PM. The patient in OR 1 is being wheeled out of the OR. Operating room 2 will finish its current case at 3:45 PM. A 2-hour *scheduled* cesarean delivery is scheduled to start at 4:15 PM in OR 2, allowing 30 minutes for room turnover. The anesthetist and staff in OR 2 will complete this last case at 6:15 PM.

The surgeon and patient for the last case in OR 2 are available and request that the case be moved to OR 1 so it can start at 2:30 PM when the room is ready. The patient prefers a regional anesthetic for her delivery but has preeclampsia. Should the team from OR 1 start the case?

If the OR director requested the team from OR 1 to stay and start the case, the patient could be brought to the OR at 2:30 PM after turnover is completed. Assume the anesthetist is skilled at epidural placement and is ready to start dosing at 2:45 PM. Assume the anesthesia team doses the epidural over a 30-minute period to avoid hypotension and other complications related to the preeclampsia. The patient would be ready for surgical incision at 3:15 PM. If the surgery takes 2 hours, it would be completed at 5:15 PM.

After finishing the case in OR 2 and transporting the patient to recovery, the anesthetist and OR nurses from OR 2 would take over the cesarean delivery in OR 1 at 4 PM. The team from OR 1 would leave when relieved, resulting in 1 hour of overutilized OR time. When the case is completed and the patient is safely delivered to recovery, the remaining anesthetist and OR nurses would leave at 5:30 PM, resulting in 1.5 hours of underutilized OR time.

At first glance, starting the cesarean early may appear to have improved OR efficiency by allowing both ORs and surgical teams to finish by 5:30 PM. Few clinicians would complain about staying until 4 PM or completing their workday 1.5 hours early. However, these issues do not affect OR efficiency. If the cesarean had been left in OR 2, and clinically managed the same, the OR team would have been finished at 6:45 PM. Operating rooms 1 and 2 would have finished on time, resulting in zero overutilized hours. Leaving the

cases as they were assigned would have yielded a more efficient use of the OR and the nurses' and anesthesiologists' time. The efficiency of use of OR time is maximized on the day of surgery when the scheduled cases are completed during the allocated OR time, thereby preventing overutilized hours.

Vignette #2

An ambulatory surgical center that specializes in outpatient orthopedic surgery has extremely predictable surgeons. Every Monday, City Orthopedics is allocated OR 1 from 7 AM to 7 PM. The surgeons always fill their allocated time and finish precisely at 7 PM. They never have underutilized or overutilized OR time.

Tom likes performing regional anesthesia and works a 12-hour shift every Monday in the City Orthopedics OR. At noon on Monday, Tom got a call that his son was sick and needed to be picked up from school quickly. Sue, another anesthetist, was scheduled to work in OR 2 from 7 AM to 3 PM but finished her last case at 11:30 AM. Sue agreed to work until 7 PM and take over Tom's OR so he could pick up his son. Sue completed the cases in OR 1, finished at 7 PM, and received 4 hours of overtime pay.

Even though Sue received overtime pay, there was no overutilized OR time. OR 1 was allocated from 7 AM to 7 PM and had cases ending precisely at 7 PM. The overtime pay resulted from staff assignment issues related to Tom's sick son. Overutilized OR time is determined by OR allocation and workload, *not* staff assignment. In vignette #1, moving cases happened to result in both overutilized OR time and staff overtime pay. In this vignette, changes in staff assignment resulted in overtime pay, but there was no overutilized OR time and therefore no inefficiency of use of OR time.

To achieve efficient use of OR time, surgeons, nursing, and anesthesia providers must communicate about the OR allocations. Then each group can make its staff scheduling and staff assignment decisions independently, resulting in increased flexibility to all groups, and often lower staffing costs. Results are the same regardless of whether surgeons and/or anesthetists are salaried employees or independent groups working fee-for-service. The commonality of the OR allocations are the basis for decision making to maximize the efficiency of use of OR time.

Vignette #3

Operating rooms 1 and 2 are allocated from 7 AM to 7 PM today. The same orthopedic surgeon is supervising residents in both ORs. Operating room 1 will finish its current case at 3:30 PM and then start its last case, scheduled for 2.5 hours, at 4 PM. Operating room 2

will finish its current case at 4:30 PM and start its last case, scheduled for 1.5 hours, at 5 PM. Operating room 3 is allocated from 7 AM to 3 PM and will finish its last case at 2:30 PM.

The orthopedic surgeon has requested that both of the last cases receive a regional anesthetic block. To facilitate the cases being started on time, the anesthesia clinical director could ask the nurses and the anesthesiologist from OR 3 to stay and place the regional blocks. It will take 20 minutes to place each block. Equivalently, the anesthesiologist from OR 3 could relieve the anesthesiologists in OR 1 and OR 2 so they can place their own regional blocks. Once both blocks are placed and the patients are in their respective ORs, the nurses and anesthesiologist that stayed late could leave. How should the anesthesia clinical director make the decision?

The placement of regional anesthetic blocks usually requires an anesthesia provider to place the block, a nurse to monitor the patient, the ability to provide routine monitors (electrocardiograph, pulse oximetry, and blood pressure), and the availability of emergency airway management if needed. Many facilities accomplish this by using unoccupied space in the preoperative or postoperative care units, an unassigned anesthesia provider, and unassigned preoperative or postoperative nursing personnel. Once blocked, the patient is monitored for a period of time determined by the specific block placed and local anesthetic administered.

If the team from OR 3 stays and prepares the patient for OR 1, that patient will enter OR 1 at 4 PM, be ready for incision at 4:10 PM, and surgery will be completed at 6:30 PM. The team from OR 3 could prepare the patient for OR 2 starting at 4 PM. The patient will enter OR 2 at 5 PM, and incision would occur at 5:10 PM. That case would be completed at 6:30 PM. At 5 PM, when the second patient is transported to OR 2, the team from OR 3 could leave, resulting in 2 hours of overutilized OR time. Operating room 1 and OR 2 would both finish at 6:30 PM, resulting in no overutilized OR time.

If the team from OR 3 does not stay, the team in OR 1 will bring the patient into the OR at 4 PM and then place the block. The patient will be ready for incision at 4:30 PM (20 minutes for block placement and 10 minutes for surgical preparation). The case will be completed at 6:50 PM. The team in OR 2 will bring the patient into the OR at 5 PM and then place the block. Incision will be made at 5:30 and surgery will be completed at 6:50 PM. Surgery in OR 3 would be finished before 3 PM, and OR 1 and OR 2 at 6:50 PM, resulting in no hours of overutilized OR time.

In this vignette, the second option of not keeping staff from OR 3 results in greater OR efficiency. Keeping staff to *reduce turnover time* would result in a less efficient use of OR time than allowing the scheduled OR teams to complete the cases as they were assigned.

Vignette #4

Operating room 1 has been allocated from 7 AM to 3 PM. The anesthesia and nursing staff in OR 1 are scheduled from 7 AM to 3 PM as well. Nevertheless, no elective cases are scheduled from noon to 3 PM.

Operating room 2 has been allocated from 7 AM to 7 PM. The anesthesiologist is scheduled to work from 7 AM to 7 PM. One team of nurses is scheduled to work from 7 AM to 3 PM. A second team is scheduled to work from 3 PM to 11 PM, setting up case carts after 7 PM if all cases are done by then. Today, no elective cases are scheduled in OR 2 from 4:30 PM to 7 PM.

A vascular surgeon calls at 10 AM to schedule a 1-hour dialysis fistula embolectomy of the upper arm. The surgeon requests a regional anesthetic, which will take a half hour to place. She is available to start the case at 3 PM today. Should the OR manager schedule the case at 3 PM in OR 1 and tell the staff that they will have to stay 1 hour to complete the case? Patient safety is unaffected by the decision. Doing so would satisfy the surgeon's request and allow both OR teams to be home for dinner.

If the OR manager schedules the case in OR 1 at 3 PM, the anesthesiologist and nursing staff from OR 1 will have to stay late to complete the case since the team from OR 2 is not available until 4:30 PM. The team from OR 1 could place the regional anesthetic block anytime between 12 PM and 3 PM, allowing the incision to be made at 3 PM. The surgeon takes 1 hour to complete these cases, which would result in 1 hour of overutilized OR time. The 2.5 hours of underutilized OR time in OR 2 resulting from the last case finishing at 4:30 PM would be irrelevant because the cost of underutilized OR time is negligible compared to the cost of overutilized OR time on the day of surgery. When the anesthesia and nursing personnel can leave is also irrelevant, since staff scheduling and assignment can vary.

If the OR manager schedules the case in OR 2 to start at 5 PM, and that team places the block, the case would still finish by 6:30 PM, resulting in no overutilized OR time. Overutilized OR time results from keeping the team from OR 1 after hours to place the block for the OR 2 team. Thus, the decision should be made not to have the team from OR 1 stay.

An alternative option would be for the anesthesiologist from OR 1 to place the block at 2 PM and leave by 3

PM, allowing the patient to be brought to OR 2 by 5 PM. That would require a nurse to stay and monitor the patient until 5 PM, resulting in 2 overutilized hours of nursing time, which would be cheaper but still inefficient.

The OR manager could have offered the surgeon OR time that would have otherwise been underutilized: time in OR 1 starting after 12:30 PM but before 2 PM or time in OR 2 at 5 PM. Either of these options would result in a more efficient use of OR time than starting the case in OR 1 at 3 PM.

The OR manager may view the surgeon as a customer for his facility and make decisions as such. It is quite possible that the surgeon's contribution margin (revenue minus variable costs)¹⁰ will cover overtime costs of all personnel needed to complete the case in OR 1 after allocated time. If this were true, and the manager wanted to please the surgeon, he could choose to start the case at 3 PM in OR 1. However, to make the decision in that manner, the manager would need to know the overall contribution margins per hour of all surgical specialties operating in the OR suite relative to each other.¹⁰ This problem is not from a lack of data—that is easily obtainable. The problem is that making decisions on the day of surgery based on contribution margin alone is unlikely, unethical, and may be politically impossible. Therefore, the manager should probably make the decision based on minimizing the inefficiency of use of OR time. That basis can be applied to making virtually all operational OR management decisions, without bias.

Discussion

Operating room management decisions, allocations of OR time, case scheduling, and staffing decisions should be based on a set of ordered priorities.³ In order of importance, the 4 pertinent priorities are: patient safety, open access to OR time for surgeons on the day they and their patients choose, maximize OR efficiency, and reduce waiting times.³ Higher ordered priorities such as patient safety must be satisfied before considering lower ordered priorities, and lower priorities must not be satisfied if they violate higher ordered priorities.³

In the first vignette, a spinal anesthetic would have reduced waiting time for the patient and surgeon, but may have caused significant hypotension, a safety concern because of the patient's history of preeclampsia. In the second vignette, patient safety would have been violated if the patients were not properly monitored during and after the placement of a regional anesthetic block. Having the regional blocks placed by a second anesthesia team resulted in overutilized OR

time to maintain patient safety but resulted in decreased OR efficiency. Patient safety should be assured first. Surgeon open access to OR time should be assured second. Only then should OR efficiency be considered.

In the third vignette, patient safety and open access were satisfied on the day chosen for surgery. Therefore, attempting to maximize OR efficiency through scheduling was appropriate. Offering the surgeon unassigned time in OR 1 or 2, even though it was at a time other than her preferred operating time, would do this. Whether or not the surgeon chose to operate during the time offered was irrelevant to the ordered priorities, as long as time was offered on the chosen day.

The purpose of this article was to use vignettes to describe how the use of regional anesthesia can affect OR efficiency; therefore, in the vignettes, the decisions to be made affected OR efficiency. If OR time has been allocated appropriately, the use of regional anesthesia will have no bearing on OR efficiency for far more than half the management decisions made on the day of surgery. As a result, the vignettes (deliberately) far overstate the impact of OR efficiency on OR management decisions on the day of surgery. In practice, the fourth priority of reducing surgeon and patient waiting has a larger and more common effect. Although waiting is the fourth of the 4 ordered priorities, in most real-world situations, the first 3 priorities do not affect decisions.

Armstrong and Cherry⁷ compared the amount of OR time utilized for brachial plexus anesthesia and general anesthesia when a block room was used to place brachial plexus blocks. They concluded that in a "busy upper limb practice" the use of a block room could reduce the operating room time associated with the placement of a brachial plexus block.⁷ Although the 22 minutes saved by using the block room was significant at $P < 0.05$, it was less than what was needed to add an additional surgical case to the daily schedule.^{7,11} Furthermore, of the cases studied, only 31% received some form of regional anesthesia, and only 15% of the total cases performed used the block room for block placement.

To conclude that a block room would increase OR efficiency would require the relatively strong assumption that the use of the block room would reduce overutilized OR time. The block room would have reduced overutilized hours by a maximum of 15%, or equivalently 3.2 minutes per OR, where 3.2 minutes equals 15% of 22 minutes per OR. In any of the above vignettes, reducing OR time by 3.2 minutes would not have changed the appropriate OR management decision.

Conclusion

Maximizing OR efficiency, appropriately a common goal of anesthesia and OR clinical directors, can be achieved through good management decisions on the day of surgery. These decisions should be guided by a set of ordered priorities: patient safety, open access, maximizing OR efficiency, and reducing waiting times.³ This article applied these priorities to the placement of regional anesthetic blocks. When patient safety is unaffected, rearranging OR schedules on the day of surgery to place regional blocks, meet surgeon requests, or move up incision times should not be done if it results in unnecessary increases in overutilized OR time.

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AUTHORS

Cormac T. O'Sullivan, CRNA, MSN, is associate director, Anesthesia Nursing Program; adjunct assistant professor, College of Nursing, University of Iowa, Iowa City, Iowa.

Franklin Dexter, MD, PhD, is professor, Departments of Anesthesia and Health Management and Policy, University of Iowa, Iowa City, Iowa.