

The objective of this case is to help you gain experience in creating brief scenarios for use in explaining operational decisions. You will start to develop the skill of devising examples to explain operational policies.

Consider the situation of a specialized infusion center. Each “chair” represents a procedural location, just like an OR. You can care for at most 20 patients a day. You have 10 identical chairs, but sometimes care for fewer than 10 patients in the afternoons. Most treatments take 3 hours, but with a wide range. Around 10% of treatments take less than 2 hours and 10% take more than 4 hours. The longest a treatment can take is 8 hours. The variability in durations is due to delays, unpredictable when patients are scheduled but obvious on the day of treatment before the treatment begins (e.g., medication is not yet prepared). Based on calculations made months in advance, you and your colleagues made the decision that all nurses would work from 8:00 AM to 4:00 PM and receive overtime for hours worked after 4:00 PM. The physician present is salaried with the expectation that she stays until all treatments are completed.

Your objective in (a) to (e) below is to explain why the five ordered priorities should be used for decision-making in this infusion center. Creating constraints can illustrate complex concepts for people in just a few sentences.

Open access on any workday means that a patient or referring physician can choose the date for the infusion, and the patient will be accommodated. Patients still need to be scheduled ahead, cannot show-up late, etc. Alternative scenarios can be created to illustrate perverse incentives that are created by real-world policies.

The following scenario shows what can happen if open access on any workday is a higher priority than patient safety: “100 patients are scheduled into 10 chairs, resulting in 10 patients sitting in each chair.”

a) Create a second scenario that shows what can happen if open access on any workday is a higher priority than patient safety. In the Excel file, fill in the blanks to complete this second scenario about safety: “Patients are scheduled into appointments starting after \_\_\_\_\_. This causes the nurses and physicians to work \_\_\_\_\_.” You can start answering the questions by entering a time and getting feedback from the Excel file.

b) Many patients start treatment at the start of the workday. Create a two-sentence scenario to teach clerks how they should choose which patients to receive care first. The first sentence should give the context. “Two patients arrive at the start of the workday at \_\_\_ AM, with treatment times of \_\_\_ hr and \_\_\_ hr.” The second sentence describes what the clerk should do. “First service the patient whose treatment will likely take \_\_\_ hr.”

c) Suppose that reducing over-time were considered a higher priority than providing open access to chairs on any workday. This is the opposite learned in class. In addition, suppose that the nurse manager were evaluated based on how well she reduces overtime. What would then be the ideal maximum number of patients scheduled each day? At what time would they be scheduled to arrive? If a nurse manager is not responsible for revenue, just reducing costs, this behavior is precisely what can happen.

d) Imagine creating a one-sentence scenario for the infusion center showing what would be a good, but bizarre, decision if reducing tardiness from scheduled start times were a higher priority than reducing over-utilized time. You could schedule all afternoon patients to start at what time?

e) Suppose that the manager were being evaluated based on numbers of patient complaints about waiting. Based on your answer to (d), what should be the minimum number of nurses caring for patients so that there would not be waiting. Answer ignoring all other economic factors.

f) Suppose that the personal satisfaction of nurses were a higher priority than tardiness from scheduled start times and the nurses would prefer to sleep later. At what time may nurses arrive for work that would result in increased tardiness for the patients and at what time would the nurses be finished?

The situation of question (f) is common in reality in surgical suites when no one who is providing clinical care pays attention to the scheduled start times.

An OR manager receives repeated criticism from surgeons that cases are being moved arbitrarily on the day of surgery. The chief hospital director asks you to provide a recommendation as to whether an airport style display would help. To assist in making the decision, you hold a meeting with stakeholders during which the group agrees on a representative scenario for more detailed investigation.

OR staffing is planned from 7:30 AM to 5:00 PM. OR 1 finishes its last case of the day at 3:15 PM. Because OR 2 is running behind, its last case, originally scheduled from 3:30 PM to 5:00 PM, will not start until 4:30 PM. The anesthesia and nursing team in OR 1 can perform the case safely, and the surgeon and patient are ready. Should the case be moved from OR 2 to OR 1? If it were moved, it would start at 3:45 PM, saving 45 min of over-utilized OR time.

Whereas the surgeons generally would want the case moved, the anesthesiologists would generally prefer to send home the anesthesiologist in OR 1. If this representative scenario were solved, then the broader problem of arbitrary decision-making would be solved for the 10 OR suite.

a) Suppose that the airport style display could let you perfectly make every possible decision about moving cases, including let you magically know how long each case would take. What would be the reduction in overtime saved per day? This savings is called "the incremental value of perfect knowledge." You can find the answer in the review article assigned for decision-making on the day of surgery. Look for the section on moving cases.

b) Using your answer to (a), what is the estimated maximum possible annual savings in units of regularly scheduled time from your magically perfect display. Use a relative cost of overtime versus regularly scheduled time of 1.50 and 250 workdays per year.

c) Each OR contains one nurse making approximately \$50,000 per year and a surgical technologist making \$30,000 per year. Benefits are 35%. They are hourly employees. What is the resulting maximum possible expected annual savings? Since the savings from (b) are in units of regularly scheduled time, no overtime should be included in your answer to this part (c). However, since maximum, do include benefits.

d) Using your answer to (c), and section 6 of the article, would there likely be a positive return on investment within 1 year from an airport style display to assist in making decisions about moving cases? Use your judgment based on how much you would think that the display system likely would cost.

e) From later in section 6 of the article, would the availability of quantitative data for use in moving cases be expected to result in more homogeneity of decision-making? Explain why or why not by including in your answer a sentence about the study's results.

Cases can be sequenced between two ORs to reduce the impact of conflicts over equipment. For example, two surgeons may want to use the same surgical microscope.

Consider the sequencing of cases between two ORs to increase the efficiency of use of OR time. Assume that the two cases involving the same microscope are scheduled several days ahead of time.

a) How would you use 90% upper prediction bounds to decide on an appropriate scheduled start time for the second surgeon needing the microscope?

b) Use a search engine like Google or Bing to search for operating room information systems that have built in methods for conflict checking over equipment. List a search protocol consisting of a combination of phrases that together result in 3 to 15 web sites, the precise value depending on your search engine and your saved settings. Use no phrases other than permutations of those in the first sentence of this part (b). You will need to use quotation marks to search exact phrases. You may need to enter "search help" in your preferred search engine to read about how to search exact phrases. The purpose of this question is partly for you to rely on the online help feature.

c) Among the operating room information system software products identified from the web search, does the software that performs conflict checking treat case durations as known with certainty or as probabilistic, like in the microscope example of part (a) above from the second lecture? Assume that if the website does not say what algorithm the software uses, then the software acts like a web calendar, treating the durations as deterministic and known with certainty.

Conflicts over your surgical microscope generally cannot be resolved by finagling on the day before surgery. All cases are listed in your OR scheduling system as having a set case duration. You perform statistical calculations of case durations separately from your scheduling system and display results on the schedulers' screens.

d) How do you trick your OR information system or scheduling software to prevent conflicts over equipment caused by cases taking longer than scheduled? How do you represent the microscope in a system designed to represent ORs?

A patient is scheduled to have surgery at 12 noon. The surgeon's preceding case in the same OR is scheduled to start at 7:30 AM and end at 11:30 AM. You need to decide what time the patient should be ready for surgery. If the surgeon finishes early, then you want the patient's case to begin as soon as the room is ready. However, you do not want the patient to wait too long. You will use a relative cost of approximately 1:19 for the patient's time to that of the OR nurses and physicians. The preceding case is an unusual and unreal procedure, in that it has precisely a:

- 5% chance of finishing at 9:15 AM
- 25% chance of finishing at 10:30 AM
- 40% chance of finishing at 11:30 AM
- 25% chance of finishing at 12:30 PM
- 5% chance of finishing at 1:30 PM.

What makes this unreal is that there is no chance of finishing between 9:16 AM and 10:29 AM, and so forth. If the patient is not ready when the preceding case finishes, then consider that the OR waits for the patient (i.e., turnover times are negligibly brief).

Using Google search, enter without quotation marks: Google Advanced Search. If the first item that appears is not that site, then at Google.com select Settings and dropdown option Advanced search.

Enter into the "site or domain:" nist.gov  
NIST is the abbreviation for the US National Institute of Standards and Technology.

Enter into "any of these words:" "prediction interval" OR percentile  
Read the instructions to the right of the Google boxes.

Depending on your screen size, you may need to use your browser's Find function to find some of these search options. If you do not know how to use **your browser's** Find function, read your browser's Help. You will be using your browser's Find function in subsequent cases. **Be sure** everyone learns how to use Find.

- a) What is the URL (hyperlink) for the Google Advanced Search page? The answer is the page's URL.
- b) Using the Google summary of the NIST web pages and/or the first 5 or so listed web sites, what is the *difference* between the dictionary definitions of prediction interval and percentile? Look at the dictionary definitions of each and compare the definitions. Answers that are one word long are sufficient.
- c) You decide to have the patient be ready at 9:30 AM. On the next 99 workdays, the equivalent patient in the same situation is also ready at 9:30 AM. Using the data above, the OR staff are expected to wait for how many of the 100 patients?
- d) Continuing from (c), calculate the percentage of the total cost of waiting that is sustained by patients, based on the patients being ready at 9:30 AM. The total cost is the sum of the costs for the patients and for the staff. You need nothing to answer this question other than the numbers above. Answer this question step-by-step in Excel.
- e) Continuing from (c), calculate the percentage of the total waiting time that is sustained by patients, based on the patients being ready at 9:30 AM. Think about how this situation is different from that of (d).
- f) Continuing from (c), suppose that the patients were ready at 9:00 AM, so that the OR never waits for a patient. What would be the percentage increase in the total cost as compared to having the patients ready half an hour later as in (d)?
- g) If the patients were ready at 11:30 AM, what would be the percentage increase in the total cost as compared to having the patient ready 2 hours earlier as in (d)?

This case continues from the preceding one on patient arrival times. You need to write brief but coherent recommendations. You do not need to do web searches to make your arguments. Just discuss the issues in your teams.

a) From parts (b) and (c) of the preceding case, write 1 or 2 sentences explaining the basis for your decision to have the patient report at 9:30 AM. They should be sufficient to convince a surgeon why you are doing what you are doing. The wording should be simple enough to be understood by physicians who know none of the science, but sufficiently detailed that knowledgeable readers will not think that you are ignorant of the field. Do not report the ordered priorities, because the physicians will not know them. To explain why you are planning 9:30 AM, you will need to use the relative cost value given in the preceding case.

b) Suppose that you work at a 10 OR rural hospital. You need to identify personnel at your hospital who can calculate arrival times for your patients. What educational field of study would be suitable for the team leader of this quantitative project? Base your answer on the experience that you gained answering the preceding case. If they have no OR experience, how would you get them that knowledge so that they can get the project done in six months? When answering the second part, do not include the name of the field in your answer, as the parts are separate.

Suppose that you work at a hospital whose cafeteria sells bagels. Ordering too many bagels for the cafeteria can be analogous to having patients wait. Ordering too few bagels can be analogous to having the OR wait. Ordering too few bagels is worse than ordering too many because you sell the bagels for much more than you purchase them.

c) Who might be the person at your hospital who figures out how many bagels are ordered daily at your hospital? What sort of expertise would the person have? Not orders the items, does the mathematics.

The same would apply to donuts, cut fruit, and other items only good for 1 day (e.g., allocated OR time).

d) Based on (b) and (c), you decide to hire consultants to complete the project. What must you specify in your RFP (request for proposals) to assure that a potential consultant will implement the evidence-based statistical methods (e.g., the appropriate computer algorithms)? Asking, "Have you done this before?" will not work, because the answer can be "Yes" even if the consultant knows nothing about the science and would tell all patients to arrive at 8 AM or at 11:30 AM. Saying "implement statistically based arrival times" will not work, because they might use an inappropriate method.

Suppose that a consulting firm succeeds at implementation, but the software would have all patients arrive at 8 AM or at 11:30 AM. That would be very bad. When choosing the firm ahead of time, you need to make sure that this would not happen.

e) Suppose that you were not involved in the preliminary stage of choosing a firm in (d). However, you are involved in a phone meeting with the firm that likely will be hired to assist. During the phone meeting, before you hire the firm, how will you evaluate whether the people can design for you something that will get the correct answer? Consider how I evaluated your knowledge in the preceding case.

SmallTown Hospital has 12 ORs. The ORs are allocated in “blocks,” which have been the same for the past decade. The anesthesia group has been performing poorly financially. The reason stems from the daily OR management.

On Mondays, total hours of orthopedic cases including turnovers follow a normal distribution with a mean of 30 hr. Use this value for (a) to (e).

a) Suppose that no rules are set for following the ordered priorities for case scheduling, other than safety. The OR allocations are 10 hr per OR per day. For this first question (a), make the simplifying assumption that all Mondays are identical. The standard deviation of total hours of orthopedic cases including turnovers is 0 hr on Mondays. Nonetheless, on average, there are 5 hr of under-utilized OR time and 5 hr of over-utilized OR time for orthopedics on Monday? How is this possible? You need to use no numbers other than those listed in the preceding and this paragraph.

After answering the question, consider whether the hours of under-utilized and over-utilized OR time could be obtained using either 2 ORs, 4 ORs, or 5 OR (i.e., why only an option of 3 ORs is provided).

b) For questions (b-e) below, you should realistically follow the ordered priorities for case scheduling. The relative cost of an hour of over-utilized OR time is twice the cost of an hour of under-utilized OR time. For this second question (b), again assume that the standard deviation of orthopedics' workload on Mondays is 0 hr. What OR allocation for orthopedics on Mondays would result in maximal efficiency of use of OR time? First, determine how many hours of orthopedic cases are performed each Monday. Then, plan your staffing (OR allocation) while considering both 8 hr and 10 hr workdays, to make up your 40 hr week ( $5 \times 8 \text{ hr} = 4 \times 10 \text{ hr}$ ). Do not answer twice, once for 8 hr workdays and another for 10 hr workdays, just consider that staffing for the 30 hr can be a combination of the two.

c) Repeat question (b), but now set the standard deviation of the workload among Mondays to a realistic 5 hr. What would be the appropriate OR allocation? To perform the calculation, you will need to look up the inverse of the normal distribution. In Excel, you can use “=NORM.INV” function, with the mean of 30 hr and standard deviation of 5 hr. If you are not sure what to do with NORM.INV, read the Help built into Excel and see what happens when you enter values for which you have previously learned the answers. You can figure out the percentile for NORM.INV from the preceding paragraph (b) and your answer to question 5 (a).

NORM.INV is the function name for English language Excel. If your default language is different, you can find the corresponding function name by searching using Google or Bing with the following phrase without quotation marks: “Excel English NORM.INV LOI.NORMALE.INVERSE”, the latter is the French equivalent.

Your OR allocation is higher for (c) than for (b), because the standard deviation is higher for (c) than for (b).

d) Repeat question (c), but now set the standard deviation to a large 10 hr. Just like for (c), you will need to use NORM.INV to calculate the inverse of the normal distribution.

e) Why does it make sense that the allocation is larger if the standard deviation is larger, even though the mean is the same? In other words, why is the answer to (d) larger than (c), and why is the answer to (c) larger than (b)?

The precise language in part (e) mattered, because you need to be able to explain the principle to stakeholders. “Rewarding” specialties that have larger variability with more staffing seems initially unfair to other stakeholders.

A hospital in a remote location has 5 ORs. People who need elective surgery either wait months for surgery at the hospital or travel elsewhere. Physicians practicing at the hospital routinely are gone for 1-2 months on vacation, training, etc. Each surgical group tends to setup their schedules with one physician gone at a time. Usually 15% of the surgeons are gone at a time, but there is wide variability because each group makes its own decisions. Each month, the Chief of Surgery uses Excel to create a “block” schedule for each of the 5 ORs for the next month. For example, Mondays might be one OR to each of Orthopedics, General Surgery, Gynecology, Otolaryngology, and Plastics. On Tuesdays, there might be one OR to each of joint replacement (orthopedics), Vascular Surgery, General Thoracic Surgery (lung and esophagus), Ophthalmology, and Neurosurgery. The Chief likes to rotate services among days of the week to be fair. Blocks are 8 hr long.

Patients are frequently referred elsewhere. Surgeons report that they “are unable to schedule cases.” Yet, there is negligible over-utilized OR time and an adjusted utilization of only 70%.

a) Explain the difference between “block” scheduling and service-specific staffing:  
“Service-specific staffing involves the \_\_\_\_\_ of staffing to \_\_\_\_\_ workload.”

b) Suppose that a General Thoracic surgeon currently operates on Thursdays and will have his assigned day of the week changed to Mondays starting next month. Make a list of 7 perioperative areas that would need to adjust staffing in response to altered workloads on each day of the week based on the change in the block time. As described above, these changes in block times are not just for the General Thoracic surgeon but involve all surgical departments simultaneously. Limit consideration to preoperative and postoperative areas or processes. There are in fact at least 15, but list just 7.

c) Among your areas from (b), which ones do you think would be able practically to change its distribution of staffing among weekdays and its workflow within a couple of weeks upon hearing of a change in the OR block schedule? Put an X into the box by the ones that you think would adjust promptly.

The implications about changing the block schedule are obvious from part (c).

d) Identify at least 3 of the 4 inconsistencies in the language and/or science in the following:

When deciding OR allocations, the block committee evaluates each surgeon’s raw utilization =  $100\% \times (\text{total hours of elective cases}) / (\text{allocated hours of OR time})$ . The committee recommends that the neurosurgeon no longer have 8 hr of block time on Fridays, because the intensive care unit is often full on Fridays. Block time for the neurosurgeon should be switched to the available OR time on Wednesdays since the intensive care unit has time. Her Wednesday clinic would be moved to Fridays.

Your answers are items that are incorrect. Pay attention to both the way words are used and the concepts presented. Do not base your answer on circumstances or situations not stated in the preceding paragraph. Limit your answers to scientific concepts that would apply at any facility.

This case explores the use of financial information from the > 50% of surgeons (subspecialties) with contribution margins per OR hour that are less than the mean.

a) Give three reasons why two plastic surgeons performing mostly cosmetic surgery can have very low contribution margin per OR hour at an academic facility and very high contribution margin per OR hour at a private facility where the same plastic surgeons also work. There are at least four (common) answers.

b) At the academic facility, cosmetic surgery has a very low contribution margin of \$200 per OR hour. The surgeons report that they “cannot get access” to OR time for their cases (i.e., times are inconvenient), and say that they want more “block time.” What analysis would you perform regarding their OR allocation? Your answer should focus on the concept of “OR allocation” and what is meant by it.

c) You decide based on your analysis that the current OR allocation is appropriate. In meeting with the surgeons, what one point would you plan to emphasize? Think operationally, particularly from the first lecture, as you decide what you can promise the surgeons.

The two surgeons have approached an outpatient surgery firm to co-develop a freestanding facility for procedures that can be performed with a length of stay of less than 16 hours. Their group of two surgeons would do almost all their cases at the facility. You expect to lose 12 hr of cases per week, which would be bad. In addition, the one anesthesia group in town has been asked to cover the 12 hr of cases per week at the freestanding facility.

d) As the hospital administrator, you are careful to avoid advising the anesthesia group against providing services. However, you do assist the anesthesia group by providing it with OR information system data on the plastic surgery cases to use in deciding how they should be paid for providing anesthesia services. List three methods of support (pay) to the anesthesia group from the freestanding facility for covering 1 OR per day, Monday to Friday.

e) Knowing the challenges of OR allocations and the plastic surgeons’ case scheduling, how should the anesthesia group ask to be paid for providing services at the freestanding surgical facility, to assure they do not lose money in the arrangement with the facility? Please assume that the compensation would be at the fair market rate, as suggested by the [US Office of Inspector General Advisory Opinion](#).



University hospital has one OR table for bariatric surgery. There currently are two bariatric surgeons. Together, they operate all days of the week. The Department of General Surgery has recruited a third bariatric surgeon.

a) Create a 1 sentence scenario wherein the addition of a third surgeon increases the amount of bariatric surgery performed even though another bariatric table is not purchased. Something like “the cases are scheduled into first-come first-scheduled OPEN time” would not apply, because the bariatric table would not be available and so more cases cannot be scheduled into the open time.

b) You want to perform a financial analysis of the bariatric surgeons. To do this, you will need to compare their lengths of stay with the US national average. You will also need to examine payer mix. Using Google, Bing, etc., determine and answer the diagnosis related group (DRG) for obesity surgery. In addition, provide the web search protocol that gets the answer nearly at the top of the list. To do both, try searching on DRG obesity surgery. Note that we are going to be searching for 2004 and 2006, so use the DRG, not the MS-DRG. The DRG have similar names in other countries (e.g., Diagnose Behandelings Groep in The Netherlands).

Using Google, search for CMS Medicare acute inpatient files for download. At that webpage, sort by Fiscal year, choose 2006 files. They are sometimes within the “Files for FY 2006” (e.g., “Files for FY 2006 Final Rule and Correction Notice”). The Table 5 - DRG Relative Weights file contains the “length of stay.” Open the Excel file. The data are in fact from 2004. Follow these steps precisely.

c) What was the (arithmetic) mean length of stay for obesity surgery among US Medicare patients in 2004?

Go to AHRQ’s HCUPnet web site (<https://datatools.ahrq.gov/hcupnet>). If asked, Accept the Data Use Agreement for HCUPnet. For the Inpatient setting of care, select the “National Inpatient” box. If you do not see a large “National Inpatient” box, and instead you see a webpage with title “AHRQ Data Tools,” then you did not accept the data use agreement (i.e., you should start over and Accept the agreement at bottom of the long text). After selecting “National Inpatient,” select + and Diagnoses and Procedures. Select Cross-Sectional. Year 2004. Classification Type of Diagnosis Related Group (DRG). At Diagnoses/ Procedures, unselect All, and then type obesity into the blank field at the top. Select the DRG used to answer question (b), above. (By doing so, you will learn another way to search DRG.) Select among Outcomes the Average length of stay. Select Characteristic All Discharges.

d) What was the mean length of stay throughout the USA for all discharges of all patients in all hospitals undergoing bariatric surgery in 2004?

Using the data from (d), revise Characteristic All Discharges to Patient Age Group. Under Characteristic Levels, select ages 65 years and older.

e) Why was 3.7 days, the national average length of stay for patients of Medicare eligible age ( $\geq 65$  years), different from the value in (c)?

Consider the HCUPnet results for all payers. Suppose that your bariatric surgeons have average lengths of stays that are far longer than the value in (d), specifically 5.4 days. In addition, your bariatric surgeons have a contribution margin per OR hour that is markedly above average for the hospital.

f) How can these two results be reconciled? How can payment compensate for the larger costs that are being sustained from the longer than average length of stays?

Surgeons at your hospital are not using resources wisely. They appear to be wasting OR supplies that are not used, as well as OR time itself. An incentive program is proposed to reduce wastage of the supplies. The program would grant surgeons with the least wastage a reward of more block time.

a) What is an estimate for the range in the contribution margin per OR hour among subspecialties (surgeons)?

b) Applying your answer, why would the proposed program be a *poor* strategy for improving the overall contribution of the hospital? In other words, why does it neglect what you learned in class and readings? [Click here](#) for abstract of an article providing the median cost of wastage of OR supplies.

When estimating contribution margin, patients admitted via the emergency department were excluded. That was appropriate for making decisions to increase block time but does not apply to operational decision making. Yet, wastage applies to all cases whereas contribution margin data were studied among outpatients and those patients admitted on the day of elective surgery.

c) Would you permit surgeons who are given more block time to schedule patients who are admitted from the emergency department into their time?

The surgeons with the least wastage would be rewarded when additional OR time is planned tactically. The wastage is known for each case by recording what is wasted.

d) How can wastage be incorporated into calculations of contribution margin per OR hour as an incremental cost? Note that this is not just or necessarily the value of the items wasted but penalizing for wastage.

[Click here](#) to read the abstract of the 2005 paper by Toyabe S et al. on the “actual and estimated costs of disposable materials used during surgical procedures.” The procedures studied included cataract extraction, strabismus surgery, hip replacement, and heart valve replacement.

e) Can cost accounting systems based on time in the OR be used validly to compare excess costs for disposable materials per OR hour among surgeons performing the same procedures? Why?

The concept of rewarding surgeons with block time ignores the use of linear programming that was considered in the lecture and was in your reading.

f) What would be the expected operational impact at a hospital if the plan were implemented to increase block time for surgeons with little waste, given that linear programming or equivalent qualitative considerations would be ignored?

Many surgeons have substantial wastage for some procedures, but many other surgeons have little wastage. The concept of rewarding surgeons with block time ignores the use of quadratic programming considered in the lecture and in reading.

g) Why is quadratic programming used when appropriately planning tactical increases in additional block?

The plan of rewarding surgeons with additional block time in return for small wastage is implemented for purely political reasons. You want to make sure that this policy has no adverse effect on your ORs. You take advantage of the second stage of OR allocation and of case scheduling to mitigate the influence of the poor long-term decision.

h) List in sequence of importance the three key operational processes that enable you to reduce the impact of the tactical decision.

Consider now that you are the head of a nursing or anesthesia department who understands OR management. You might get the false impression from part (h) that tactical planning of OR time is not important and that you can leave tactical block time decisions to the whims of surgeons.

i) List 2 of the 5 ways that block time decisions can affect the inefficiency of use of OR time so much that your ability to compensate would be limited. A few words each are sufficient.

You are working as the head administrator for a group of 35 surgeons. They do 90% of their cases at a comprehensive hospital with 22 ORs. You spend much of your time working with the hospital administrator in charge of the ORs.

a) The average setup and cleanup time at the facility is 45 min. Using the figure that I showed during lecture, which is from a 2005 article, what percentile is this for a large sample of hospitals? To answer the question, you can use the number of hospitals with briefer turnovers or the number of hospitals with longer turnovers.

After multiple meetings with OR stakeholders including anesthesiologists, and repeated efforts at change over a year, you are convinced that the anesthesiologists perceive that reducing the turnover times would be of no value. The anesthesiologists do only OR anesthesia.

b) What piece of information would you need to know about your ORs to understand the anesthesiologists' perspective? To emphasize, this question is from the perspective of the surgical department administrator, responsible for non-physician personnel, clinics, assisting the departmental chair, etc.

The anesthesiologists all work 225 clinical days per year. The number of anesthesiologists scheduled to work in the ORs each day is 24, which is 22 plus 2 extra to cover for illness or to help with breaks. Each anesthesiologist works from 7:30 AM to 6:00 PM. By 6:00 PM, almost all ORs are finished for the day.

c) How would staff scheduling of the anesthesiologists need to be changed for the anesthesia group to realize a financial benefit from reducing turnover times? Answer the question assuming (artificially) that all 22 ORs start promptly at 7:30 AM and cases are scheduled to be performed consecutively in each OR.

The reality at the hospital is that cases are not scheduled consecutively. There are morning blocks and afternoon blocks. Some ORs start at 7:30 AM, have cases to 11:30 AM, and then do not start up again until 2:00 PM, often finishing after 4:45 PM. You have available accurate historical OR information system data. To provide an incentive for anesthesiologists to reduce turnover times you will try to provide them with predictable end of the day times. The anesthesiologists could then adjust their staffing to closely match the OR workload.

d) Why is it necessary to schedule cases consecutively for service-specific staffing calculated based on minimizing the inefficiency of use of OR time to be planned appropriately from forecasted workload?

An effective method to achieve reductions in turnover times in ORs is to apply six sigma methods and/or change workflow. You may choose to target certain surgeons for turnover time reductions. However, there can be unintended and undesirable consequences of such efforts.

Using PubMed, search all permutations of “turnaround time”, without quotation marks. Select Advanced, then Search Details by clicking on the right-facing arrow. Copy and paste the search as plain text into the Query box, not the Translations, and edit the search to include only words in the title or abstract (i.e., use “[TIAB]”).

Use Advanced Search to combine the preceding search results with the results of a second search, that being for six-sigma. For this second search, do not add the field “[TIAB]”. Look at Search Details for that obtained. Try including and excluding the dash in six-sigma to learn how PubMed handles dashes. Use OR to include six-sigma spelled using the number (i.e., 6-sigma). If your Search Details includes MeSH terms and/or phrases related to six-sigma but without the term itself, exclude those words using the Query box. This case teaches about how PubMed works and the [need to learn vocabulary](#) as used in scientific papers.

Finally, combine the preceding search pair with “surgery,” “surgical,” “operating room,” or “operating rooms”.

a) What article from 2004 did you find from our lectures about six-sigma methodology to reduce turnover time? Copy and paste the title into the Excel formula bar.

Click on the article to display the abstract. There are several subheadings of the “Operating Rooms” MeSH terms listed. MeSH is the abbreviation for **M**edical **S**ubject **H**eadings. If you do not find the article's MeSH terms on the webpage, use your browser's function to search the webpage.

b) Which MeSH including the subheading would be relevant to our interest in how to reduce turnover times?

In Google, request: PubMed search MeSH. At the NCBI website (National Center for Biotechnology Information), search MeSH for “burnout”. Copy into the clipboard the MeSH related to physicians and nurses working in their operating room environment. Return to searching PubMed. Enter that appropriate MeSH term for burnout. Then, edit in the Query box what is produced so that you are searching just the MeSH term.

c) What code (“query translation”) is produced from by searching just that MeSH heading? These are the words remaining in the Search Details box.

Use the Query box to combine the search numbers of the MeSH term from (b) and the search from (c). Select the scientific article from 2005 that is relevant to turnover times.

d) Increased exposure to new technology resulted in what differences in findings for personal accomplishment between the OR nurses and the surgeons?

e) Using PubMed, identify another article that was published by most of the same authors in the same year. In this new paper, what was the impact of the intervention on the number of cases that the surgeons chose to schedule and/or performed each workday?

f) What is the relationship between the findings of (d) and (e) from the perspective of surgeons? This behavioral factor potentially explains the surgeons' decision to schedule more cases.

g) At a freestanding outpatient facility, the ORs start at 7:30 AM and finish daily around 3:15 PM. The surgeons argue that, “Their overall excellent financial return justifies hiring another housekeeper to reduce turnover times, so that they can schedule more cases.” What is wrong with their argument?

Previous studies have suggested that reducing turnover times does not permit you to schedule another case, except for ORs with many very brief cases. To explore the evidence, go to [FranklinDexter.net](#), Select the “Bibliography of operating room management articles,” and Select the “Economics and mathematics of decreasing anesthesia, turnover, or surgical times,” and then scroll to 1995. Click on the hyperlink to view the Abstract. Also, read the Abstract of the related paper from 1999.

h) Based on the turnover time lecture and the abstracts, explain how the situation studied in the articles differs from open access to OR time on any future workday. The key is one crucial word in the results of the Abstract of the 1995 paper. The results are the 3<sup>rd</sup> to last and 2<sup>nd</sup> to last sentences of the abstract. This problem highlights the importance in operations research of considering every word and its precise meaning.

Your hospital's board is markedly upset with you for your "letting" some busy orthopedic surgeons proceed with a plan to move most of their practice to a competing hospital down the street. The reality is that you were shocked. One day the president of the orthopedic group said, "Oh, by the way, XYZ hospital is providing a salary guarantee for 5 new surgeons. We are going to start operating there almost exclusively." You need to create a list of arguments explaining why this unfortunate circumstance is, really, not that bad, sort of "good riddance."

You know that the orthopedic surgeons have lengths of stays that are longer than the national average. They have been resistant to repeated efforts over the years to reduce their lengths of stay. You want to calculate the difference between each orthopedic inpatient's length of stay and the national average length of stay for patients with the same DRG. Consider each step that you used in case #9 to get the average length of stay nationally by DRG using HCUPnet.

As you answer the questions, remember that your goal is politics, not decision-making. Therefore, as you make these decisions, choose answers that best make your case. Show that you fully understand the principles by making choices that bias the results to make your point.

- a) Which of the surgeons' patients would you include in the analysis and why?
- b) Would you calculate confidence intervals and why?
- c) Would you use the median or mean differences and why?
- d) For (a), (b), and (c), what would you do differently if you were interested in an unbiased quantitative assessment? Answer separately for each of the three, without explaining why.

Publicly available data are useful in strategic planning, determining growth potential, and understanding the financial implications of decisions. Hip replacements were performed only inpatient in 2004.

Search the web for Agency for Healthcare Research and Quality (AHRQ) Clinical Classifications Software (CCS). You will need to think about and use quotation marks. Under “Research Tools,” you want the version for ICD-9-CM. Select the “Appendix B: Single Level Procedures” text file.

a) Search for “hip replacement”. Copy and paste all the ICD-9-CM, without the decimal points.

Go to <https://www.hcup-us.ahrq.gov/db/nation/nis/nisdbdocumentation.jsp>, National Inpatient Sample (NIS) Database Documentation. Under Data Elements, download the Excel file that includes the frequencies of inpatient procedures nationwide in 2004. Using the Table of Contents worksheet, select the worksheet for weighted records by ICD-9-CM procedure code, the weights giving national counts from the sample.

b) What is the listed description for the ICD-9-CM from part (a) that has the most cases? Using Ribbon: Home, Editing, Filter, and search using the CCS column or using the adjacent CCS Description column. (Keep the Excel file open until you have answered question [d], below.)

I created tables using the National Inpatient Sample. These are the national discharges in 2004.

Age group (yr)	81.51	81.52	81.53
1-17	165	68	
18-44	14681	1141	2769
45-64	78989	7619	11259
65-84	114441	55648	19963
85+	11043	36253	3258

Payer	81.51	81.52	81.53
Medicare	122352	86393	24297
Medicaid	6543	2190	1416
Private insurance	83895	9893	10332
Uninsured	2174	902	358
Other	4777	1326	908

Age group (yr)	Medicare	Medicaid	Private insurance	Uninsured	Other
1-17		73	146		
18-44	2419	2802	11845	390	999
45-64	12705	5861	72633	2002	4289
65-84	169939	1147	16372	802	1439
85+	47454	208	2469	135	205

c) What percentage of patients undergoing the procedure from (b) had Medicare as their primary payer? Enter a formula into Excel, with the denominator being the sum of counts.

d) Using the tables that I created, what is the ICD-9-CM code for the procedure that had the largest percentage of patients 65 years of age and older? Once you have that calculated, also include in the answer the description of the code. You can obtain the description from the Excel file used for question (b). You also can search Google or Bing.

e) The third table from the National Inpatient Sample includes the ICD-9-CM codes of the CCS of hip replacement, total and partial, from question (a). What percentage of patients 65 years of age and older had Medicare as their primary payer? To answer, enter a formula into Excel, both numerators and denominators being sums of counts.

f) What percentage of US patients of any age in the CCS had Medicare as their primary payer in 2004? You can use either of the two tables with payer for the calculation.

You will complete your study of OR efficiency by explaining results from real, but redacted, OR management reports. At [FranklinDexter.net/education.htm](http://FranklinDexter.net/education.htm), where it is written "For examples of OR management reports, click here (ORs)," do indeed "click here."

Comparing pages 2 and 4, Oral Surgery (OralS) averaged 5.9 hr of cases including turnovers on Mondays and received an 8 hr allocation. In contrast, Pacific Vascular (Pacif) averaged 5.1 hr of cases on Wednesdays and did not receive an allocation. To learn the principles, consider two *hypothetical* services.

a) Each hypothetical service has the same mean workload of  $X$  hr and standard deviation of 0 hr. What would be the value of  $X$  such that the efficiency of use of OR time would be the same whether the two services share an 8 hr allocation or each receives its own 8 hr OR? Use a relative cost ratio of 1.75.

One way to solve the problem (a) is to use the basic algebraic equation before using Excel. This is done most easily with using a variable (e.g., " $r$ ") to represent the ratio. The formulas to set equal to one another are present in the Excel file. The second way to solve the problem is to use iteration in the Excel file. You can predict ahead that the value calculated will be in between the 5.1 hr of Pacif and the 5.9 hr of OralS.

b) Suppose that the hospital was to change its management to allocate OR time and schedule its cases based on the efficiency of use of OR time. From page 5, what would be the minimum additional hours of capacity that the hospital could reasonably expect to have available for future surgical growth?

From page 8, no argument can be made based on the efficiency of use of OR time to plan 29 ORs on Thursdays, only 27 ORs. However, a political decision is made to run 29 ORs on all workdays.

c) If the goal were to maximize the potential to grow future workload, how should the 2 extra ORs be used on Thursdays? Answer from the perspective of this OR allocation report, not decision-making on the day of surgery.

From page 10, reducing turnover times for Oral Surgery (OralS) on Wednesdays could reduce its labor costs in units of time by 23 min. The 23 min is based on a relative cost ratio of 1.75 and Oral Surgery's actual OR workload on all Wednesdays.

d) To learn the principles, suppose that Oral Surgery's standard deviation of workload among Wednesdays equaled 0 hr. From page 2, the OralS mean was 8.30 hr of cases and turnover times on Wednesdays. From page 4, the OR allocations are for 8 hr or 10 hr. Based on a relative cost ratio of 1.50, what would be the maximum potential savings in units of minutes from reducing Oral Surgery's turnover times?

Compare your answer to part (d) to the 23 minutes on page 10 and consider their similarity.

e) Comparing pages 4 and 21, what would be the minimum mean hours of OR time allocated weekly to Otolaryngology (ENT) that would not be "blocked out" to specific ENT surgeons?

f) From page 25, when calculations were performed with a relative cost ratio of 4.0, how many afternoon teams were calculated as being needed from 3:00 PM to 4:59 PM?

A private hospital provides complete healthcare coverage (“Health Maintenance Organization”) for 40,000 enrollees of a company including employees’ dependents. When a surgeon has a patient needing a procedure that cannot be performed at the private hospital, or the patient has an uncommon medical condition, the surgeon’s clinic arranges for the enrollee to receive care at the nearby University hospital. During the past year, \$7 million was paid to the University hospital by the Health Maintenance Organization for inpatient surgical care. The Health Maintenance Organization provides you with a list of Diagnosis Related Groups (DRGs) for the patients undergoing surgery at the private hospital and for the patients sent to the University hospital. There were 15 DRGs that each accounted for at least 1% of the \$7 million. There were only a few patients at the private hospital with one of these 15 DRGs.

a) You decide to hire a consultant to come to the private hospital to evaluate whether the \$7 million loss can be reduced. What should be his or her principal activity on-site to learn why the patients are being referred to the University hospital?

Think about each of the end-points that I taught in lecture and that are in your readings.

b) What one statistical method would best highlight the differences in the types of procedures performed at the private hospital versus the types of procedures performed on patients sent to the University hospital? You can answer in a few words.

c) From the description of the data and your answer to (b), would the analysis be by sum of dollars, number of patients, number of procedures, or something different? In other words, what is the “N” for a DRG?

You want to create a table with each row being a different one of the 15 DRGs. The next column is the value from part (c) among the patients sent to the University hospital.

d) How can you statistically quantify the heterogeneity among DRGs in the numbers of dollars, patients, procedures, or discharges from part (c)? Again, your answer will be from lecture and from the readings. You do not need to have answered part (c) correctly to answer this part correctly.



Suppose you have access to discharge abstract data for your US state. You are going to assess differences in your hospital's surgical procedures from those of other hospitals in your region. Answer literally for *your* state (or province if from another country) and hospital.

The curator at your hospital receives updated access each quarter to a data warehouse managed by the State. To answer, review the strategic financial analysis lecture or the marketing lecture.

- a) When you submit your formal request for the data to the curator at your hospital, what fields will you ask the curator to provide?
  
- b) What other information will you need when you perform your analysis? This is not a question about data from the hospital discharge abstract database, but books, tables, charts, etc., to interpret codes and abbreviations in the discharge abstract data. To know what codes you may be given in (a), look at the lectures and/or the readings. Your list can include 2 to 4 items.
  
- c) List two questions that you would like to answer about your hospital compared to other hospitals. The answers should be available from the discharge abstract data. Literally reply for your own hospital in two sentences. The purpose is for you to think about what can be analyzed.
  
- d) What are the three principal limitations of analyzing hospital state discharge data for making strategic decisions for surgery? At the web site, [FranklinDexter.net/education.htm](http://FranklinDexter.net/education.htm), open the lecture: "Showing differences among hospitals and their surgical practices." This lecture at the website is longer than the version from class; that is true for most of the lectures at the website. Follow the instructions on the first slide. To answer the question, using Chrome or Edge, search within the PDF for "limitations". Alternatively, download the PDF file and use Adobe Reader or Acrobat to Edit Find "limitations".
  
- e) Suppose that you wanted to compare the number of intracranial neurosurgical procedures performed in children at your hospital with the number performed at the hospital across town. How would you determine which types of procedures to study? Consider your approach in case #14.
  
- f) You want to find someone in your hospital who can help you with this project. They need to be facile in computer skills such as the use of Excel pivot tables and array formulae. List three groups of people at your hospital who likely have the expertise. Do not enter a department, but the job category for which training (degree) would be suitable.
  
- g) What can you attach to your e-mail for the target people of part (f) to understand quickly what you want done and determine whether he/she has the skills? If unclear as to why e-mail is the appropriate method of communication, and to expand upon what you learned in question (4a), use the Google site option to search [FranklinDexter.net](http://FranklinDexter.net) for "e-mail communication" without the quotation marks and including the hyphen. If you do not find the article promptly, add "Prah" to the search, but before the site option. Read the abstract of the 2015 paper by Prah A. You can alternatively find the article using PubMed. In addition, using the web site bibliography or PubMed, find and read the abstract of the 2016 paper by Dexter F and Van Swol LM. Finally, retry the search without the hyphen and/or with quotation marks.