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# THE VALUE OF BLOCK RELEASE POLICIES IN SURGICAL SETTINGS

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## ABSTRACT

Before the day of surgery, it is common for hospitals to take advantage of block release time in order to better fill operating rooms (ORs) and increase room utilization levels. Surgery groups are forced to release unscheduled OR time, which then becomes available for other groups to use. In this paper, we investigate release policies based on various surgery arrival distributions, capacity levels, and case durations. We show the tradeoffs of different policies involving assigned block and open posting rooms' utilization levels and number of cases not accommodated in the schedule. Our results show that block release has a minor benefit for services with high room utilization (at or above 80%). Services with lower room utilizations may benefit from release, but one must consider whether to use block release or to reallocate the service's block time.

## 1 INTRODUCTION

Due to different surgery types and characteristics, certain surgical groups may be able to plan their surgery schedule farther ahead than others. It is a common practice at many hospitals to allow surgical time to be "released" when the allocated block time will not be needed or used. This allows for excess and add-on cases to be added to the surgery schedule.

The policy set forth by the hospital for the release time can affect how and when surgeries are scheduled. If a surgical group holds on to their time for too long and does not fill their block, they will be penalized for having a low room utilization. However, if a surgical group releases their unfilled time, they will only be accountable for what they have scheduled.

In this paper, we use simulation techniques to find suggested block release times for particular surgical groups using the ideas of blocked and open posting time to create the Master Surgical Schedule. We provide results and discussion about these policies and how scheduling accuracy and variability may impact these decisions.

## 2 LITERATURE REVIEW

Block release times and methods to obtain optimal policies have not been studied much in the literature. Dexter, Shi, and Epstein (2012) present a "descriptive study" of case scheduling, add-ons, and cancellations a week before the day of surgery. They found that surgical groups that had filled their blocks and needed more surgery time did this about two days prior to the day of surgery. They also noted that at least half of the ORs studied had their last case scheduled or changed within two days before surgery. They concluded that, "There are so many changes made to so many cases in so many ORs even 2 workdays ahead, that making plans more than 2 workdays ahead is unlikely to be productive."

Similarly, Dexter and Macario (2004) analyzed when block time should be released by adding hypothetical cases to ORs with excess allocated time. They studied cases scheduled on the day of surgery, morning of the day before surgery (shortest possible), three days before the day of surgery, and five days before the day of surgery. Cases of length one, two, and three hours were tested to represent actual cases. They concluded that, most often, adding new cases prior to the day of surgery reduced overutilized time better than releasing block time three to five days before surgery. This showed that OR time release has a negligible effect on OR efficiency.

Dexter and Traub (2002) also noted that there is no advantage in terms of OR efficiency to releasing a service's allocated OR time until there is a case to be scheduled into that OR time. They explain that: "A few days before surgery, maximizing the efficiency of use of OR time is synonymous with minimizing overutilized OR time."

May et al. (2011) provide a literature review of current surgical scheduling techniques. Their compilation pointed out the high frequency of changes to the surgical schedule. However, despite these results, medical doctors Dr. Mazzei and Dr. Blasco (2004) feel that "Variable release times are a quick way to build flexibility into a schedule." Their suggested list of block release times ranges from one day for Burn service and Cardiac specialties to 14 days for Orthopedics (joint) and Plastic (cosmetic).

Other papers have investigated the role of block release time when scheduling new cases into the block. Dexter, Traub, and Macario (2003) examine impacts on OR utilization levels when deciding which surgical group should release their block time. They concluded that scheduling new cases into rooms that have the largest difference between scheduled and allocated time, rather than the room with the most unscheduled time, has a better effect on OR efficiency levels.

Discrete-event simulations in the field of healthcare have begun to increase over the years according to Jun, Jacobson, and Swisher (1999) and Hamrock et al. (2013). Both papers deem simulation as a cost-effective tool to help allocate resources, improve patient flow, manage bed capacity, schedule staff and surgeries, and more. Dexter et al. (1999) conduct a computer simulation to analyze methods affecting utilization and efficiency. They concluded that OR utilization was mainly affected by how far in advance a case was posted. Cases requested further in advance are better able to be fit into remaining OR time in order to better fill the block. Persson and Persson (2009) use discrete-event modeling to simulate two management policies and their effects on patient wait time, number of surgeries cancelled, and OR utilization. They also consider cost in reference to the amount of overtime incurred. Probability distributions based on historical data were used to generate patient arrivals and case durations.

## 3 METHODS, ASSUMPTION, AND APPROACH

A two-room system, one blocked and one open posting, was created and tested in our simulation model. Figure 1 shows the flow of the simulation relating to how and when a surgery is booked in an OR. Once a surgery is called in and assigned relevant information (Modules 1A,B and 2A,B), it is immediately placed in its proper OR if there is time available on the schedule (5A,B). If there is no time available and the surgery was posted to the blocked room, the surgery will immediately check if there is time available in the open posting room (7,8A). If there is no time in either room, the case is recorded as not posted to the schedule (9A,10B). Rooms cannot be overbooked. If there is no time available and the surgery posted to the open room, it will go into a holding queue, where it will wait for block time to be released (7B). Once the block is released, the surgery may check the blocked room to see if there is available time for it to occur (8B). If block release is occurring, cases will be sent to the room with the largest amount of available space, or unfilled block time, compared to its total allocated time. Dexter, Traub, and Macario (2003) found that this was a good way to maximize efficiency levels. Number of cases successfully entered in another room, number of cases not posted to the schedule, and room utilization levels are tracked. Different arrival patterns, flows, and block release times are tested to suggest the best release policies based on the arrival distribution and expected room utilization.

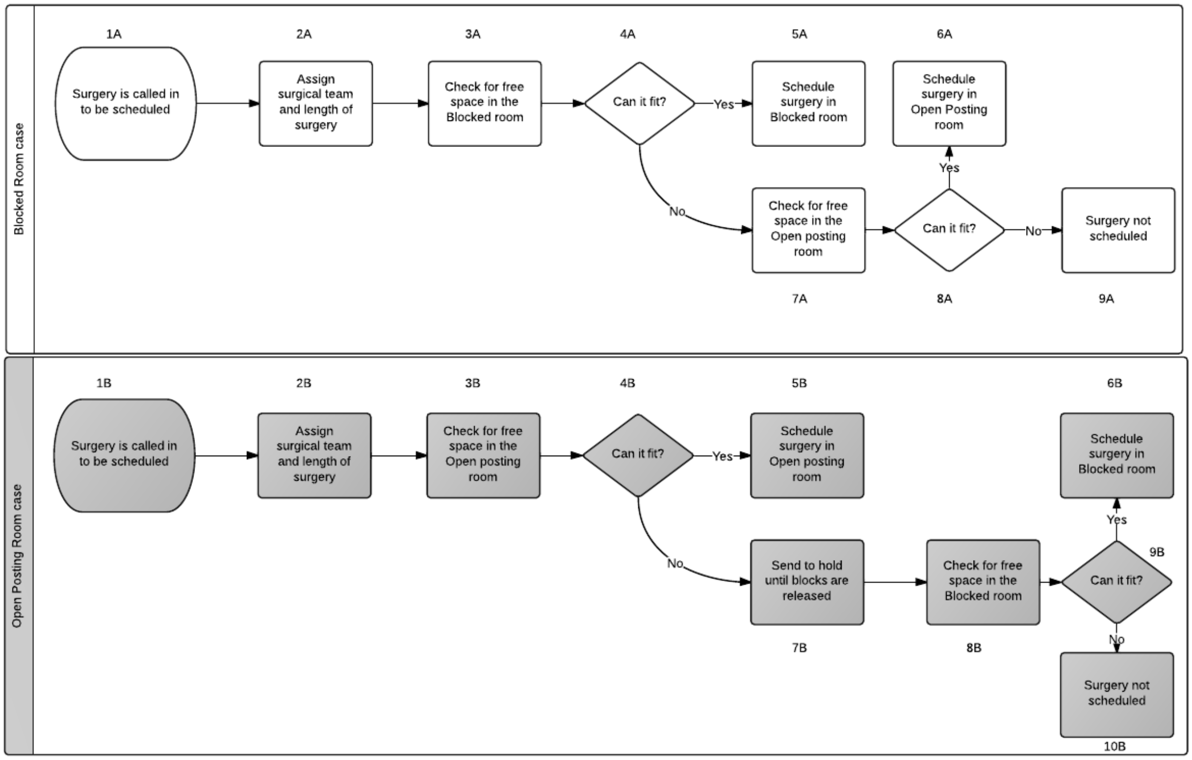


Figure 1: Simulation flows for cases arriving to the blocked and open posting rooms.

The cases that are scheduled in each room are then played out. For purposes of simplicity with this initial testing, we let the scheduled surgery duration also act as the actual surgery duration. These durations can later be manipulated to allow for more variation in actual duration lengths. Once the surgeries play out, the utilization of each room is calculated by taking the total sum of the surgery durations divided by the room length.

Room lengths were set to be 10 hours, each with a simulated caseload of 60%, 80% and 100% of room capacity, on average. In other words, the surgery arrivals (or caseload) provided in the three scenarios would result in an expected utilization of 60%, 80%, or 100%, respectively. These utilizations provide adjustments for hospitals during slow or peak times while also showing the equivalent of what might be an 8, 10, or 12-hour room respectively.

The surgery arrivals for each room type, shown in Figure 2, were kept separate in order to test different flows and number of cases. The arrival patterns, referred to as "Early," "Middle," and "Late," peak seven, five, and three days prior to the day of surgery, respectively. The distributions all have the same peak number of surgery arrivals and uniformly increase until they hit the peak, then decrease until they hit zero or do not have any days left. The "Early" and "Late" distributions are mirrors of each other.

These patterns, verified and generalized by data from the Medical University of South Carolina (MUSC), were used to encompass a wide variety of specialties and to imitate arrival patterns of surgical groups who plan close to and far ahead of the day of surgery. We take a ten-day span into consideration for our initial analysis because it allows for at least a week of posting cases and up to three days of block release time. These distributions can be adjusted to fit other representative or specific case posting patterns.

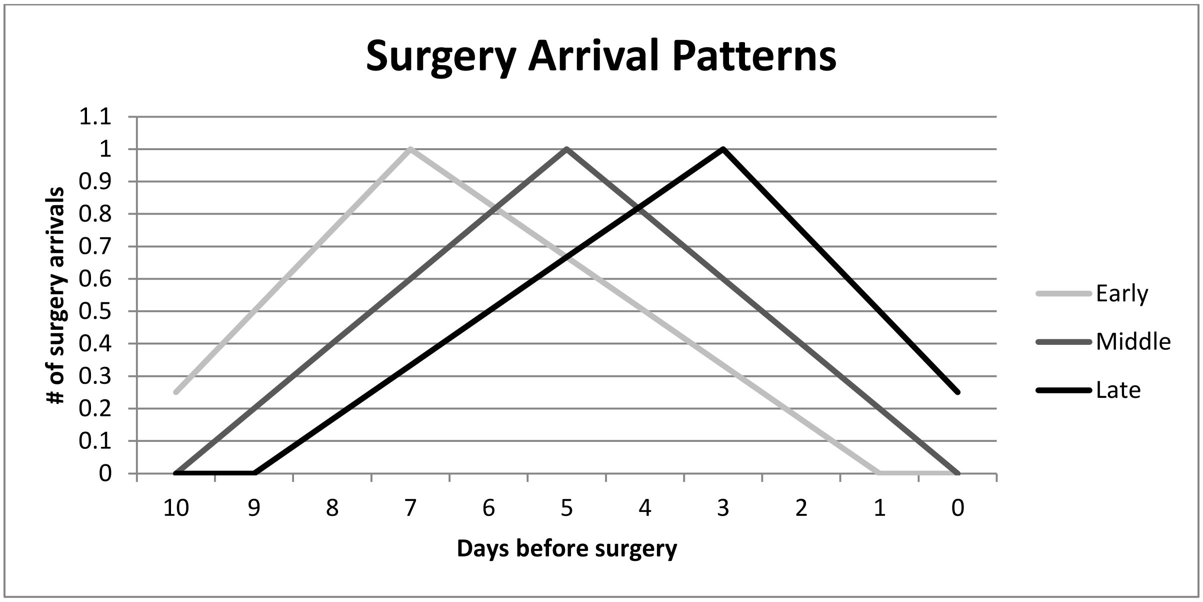


Figure 2: Base case scenario surgery arrival distribution patterns with three different peak times.

In addition to testing different arrival patterns, we used four duration scenarios (as shown in Table 1). The Short, Medium, and Long surgical durations represent a spread of the types of surgical cases services encounter. The Base Surgical duration, derived from the duration used in Dexter and Macario (2004), allows for more variability in case lengths. The other three durations are slight variations of the Base case. The expected number of surgery arrivals (or postings per room) was calculated by taking the room length (10 hours) and dividing it by the average length of the duration for each scenario.

Table 1: Surgical duration scenarios.

| **Code** | **Description** | **# of Surgery Postings Per Room** |
|---|---|---|
| Base Surgical Duration | Uniformly distributed between 1 and 3 hours | 5 |
| Short Surgical Duration | Uniformly distributed between 1 and 2 hours | 6.67 |
| Medium Surgical Duration | Uniformly distributed between 1.5 and 2.5 hours | 5 |
| Long Surgical Duration | Uniformly distributed between 2 and 3 hours | 4 |

# 4 ANALYSIS

A total of 432 simulations were run using Arena's Process Analyzer with 100 repetitions each. Rooms were allowed to have different arrival distributions, but surgical durations and expected utilizations remained the same. Nine different combinations of surgery arrival patterns were used, and their results were combined and averaged. Room utilization levels and percent of cases that could not be added were the main statistics used to suggest the best block release time from these simulations.

An initial test was run on the Base case surgical duration using block releases ranging from no release to a 5-day release. We define release times as the number of days prior to surgery that excess or unfilled surgery time in a blocked room becomes available to other surgical groups. When the block is released, any cases that could not fit in the open posting room can have a chance at being scheduled in the blocked room's excess time. As shown in Figure 3, there is a 1-2% increase in combined room utilizations when switching from no release to having release. There is very little difference in average room utilization across all of the scenarios with block release (<1% increase or decrease).

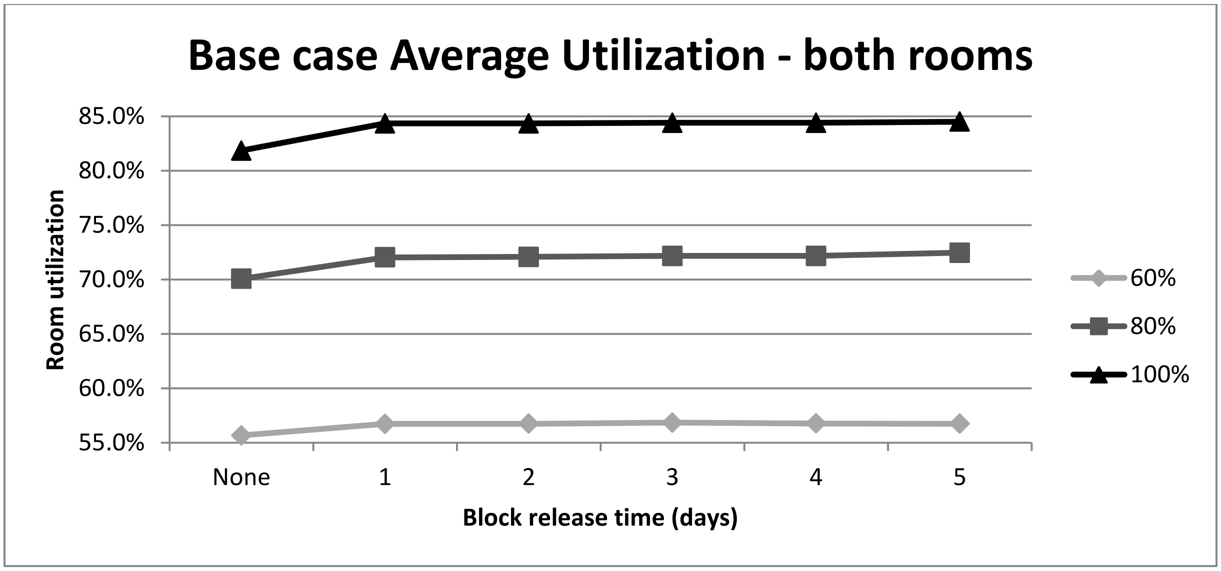


Figure 3: Effects of six block release policies on average room utilization levels using the Base surgical duration.

Similar results are shown in Figure 4, which displays the percentage of cases not posted to the schedule for the same release periods. Once again we see a 1-2% decrease in average unscheduled cases when switching from no release to having block release, while there is very little variation across the individual scenarios with block release.

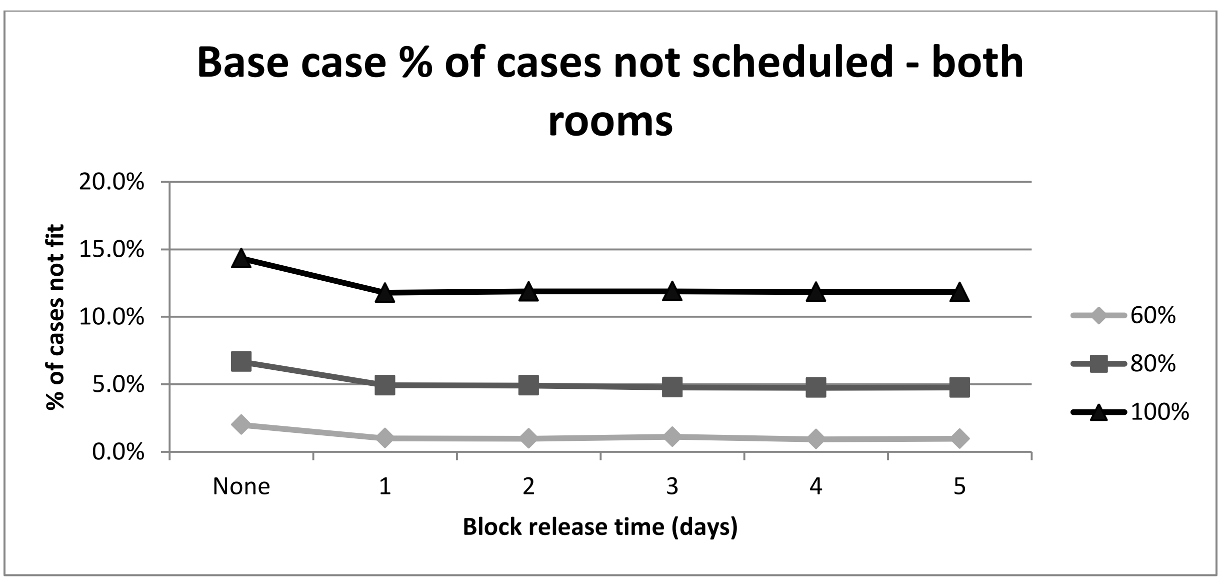


Figure 4: Effects of six block release policies on average percent of cases not scheduled for both rooms using the Base surgical duration.

Because there was very little difference across the scenarios with block release, long block releases are not frequently used, and our sponsoring hospital specifically had an interest in a 3-day release, comparing no release against a 3-day block release seemed most appropriate. Results from each test were examined for each room specifically, as well as both rooms combined.

The results showed that using a 3-day block release led to higher room utilization and a lower percent of cases not scheduled for the blocked room, while no release was preferred for the open posting room. Figure 5 shows a comparison of these release policies and their effect on room utilization levels for the combined room utilization of the blocked and open posting rooms for every scenario. Overall, the three-day block release policy showed slightly higher room utilization levels than a no release policy. A block release policy allows for more cases to be (or tried to be) fit into the blocked room if there is available space, which boosts the room utilization of the blocked room. Without a block release policy, cases that do not fit into the open posting room are sent away, even if they were able to fit into the blocked room.

While it seems unrealistic that cases that could have fit into a block do not get scheduled, it is indicative of the overall picture of not having forced block release. If a surgical group holds on to their block time, despite not having enough cases to completely fill the block, their calculated room utilization is often punished because they are being judged on using their entire block, rather than a subset of their allocated time. A similar punishment occurs here. By not allowing extra cases to use the extra time, the service receives an overall lower room utilization rate.

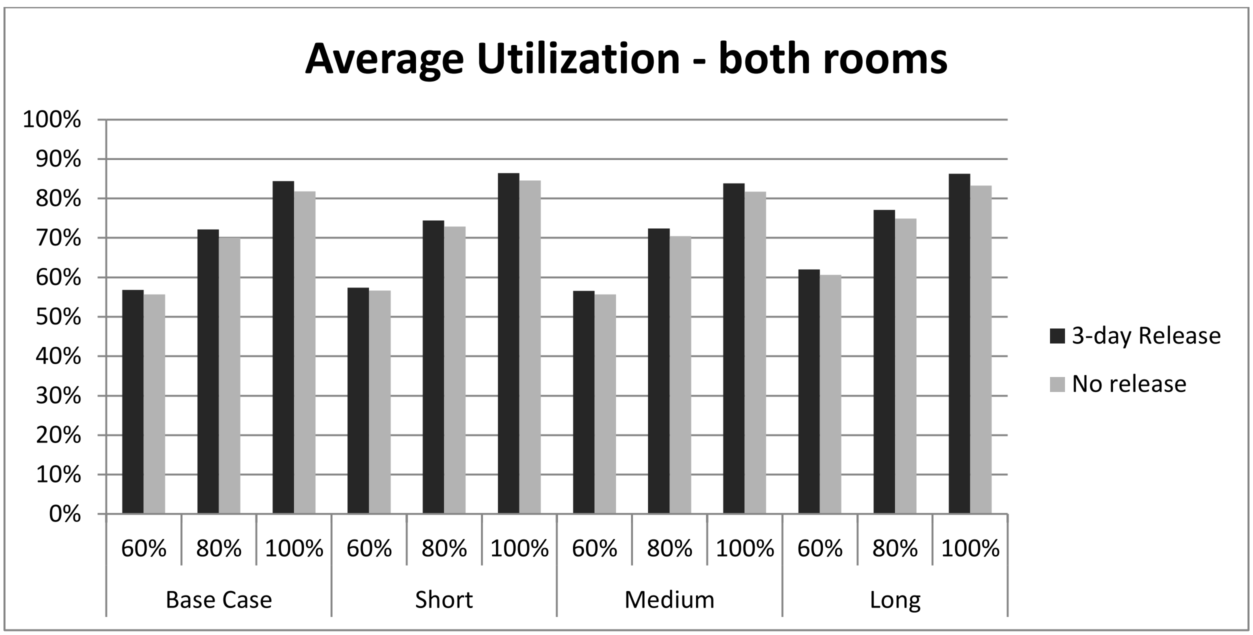


Figure 5: Effects of two block release policies on average room utilization levels.

Figure 6 shows the differences in utilization when the two rooms are examined separately. To clarify, the difference takes the room utilization received from a 3-day release less the no release policy. The positive differences indicate higher utilizations occurred in the blocked room, while negative differences indicate higher utilizations occurred in the open posting room.

When examining the blocked room, we see an 8-11% difference (in favor of the 3-day release) in room utilization levels between the two release scenarios. For the open posting room, we see a 2-9% difference (in favor of no release). Due to the magnitude of each difference, with a larger difference for the 3-day release, when we view the combined utilizations, there is only a 1-3% difference (in favor of the

3-day release). This poses some interesting insights about the pros and cons of protecting a service's block, which will be discussed in further detail in the Managerial Insights section.

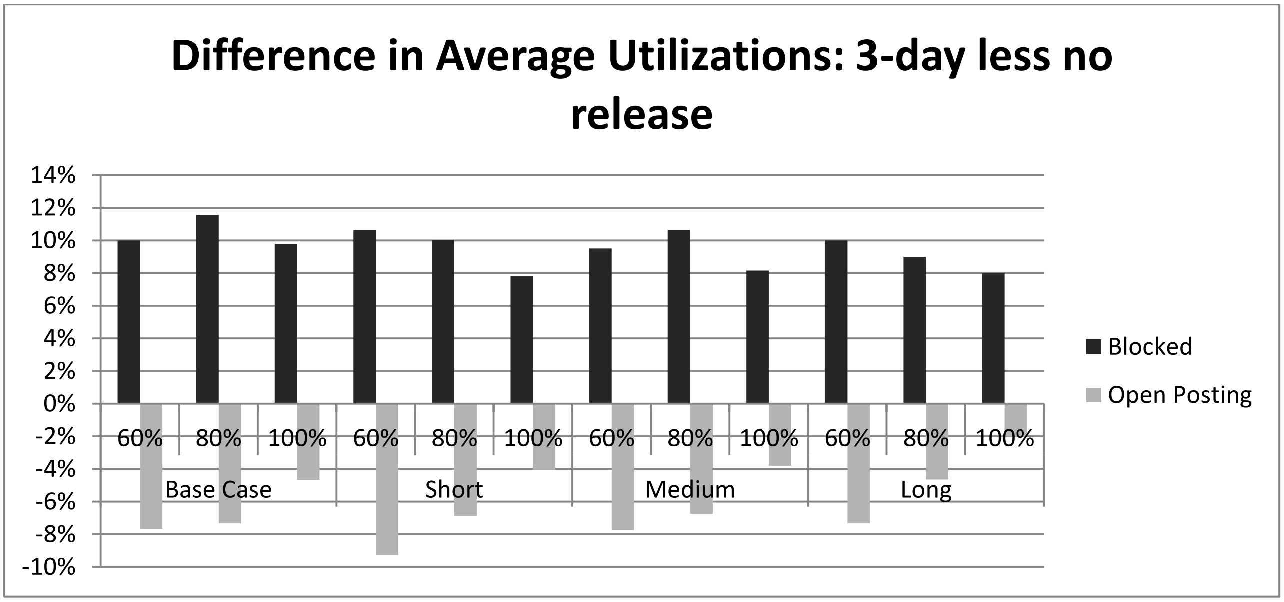


Figure 6: Blocked / Open Posting room utilization differences from 3-day release to no release.

In addition to tracking room utilization levels, the number of cases not scheduled was also recorded. This statistic is meant to represent cases that are either delayed and set for another day or for cases that will find another hospital completely. According to Macario et al. (2006), this is one of eight strong measures of OR efficiency. Figure 7 shows a comparison of the combined percentage of these numbers for the blocked and open posting rooms. Once again, the results favor the 3-day release policy since the no release policy does not allow for open posting cases to be sent to the blocked room. This leads to more cases not being posted to the schedule.

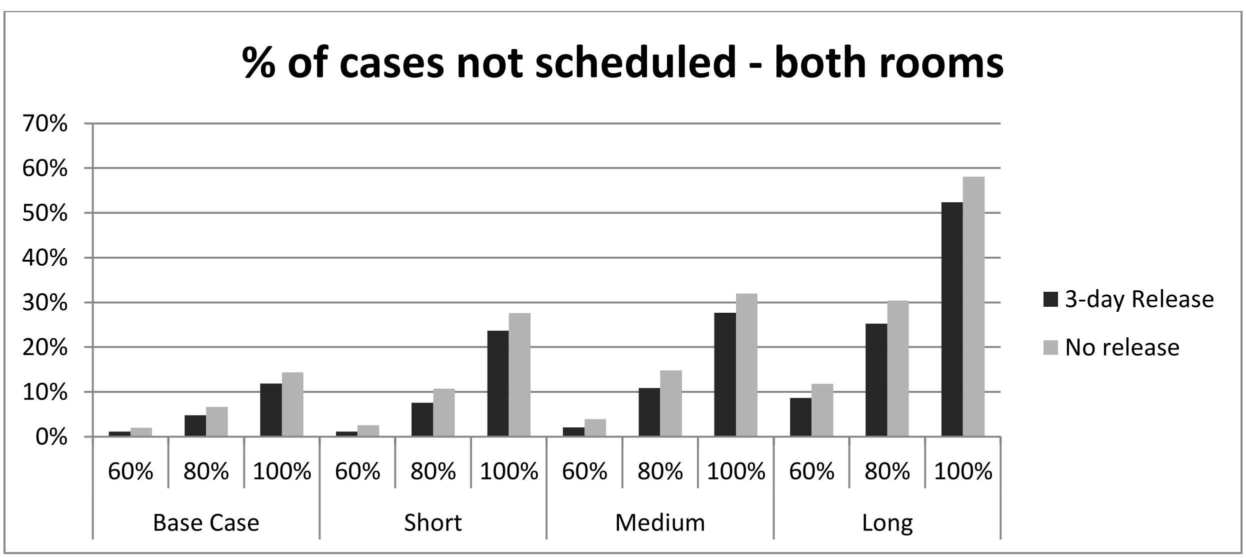


Figure 7: Effects of two block release policies on average percent of cases not scheduled for both rooms with four surgical duration scenarios.

As expected, the distribution arrival pattern impacted the percentage of cases that could not be scheduled. For the Base Case and Short scenarios (uniformly distributed between 1 and 3 hours and 1 and 2 hours respectively), shorter case durations allowed for a better and easier fitting of cases while the Long scenario (uniformly distributed between 2 and 3 hours) rooms were more difficult to fill completely.

Figures 8 and 9 show the effects on the percentage of cases not scheduled for the individual rooms. When the rooms are examined separately, there's a much more significant difference than when averaged together. There is a 1-10% difference (in favor of the 3-day release) in percent of cases not scheduled for the blocked room and a 3-15% difference (in favor of no release) for the open posting room. The percentage of total cases, across both rooms, only shows 1-2% difference (in favor of no release).

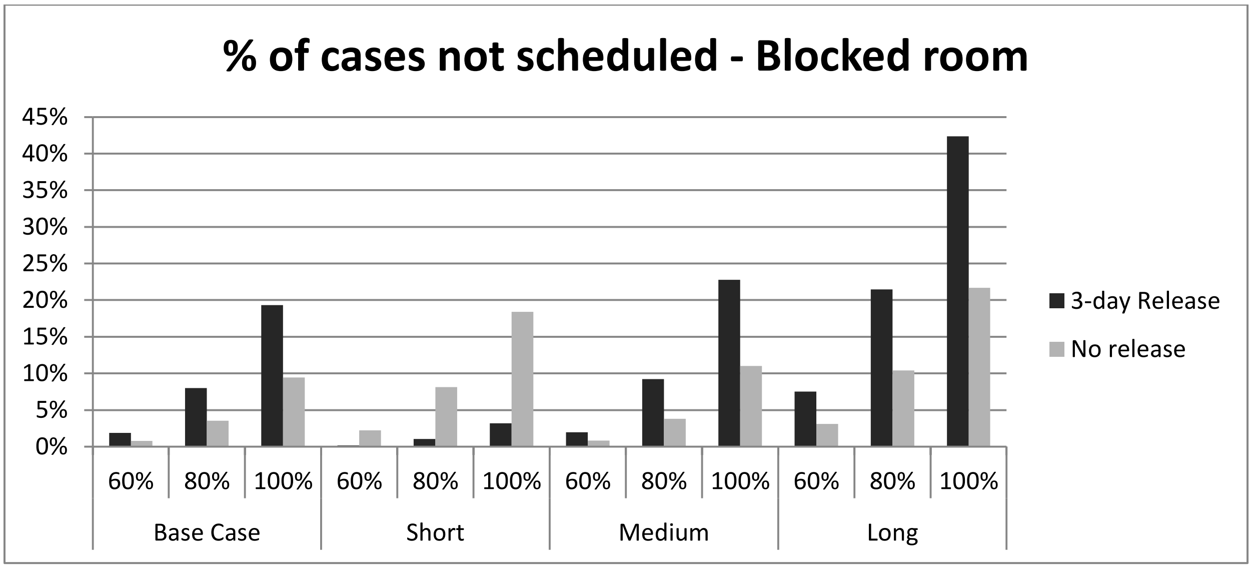


Figure 8: Effects of two block release policies on average percent of cases not scheduled for the service-specific room with four surgical duration scenarios.

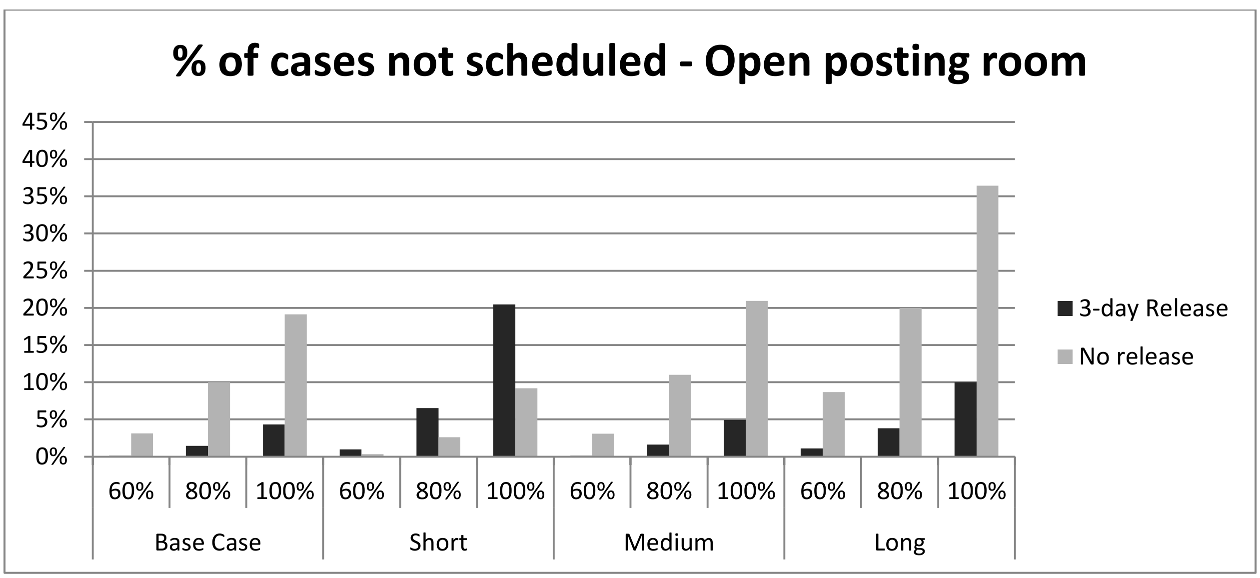


Figure 9: Effects of two block release policies on average percent of cases not scheduled for the open posting room with four surgical duration scenarios.

## 5 RESULTS

For the given scenarios, the 3-day block release favored higher room utilizations and a lower percentage of unscheduled cases for the block-specific room, while no release favored the open posting room. While our results show a preference for the 3-day block release, upon close examination of the data, we can gain knowledge about the benefits of protecting a surgical group's block.

For services that are active and highly utilizing their blocks (at or above 80% expected utilization levels), forcing the block to release time increases the number of cases not booked by about 5% and increases utilization by about 9% (Figures 4,6). For services that are already operating at a high utilization level, the increase is likely not needed and is not a worthwhile tradeoff. On the other hand, if the service is operating below the 80% mark, forcing a 3-day release might be beneficial to raise the utilization without losing as many cases. On average, a surgical group with a 60% expected utilization will only lose about 1.25% of their cases for that day and gain about a 10% increase in utilization.

We can also look at this information by average case duration length. Blocked rooms that are paired with surgical groups that have shorter, faster cases may expect an 8% decrease in the number of cases not booked and a 9% increase in utilization with a 3-day block release. When paired with surgical groups with longer case durations, blocks may experience a 12% increase in the number of cases not booked but a 9% increase in utilization with forced block release. When paired with surgical groups with medium duration cases, results lie somewhere in the middle, with an expected loss of about 6% of cases and an expected increase of 10% utilization.

Table 2 shows the average result in changes of room utilization and percentage of cases not booked when switching from no block release to 3-day block release *for the blocked room only*. In every case, switching from no block release to having block release allows for an increase in utilization. However, forcing a block release is likely only necessary when the block is running below the 80% expected utilization mark because the loss in cases does not balance out the utilization increase, except for groups paired with shorter surgical durations.

Table 2: Differences in average tracked statistics when switching from no release to a 3-day block release for the blocked room.

| | **60%** | | **80%** | | **100%** | |
|---|---|---|---|---|---|---|
| | Utilization | % of cases not booked | Utilization | % of cases not booked | Utilization | % of cases not booked |
| **Base** | +10% | +1% | +11% | +4% | +10% | +10% |
| **Short** | +10% | -2% | +10% | -7% | +8% | -15% |
| **Medium** | +10% | +1% | +11% | +5% | +8% | +12% |
| **Long** | +10% | +5% | +9% | +11% | +8% | +20% |

Table 3 shows the average result in changes of room utilization and percentage of cases not booked when switching from no block release to 3-day block release for both rooms. In every case, switching from no block release to having block release allows for an increase in room utilization and a decrease in unscheduled cases. Unlike the results in Table 2, because the blocked room receives a large increase (~10%) in room utilization and the open posting room receives a decrease (~7%) in room utilization, when averaged together the combined utilization does not nearly change as much.

Table 3: Differences in average tracked statistics when switching from no release to a 3-day block release for both rooms.

| | **60%** | | **80%** | | **100%** | |
|---|---|---|---|---|---|---|
| | Utilization | % of cases not booked | Utilization | % of cases not booked | Utilization | % of cases not booked |
| **Base** | +1% | -1% | +2% | -2% | +3% | -2% |
| **Short** | +1% | -1% | +2% | -3% | +2% | -4% |
| **Medium** | +1% | -2% | +2% | -4% | +2% | -4% |
| **Long** | +1% | -3% | +2% | -5% | +3% | -6% |

A final comparison test was conducted in order to identify differences between arrival pattern combinations. Nine combinations of the patterns shown in Figure 2 were used for the previous tests, but their results were combined and averaged together. Figure 10 shows the results from each of the nine combination patterns using the Base case surgical duration and 80% expected utilization levels. The highest utilization for both release policies occurs when the blocked room has Late arrivals, or a peak occurring on day 7 out of 10, and the open posting room has Early arrivals, or a peak occurring on day 3 out of 10. The worst utilization for both release policies occurs when the blocked room and the open posting room both have Early arrivals.

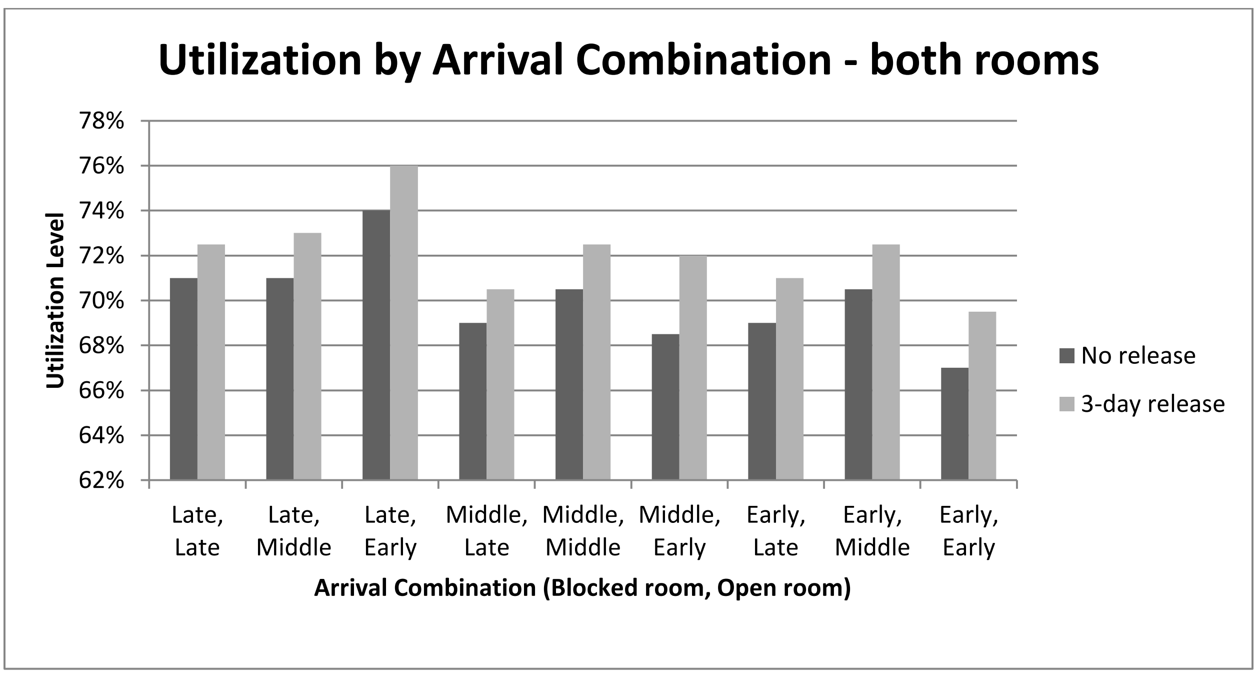


Figure 10: A comparison of utilization levels of the nine arrival combinations for the Base case surgical duration for both rooms with expected utilization levels of 80%.

On the other hand, for the number of unscheduled cases, the results are not the same. The combination with the fewest number of unscheduled cases occurs when the blocked room receives Middle arrivals, or a peak occurring on day 5 out of 10, and the open posting room receives Late arrivals, or a peak occurring on day 7 out of 10. The most unscheduled cases occurs when both rooms receive Early arrivals, or peaks occurring on day 3 out of 10. Overall it seems that a combination of Late arrivals with either a Middle or Early arrival pattern will give positive results.

These results may be due to being able to make better scheduling decisions and fit cases together when blocked cases arrive later, rather than immediately filling up the block when they arrive sooner. This is because if there is block release occurring, cases will be sent to the room with more available space, rather than the room to which they were assigned. If no release is occurring, late-arriving cases may not make it to the schedule in time for the day of surgery.

## 6 MANAGERIAL INSIGHTS

According to OR Analytics Manager Charles Hajzus (Medical University of South Carolina), significant differences in surgery posting distributions arise from natural and self-inflicted variation. Self-inflicted variation may occur due to ineffective schedulers, staff or policy-related issues, inefficient clinic setups, equipment issues, and backlog. However, the focus should be on reducing the self-inflicted variation because it is easier to defend and will last over time.

We provide a variety of surgery arrival patterns to encompass the variation and prioritization between surgical groups and their cases. When viewed individually, release policies may favor one type of room over another. Our results are intuitive with how cases are posted to each room – the 3-day block release allows for better utilization of the block-specific room because it is allowed to take on more add-on cases, while the open posting room will continue to accept all cases for which it has space.

Our overall results match the suggestions of Dexter and Macario (2004), whose study showed that block release has a negligible effect on OR efficiency when rooms receive properly allocated time. However, our results showed that individual rooms can have significant impacts on utilization and unscheduled cases that when looked at as a whole, are often minimal. These utilization changes may appear to be minimal when averaged together due to utilization increases offsetting the decreases.

A standard, rather than optional, block release may have positive influences on surgical groups that do not release their time in hopes of filling it with an incoming case. With a forced block release time, services can be more confident about getting a last minute case scheduled while keeping high utilization levels and low unscheduled case rates for their specific OR.

## 7 CONCLUSIONS AND FUTURE WORK

This paper presented the results of two main block release policies and showed their effects individually and combined on a small-scale simulation of two ORs.

One thing to consider when reviewing these results is how the setup of the block schedule can affect the need to have block release. Epstein and Dexter (2002) found that a utilization level of 80% was a desirable rate for many hospitals. A block schedule where all services achieve an 80% utilization will not benefit from block release. As service utilization decreases, then block release can improve overall OR utilization. However, it would likely be more beneficial to adjust the block size to better fit the service's needs. This point has been mentioned in prior work as well (McIntosh, Dexter, and Epstein 2006). Dexter and Macario (2004) also emphasize this point, suggesting that block release can be decided by the political environment as long as proper time allocation occurs.

The work presented is a small piece of a larger, untapped field of OR and block release research. Future work will consider different surgical distributions and expected utilization levels for each room. Longer spans and block release periods, smarter surgical duration lengths, and accuracy of scheduled versus actual surgery times and their impacts on release policies may also be items to investigate.

## ACKNOWLEDGMENTS

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