Tactical Increases in Operating Room Block Time for Capacity Planning Should Not Be Based on Utilization

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When a decision has been made to expand operating room (OR) capacity, the choice of surgical subspecialties to receive additional block time and fill the additional OR capacity is a tactical decision. Such decisions are made approximately once a year. Afterwards, typically a few months before the day of surgery, a second stage occurs in which operational decisions allocate OR time and determine the hours of staffing for each specialty based on its expected workload. In practice, cases are not scheduled into block time that has been planned tactically, but instead are scheduled during the second stage into the staffed time that is allocated operationally. This article reviews the literature on tactical decision-making for expansion of OR capacity. When additional OR capacity is available, it should be planned for those subspecialties that have the greatest contribution margin per OR hour, that have the potential for growth, and that have minimal need for limited resources such as intensive care unit beds. Numerous reasons are presented to explain why tactical planning of additional block time should not be based on current or past utilization of block time.

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This article applies to hospitals or surgery centers that want to increase the number of surgical procedures performed. Additional operating room (OR) time may be planned for individual surgeons or groups of surgeons in the hope they will attract additional patients and perform more procedures.

OR time is often apportioned among surgeons by an OR or surgical services committee. Block time is usually planned for each surgeon in 4-, 8-, or 10-h intervals.[1–3] Planning OR time in blocks designated for individual surgeons has several advantages. The surgeon knows months in advance which day(s) of the week he will operate, and thus can avoid scheduling clinic appointments on those days. He knows how many ORs have been planned for him, and can schedule patients and surgical assistants accordingly. For the hospital, block time for different surgeons can be planned to spread the workload evenly among days of the week. Block time can also be planned to distribute admissions to the intensive care unit (ICU) more uniformly on different days of the week. If certain OR resources are limited (e.g., only a single surgical robot or only one pediatric cardiac anesthesiologist), OR time can be planned so that surgeons who use those resources will operate on different weekdays.

Planning additional block time beyond that needed to meet current needs is a tactical decision made for the purposes of capacity planning. Methods for deciding which surgeons should receive additional block time have been well developed statistically.[4–6] Each surgeon or subspecialty's contribution margin per OR hour,[4–9] in combination with its potential for growth[6,10–12] and need for limited resources such as ICU beds,[4,13,14] provides a rational basis for deciding which surgeons or subspecialties should receive additional block time to promote expansion of their practices. This article does not consider the details of such methods, as there are multiple examples in recent references,[5,6] but instead focuses on the pitfalls of the alternative of planning block time based on OR utilization.

Terms used in this article are defined in the Appendix.

WHY SOME PEOPLE BELIEVE THAT BLOCK TIME SHOULD BE BASED ON UTILIZATION

Utilization is often used as a basis for planning of OR block time.[1,2,15,16]

For example, the pediatric otolaryngologists are very busy, with an adjusted utilization of 90%, which is very high. If they are given additional block time, the surgeons will likely be able to perform even more cases.

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For example, the cardiothoracic surgeons have an adjusted utilization of 40%. They do not fully using the block time they currently have. How could they possibly need any additional time?

What could be the reasoning behind this approach to planning of block time based on utilization? 1) If OR time is limited, subspecialties that have lower utilizations appear to be wasting valuable resources. OR time should be given to those subspecialties that actually use their time instead of allowing the OR to sit idle. 2) Administrators may want the OR to be occupied for the entire length of the workday for which staffing has been planned, hoping to care for as many patients as possible without increasing labor costs.[1,7,17,18] 3) Planning of block time based on utilization seems equitable. Those subspecialties that use the most OR time are given the convenience of blocks reserved just for them. Subspecialties that use little OR time must schedule into "open," "unblocked," or "other" time that is filled on a first come, first served basis. Surgeons are treated like customers, and the best customers receive the most perks. 4) Managers may erroneously extrapolate the concept of bed occupancy and percent utilization of hospital beds to the OR. The analogy may be appropriate if all patients are admitted the night before surgery or require inpatient care after their surgery, but bed occupancy is not applicable to outpatient surgery. 5) Hospital executives may misuse utilization of OR block time as a surrogate for some other resource that is a limiting factor. For example, a surgical microscope may limit the number of cases performed by some specialties. If block time is planned and the surgery schedule is designed to maximize use of the microscope, then surgeons with low OR utilizations will not be using the microscope effectively.[19]

However, multiple studies have shown that utilization should not be used to plan additional block time when a hospital decides to increase its surgical capacity.[1,4–8] Using utilization to determine block time, as in the arguments above, mistakenly confuses the initial stage of tactical planning of block time for capacity expansion with a second, operational stage of matching staffing to anticipated workload.[20] In practice, cases are not scheduled into block time that has been planned tactically, but instead are scheduled during the second stage into the staffed time that is allocated operationally.[20]

Earlier articles on OR block time used inconsistent nomenclature and often failed to differentiate between these two processes. Papers discussed allocation of block time based on the expected hours of elective cases to be performed.[1,21] Hospitals then planned block time based on each surgeon's utilization of existing block time.[1–3,7,15,16] Although previous methods and conclusions are all valid, the terminology was imprecise and sometimes even incorrect based on our current understanding of the field. Earlier results may easily be misinterpreted unless the reader pays careful attention to the context in which each term is used. Now that we realize the two sequential stages must be treated separately,[5,6,20] terms can be defined accordingly. These terms can then be used in a manner that permits clear and unambiguous communication of results. Our synthesis of the literature, and translation of terms into a consistent nomenclature, has led us to the conclusion that planning of block time should not be based on utilization. This article provides a definitive guide to the concept of utilization, and its lack of usefulness when planning block time, bringing together 10 yr of research into OR management.

STRATEGIC, TACTICAL, AND OPERATIONAL DECISION-MAKING

Tactical decisions must be differentiated from both strategic decisions and operational decisions, which have different objectives and affect practices for different lengths of time.

Strategic Decisions

Strategic decisions may require years of planning before implementation and may permanently change OR function. Examples of strategic decisions include building a new ambulatory surgery center for ophthalmology and pediatric otolaryngology patients or spending $2.5 million plus $50,000 a year for an intraoperative magnetic resonance system. Like tactical decisions, strategic decisions have the potential to change OR capacity and can modify the ability of an institution to provide certain types of care.[22,23]

Tactical Decisions

Tactical decisions to increase total block time[6] will increase OR capacity and may alter the amount of clinical care that is provided by a hospital. Such decisions are made once, perhaps twice a year. An increase in OR capacity may arise from either an increase in the number of physical rooms available or an increase in the number of hours each day that existing ORs will be staffed. Additional block time may be planned for individual surgeons or small groups of surgeons of the same subspecialty to encourage those surgeons to increase their caseload.

To increase profits, additional block time should be planned tactically for those surgeons or subspecialties that have above average contribution margins per OR hour,[4–9] that have the potential for growth,[10–12] and that lack constraints imposed by limited resources such as ICU beds.[13,14] Subspecialties are also excluded from receiving tactical increases in OR block time if they perform only small numbers of cases, or if their cases cannot safely be performed in the OR space available.[5,6] Contribution margin per OR hour often includes a component of intangible revenue for the added value that the facility places on certain types of cases, perhaps for public relations or gifting purposes. The precise formulae for apportioning time among

subspecialties to maximize overall contribution margin per OR hour, incorporating both growth potential and any constraints, are in the Appendix of Ref. 5. The methods are reviewed in Ref. 6.

The goal of tactical increases in OR block time is to increase profits, measured either as monetary gain or some intangible benefit. Although one may want to believe that hospitals should not use financial criteria as a basis for planning block time, income and expenses cannot be ignored. If money were irrelevant, every subspecialty would currently be able to purchase every piece of equipment requested. Staffing levels would be higher and positions would never be cut. OR time would never be a bottleneck to surgery. Every subspecialty could perform cases whenever it wanted. The need to allocate block time is itself evidence of limited funds.

By planning additional block time tactically, a hospital can increase profits by targeting specific subspecialties for growth. Decisions not to increase block time for certain subspecialties does not mean that they cannot grow. In a well-run surgical suite, surgeons who have filled all their allocated time would be able to schedule additional cases, although designated block time has not been planned specifically for them.[20] Provided there are not other constraints besides OR time, their cases should not be turned away.[20] The surgeons would simply find it less convenient to schedule many of their cases into "open," "unblocked," or "other" time not planned for any specific service, or into OR time planned for other services that has been released because it has not been filled.

For example, a new urologic surgeon is known for his skills in performing nerve-sparing radical prostatectomies. He is fully booked for the next 3 mo. Should his OR time be increased in the hope that he will raise his caseload by expanding the number of hours each week he performs surgery?

For example, two orthopedic surgeons specialize in joint replacement. They attract patients from a hundred miles away. Patients wait an average of 3 mo for surgery. On the 3 days per week that one or the other operates, they fully fill a 10-h OR. Utilization is 90%. They want a second OR each of those 3 days so that a single surgeon can work room to room, and will then schedule more cases. Would that be a good decision for the hospital?

For example, two neurosurgeons specialize in implantable nerve stimulators to treat chronic movement disorders. They would like to expand their practice, claiming that many more patients could benefit from nerve stimulators if they were properly evaluated. Since utilization is already close to 90%, the neurosurgeons have requested two additional days of OR time each week. The hospital does have two ORs that are not staffed Mondays or Fridays. However, the nerve stimulators cost about $40,000 each, and private insurance often does not cover the cost because the procedure is sometimes considered experimental. The hospital loses an average of $10,000 on each case. Should the hospital increase its OR capacity by allocating additional block time to the neurosurgeons?

For example, two vascular surgeons have an average adjusted utilization of only 60% because the intensive care unit is often full. Nevertheless, they desire greater flexibility in scheduling and would like additional block time. Should they be given additional block time even though they do not fully use the time already allotted to them?

The answers to the preceding example questions are all the same. The answers should not consider utilization of existing block time, except where a low utilization reflects a limited potential for growth. The surgeons should be given additional block time tactically, provided their contribution margin per OR hour is above average, they have the potential for growth, and other constraints are not limiting. If the hospital places some intangible value on certain types of surgery and wishes to encourage growth, then that intangible value should be added to the contribution margin for these cases, and more OR block time may be planned tactically. If other factors constrain the amount of certain types of surgery that can be performed, such as a robotic arm or ward beds, increases in block time must be limited. If block time is not increased sufficiently to perform the number of cases available, surgeons will still have access to additional OR time operationally by booking into "open," "unblocked," or "other" time not planned for any specific service or into OR time that has been released from other services.[5,6,20]

Operational Decisions

OR management decision-making at the operational level was recently reviewed by McIntosh et al.[20] In contrast to tactical and strategic decisions, operational decisions do not affect the numbers or types of surgical procedures performed. Operational decision-making may be considered in two stages: 1) Approximately every 3 mo, staffing plans are adjusted to match anticipated workload. Decisions include the numbers of ORs that will be staffed and the hours they will be staffed each day.[15,17,20,21,24–28] OR time is allocated to each service (usually a specialty), and surgeons schedule cases into their service's allocated time.[20,29] The hours of OR time allocated to each service depend on the hours of cases that the service is expected to perform. The anticipated workload depends on both expected under-utilized OR time, which decreases utilization percentages, and expected over-utilized OR time.[15,20,25–29] 2) Closer to the day of

surgery, operational decisions focus on reducing over-utilized time.[20,29,30] Decisions include scheduling cases into allocated time released from another service, assigning each case to a specific OR, determining the scheduled start time of each case, and moving cases from one OR to another.[2,20,24,29–31]

For example, utilization of OR time at some facilities has been reported at 45%–55%.[32–34] Eleven community anesthesiology groups averaged 6.0 h of anesthesia time per OR per day.[35] At nine community hospitals in the mid-western United States, ORs in which one or more knee or hip replacements were performed averaged 5.6 h of cases.[36] If staff were scheduled for 8 h, under-utilized time would be high. An operational decision at these facilities would be to run fewer ORs each day, while still performing the same number of cases.

For example, a urologist had an 8-h block of 1 OR every Monday. His radical prostatectomies averaged 2 h in duration, and three cases were usually scheduled for each Monday. However, the surgeon took a job elsewhere. Another urologist was hired and has the same block. He averages 3 h for each radical prostatectomy. Three cases are still scheduled daily. On most Mondays, his OR ends 2 h late. When nurses are scheduled for the next quarter, staffing for the OR assigned to urology on Mondays should be increased from 8 to 10 h. This operational decision to increase the OR time allocated to urology would have no effect on the urologist's block time. Changing the hours into which the cases are scheduled helps prevent over-utilized time.

Each of these operational decisions matches staffing to workload and occurs anywhere from 3 mo in advance (reviewed in Ref. 20) to the day of surgery (reviewed in Ref. 30). Operational decisions do not increase or reduce workload.

OR management can thus be considered in three stages: strategic, tactical, and operational. The effects of strategic decisions last for many years. Tactical decisions that alter planning of OR block time may affect not just the total OR workload, but also the distribution of cases among subspecialties. Operational decisions do not affect the number of cases performed, but govern the scheduling and assignment of cases, nurses and anesthesia providers.

Strategic and operational decisions will not be considered further. This article concerns expansion of OR capacity through tactical planning of additional OR block time for specific groups of surgeons. Although utilization may be used to determine service-specific staffing (OR allocations), block time should not be based on past utilization of OR time. This conclusion is based on multiple previous studies. This article attempts to bring together those apparently disparate results into a single coherent argument.

TEN REASONS WHY TACTICAL DECISIONS SHOULD *NOT* BE BASED ON UTILIZATION

1. Utilization percentages can be artificially inflated
2. Estimates of utilization are not accurate for individual surgeons
3. Subspecialties with longer case durations will have lower utilizations
4. Optimal utilization differs among subspecialties
5. Efforts to increase utilization can impair growth of some subspecialties
6. Utilization correlates poorly with patient waiting times
7. Increasing utilization to high levels can reduce revenues
8. Utilization does not indicate the potential for future expansion
9. Utilization is poorly related to contribution margin
10. Utilization is poorly related to variable costs

1. Utilization Percentages Can Be Artificially Inflated

For example, OR block time and staffing have been planned from 7 AM to 3 PM. Cases are scheduled from 7 AM to 1 PM. Nevertheless, the surgeon deliberately leaves the OR before closure of each case, allowing a medical student to close under the supervision of a junior resident. Delays in finishing cases occur frequently.[2,18]

OR utilization appears high for this surgeon because of the delays. Thus, OR utilization is not an accurate reflection of the time needed to complete a series of cases. In contrast, contribution margin per OR hour would be reduced, reflecting the impact of the delays, unless an extremely high intangible value were placed on medical student education.

2. Estimates of Utilization Are Not Accurate for Individual Surgeons

Block time is effectively planned for individual surgeons or subspecialties.

For example, waiting lists are long for cataract surgery. The Regional Health Authority will provide incremental revenue per case to reduce the waiting lists. The hospital wants to meet the needs of the community and benefit from the incremental revenue. However, a tactical decision to give more block time to the Department of Ophthalmology would not necessarily increase cataract surgery. Block time needs to be planned by subspecialty, specifically for the one or two surgeons who perform cataract procedures.

However, average OR utilization cannot be estimated accurately for individual surgeons or subspecialties, only for surgical groups. For the purposes of

determining appropriate service-specific staffing, almost a year of OR data is preferable.[37] A bit less than a year of data is a good choice to predict future monthly OR workload for groups of surgeons.[21] For an individual surgeon, more than 10 yr of data can be needed for measurements of average OR utilization to be sufficiently accurate for decisions to differ from those based on random chance.[1,38]

For example, during the preceding 3 mo, a surgeon's measured adjusted OR utilization was 65%. However, no one block was average. The 95% confidence interval on the surgeon's average adjusted utilization was 38%–83%.[39]

For example, during the previous quarter, average adjusted OR utilization was 65% for Surgeon 1 and 80% for Surgeon 2. Should the OR time planned for Surgeon 1 be reduced and instead given to Surgeon 2? The probability exceeds 16% that the surgeons have the same true average OR utilization.[38]

The reason for the wide confidence intervals in OR utilization is random variations in the numbers of patients each week requesting to be scheduled for surgery.[38] Typically, one patient does not affect the next patient's decision when to call and ask to be added to the surgery schedule. When they do call, patients generally want to be scheduled for surgery on the next available date.[40,41] If one day the surgeon's block has an OR utilization less than the surgeon's average, in all likelihood the surgeon's next block will also have an OR utilization less than the surgeon's average. Large variations in utilization among blocks are particularly significant for lower workload surgeons.[38] Thus, use of workload (hours of cases) instead of utilization does not circumvent the problem.[38] A control chart that displays the utilization of a surgeon's successive blocks can be used to illustrate the variability in utilization.

Paradoxically, imprecision in case duration estimates[20,29,42–47] decreases the widths of the confidence intervals surrounding estimates of utilization.[38]

For example, measured OR utilization for a surgeon during one quarter is 80%. With a mean case duration of 3.8 h and a standard deviation of 2.4 h, the 95% confidence intervals are 67%–86%. In contrast, suppose that every case took exactly 3.8 h (i.e., the standard deviation were zero). OR utilization would then be 50%–98%.[38] The confidence intervals become wider when all the cases have exactly the same duration because the number of cases per 8-h day varies by 100%. Either one or two cases can be performed, never three. With different case durations, however, the number of cases performed each day will vary by a smaller percentage.

Tactical decision-making for increases in block time based on contribution margin per OR hour is unaffected by the inability to measure utilization accurately for a single surgeon.[4–8,20]

3. Subspecialties with Longer Case Durations Will Have Lower Utilizations

Under-utilized OR time for a subspecialty may be brief intervals in each OR that are too short to be usable by that subspecialty.[23,48,49] Thus, block utilizations for subspecialties with cases of long durations will be lower than for subspecialties that perform larger numbers of short cases each day.[1,23,49] Comparison of utilizations among subspecialties may therefore be misleading. For a surgical suite that performs mostly long cases, an increase of 11% in the number of covered lives can result in an increase in OR utilization of <1% due to the small numbers of cases performed in each OR per day and difficulty in fitting the additional cases into the scheduled workday.[50] Except for brief procedures such as placement of myringotomy tubes, the average number of cases a surgeon performs daily is a small number. Hospitals in the United States average only 2.1 cases per OR per day.[51]

For example, all block time is for 8 h and staffing has been planned from 7 AM to 3 PM. A surgeon performs cases that average 5 h in duration. Only a single case can be scheduled each day without creating over-utilized time. In spite of his low utilization of 66%, lack of OR time may be the bottleneck that prevents this surgeon from performing more cases. The surgeon is simply unable to fit additional cases into the time allotted.

Tactical decision-making for increases in block time based on contribution margin per OR hour is not dependent on how cases fit into the length of the staffed workday.[5,6,20]

4. Optimal Utilization Differs Among Subspecialties

Subspecialties with greater variability in utilization need different target utilizations to determine the extent to which they are using the time planned for them. For a given subspecialty, utilization will fluctuate from one day to the next due to differences in the number of cases scheduled for surgery each day, inherent variability in case durations, and imprecision in case duration predictions.[1,15,17,20,29,31,42–47] These fluctuations will be much larger for some surgical subspecialties than for others. For those subspecialties that perform only a few cases in each block, a difference of 2, 3, or 4 patients from one wk to the next represents a large percentage variation in utilization among blocks.[38]

For example, a thoracic surgeon has 10 h of block time on Tuesdays and Thursdays. For every three patients seen in clinic, only one patient needs surgery. Patients usually have surgery

within 2 wk. Surgical workload is thus unpredictable from one week to the next. The thoracic surgeon cannot be expected to achieve an average adjusted utilization higher than 75%.

To provide every surgeon with the same flexibility in scheduling cases, as measured by average patient waiting time, each subspecialty should have a different optimal target utilization.[1,15,23,52] However, as explained above in Section 2, the number of days of data required to determine target utilizations is too large to be practical.[1,38] In contrast, making tactical decisions for increases in block time based on contribution margin per OR hour does not rely on the setting of target utilizations.[4–8]

5. Efforts to Increase Utilization Can Impair Growth of Some Subspecialties

Factors other than the availability of OR block time may limit workload of some surgeons.

For example, lack of ICU time is the bottleneck for a vascular surgeon.[4,13,14] The surgeon has to cancel a case if the ICU will not be able to accommodate his patient postoperatively.[13] Because of variability in ICU lengths of stay, however, the availability of ICU beds can be hard to predict days in advance.[53] Both the surgical suite and the surgeon must adjust their schedules around the availability of ICU beds.[13,25] The surgical suite should be flexible enough to provide OR time for this surgeon when an ICU bed becomes available. OR utilization is low because the surgeon's caseload is erratic. If block time for the surgeon is reduced in an effort to increase utilization, workload of vascular surgery would be compromised, and growth would be stunted.

For example, recent newspaper articles have highlighted a hospital's interventional neuroradiology program. Grateful patient donations total $2 million. However, the two neuroradiologists travel frequently and often cancel cases. The hospital benefits strategically from the interventional procedures, in spite of low utilization of the anesthesia block time.[54,55]

When contribution margin per OR hour is used to determine increases in block time, surgeons who are limited by the availability of scarce resources, or are constrained by other responsibilities, are not penalized for low utilizations. In addition, the intangible value of certain factors, such as a surgeon's ability to attract cases that provide good public relations, can be incorporated into the revenue term of contribution margin to reflect the importance of that subspecialty to the facility.

6. Utilization Correlates Poorly with Patient Waiting Times

Hospitals may want to meet the needs of larger numbers of patients or reduce the number of weeks that patients wait for surgery.[15,23,41,56]

For example, a hospital is being pressured by the community to reduce the waiting time for hip replacement surgery. Another joint replacement surgeon and assistants are being recruited. Increased OR capacity should be provided for this surgeon. Utilization may initially be low as his practice grows.

For example, political candidates want to reduce the total number of patients waiting for surgery. Block time should be planned for subspecialties with the largest number of cases per OR hour, even though those subspecialties may not have the highest utilizations.

When planning OR time tactically based on contribution margin per OR hour, overall patient waiting can be reduced by adding an intangible value to each surgical case.

7. Increasing Utilization to High Levels Can Reduce Revenues

Planning additional OR block time based on OR utilization assumes that higher utilizations are better. Increasing the number of covered lives can boost adjusted utilization to 90% or more. However, increases in OR utilization to such high values can reduce contribution margin.[50]

For example, overall adjusted OR utilization at one hospital is 90%. Some administrators see the ORs as 10% empty.[57] They think that revenues could be increased without any change in staffing costs.[1,17,18] The hospital signs a contract to become a preferred provider for an additional insurance plan. The hospital will perform surgery on plan members at a discounted rate in hopes of increasing OR utilization above 90%. The problem is that patient waiting times for surgery become longer as utilization rises.[1,40,50,52] The new patients recruited at a discount displace more lucrative patients.

The change in revenue that results from an increase in workload is taken into account when 1) operational decisions are based on reducing under-utilized and over-utilized OR time,[5,6] and 2) tactical decisions for increases in block time are based on contribution margin per OR hour.

8. Utilization Does Not Indicate the Potential for Future Expansion

Even though a subspecialty may have a high utilization of block time, the subspecialty may be limited by either the number of cases available or the interest of the surgeons in performing additional cases.[5,6] Past utilization does not consider the potential for expansion of a subspecialty. In contrast, tactical decision-making to increase block time based on contribution

margin per OR hour can incorporate forecasts of growth in market demand.[5,6,11]

9. Utilization Is Poorly Related to Contribution Margin

To increase profit, OR time should be planned tactically for those surgeons or subspecialties with the highest contribution margin per OR hour. Contribution margin can include both hospital and professional payments, or the two components can be considered individually.[54,58] Contribution margin can also include intangibles, such as the value of additional patients of a certain type targeted by a strategic plan.

Contribution margin per OR hour differs markedly among surgeons.[4–8,59] Data have been published from four hospitals.[4–7] At one hospital,[4] surgeons performing oral surgery, outpatient pediatric otolaryngology, and hand surgery had contribution margins per OR hour less than $250. The nine surgeons with contribution margins per OR hour more than $2500 performed cardiothoracic surgery. At all hospitals, the differences between the 10th and 90th percentiles in contribution margin per OR hour among surgeons ranged from $1520 to $2200 per OR hour. Assuming 7 h of OR time per day, a difference of $2000 per OR hour is $3.5 million per year. Consequently, hospitals could see large increases in working capital if casemix were altered to increase average contribution margin per OR hour.

For example, outpatient pediatric otolaryngology and minimally invasive thoracic surgery both perform an average of 7 h of cases in an 8 h workday. They have identical raw utilizations. However, outpatient pediatric otolaryngology brings in greater revenues and has lower variable costs than minimally invasive thoracic surgery. If the hospital wants to plan additional OR time tactically based on financial considerations, the time should be given to pediatric otolaryngology.

For example, two surgeons perform laparoscopic cholecystectomies. One surgeon averages 50% longer than the other surgeon to perform the same procedure. However, when compared with other subspecialties, differences in contribution margin per OR hour between surgeons performing the same procedure are small. Such differences are unlikely to affect tactical decisions involving planning of OR block time.

If a hospital's ability to expand OR capacity and perform more surgery is limited by available funds, planning additional OR block time for subspecialties with larger contribution margins will increase cash flow and ease financial constraints for all of the surgeons, including those of other subspecialties.[4–6]

10. Utilization Is Poorly Related to Variable Costs

Reimbursement of hospitals on a fee for service basis continues to be increasingly common, particularly as European countries migrate to Diagnosis Related Groups systems.[60] Nevertheless, funding is fixed at some facilities, such Veterans Affairs hospitals in the United States. They receive zero incremental revenue for each surgical case. Since funding is limited, hospitals must consider how planning of OR block time affects variable costs.[3,7,22,59,61,62]

The cost of OR time is not the only component of total perioperative variable costs.[54,59,63] OR time, implant costs, hours of ICU time, and hours of hospital ward time together account for 62% of total costs and 97% of the variance in total hospital variable costs.[59] Increasing OR block times for surgeons who use these other resources can greatly increase hospital perioperative variable costs.[59]

Two hospitals have published data on their variable costs per OR hour.[7,59] Differences between the 10th and 90th percentiles of variable costs were $1400 and $2200 at the two hospitals. At one hospital, the 10 surgeons with variable costs more than $2500 per OR hour performed cardiothoracic surgery requiring a stay in the intensive care unit or hip and knee replacement surgery with implants.[59] The two surgeons with variable costs less than $600 per OR hour performed either dental or pediatric urology cases.[59] If additional OR block time were planned tactically, costs could increase considerably with no increase in revenues, depending on which surgeons performed more cases.

For example, the National Healthcare Administration has increased a hospital's budget, providing staffing for one additional OR. Two extra days of block time are planned each week for the subspecialty with the highest utilization, which is joint replacement surgery. The number of hip and knee replacements increases by 50% over the previous year. Because the hospital did not consider the cost of the implants when planning block time, a large deficit resulted. OR nurses were made redundant and laid off. Two ORs had to be closed for the next year.

DISCUSSION

Because of increasing numbers of elderly patients and expanding surgical technologies,[64–66] almost all decisions regarding tactical planning of OR time involve either no net change or an increase in total OR capacity. Closing of ORs due to excess capacity and low utilizations is extremely uncommon.

When total OR time is to be increased, additional block time should be planned for those subspecialties that meet all of these criteria: 1) relatively high contribution margin per OR hour, 2) no constraints such as limited intensive care unit beds, 3) appropriateness of the procedures to be performed, given the training of the staff and the equipment available at the hospital, 4) surgeon(s) who want to grow their practice, 5) potential for growth, such as additional patients in the community not currently having surgery at the facility, and 6) expected revenues that will maintain a high

contribution margin per OR hour. The scientific basis of these methods for determining how additional OR time should be apportioned between subspecialties is well developed.[5,6] In this article, we explained why utilization of block time is not an appropriate metric for tactical planning of additional block time.

Utilization is not a good basis for planning additional OR block time for several reasons. Utilization is not a stable and reliable statistic for a given subspecialty. It does not treat all subspecialties equally, in that subspecialties with longer cases durations or subspecialties that rely on scarce hospital resources will inevitably have lower utilizations. Utilization does not consider strategic goals or organizational objectives, such as targeted growth of certain subspecialties, recruitment of certain patient groups, or reductions in waiting lists and/or waiting times for surgery. Utilization does not consider the financial impact on the hospital of the increased workload, including the incremental revenue brought in by the additional patients, the incremental costs incurred in caring for the additional patients, or an increase in over-utilized OR time. Thus, use of OR utilization as a basis for capacity planning decisions has no sound foundation.

The impact of tactical decisions that plan OR block time should be adjusted and fine-tuned operationally when OR time is allocated based on matching staffing to workload, staff are scheduled to work specific shifts, and cases are scheduled into the allocated time.[5,6,20] An understanding of operational decision-making and case scheduling is crucial for planning block time effectively.[5,6,20] Operational decisions compensate for actual workloads that do not match tactical block times. The goal of operational scheduling decisions is partly to prevent under-utilized OR time, but first and foremost, to prevent over-utilized OR time.

Planning OR block time tactically, and deciding which surgical subspecialties to target for expansion based on contribution margin per OR hour, raises certain ethical issues. Although surgeons with lower contribution margins can book additional cases into "open," "unblocked," or "other" time not planned for any specific service,[20,29,31,67,68] or time released from other services, those surgeons do not have the convenience of additional block time. They cannot be assured of OR time every Tuesday morning. Is it appropriate for a hospital to plan additional block time for certain patients just because those patients are more profitable?

> *For example*, a plastic surgeon attracts patients from all over the country because of his reputation for performing facelifts and rhinoplasties. The majority of his patients are self-pay, and the hospital requires a $5000 advance deposit. Should the hospital plan additional block time for this surgeon, while not providing as much flexibility in scheduling to other surgeons whose patients are not as lucrative?

With the expansion of outpatient surgery, the physical number of ORs is rarely a limiting factor.[32–36] Workload is limited by a facility's willingness to expand staffing tactically and run the ORs for long workdays. The duration of the allocated time limits workload. Reality is that few facilities choose to run their ORs for long workdays for elective cases, despite the resulting low utilization of expensive capital equipment. Growth of those subspecialties that have higher contribution margins is thus particularly important for ensuring the continued financial health of the facility, to the benefit of all subspecialties. At one hospital, 26% of cases had a negative contribution margin.[7] Allocating additional time to subspecialties with negative contribution margins in the hopes of expanding those markets does not serve the long-term interests of hospitals unless they have financial benefactors who are willing to subsidize that type of medical care.

The mission of some hospitals may dictate that they provide care without regard for an individual's ability to pay. Surgeons at those hospitals should not be penalized with more inconvenient access to the OR if many of their patients lack insurance coverage, if their payer mix is less favorable, or if the procedures they perform are less profitable. At these hospitals, financial considerations and contribution margin per OR hour may be irrelevant. Crucially, utilization would still be an inappropriate metric for determining which subspecialties should receive additional OR time, as all of the limitations of Sections 1 to 6 and 8 would still apply. In this situation, additional OR block time should not be planned tactically for individual subspecialties. Increases in OR capacity should be classified as "open," "unblocked," "other," or "overflow" time that that would be allocated operationally when surgeons had filled all their block time but still had additional cases to perform.[5,6,20] The goal of decisions involving expansion of OR capacity would be to reduce under-utilized and over-utilized OR time, as explained in Ref. 6 and reviewed in Ref. 20.

APPENDIX: DEFINITIONS OF TERMS

Subspecialty or Service, Block Time, and Allocated Time

At most facilities, surgeons are not interchangeable. Individual surgeons hold clinics on different days of the week and invariably operate on just a few predetermined days of the week. Consequently, for all practical purposes, *block time* is planned and OR time is allocated to individual surgeons or small groups of surgeons of the same subspecialty.[1,3,7]

By *subspecialty*, we refer to a group of surgeons, rarely comprising more than two surgeons, who perform the same types of procedures and who share OR block time. Examples of subspecialty groups include

pediatric urologist(s), general thoracic surgeon(s) performing mostly esophageal cases, cardiac surgeon(s) specializing in ventricular assist devices, and vascular surgeon(s) with board-certification in interventional radiology.

Block time may officially be planned for departments or specialties that include multiple surgeons. However, the departments then decide how individual surgeons may use the blocks planned for that service. If the department (e.g., general surgery) consists of surgeons of different subspecialties, the department may designate certain days for use by one or more surgeons practicing in the same subspecialty (e.g., pediatrics, or the "red" or "green" team).

When staffing is planned, "*service*" refers to the unit of OR allocation, which can be an individual surgeon, a small group of surgeons that comprise a subspecialty, a specialty, and/or a department. OR *allocations* are the hours into which cases are scheduled.[20] OR time is allocated to services, which are usually specialties. If multiple ORs are allocated to a service, the ORs are considered equivalent. Usually several specialties that are allocated OR time on the same day may functionally be coalesced into a single service for purposes of staffing and case scheduling.

Block time is the hours that have been planned months in advance for a surgeon or subspecialty.

Utilization of block time is the hours of block time during which elective cases are performed divided by the hours of block time planned for that surgeon, subspecialty, or service.[69] For raw utilization, turnover times are excluded from the hours of elective cases. For adjusted utilization, setup and cleanup times are included.[70]

Allocated time is the hours reserved for each service for which staffing has been planned and into which cases are scheduled. If the block time calculated for individual subspecialties is insufficient to perform most of the cases, then the time allocated will invariably exceed total block time.[20]

"Open," "unblocked," or "other" time is the hours for which staffing has been planned that have not been reserved for any specific service or specialty. The hours are designed for overflow cases[20,31] in the event a service has filled its allocated time, but still has additional cases to perform. Services with small caseloads that do not have their own allocated time must schedule their cases into "open," "unblocked," or "other" time. Such OR time is analogous to "swing beds" that can assume various roles, depending on the need.

Released time is the hours that have been allocated to a specific service that are subsequently made available to other surgeons because the service has not filled its time.[29,67,68]

Workload is the total hours of cases, including turnovers.

Under-utilized time is the hours during the workday for which staffing has been planned but the OR sits idle.[25]

For example, staffing has been planned from 7 AM to 3 PM in each of 4 ORs every Friday. On one particular Friday, the 4 ORs finish at 1:30 PM, 2 PM, 2:30 PM, and 4 PM. For the day, there are 3.0 h of under-utilized time, where 3.0 h = 1.5 h + 1.0 h + 0.5 h + 0.0 h.

Over-utilized time is the hours the OR is busy beyond the end of the workday for which staffing has been planned (i.e., past the allocated time).[25] Hourly workers would generally be paid overtime wages for their work during over-utilized OR time. Other costs include dissatisfaction on the part of salaried staff.

For example, staffing has been planned from 7 AM to 3 PM in each of 4 ORs every Friday. On one particular Friday, the 4 ORs finish at 1:30 PM, 2 PM, 2:30 PM, and 4 PM. For the day, there is exactly 1 h of over-utilized time, where 1.0 h = 0.0 h + 0.0 h + 0.0 h + 1.0 h.

Cost Accounting

Fixed costs do not change with the number of cases performed. Examples of fixed costs include the rent paid for the building in which the surgical suite is located, maintenance of the building and grounds, equipment rental or depreciation, and office support staff.

Variable costs change relative to the volume of activity. Examples of variable costs include implants, disposable supplies, medications, and laundry. Since each patient undergoing total knee replacement surgery needs a knee implant, the total cost of knee implants depends on the number of cases performed. Knee implants are a variable cost. For purposes of tactical decision-making, variable costs should include not just the OR, but ICU usage and ward time. Healthcare providers can be considered a variable cost when planning OR time tactically. OR nurses and technicians and the number of shifts they are scheduled to work can be changed on a long-term basis.[4,62] On a short-term operational basis, however, staffing costs for an OR are fixed unless cases are performed in over-utilized time.[20,26]

Revenue is the sum of payments received in return for goods or services. Revenue can include both hospital and professional payments.[53,54,58] Revenue is usually money, but it may also be intangible, in the form of goodwill or an enhanced reputation. It may also reflect the value of research or teaching missions of the hospital.[71] A dollar value must then be assigned to these intangible revenues.

Contribution margin for each patient visit is the revenue gained from that patient visit minus the variable costs associated with that patient visit.

Profit equals contribution margin minus fixed costs

Contribution margin is a more useful measure than profit for planning block time, because hospital fixed costs are more than twice variable costs.[7,72–75] Because fixed costs are not changed by block time decisions, fixed costs should not be considered when making such decisions.

Contribution margin for a subspecialty is calculated from the total revenues and total variable costs for all cases combined, and from the total hours of OR time for all cases combined. A separate contribution margin per OR hour should not be calculated independently for each surgical case, with subsequent averaging of the individual values.[7,8,54]

Different facilities may exhibit a wide range of contribution margins for the same procedure, depending on implants costs, local wages, payer mix, etc. Contribution margins should not be compared between facilities, but must be interpreted independently for each facility.[54]

When calculating the contribution margin of a subspecialty for the purpose of tactical planning of additional OR time, only elective surgery performed on outpatients or patients admitted the day of surgery should be considered. Decisions made by a surgical services committee once or twice a year can attract patients needing certain types of elective care, or encourage some patients to be referred elsewhere. In contrast, hospitals and surgeons cannot readily change the number or types of procedures performed on an emergent basis. Similarly, surgeons have little control over the procedures to be performed on patients who have already been admitted, because the hospital has previously committed to providing whatever care those patients require. In addition, the entire cost of a prolonged hospital stay cannot reasonably be attributed to a single surgeon who provided care sometime that stay, but did not make the decision to admit the patient.

For example, a patient is admitted to the hospital on the day of his scheduled nephrectomy. Late that evening, the patient returns to an OR briefly for exploration of postoperative bleeding. Hospital costs for the second trip to the OR are attributed to the patient's first surgery. The decision to schedule the patient for the initial elective case was the trigger that resulted in the subsequent costs incurred later in the patient's hospitalization. The entire cost of the hospital stay should be included when calculating contribution margin for the initial procedure.

For example, contribution margin for a 40-day hospitalization for cerebral trauma from a motor vehicle accident cannot reasonably be attributed to the orthopedic surgeon who performed an open reduction of a tibial fracture on the day of admission. Contribution margin for this particular case may include costs and revenues generated by neurosurgery, neurology, internal medicine, physical therapy, and other specialties.

Managerial cost accounting for surgery is more accurate when average OR utilization is high. This condition is usually satisfied for those subspecialties for which more block time may be planned. If utilization were not already high, access to OR time would not be a limiting factor and additional OR time would not be needed to increase caseload.

Potential for Growth

Data envelopment analysis[6,10–12] can be performed to determine which inpatient subspecialties have the potential for growth. By examining the market visibility of individual hospitals and estimating the need for medical services in the local area, data envelopment analysis determines whether a hospital is performing fewer of certain types of procedures than expected in a given specialty based on its workload of procedures in other specialties. Specialties that are performing more procedures than expected would, in all likelihood, have minimal potential for growth. Those specialties would not be able to fill additional time planned for them. Specialties that are performing fewer procedures than expected may be able to increase their caseloads.

A hospital can also determine the potential for growth of specific specialties by identifying other facilities that may be substantively affecting its caseload. The hospital can perform a competition analysis[76] to determine factors involved in patients' decisions about where to go for surgery.

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