How to Increase OR Throughput and Profitability

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Introduction

The surgeon has just applied the dressings, having performed a procedure that took about an hour; now the anesthesia team is awaking the patient. If this operating room (OR) is run like many others in the U.S., it will be another hour or so before the surgeon will start on the next patient! Meanwhile, patients in the pre-operative holding area and waiting room are wondering when their turn will finally come. It's now well past the time of their scheduled surgeries.

Surely something is wrong with the process for managing patient throughput at this institution. If the case mix consists of many short procedures, the hospital is potentially missing the opportunity to increase the number of cases it schedules into its regular work day. And the opportunity corresponds to a foregone profit of about $500,000 per year, based on a contribution margin about $2,000 per 80-minute case[1]. Moreover, unbeknownst to many on the hospital's staff, the hospital may missing other opportunities – the opportunity to improve its patients' satisfaction by making their waiting times more predictable and the opportunity to reduce some of the stress on its OR staff.

What can be done? Health care facilities committed to improving their bottom line by increasing patient flow through their ORs and capturing the opportunities just mentioned can do so by applying some combination of five methods,[2] aimed at reducing the so-called Non-Operative Time. This article, which builds upon the results of a spate of recent initiatives in the US and Europe[3,4,5,67], describes the methods and their observed impact on patient flow.

Who should be interested? Ambulatory surgery centers (ASCs) for one. They tend to concentrate on short cases, and many are for-profit institutions that need to build a patient-centered reputation. For them and their owners, managing their OR facilities in an efficient manner is critical to success. How about other hospitals? Many of them compete to retain surgeons who might steer their patients to ASCs or more efficient, more patient-friendly, hospitals. What's to keep them from adopting, and even improving upon, the methods of their competitors?

What's the catch? Implementing some of the methods requires an investment. And long-run success requires more than money: It often depends on changing deeply ingrained habits. Moreover, it requires changes to management systems, including incentives to make sure that new processes and habits continue to be observed. However, for those who step up to manage the change and to make the investments in technology and processes, it promises to be a winning strategy.

Some definitions

Before describing how to increase patient throughput, we pause to define several terms. We begin with *Operative Time.* This is the interval during which the patient is under the control of the surgeon. It includes the so-called "patient prep and drape" phase, the surgery itself, and the application of dressings. The *Non-Operative Time* is the interval between surgeries during which the patients are not under the direct care of the surgeon. It is made up of the *Anesthesia Controlled Time,* the interval in which the patient is the responsibility of the anesthesia team and *Turnover Time,* which is the interval measured from the departure of one patient from the OR to the arrival of the next. *Anesthesia Controlled Time* is itself the sum of two intervals. The first, *OR Induction Time,* is the interval from the patient's arrival in the OR to the point where anesthesia has been administered and the patient is turned over to the surgical team. The second, *OR Emergence Time,* is the interval required to wake up the patient and move the patient out of the OR. One final term, *OR Throughput* is defined as the rate of patient flow through the OR, say, five patients per day through OR 3.

The typical non-operative interval

Let's go to the end of the operative interval at a typical hospital and trace what happens after the surgical team has applied the dressings. First, the anesthesia team wakes the patient. Then, someone moves the recovery room bed to the side of the OR table, and, when an appropriately large team is assembled, the team transfers the patient from the table to the bed. Finally, the anesthesiologist and possibly one other clinical person move the patient to the recovery area. Their departure from the OR signals the end of the OR Emergence Time and the beginning of Turnover Time.

Now that the patient is out of the OR, it's time to alert Housekeeping to come and clean up. After some delay, the Housekeeping team arrives, removes the trash,

wipes down multiple surfaces, mops the floor and places sheets on the OR table. After announcing it has completed its work, it moves on.

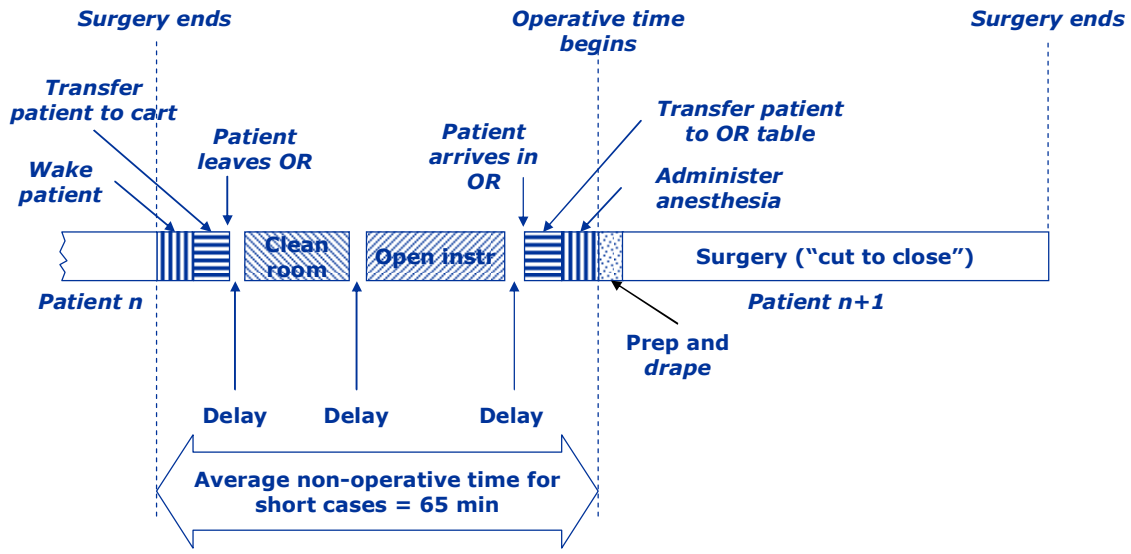
After the floor is clean and dry, the Circulating Nurse and the Surgical Scrub come to the room to open the instruments for the next case. When their task is complete, they can signal that the room is ready for the patient or, possibly, the Circulating Nurse goes to the pre-operative holding area to bring the patient to the OR. Regardless of the protocol followed, Turnover Time ends when the next patient enters the OR.

If the patient arrives on a gurney, and if the patient is not able to transfer herself from the gurney to the OR table, a team must be assembled to move the patient. Then, it's time to administer anesthesia. However, unless the surgeon is present, everyone waits. So, as a result of these potential diversions, OR Induction Time, which starts when the patient arrives in the OR, can easily exceed 15 minutes.

The sequence of events just described is depicted in Figure 1. It suggests how serial processing contributes to stretching out Non-Operative Time and how any delays between the steps can stretch it even further. And it is the wide variation in the delays that makes the waiting times for patients – which are already unpredictable owing to the natural variability of Operative Times– even more difficult to predict.

Figure 1

Typical sequence of events for a short case. The durations of the intervals are approximately to scale. Delays, when they occur, are generally of one variety only.



Lessons from hospitals in the U.S. and Europe

Increasing patient throughput is by no means a new objective for OR management. In the past, the emphasis has been almost exclusively on the reduction of Turnover Time. More recently, however, several teams in the US and Europe, recognizing they could also reduce Anesthesia Controlled Time, have placed Non-Operative Time in their sights. In doing so, they have harnessed different combinations of the five distinct methods described below:

Process Change – The most common example of this method is the introduction of parallel processing – removing some trash during the Operative Time as dressings are being applied, or bringing the patient into the OR while the Surgical Scrub is still laying out the instruments. It may also mean assigning a task, traditionally performed by one member of the OR Team to another. For example the CRNA may go to the pre-operative holding area to pick up the patient instead of the Circulating Nurse.

Technology – Many of the teams reporting success in reducing Non-Operative time used OR mobile table tops. They effectively allow the patient to be placed on the operating table while in the pre-operative holding area, with the table top itself resting on a special cart. Upon arrival in the OR, the table top, with the patient, is transferred from the cart to a column. . An example is shown in Figure 2. Using this technology, quite common in Europe but rare in the U.S., the step of transferring the patient between two surfaces is eliminated both before and after surgery. As a result, OR Induction and Emergence Times are shortened and made more predictable, and the backs of the staff in the OR are spared. In addition, since the operating surface leaves the OR with the patient and a new table top arrives with the next, the need to clean and prepare the OR table no longer falls into the Non-Operative interval. Instead, it's performed off-line, so to speak, after the patient is in a Recovery Area bed.

A less visible but vitally important ingredient that contributes to the achievement of process efficiency consists of software and communications systems that generate and distribute synchronizing signals required by parallel processing. They also record events and organize data essential for tracking performance and facilitating improvements. As such, they are vital to long-run success.

Some "technologies" to reduce Non-Operative Time don't have to be complex. Consider the use of a Swiffer® mop. By replacing a wet mop with a damp one (where feasible, of course), the floor can be walked on almost immediately after it has been wiped down. This eliminates a source of delay between clean up and opening instruments.

Special facilities – Suppose that, instead of anesthetizing the patient in the OR, the anesthesiology team puts the patient to sleep on a mobile table top in an induction area outside the OR such as shown in Figure 3. Then, when the staff in OR signals that the room is ready, the patient can be brought in, and the surgical team can begin its work almost as soon as the table top has been transferred from the cart to column. Similarly, if the patient can be anesthetized outside the OR, why not wake

the patient outside the OR in an early recovery room? This could shave several more minutes from the OR Emergence Time.

Figure 2

OR mobile table top resting on the special cart used for moving it to and from the OR. The column to which the table top will be transferred is to the left.

While these special areas can reduce Non-Operative Time, they carry a price: the investment in additional floor space and anesthesia machines and the expense of a more anesthesia support. Indeed, all of the teams that used induction rooms to reduce Non-Operative Times applied a higher level of anesthesia staff than the normal U.S. practice of one anesthesiologist and two medically directed personnel for two ORs.

Another non-traditional facility is one used for opening instruments outside the OR. This requires a sterile area, a protocol for covering the instruments with sterile material and a protocol for removing the coverings in the designated OR. By adopting this method, Non-Operative Time can be reduced by an amount roughly equal to the time needed to open them and lay them out. This strategy carries the price of an additional sterile space and the staff to open the instruments.

Figure 3

Example of an induction area. The OR mobile table top rests on its special cart. Anesthesia equipment is to the right.

Investing in the additional space and equipment, and assigning more staff to these special facilities would appear to be an extravagance. However, since the resources can be shared by multiple ORs, the incremental expense per OR may be more than offset by the benefits of incremental revenue margin.

Additions to staff – Other creative ways exist to add staff to achieve improved performance. One of the study teams[5] assigned a so-called perioperative nurse to monitor the patient in the early recovery area adjacent to the OR, and, at the appropriate time, to transport the patient to the main recovery area. It also dedicated a member of Housekeeping to clean the OR, and occasionally called on an extra nurse to assist with opening instruments. Despite the additional expenses so incurred, a rigorous analysis revealed that the financial benefits associated with the incremental Throughput exceeded the incremental expenses.

Systematic elimination of delays – None of the above four methods will ensure that the surgeon is indeed present in the OR when the patient arrives; none will

guarantee that the instrument cart will have all the necessary instruments; and none will prevent the late arrival of the patient in the OR because a preoperative test result is has failed to arrive promptly from the lab. Eliminating these and similar delays requires that many supporting processes be brought under control. And, as one of the teams reports, the scope of these efforts may reach into the surgeon's office when the decision to perform surgery is made. That team arranged for the patient's informed consent to be signed and scanned in the surgeon's office so it could be accessed on line on the day of surgery. By making this process change, they spared the nurses in the pre-operative holding area the headache of chasing down the surgeon. Eliminating the delays, or substantially reducing them, should also reduce the variability in Non-Operative Time, and thus the variability in patients' waiting times.

What is the potential contribution of the above methods to reducing Non-Operative Time? By analyzing the recently reported results we have deduced their impact. It is portrayed by means of "waterfall" diagrams in Figures 4 and 5. The former culminates with the use of an additional facility to open instruments outside the OR, while the latter concludes with the impact of induction and emergence areas. Both figures suggest that, just by introducing parallel processing and by launching an aggressive program to eliminate delays, a hospital might expect to reduce Non-Operative Time to the 40- to 50-minute range. Although the figures show the starting point to be in the 60- to 70-minute range, the starting point could well be higher or lower. Regardless of the initial point, we believe it is possible to attain an average Non-Operative time of about 45 minutes without resorting to the use of OR mobile table tops or special facilities.

Figure 4

Impact of applying a sequence of four methods on Non-Operative Time

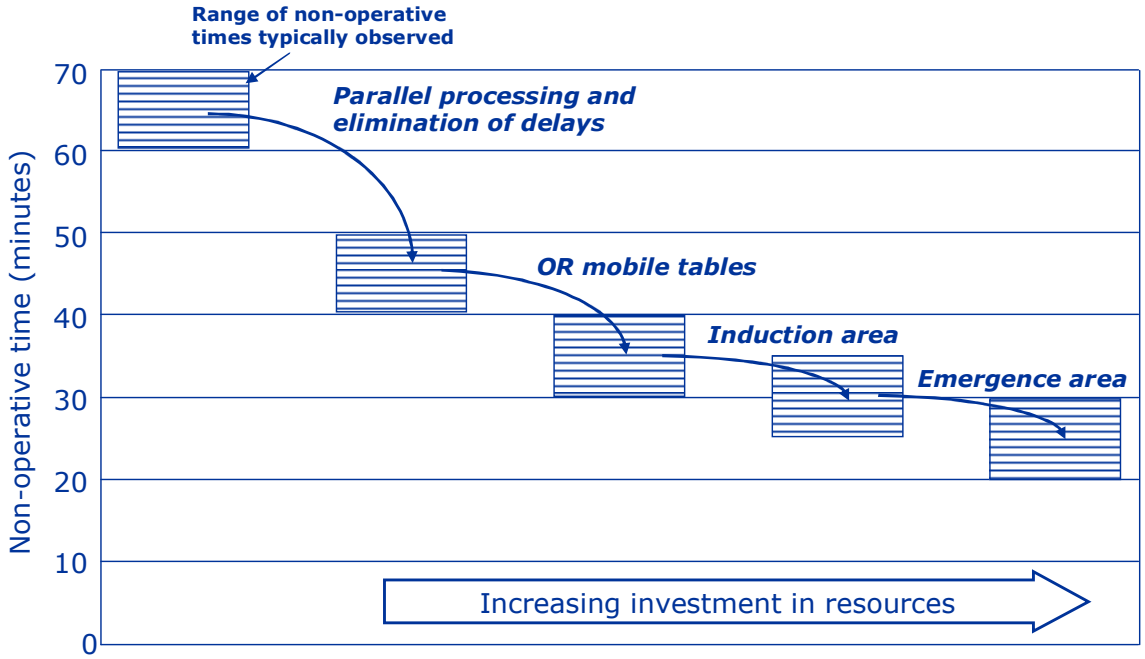
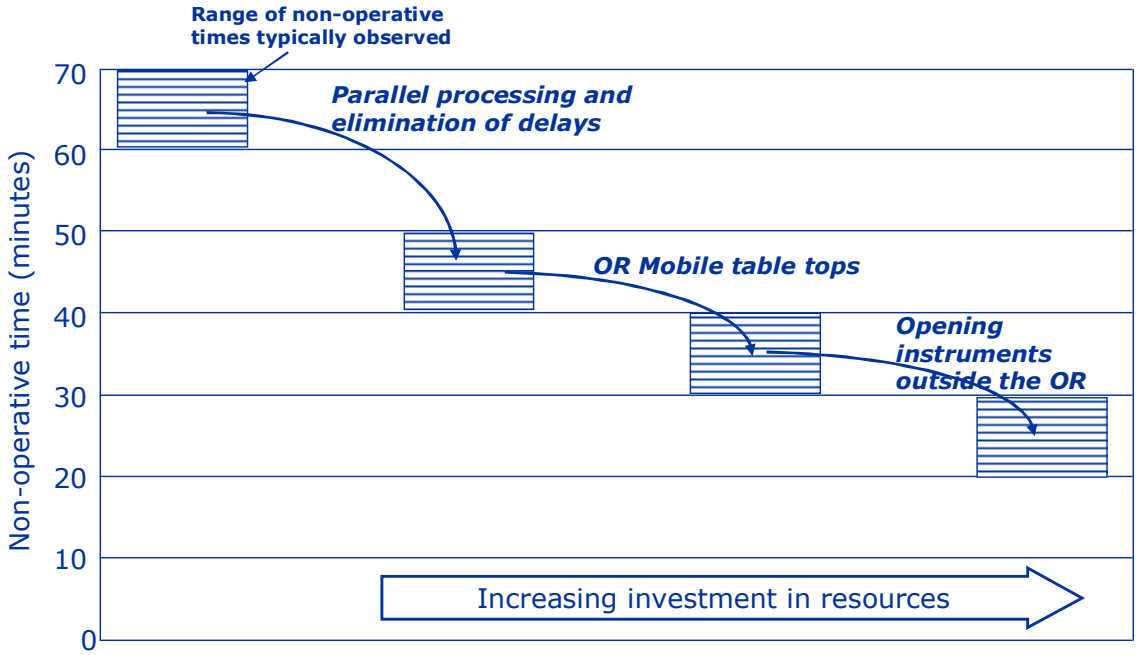


Figure 5

Impact of applying a different sequence of methods on Non-Operative Time



Attaining a Non-Operating Time of less than 40 minutes will likely require an investment; in both figures we have assumed the first step beyond the introduction of parallel processing and delay elimination involves the introduction of a patient transport system of mobile OR tables tops or mobile OR tables. According to the recently reported results, such a system is capable of shaving another ten minutes off Non-Operative – down to an average of about 35 minutes. Further reductions in Non-Operative Time can be achieved through special facilities, either allow induction and emergence outside the OR or to open instruments outside the OR. As shown in Figures 4 and 5, it should be possible to drive Non-Operative down to about 25 minutes. Is this really possible? It is. In fact, as described in Reference 3, a team from University Hospital Schleswig-Holstein in Kiel, Germany, using a combination of mobile table tops, and induction and emergence areas, achieved an average Non-Operative Time of 28 minutes.

Although these reductions in Non-Operative Time may appear impressive, how do they affect the bottom line? To answer this question, we first need to determine – rigorously – how many cases can be confidently scheduled.

How many cases will fit into an OR's regular schedule?

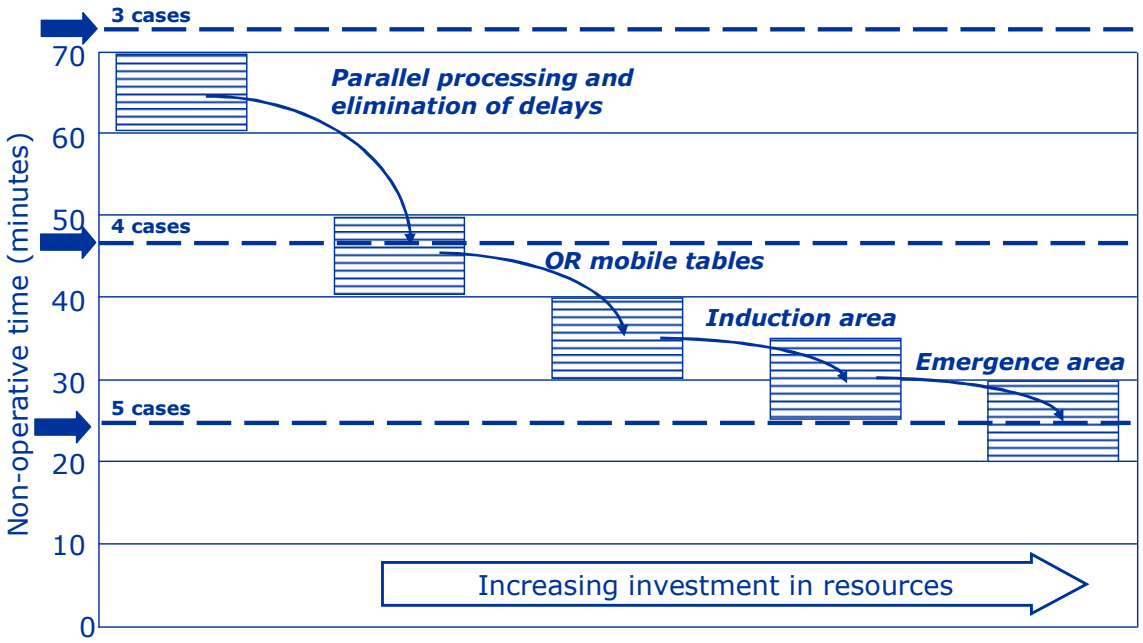
It's easy to see that, if cases are short – or more accurately, if the Operative Times are short – substantial reduction of the Non-Operative Time may allow one or more additional cases to be routinely scheduled into an OR's regular hours. How many more can you fit in? If a rough answer suffices, simply compare the number of regularly scheduled OR hours with the estimated time to perform the cases, using average values for all intervals.

On the other hand, if you really don't want to pay overtime or if your staff simply doesn't want to work extra hours, you need a more rigorous method. We used discrete event simulation arrive at our answers, but won't go into the details here; instead we'll use an example to give a feel for the impact of reducing Non-Operative Time on the number of cases that can be confidently scheduled into regular hours. And we define "confidently" as representing only a 5% probability of running over.

Suppose that a surgeon at your hospital performs a series of identical procedures, each having an average Operative Time of 60 minutes. Suppose, further, that you insist that the probability of incurring overtime must be very low. The dashed lines in Figure 6 show how many such procedures the surgeon is able to perform as a function of Non-Operative Time under the following conditions: (1) the OR is staffed for nine hours and (2) the probability of overtime cannot exceed 5%.

Figure 6

Number of cases with 60-minute Operative Times that can be fitted into a nine-hour OR schedule. The probability of overtime is assumed to be 5%.



You can see that the hospital would have to reduce the average Non-Operative Time to about 48 minutes before it could confidently schedule four cases into the 9-hour day. It could schedule as many as five cases if it could reduce Non-Operative Time to 25 minutes. As the figure suggests, this would require successfully implementing several methods to reduce Non-Operative Time. In the case shown in Figure 6, one of the methods would be to induce and wake the patients outside the OR. An alternative strategy would be to open instruments in a sterile area outside the OR. For additional details and to learn about other assumptions made in arriving at Figure 6, we encourage the interested reader to consult Reference 2.

Potential financial impact of reducing Non-Operative Time

What is the financial value of increasing Throughput? Although one often hears about the high cost of one minute in the OR, saving a few minutes here and there will not lead to any financial impact. It's only when enough time is saved to allow one or more additional cases to be routinely scheduled that the hospital is poised to benefit financially. And here, the critical word is "poised" because simply creating the additional capacity is not enough. The number of cases must rise. That means attracting more surgeons who perform short cases or current surgeons performing more short cases.

For a hospital, the incentive to stimulate additional demand is substantial. It has been estimated (please see Reference 1) that the contribution margin, i.e., the amount falling to the bottom line after paying for the materials and supplies consumed in the additional surgeries, is about $1,500 per hour that the patient remains in the OR. If we continue with the example of the surgeon who performs procedures whose Operative Time is 60 minutes in a hospital where the Anesthesia Controlled Time is 20 minutes, then the hospital's contribution margin is about $2,000 **per additional case**. If we further assume that such a case can be added 250 days in a year, then the annual contribution margin would increase by about $500,000.

It's important to stress that this figure assumes that the hospital has reduced Non-Operative Time without adding staff or making additional investments in equipment or facilities. But that's highly unlikely because some of the methods to reduce Non-Operative require additional outlays. Because investments in equipment and facilities are depreciated, their impact on reducing the effective contribution margin is relatively small. For example, an investment in equipment and facilities of $500, 000 with a depreciation life of 10 years results in an annual depreciation expense of about $50,000. By contrast, reducing an anesthesiologist's responsibility from covering two ORs to one – a step that may be required if using an induction room – would increase annual operating expenses by nearly $200,000. Thus, when you select the methods to be used to reduce Non-Operative Time, it's essential that you take into account the associated expenses.

If your hospital is unable to generate additional demand, it may still be able to take advantage of the "found" capacity by closing one or more ORs. Your institution may be reluctant to adopt this response, however, because it would reduce the number of first-case-of-the-day opportunities. An alternative to closing one or more ORs would be to reduce shift durations and run the ORs for fewer hours.

Potential impact of reducing Non-Operative Time on patients

While it's relatively straightforward to estimate the financial impact of reducing Non-Operative Time, assessing the impact on patients is more difficult. In fact, the impact on patients has yet to be documented in the peer-reviewed literature. Nonetheless, we believe that patients may benefit by experiencing more predictable wait times and a safer environment.

In general, wait times for patients are unpredictable because both Operative and Non-Operative Times are variable. While little can be done to deal with the variability of the former, reducing the Non-Operative Time will inevitably decrease its variability and make the wait time somewhat more predictable. The improvement will be most noticeable in situations where the Operative Time has little variability but the Non-Operative Time has been highly variable.

The argument regarding potential improvement in patient safety is more complex. Many of the delays mentioned earlier are caused by issues that distract nurses. They include tracking down informed consent forms, calling the lab to obtain results needed before the surgery, chasing down missing instruments, dealing with late patients and so on. In principle, the elimination or reduction in these delays should allow nurses to concentrate on their core clinical responsibilities, and should create a safer patient environment. Proving the case is difficult, however, because the number of errors that cause injury is low. Consequently a credible study would take a long time and would have to distinguish among other factors contributing to clinical staff errors.

Overall, we believe that substantial reductions in Non-Operative Time improve patient satisfaction. Proving the case, however, awaits more experience with high-performance perioperative systems.

Potential impact of reducing Non-Operative Time on clinical staff

When their compensation is based on the number of patients they treat, it's not hard to imagine that surgeons and anesthesiologists would support reducing Non-Operative Time. When they are salaried employees of the hospital, however, their

support for a program to increase OR Throughput may depend on how the hospital capitalizes on the improved productivity. If the improvement program leads to a shorter day while maintaining the existing work load, they are likely to support it. If it results in an increased work load within existing hours, however, their support is not assured.

Staff members whose compensation is determined by hours worked – nurses, surgical scrubs, ancillary staff – are less likely to endorse a program to increase OR productivity if they are unable to derive some benefit. In fact, unless hospital administrators find creative ways to deal with the consequences of improved productivity, hourly employees who are members of a union may be penalized. What benefits might nurses derive from an effort to reduce Non-Operative Time? If, as argued in the previous section, part of the program includes systematically eliminating the annoying sources of delays that plague the nurses, then they would be working to create a more hassle-free environment for themselves – one that would allow them to devote more of their energies to their core clinical responsibilities.

Anecdotally, we've learned that nurses who enjoy working in a highly productive OR cite the enhanced teamwork as one reason for their support. It's important to note, however, that these advanced programs generally rely on staff members who have volunteered to participate. Consequently, we can't rely on anecdotes.

If, as part of the program to increase Throughput, the hospital implements a patient transport system that eliminates transfers in the OR, staff members are spared the physical effort associated with the transfers and thus avoid the possibility of a back injury. So, in addition to virtually guaranteeing that the Non-Operative will drop by 10 minutes, this patient transport technology has the potential to contribute to the improvement of staff satisfaction.

Conclusion and caveat

Should your hospital embark on a program to improve Throughput by reducing Non-Operative Time? Our answer is an emphatic yes. Before doing so, it's important to remember it will require a leadership team committed to the program's success. It must thoughtfully select the participants, clearly define performance goals, maintain frequent and open communications with the implementation team, and be willing to provide support, even when that may involve modifying long-hallowed rules regarding compensation. Since your hospital stands to achieve substantial financial improvement, however, it will be in a position to share some of the gains with the perioperative staff.

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[7] See also, OR Manager, January 2006, 10-13, for accounts of additional projects to decrease Non-Operative Time.