

# 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



# 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



# Calculating Allocated OR Time

- On Mondays, hospital currently plans 3 ORs for orthopedics, each OR for 10 hr
  - $3 \text{ ORs} \times 10 \text{ hr} = 30 \text{ hr}$
- 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 =  $2.0 \times$  that of 1 hr under-utilized OR time

McIntosh C et al. Anesth Analg 2006

Pandit JJ, Dexter F. Anesth Analg 2009



# Calculating Allocated OR Time

- 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 66<sup>th</sup> percentile of the normal distribution function with mean 30 hr and standard deviation 5 hr equals **32 hr**



# Calculating Allocated OR Time

- 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 × 8 hr, 0 × 10 hr
  - 5) 4 ORs : 3 × 8 hr, 1 × 10 hr
  - 6) 4 ORs : 2 × 8 hr, 2 × 10 hr

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# Calculating Allocated OR Time

- 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 66<sup>th</sup> percentile of the normal distribution function with mean 30 hr and standard deviation **10** hr equals **34 hr**



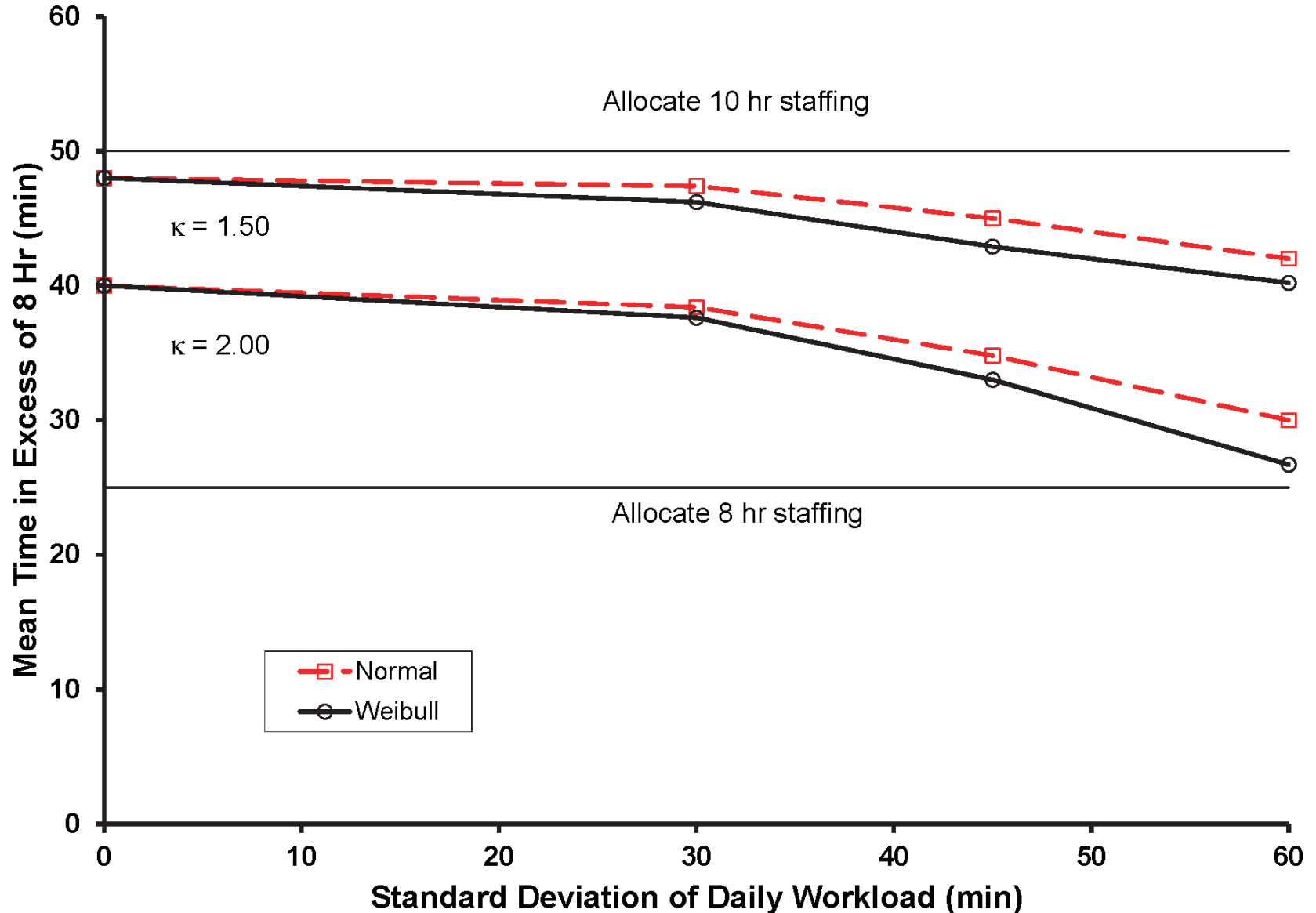
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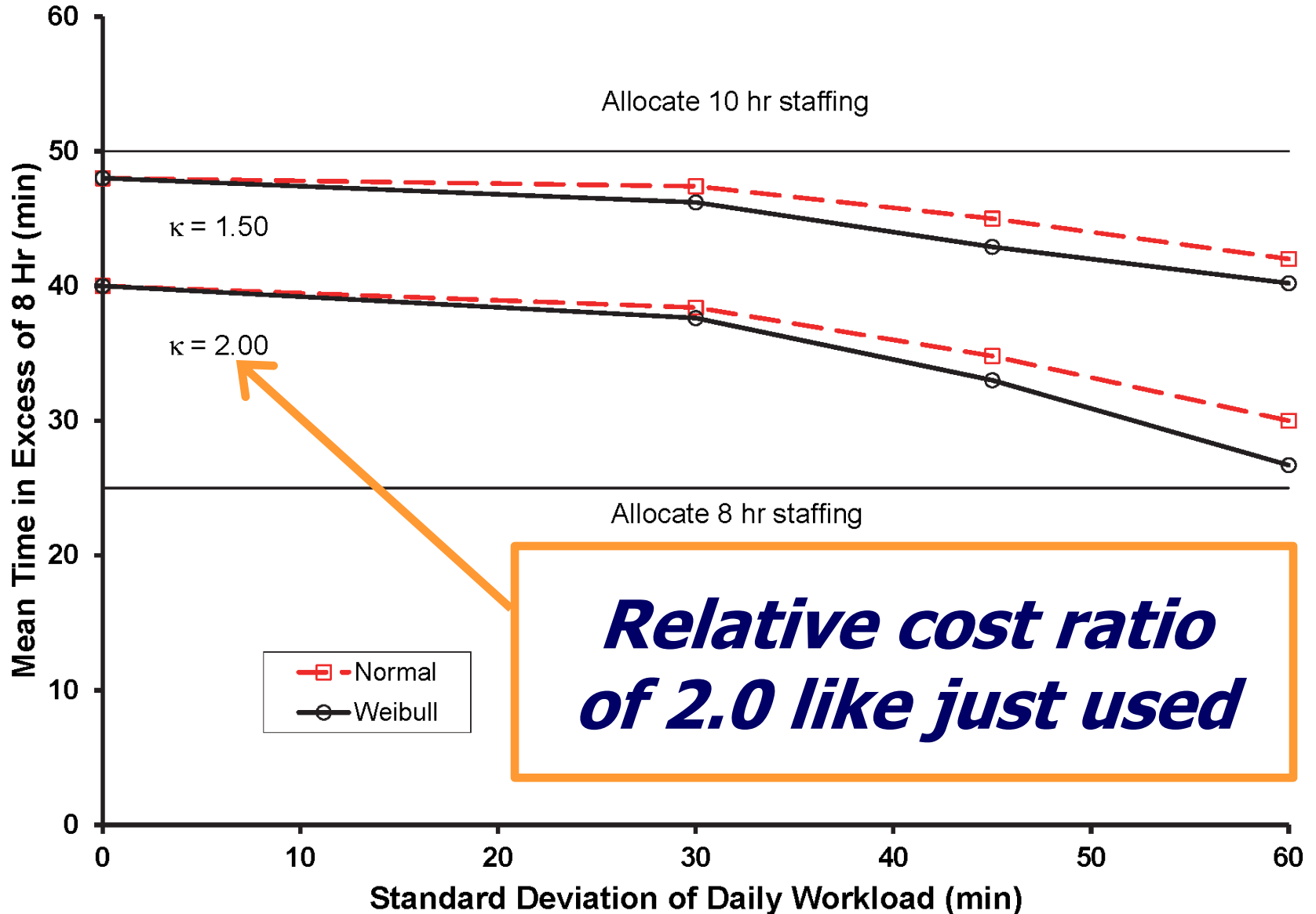
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# Allocated Times for Single ORs From Pandit & Dexter 2009

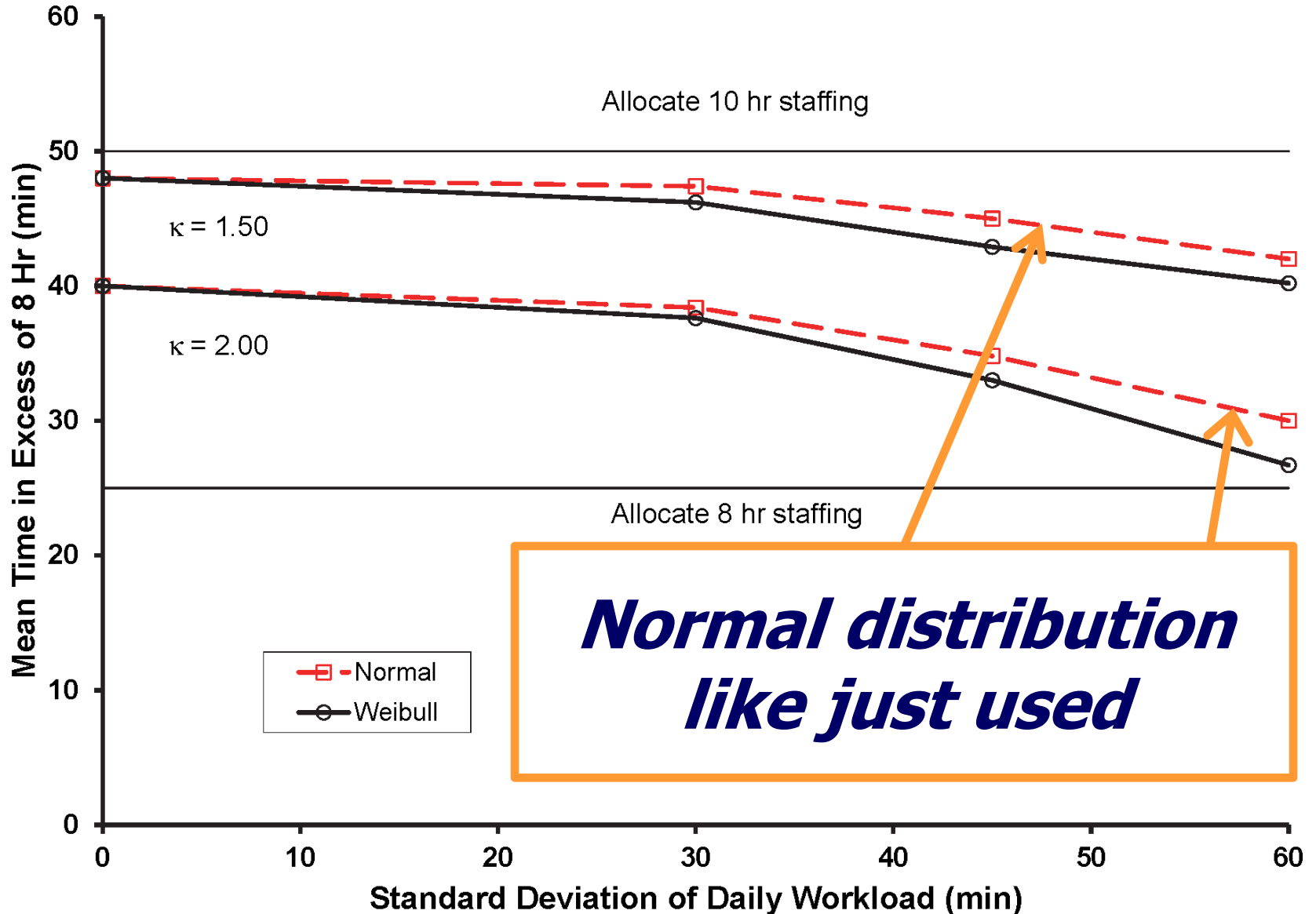


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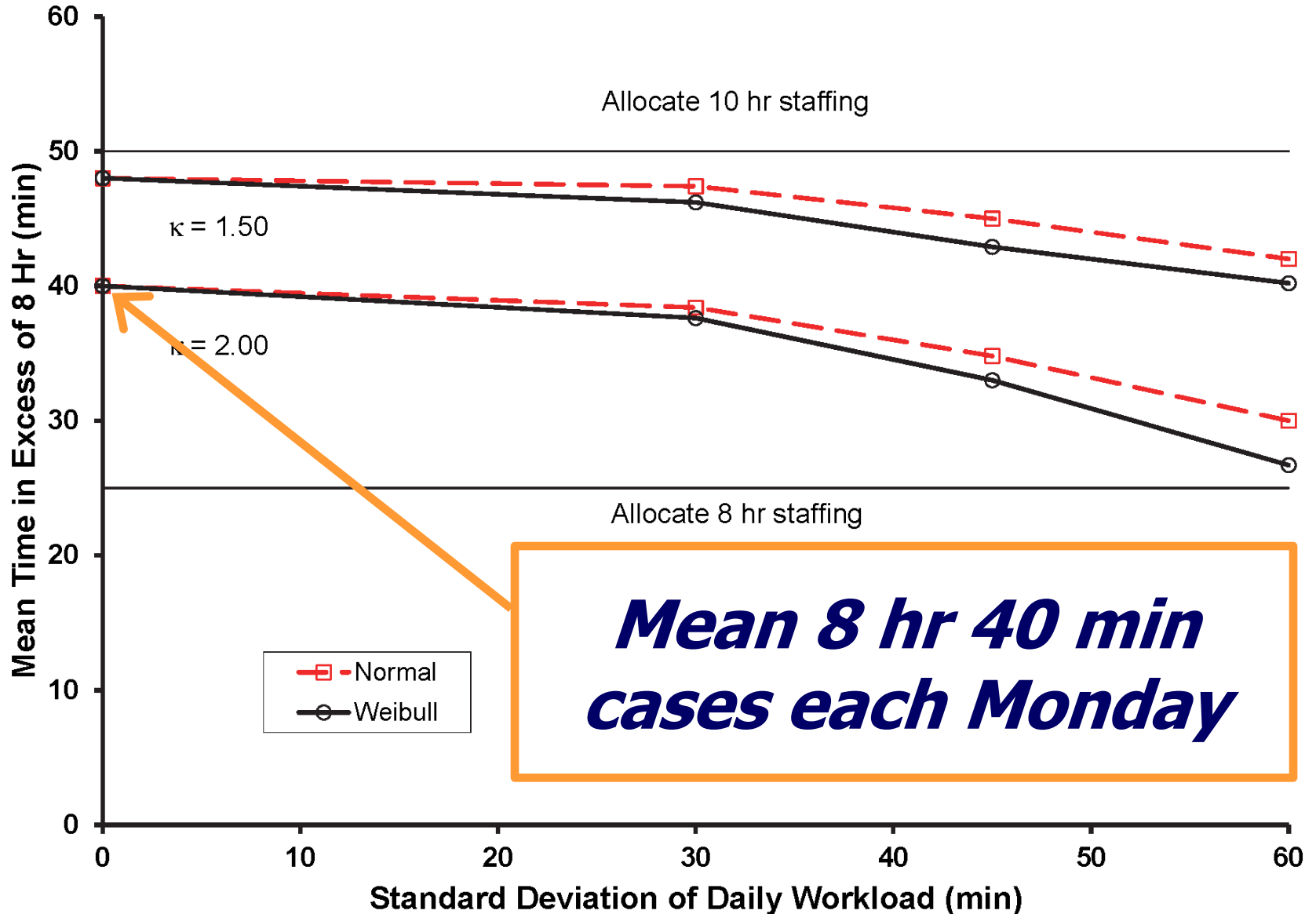




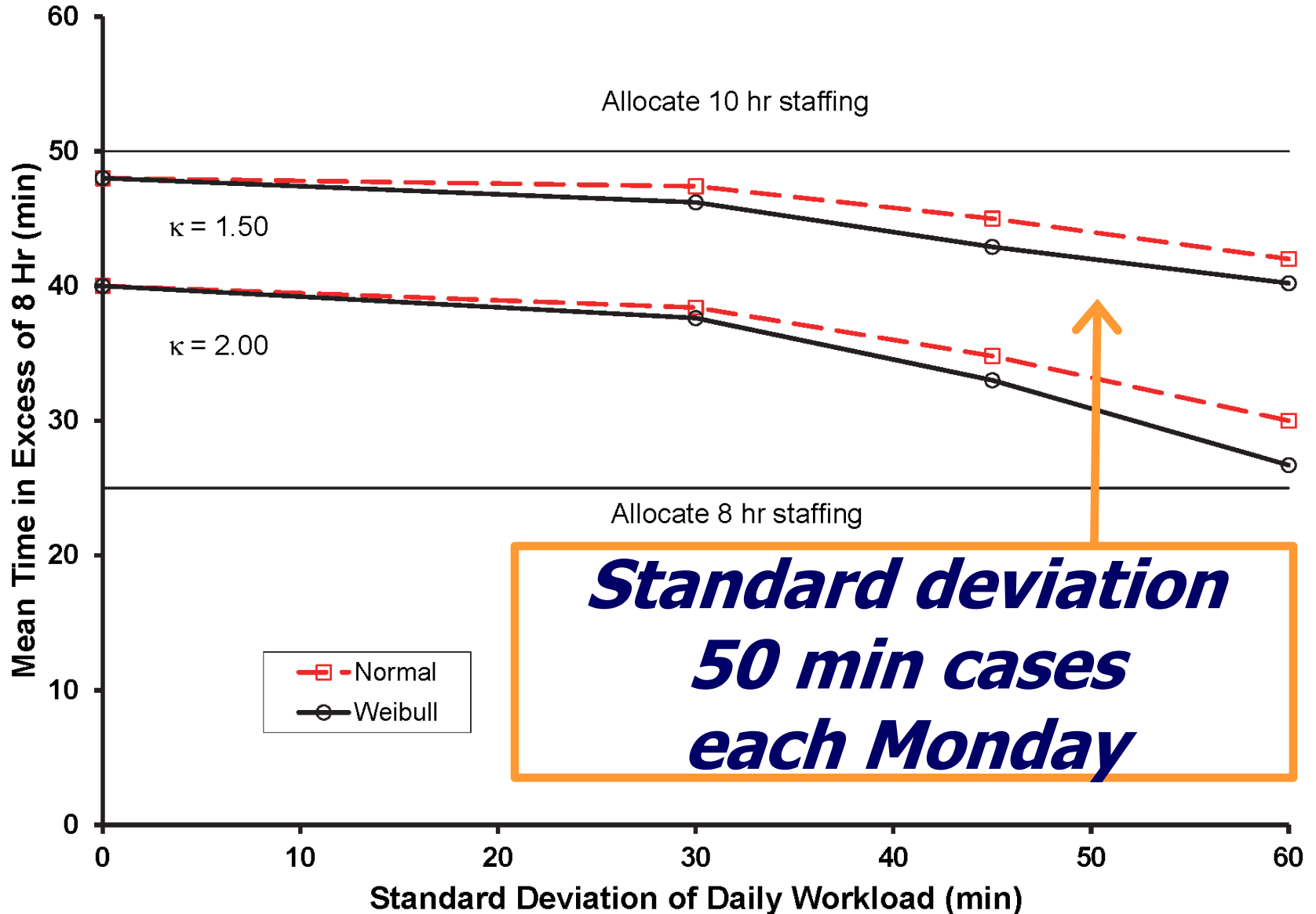
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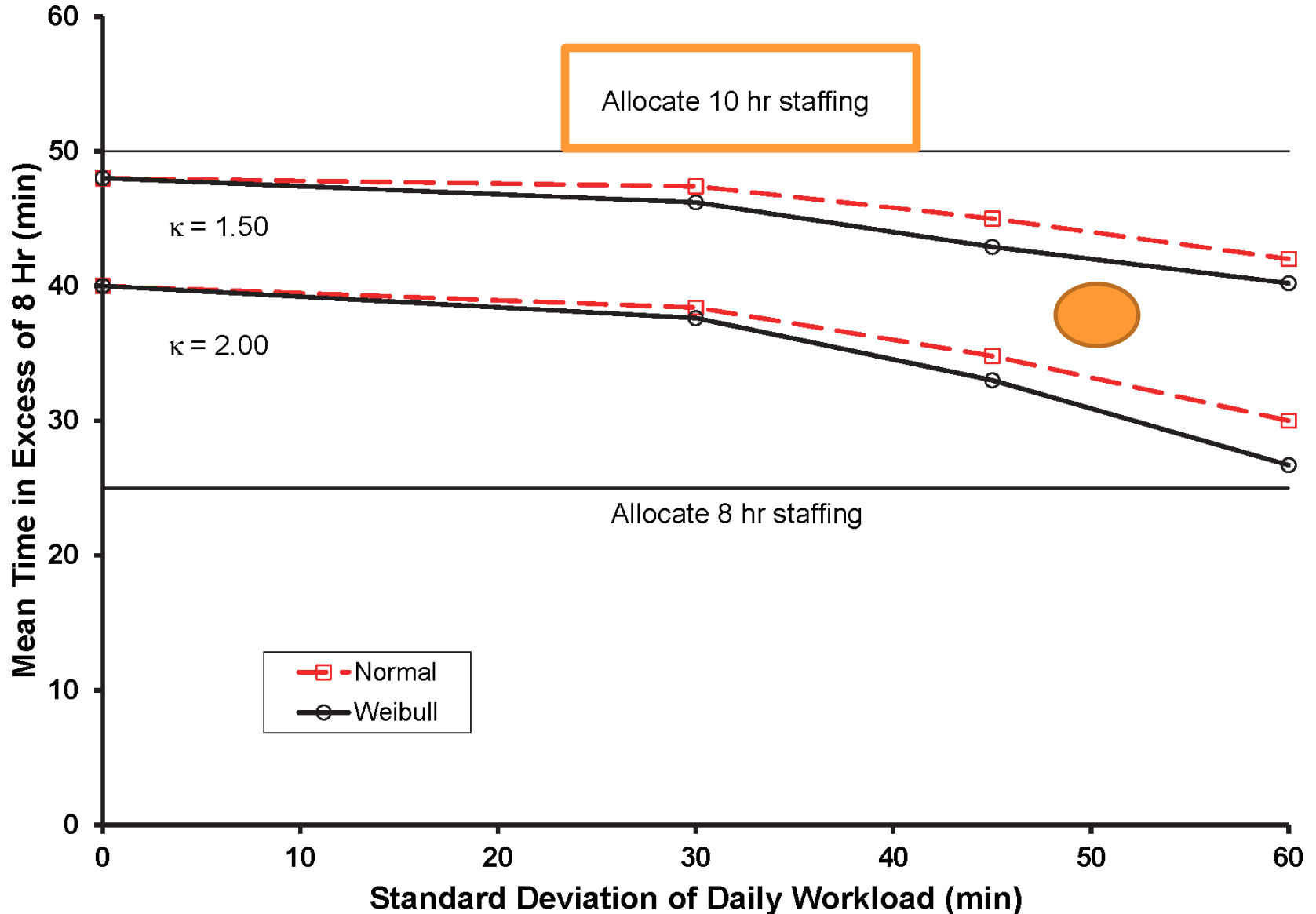
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# Topics of Talk on First Case Starts

- 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



# Reducing Tardiness of First Case Starts Can Increase Efficiency

- 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?



# Reducing Tardiness of First Case Starts Can Increase Efficiency

- 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



# Reducing Tardiness of First Case Starts Can Increase Efficiency

Inefficiency of use of OR time (\$)  $\cong$   
~~(Cost per hour of under-utilized OR time)~~  
× (hours of under-utilized OR time)  
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Dexter F, Traub RD. Anesth Analg 2002

Dexter F et al. Anesthesiology 2004





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



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# Reducing Tardiness of First Case Starts Can Increase Efficiency

- 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



# Reducing Tardiness of First Case Starts Can Increase Efficiency

- Good OR management operational decision-making 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



# Reducing Tardiness of First Case Starts Can Increase Efficiency

- Good OR management operational decision-making 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



# Tardy First Case Starts Have Small but Significant Effect



# Tardy First Case Starts Have Small but Significant Effect

- For ORs with  $\leq 8$  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



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  - One simulation method (study), 1.1 min
  - Another simulation method, 1.2 min
- Principally achieved by reducing allocated time



# Tardy First Case Starts Have Small but Significant Effect

- 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



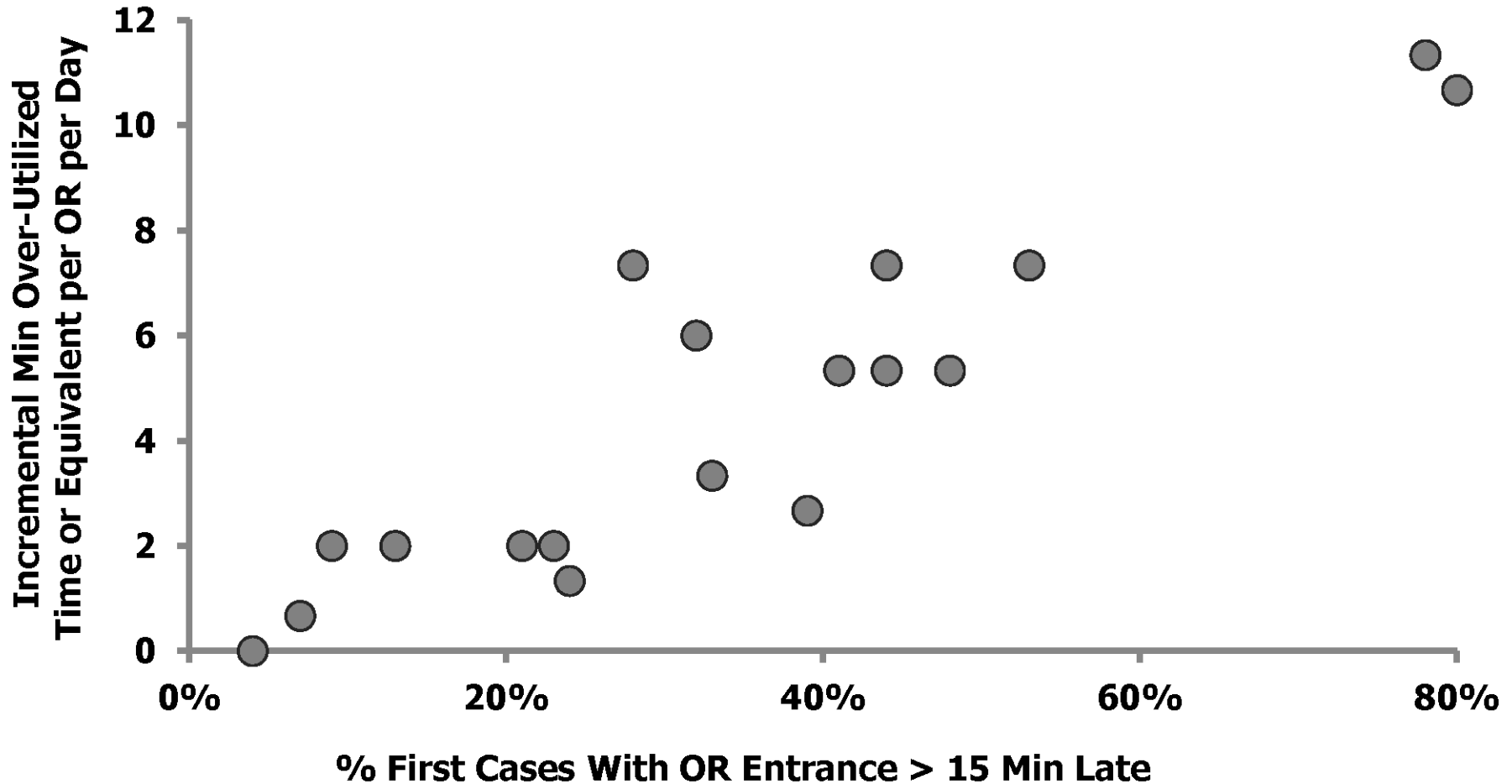
# Tardy First Case Starts Have Small but Significant Effect

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- 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





# Tardy First Case Starts Have Small but Significant Effect



# Topics of Talk on First Case Starts

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# Behavioral Influence of Expected Over-Utilized Time

- Rational to target ORs with expected over-utilized 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 under-utilized 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 under-utilized 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



# Effect of Surgeons and Anesthesiologists



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# Effect of Surgeons and Anesthesiologists

- 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



# Effect of Surgeons and Anesthesiologists

- 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



# Effect of Surgeons and Anesthesiologists



# Effect of Surgeons and Anesthesiologists

- 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

# Effect of Surgeons and Anesthesiologists

- 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 ( $P < 0.0001$ )

# Effect of Surgeons and Anesthesiologists

“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.”

# Effect of Surgeons and Anesthesiologists

- Important lesson for handling first case starts

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- Important example of what to do when have operational type problem in OR management



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  - 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



# Effect of Surgeons and Anesthesiologists

- 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



# Why Perception that Important to Have No Tardiness in All ORs?



# Why Perception that Important to Have No Tardiness in All ORs?

- 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



# Why Perception that Important to Have No Tardiness in All ORs?

- 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 scheduled ( $P = 0.008$ )
- Most respondents falsely believed that 10 min tardiness of first case caused subsequent cases in the OR to start  $\geq 10$  min late ( $P < 0.0001$ )



# Why Perception that Important to Have No Tardiness in All ORs?

- Not a single respondent ( $P = 0.0002$ ) who:
  - Knew that most cases take less time than scheduled {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



# Why Perception that Important to Have No Tardiness in All ORs?

- 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?

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# What is the Role of Managers?

- Provide electronic displays with evidence-based 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 ( $P < 0.001$ )

# 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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# Target ORs Starting Afternoon Working Day Before Surgery



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- At facilities where anesthesiologists supervise multiple ORs, they must effectively use staggered starts ( $\cong 20$  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



# Target ORs Starting Afternoon Working Day Before Surgery

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

Koenig T et al. Anaesthesia 2011





# Target ORs Starting Afternoon Working Day Before Surgery

- Let the surgeons know so that those with the later starts are not waiting in the ORs
- Yes, preferentially focusing on ORs with over-utilized 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



# Target ORs Starting Afternoon Working Day Before Surgery

- 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



# Target ORs Starting Afternoon Working Day Before Surgery

- 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



# Target ORs Starting Afternoon Working Day Before Surgery

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

Dexter F, Wachtel RE. Anesth Analg 2006



# Target ORs Starting Afternoon Working Day Before Surgery

- 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  $P < 0.0001$ )



# Target ORs Starting Afternoon Working Day Before Surgery

- 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

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- As feasible, sequence cases within surgeons' lists so that more of the cases with peripheral nerve blocks are performed later in workday



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- 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





# Target ORs Starting Afternoon Working Day Before Surgery

- 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



# Target ORs Starting Afternoon Working Day Before Surgery

- 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



# Target ORs Starting Afternoon Working Day Before Surgery

- 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 ( $P < 0.001$ )

Javed S et al. Injury 2013



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# Question and Answer #1

- 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?



# Question and Answer #1

- 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



# Question and Answer #2

- 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?



# Question and Answer #2

- 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





# Question and Answer #3

- 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%?



# Question and Answer #3

- 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



# Question and Answer #4

- 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?



# Question and Answer #4

- 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



# 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?



# 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](http://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](http://www.FranklinDexter.net)
  - Comprehensive bibliography of peer reviewed articles in operating room and anesthesia group management
    - Sign-up for notifications of new articles