First Case Starts

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Targeting First Case Starts To Reduce Over-Utilized Time and To Do More Cases

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Financial Disclosure

- I am employed by the University of Iowa, in part, to consult and analyze data for hospitals, anesthesia groups, and companies
- Department of Anesthesia bills for my time, and the income is used to fund our research
 - I receive no funds personally other than my salary and allowable expense reimbursements from the University of Iowa, and have tenure with no incentive program
 - I own no healthcare stocks (other than indirectly through mutual funds)

Topics of Talk on First Case Starts

- Review of principles in calculating allocated OR time for use in reducing over-utilized time
- Reducing tardiness of first case starts can increase efficiency of use of OR time
- Perceptions, biases, and physicians' roles
- Notifications on the day of surgery
- Planning the working day before surgery



Example of Under-Utilized OR Time

- Allocated time is from 7:15 AM to 3:30 PM
 These are hours into which cases are scheduled
- An OR's last case of the day ends at 1:30 PM
- There are 2 hours of under-utilized OR time
 Under-utilized time is from 1:30 PM to 3:30 PM

McIntosh C et al. Anesth Analg 2006 Dexter F, Epstein RH. Periop Care Oper Room Manag 2024

Example of Over-Utilized OR Time

- Allocated time is from 7 AM to 4 PM
- OR's last case of the day ends at 6 PM
- There are 2 hours of *over-utilized OR time*
 - Over-utilized OR time is from 4 PM to 6 PM



Precise Meaning of Maximize OR Efficiency

Inefficiency of use of OR time (\$) =
 (Cost per hour of under-utilized OR time)
 × (hours of under-utilized OR time)
 + (Cost per hour of over-utilized OR time)
 × (hours of over-utilized OR time)

Strum DP et al. J Med Syst 1997 Dexter F, Epstein RH. Periop Care Oper Room Manag 2024

- On Mondays, hospital currently plans 3 ORs for orthopedics, each OR for 10 hr
 - 3 ORs × 10 hr = 30 hr
- On Mondays, total hours of orthopedic cases including turnovers follows a normal distribution with a mean of 30 hr
- Relative cost of 1 hr over-utilized OR time = 2.0 × that of 1 hr under-utilized OR time

McIntosh C et al. Anesth Analg 2006 Pandit JJ, Dexter F. Anesth Analg 2009 Dexter F, Epstein RH. Periop Care Oper Room Manag 2024

- Consider standard deviation of orthopedics' workload on Mondays = 5 hr, a typical value
- Since workload follows a normal distribution, need inverse of normal distribution function
 - Ratio of 2.0:1.0 over-utilized: under-utilized
 - Excel "= NORMINV(2/3, 30, 5)"
- The 66th percentile of the normal distribution function with mean 30 hr and standard deviation 5 hr equals *32 hr*



- Consider standard deviation of orthopedics' workload on Mondays = 5 hr, a typical value
- Using the mean of 30 hr, what OR allocation maximizes efficiency of use of OR time?
 - 1) 3 ORs: 2×8 hr, 1×10 hr
 - 2) 3 ORs: 1×8 hr, 2×10 hr
 - 3) 3 ORs: 0×8 hr, 3×10 hr
 - 4) 4 ORs: 4 \times 8 hr, 0 \times 10 hr
 - 5) 4 ORs: 3×8 hr, 1×10 hr
 - 6) 4 ORs: 2×8 hr, 2×10 hr

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 - 4) 4 ORs: 4×8 hr, 0×10 hr
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 - 6) 4 ORs: 2×8 hr, 2×10 hr

- Consider standard deviation of orthopedics' workload on Mondays = 10 hr, a large value
- Since workload follows a normal distribution, need inverse of normal distribution function
 - Ratio of 2.0:1.0 over-utilized: under-utilized
 - Excel "= NORMINV(2/3, 30, 10)"
- The 66th percentile of the normal distribution function with mean 30 hr and standard deviation *10* hr equals *34 hr*



- Consider standard deviation of orthopedics' workload on Mondays = 10 hr, a large value
- Using the mean of 30 hr, what OR allocation maximizes efficiency of use of OR time?
 - 1) 3 ORs: 2×8 hr, 1×10 hr
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6) 4 ORs: 2×8 hr, 2×10 hr



- Suppose normal distribution, mean workload 30 hours, standard deviation 5 hours, relative cost ratio of 2.00, and 10 hours allocated time
- Inefficiency of use of OR time proportional to:

= AVERAGE (LET (X,

NORM.INV(RANDARRAY(1000000), 30, 5), IF(X < 10, 10 - X, 2.0*(X - 10)))

Dexter F et al. Am J Vet Res 2024













Topics of Talk on First Case Starts

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- Notifications on the day of surgery
- Planning the working day before surgery



- OR nurses, nurse anesthetists, and anesthesiologists are full-time employees
- Allocated time is from 7 AM to 3:00 PM
- There are estimated to be 9.0 hours of cases
 Other ORs estimated to end earlier in the day
- Intravenous catheter and regional nerve block placed in holding area 6:25 AM to 6:50 AM
- OR finishes at 3:35 PM, instead of 4:00 PM
- Increased efficiency of use of OR time?



 OR nurses, nurse anesthetists, and anesthesiologists are full-time employees
 On the day of surgery, the cost of an hour of under-utilized OR time is negligible relative to the cost of an hour of over-utilized OR time



- Inefficiency of use of OR time (\$) \cong
- (Cost per hour of under utilized OR time) × (hours of under-utilized OR time)
- + (Cost per hour of over-utilized OR time) × (hours of over-utilized OR time)

Dexter F, Traub RD. Anesth Analg 2002 Dexter F et al. Anesthesiology 2004



Inefficiency of use of OR time (\$) ≅
(Cost per hour of over-utilized OR time)
 × (hours of over-utilized OR time)



Inefficiency of use of OR time (\$) ≅ (Cost per hour of over utilized OR time) × (hours of over-utilized OR time)

Constant



Inefficiency of use of OR time (\$) ≅ (Cost per hour of over utilized OR time) × (hours of over-utilized OR time)

Constant

Implication

 Maximize OR efficiency on the day of surgery by minimizing hours of over-utilized OR time



Inefficiency of use of OR time (\$) ≅ (Cost per hour of over utilized OR time) × (hours of over-utilized OR time)

Constant

Implication

Maximize OR efficiency on the day of surgery
 by minimizing hours of over-utilized OR time



Scenario

- Allocated time is from 7 AM to 3:00 PM
- Having the existing personnel target the OR with the largest hours of cases resulted in the cases finishing in 8:35 hours instead of in the expected 9:00 hours
 - Sustained 0.58 hours of over-utilized time instead of 1.00 hour of over-utilized time



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- Increased efficiency of use of OR time by reducing the hours of over-utilized OR time



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- No increase in efficiency of use of OR time



 Good OR management operational decisionmaking the working day before the day of surgery and on the day of surgery is highly sensitive to the OR allocations, which is why need to calculate those values appropriately

Dexter F et al. Anesth Analg 2016



- Good OR management operational decisionmaking the working day before the day of surgery and on the day of surgery is highly sensitive to the OR allocations, which is why need to calculate those values appropriately
 - Over-utilized time is not that based on an arbitrary (desired) end of the workday, but rather as compared with the allocated time that minimizes inefficiency of use of OR time

Shi P et al. Anesth Analg 2016




- For ORs with ≤ 8 hours of cases, no savings from reducing tardiness of first case starts
- For ORs with > 8 hours of cases, each 1.0 min reduction in tardiness results in savings of > 1 min of regularly scheduled time:
 - One simulation method (study), 1.1 min
 - Another simulation method, 1.2 min

Dexter F, Epstein RH et al. Anesth Analg 2009 Dexter F et al. Anesth Analg 1999



- For ORs with ≤ 8 hours of cases, no savings from reducing tardiness of first case starts
- For ORs with > 8 hours of cases, each 1.0 min reduction in tardiness results in savings of > 1 min of regularly scheduled time:
 - One simulation method (study), 1.1 min
 - Another simulation method, 1.2 min
- Principally achieved by reducing allocated time



- If OR has 3 cases and the first case of the day enters the OR 8 min late, that is same as increasing mean turnover time by 4 min
- Consequently, can analyze effect of reducing tardiness of first case starts on productivity just like do for turnover times

McIntosh C et al. Anesth Analg 2006 Dexter F, Epstein RH. Anesth Analg 2009



- If OR has 3 cases and the first case of the day enters the OR 8 min late, that is same as increasing mean turnover time by 4 min
- Consequently, can analyze effect of reducing tardiness of first case starts on productivity just like do for turnover times
 - Analysis performed for each combination of service and day of the week





% First Cases With OR Entrance > 15 Min Late

McIntosh C et al. Anesth Analg 2006

 Using "8 hours" as shortest period expensive personnel regularly are scheduled to work



- Using "8 hours" as shortest period expensive personnel regularly are scheduled to work
- ➢ By <u>un</u>adjusted analyses, decreases in number of cases starting ≥ 5 minutes late associated with significantly less over-utilized OR time

Dexter F et al. J Clin Anesth 2020





- Using "8 hours" as shortest period expensive personnel regularly are scheduled to work
- By unadjusted analyses, decreases in number of cases starting ≥ 5 minutes late associated with significantly less over-utilized OR time
- No relationship when control for workload





Independent variable	Linear regression coefficient (SE) for influence on log ₁₀ of minutes after 4:00 PM	P-value
Count of the 7 rooms starting ≥ 8:05 AM	-0.0142 (0.0129)	0.27
Count of the 7 rooms starting \geq 8:15 AM	-0.0124 (0.0138)	0.37
Mean among the 7 rooms of minutes starting \geq 8:00 AM	-0.0015 (0.0021)	0.48

Independent variable	Linear regression coefficient (SE) for influence on log ₁₀ of minutes after 4:00 PM	P-value
Count of the 7 rooms starting ≥ 8:05 AM	+0.0017 (0.0161)	0.92
Count of the 7 rooms starting \geq 8:15 AM	-0.0005 (0.0145)	0.98
Mean among the 7 rooms of minutes starting \geq 8:00 AM	-0.0003 (0.0022)	0.88

Controlling for the daily caseload of elective cases

- Using "8 hours" as shortest period expensive personnel regularly are scheduled to work
- By unadjusted analyses, decreases in number of cases starting ≥ 5 minutes late associated with significantly less over-utilized OR time
- No relationship when control for workload
- Mechanism is that days with lesser workloads and caseloads have fewer first-case of the day starts to be handled near simultaneously (both P < 0.001)</p>



Topics of Talk on First Case Starts

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Behavioral Influence of Expected Over-Utilized Time

- Rational to target ORs with expected overutilized time for reduction in tardiness of the first case of the day starts
 - How about the other ORs?
- Behaviorally, do surgeons, anesthesiologists, and nurses in ORs with substantial underutilized OR time slow down?
 - For example, to prevent add-on case ...
 - For example, because of team culture ...



Behavioral Influence of Expected Over-Utilized Time

- No, behavior of slowing down not observed
 - Very slight but significant effect in the opposite direction (P = 0.008)
 - On days with substantially more underutilized time than typical, mean tardiness was slightly less because fewer ORs were medically directed 1:3 by anesthesiologists

Wang J et al. Anesth Analg 2013







- Only 1% of the variance in tardiness among first cases attributable to anesthesiologists
 Only 3% among specialties
- No significant differences in tardiness among the 85 anesthesiologists or 14 specialties

Dexter F, Epstein RH. Anesth Analg 2009



- Only 1% of the variance in tardiness among first cases attributable to anesthesiologists
 Only 3% among specialties
- No significant differences in tardiness among the 85 anesthesiologists or 14 specialties
- Observation matches what ought to observe for a rational organization, since targeting ORs based on their expected over-utilized time



 Most common cause of late first case of the day starts is tardiness of the surgeon

Truong A et al. Can J Anesth 1996 Lapierre SD et al. Health Care Manag Sci 1999 Shelver SR, Winston L. AORN J 2001 Panni MK et al. Acta Anaesthesiol Scand 2013 Mathews L et al. J Neurosurg Anesthesiol 2015

- Time series models of progressive changes over months in tardiness of first case starts
- Anesthesiologists responded to improved on time readiness of nurses and equipment with a lag of 1 month (P=0.005)
- Surgeons responded to improved on time readiness of anesthesiologists, nurses, and equipment with a lag of 2 months (P<0.0001)

Lapierre SD et al. Health Care Manag Sci 1999

"These results contradict the Pareto principle: surgeons are the main cause of delay for first surgeries but one should not focus on them. It is the first source of the chain that needs to be closely controlled rather than the one which appears to cause the most delays."

Lapierre SD et al. Health Care Manag Sci 1999

Important lesson for handling first case starts

Lapierre SD et al. Health Care Manag Sci 1999

Important lesson for handling first case starts
Important example of what to do when have operational type problem in OR management



- Important lesson for handling first case starts
- Important example of what to do when have operational type problem in OR management
 - Unless facility has accurate internal data and analyses will be performed as in the relevant scientific papers, rely not on poor quality data and analysis, but results of those papers

Wachtel RE, Dexter F. Anesth Analg 2013



- Important lesson for handling first case starts
- Important example of what to do when have operational type problem in OR management
 - Unless facility has accurate internal data and analyses will be performed as in the relevant scientific papers, rely not on poor quality data and analysis, but results of those papers
 - No additional effort to do the literature search because cannot know if facility has accurate data or performed appropriate analyses without having read the papers



 Surveyed surgeons, anesthesiologists, and OR nurses about preference cards, but included a few (i.e., the real) scientific questions

Dexter EU et al. Anesth Analg 2009



- Most survey respondents lacked scientific knowledge of over-utilized OR time (P< 0.0001)
- Most respondents did not know that most cases took less time than estimated (P=0.008)
- Most respondents falsely believed that 10 min tardiness of first case caused subsequent cases in the OR to start ≥ 10 min late (P < 0.0001)



- Not a single respondent (P = 0.0002) who:
 - Knew that most cases take less time than estimated {based on maximizing OR efficiency}
- Applied that knowledge to infer that:
 - 10 min tardiness of first case does not cause subsequent cases to start \geq 10 min late



- Individuals' focus (fixation) on first case of the day starts is immutable to education
- Cognitive bias is amplified by small groups
 - Surgical committee even less likely to make evidence-based decisions

Dexter F et al. Anesth Analg 2007 Prahl A et al. Anesth Analg 2013



What is the Role of Managers?


What is the Role of Managers?

- Provide electronic displays with evidencebased recommendations for use the working day before surgery and the day of surgery
 - Include OR allocations calculated based on maximizing efficiency of use of OR time
- Provide education, the value of which is increased trust in the recommendations

Dexter F et al. Anesth Analg 2007 Wachtel RE, Dexter F. J Grad Med Educ 2010

What is the Role of Managers?

- When monitoring managers' performance, good criterion is use by their facility of either:
 - Displays providing recommendations
 - Displays providing information and checklists for how to use the information

Stepaniak PS, Dexter F. Anesth Analg 2013



What is the Role of Managers?

- When monitoring managers' performance, good criterion is use by their facility of either:
 - Displays providing recommendations
 - Displays providing information and checklists for how to use the information
- Use anesthesia group facility agreement to codify the performance criteria

Dexter F, Epstein RH. Anesth Analg 2008 Dexter F, Epstein RH. Anesth Analg 2015



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Notification (Recommendation) Systems on Day of Surgery

- Each patient's information was reviewed repeatedly and an escalating notification system was used to contact each team member to attend to pending tasks
- Significantly reduced delayed first case starts (P < 0.001)

Panni MK et al. Acta Anaesthesiol Scand 2013

Notification (Recommendation) Systems on Day of Surgery

- Notified patient care assistants 45 min before OR start time to go to selected intensive care unit (ICU) bed for preparation for transport
- Notified anesthesia provider to be at the bedside 15 to 20 min ahead for patient communication handoff with the ICU RN
- Significantly reduced mean tardiness (P < 0.0001)

Brown MJ et al. J Healthc Qual 2015



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 At facilities where anesthesiologists supervise multiple ORs, they must effectively use staggered starts (≅ 20 min) of first cases of the day, since otherwise they cannot be present at all critical portions of cases

– Otherwise 1:2 MD:CRNA, lapses > 30% of days

Otherwise 1:3 MD:CRNA, lapses > 96% of days

Epstein RH, Dexter F. Anesth Analg 2012



 Let the surgeons know so that those with the later starts are not waiting in the ORs

Koenig T et al. Anaesthesia 2011



- Let the surgeons know so that those with the later starts are not waiting in the ORs
- Yes, preferentially focusing on ORs with overutilized time, since ordered priorities are first performing all the cases safely and second reducing expected over-utilized time

Dexter F et al. Anesthesiology 2004 Dexter F et al. Anesth Analg 2007



- Anesthesiologists are good at forecasting time from OR entrance until start of positioning
- Times differ depending principally on:
 - Anesthetic technique (e.g., general)
 - American Society of Anesthesiologists' Physical Status of patient
 - Anesthetic procedures to be performed (e.g., arterial line placement)

Ehrenwerth J et al. Anesth Analg 2006 Escobar A et al. Anesth Analg 2006



 Teaching of anesthesiology residents increases OR time before the start of surgery by mean of 4 min

Eappen S et al. Anesthesiology 2004 Davis EA et al. Anesth Analg 2006



- Make decisions based on expected teaching and communicate this to the anesthesiologists
 - Assign experienced CRNAs to the 1/3rd of ORs with over-utilized time when little or no difference in educational value of cases
 - Assign trainee OR nurses and 1st and 2nd year anesthesiology residents to ORs with substantial under-utilized OR time

Dexter F, Wachtel RE. Anesth Analg 2006



- Anesthesiologists faster when not teaching
- Observational study of anesthesiologists solo, 1:1 with resident or CRNA, or 1:2 supervision
 - Controlling for patient age, ASA physical status, and ASA base units
- Patient into OR by scheduled start time
 - Solo 86%, 1:1 84%, 1:2 85%
- Time from into OR to induction < 20 minutes
 Solo 67%, 1:1 56%, 1:2 57% (both P < 0.0001)

Chen Y et al. J Med Syst 2016



 End surgery to tracheal extubation (≥ 15 min) delays start next case, rated poorly by anesthesiologists, and important to surgeons

Apfelbaum JL et al. Anesth Analg 1993 Vitez TS, Macario A. J Clin Anesth 1998 Masursky D et al. Anesth Analg 2012 Dexter F, Epstein RH. Anesth Analg 2013



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- End surgery to tracheal extubation (≥ 15 min) delays start next case, rated poorly by anesthesiologists, and important to surgeons
- Odds ratio 2.10 (P = 0.025) for the 57% of cases when nurse anesthetist or resident physician worked with neurosurgeon < 5 previous cases</p>

Apfelbaum JL et al. Anesth Analg 1993 Vitez TS, Macario A. J Clin Anesth 1998 Masursky D et al. Anesth Analg 2012 Dexter F, Epstein RH. Anesth Analg 2013 Epstein RH et al. J Clin Anesth 2020



- Odds ratio 4.4 (P = 0.005) for the cases when the anesthesiologist worked with neurotologist < 5 previous cases</p>
- Odds ratio 2.10 (P = 0.025) for the 57% of cases when nurse anesthetist or resident physician worked with neurosurgeon
 < 5 previous cases

Xia J et al. Otol Neurotol 2022 Epstein RH et al. J Clin Anesth 2020



- Odds ratio 4.4 (P = 0.005) for the cases when the anesthesiologist worked with neurotologist
 < 5 previous cases
- Odds ratio 2.10 (P = 0.025) for the 57% of cases when nurse anesthetist or resident physician worked with neurosurgeon
 < 5 previous cases

Threshold is <5 previous cases over 3 years, which at hospital was for 74% of cases, causing 23% prolonged extubations

Dexter F et al. Periop Care Oper Room Manag 2023

 Assign sufficient numbers of anesthesiologists and support personnel to perform peripheral nerve blocks before OR entrance

Chelly JE et al. J Clin Anesth 2010 Brown MJ et al. Int J Health Care Qual Assur 2014 Gleicher Y et al. Reg Anesth Pain Med 2017



- Assign sufficient numbers of anesthesiologists and support personnel to perform peripheral nerve blocks before OR entrance
- As feasible, sequence cases within surgeons' lists so that more of the cases with peripheral nerve blocks are performed later in workday



- Assign sufficient numbers of anesthesiologists and support personnel to perform peripheral nerve blocks before OR entrance
- As feasible, sequence cases within surgeons' lists so that more of the cases with peripheral nerve blocks are performed later in workday
 - Such sequencing does not increase the incidence of days with delayed PACU entrance

Marcon E, Dexter F. Anesth Analg 2007



- Work with surgical residents of specific specialties to have systems in place to assure no or small lateness of starts, when relevant
 - Example is having a mid-level resident leave team rounds early when rounds are taking sufficiently long as to influence first case start

Warner CJ et al. J Vasc Surg 2013



- Work with surgical residents of specific specialties to have systems in place to assure no or small lateness of starts, when relevant
 - Example is having a mid-level resident leave team rounds early when rounds are taking sufficiently long as to influence first case start

Example is to start rounds earlier if needed for completion of site marking and surgical consent 30 min before scheduled start time of first case

Han SJ et al. J Surg Educ 2016



- For an OR to be used for patients who are inpatient preoperatively, identify the case most likely to start on time
- Schedule that case to be the first case start
 Change only if (new) emergency case
- Reduced mean tardiness of first case starts of trauma list by 26 minutes (P < 0.001)



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- OR time is allocated at a surgical suite either for 8 hours or 10 hours
- A service on Tuesdays has a mean of 8 hr 40 min with a standard deviation of 50 min
- Allocate 8 hr or 10 hr and why?



- OR time is allocated at a surgical suite either for 8 hours or 10 hours
- A service on Tuesdays has a mean of 8 hr 40 min with a standard deviation of 50 min
- Allocate 8 hr or 10 hr and why?
- > 10 hr maximizes efficiency of use of OR time



 Since the most common cause of late first case starts is tardiness of surgeons, a rational focus of efforts to improve on-time starts is monitoring and feedback to surgeons?



- Since the most common cause of late first case starts is tardiness of surgeons, a rational focus of efforts to improve on-time starts is monitoring and feedback to surgeons?
- No, because surgeon response is to timeliness of other staff in a temporal chain



- What percentage of the variance in the tardiness of first case starts among cases is attributable to the anesthesiologist (i.e., some are significantly more tardy than others)?
 - -1%?
 - 5%?
 - 20%?
 - 50%?



- What percentage of the variance in the tardiness of first case starts among cases is attributable to the anesthesiologist (i.e., some are significantly more tardy than others)?
 - ≻1%
 - 5%
 - 20%
 - 50%

Just 1%; there are negligible differences among anesthesiologists, as appropriate for a rational organization



- For OR with > 8 hours of cases, each 10 min reduction in tardiness of first case starts results in savings of how many minutes of regularly scheduled OR time?
 - 10 minutes?
 - 12 minutes?
 - 20 minutes?
 - 40 minutes?



- For OR with > 8 hours of cases, each 10 min reduction in tardiness of first case starts results in savings of how many minutes of regularly scheduled OR time?
 - 10 minutes
 - ≻12 minutes
 - 20 minutes
 - 40 minutes



- Teaching of anesthesiology residents increases
 OR time before the start of surgery
 by mean of how many minutes?
 - 1 minute?
 - -4 minutes?
 - 10 minutes?
 - 15 minutes?


Question and Answer #5

Teaching of anesthesiology residents increases
OR time before the start of surgery
by mean of how many minutes?

- 1 minute
- ≻4 minutes
- 10 minutes
- 15 minutes



Additional Information on Operating Room Management

www.FranklinDexter.net/education.htm

- Full course (e.g., medical directors and analysts)
- Lectures on day of surgery decision making, case duration prediction, allocating OR time, increasing anesthesia productivity, financial analysis, and strategic decision-making

www.FranklinDexter.net

- Comprehensive bibliography of peer reviewed articles in operating room and anesthesia group management
 - Sign-up for notifications of new articles