Reducing Tardiness from Scheduled Start Times

- This talk includes many similar slides
  - Paging through produces animation
  - Use right/ left arrow keys, → and ←
- PDF viewers
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Reducing Tardiness from Scheduled Start Times

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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)

Reducing Tardiness from Scheduled Start Times

- Not for the cases scheduled within 1 workday
- Definitions, examples, and methodology
- First case starts are most effective approach from perspective of start time of surgeons
- Moving cases
- Correcting for lateness of first cases of day
- Correcting for case duration bias
- Scheduling time gaps between surgeons

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Reducing Tardiness from Scheduled Start Times

- Not for the cases scheduled within 1 workday, since that topic is a separate lecture
  - Calculation of the time remaining in cases

Dexter F et al. Anesth Analg 2009

Tiwari V et al. Anesth Analg 2013

Reducing Tardiness from Scheduled Start Times

- Not for the cases scheduled within 1 workday, since that topic is a separate lecture
  - Calculation of the time remaining in cases
  - ➢ Calculation of appropriate allocated OR time and corresponding staff scheduling

Dexter F, Epstein RH. AORN J 2003

Dexter F, Epstein RH. Anesth Analg 2006

Van Oostrum JM et al. Anesth Analg 2008

Dexter F et al. Anesth Analg 2009

Masursky D et al. Anesth Analg 2009

Reducing Tardiness from Scheduled Start Times

- Not for the cases scheduled within 1 workday, since that topic is a separate lecture
  - Calculation of the time remaining in cases
  - Calculation of appropriate allocated OR time and corresponding staff scheduling
  - ➢ Agreements and monitoring of agreements to counteract cognitive biases

Dexter F et al. Anesth Analg 2007
Ledolter J et al. Anesth Analg 2010
Stepaniak PS, Dexter F. Anesth Analg 2013

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  - Calculation of the time remaining in cases
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  - Agreements and monitoring of agreements to counteract cognitive biases

➢ "Decision-making on the day of surgery"
www.FranklinDexter.net/education.htm

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Definition of Tardiness

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  Tardiness = lateness

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- If actual start time > scheduled start time

  Tardiness = lateness

➢ Otherwise

  Tardiness = 0

Example of Tardiness

- Scheduled start time 10:00 AM
  - Actual start time 10:15 AM
    - Lateness is 15 min
    - Tardiness is 15 min
  - Actual start time 9:45 AM
    - Lateness is -15 min
    - Tardiness is 0 min

Rationale for Relying on Mean Tardiness

- 3 cases performed in same OR on same day
- 2 cases start on time, and 3rd starts 3 hr late
  - Proportion tardy = 1/3
  - Mean tardiness = (1 × 3 hr)/ 3 = 1 hr
- 1 case on time, and 2 cases start 15 min late
  - Proportion tardy = 2/3
  - Mean tardiness = (2 × 15 min)/ 3 = 10 min

Wachtel RE, Dexter F. Anesth Analg 2009

Rationale for Relying on Mean Tardiness

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➢ Decisions based on mean tardiness do not ignore cases exceeding threshold

Methodology of Two Observational Studies

- Examples and quantitative results in this talk are from papers that used 2 years of data
  - MAIN 24 OR tertiary suite (26,003 cases)
  - ASC 6 OR outpatient suite (11,541 cases)
- Regularly scheduled workdays
  - No weekends or holidays
- Limited measurement of tardiness to elective cases scheduled ≥ 1 workday in advance

Wachtel RE, Dexter F. Anesth Analg 2009 (two companion papers)

Reducing Tardiness from Scheduled Start Times

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Surgeon Perspective

- Starting first results in ***much*** less tardiness

Tardiness sustained by surgeon (min)	First case of day start	***Not*** first case of day start
MAIN suite	8	40
ASC suite	4	30

SE < 1 min

Perspective of Patients Without First Case Starts

- If a case finishes early, and same surgeon performs next case, usually (≅ 95%) the next case can start right away
  - Accumulated earliness compensates for cases that take longer than scheduled

Tyler DC et al. Anesth Analg 2003

Wachtel RE, Dexter F. Anesth Analg 2007

Perspective of Patients Without First Case Starts

- If a case finishes early, and same surgeon performs next case, usually (≅ 95%) the next case can start right away
  - Accumulated earliness compensates for cases that take longer than scheduled
- ➢ If next case performed by a different surgeon, often the next case cannot start early

Perspective of Patients Without First Case Starts

- Substantive reduced tardiness through policies to encourage each OR to be scheduled each day with the cases of a single surgeon?

Perspective of Patients Without First Case Starts

- Substantive reduced tardiness through policies to encourage each OR to be scheduled each day with the cases of a single surgeon?
  - Only small increases in tardiness for cases with preceding case in the same OR having been performed by different surgeon
    - MAIN suite 0 ± 1 min
    - ASC suite 4 ± 1 min

Perspective of Patients Without First Case Starts

- Substantive reduced tardiness through policies to encourage each OR to be scheduled each day with the cases of a single surgeon?
- Only small increases in tardiness for cases with preceding case in the same OR having been performed by different surgeon
  - MAIN suite 0 ± 1 min
  - ASC suite 4 ± 1 min

Reminder: All slides unless listed otherwise

Wachtel RE, Dexter F. Anesth Analg 2009

Perspective of Patients Without First Case Starts

- Most cases take less time than estimated
- However:

  (Mean minutes that cases end early,
  among cases taking less time than estimated)
  < (Mean minutes that cases end late,
  among cases taking longer than estimated)

- There are too few cases per OR per day for cumulative earliness to be sufficient to compensate for the occasional case taking much longer than estimated

Perspective of Patients Without First Case Starts

- Substantive reduced tardiness through policies to encourage each OR to be scheduled each day with the cases of a single surgeon?

Surgeon Perspective

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Surgeon Perspective

- Substantive reduced tardiness through policies to encourage each OR to be scheduled each day with the cases of a single surgeon?
  - ➢ No, the benefit of having multiple extra ORs is increased productivity of the surgeons

Sulecki L et al. Anesth Analg 2012

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Influence of Time of Day

- Simulations of individual ORs
  - If case durations are estimated based on the mean of historical durations, slightly fewer than half of cases will take longer than estimated

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  - ➢ Each increase in total duration of preceding cases will increase the uncertainty in the time to complete that preceding list of cases

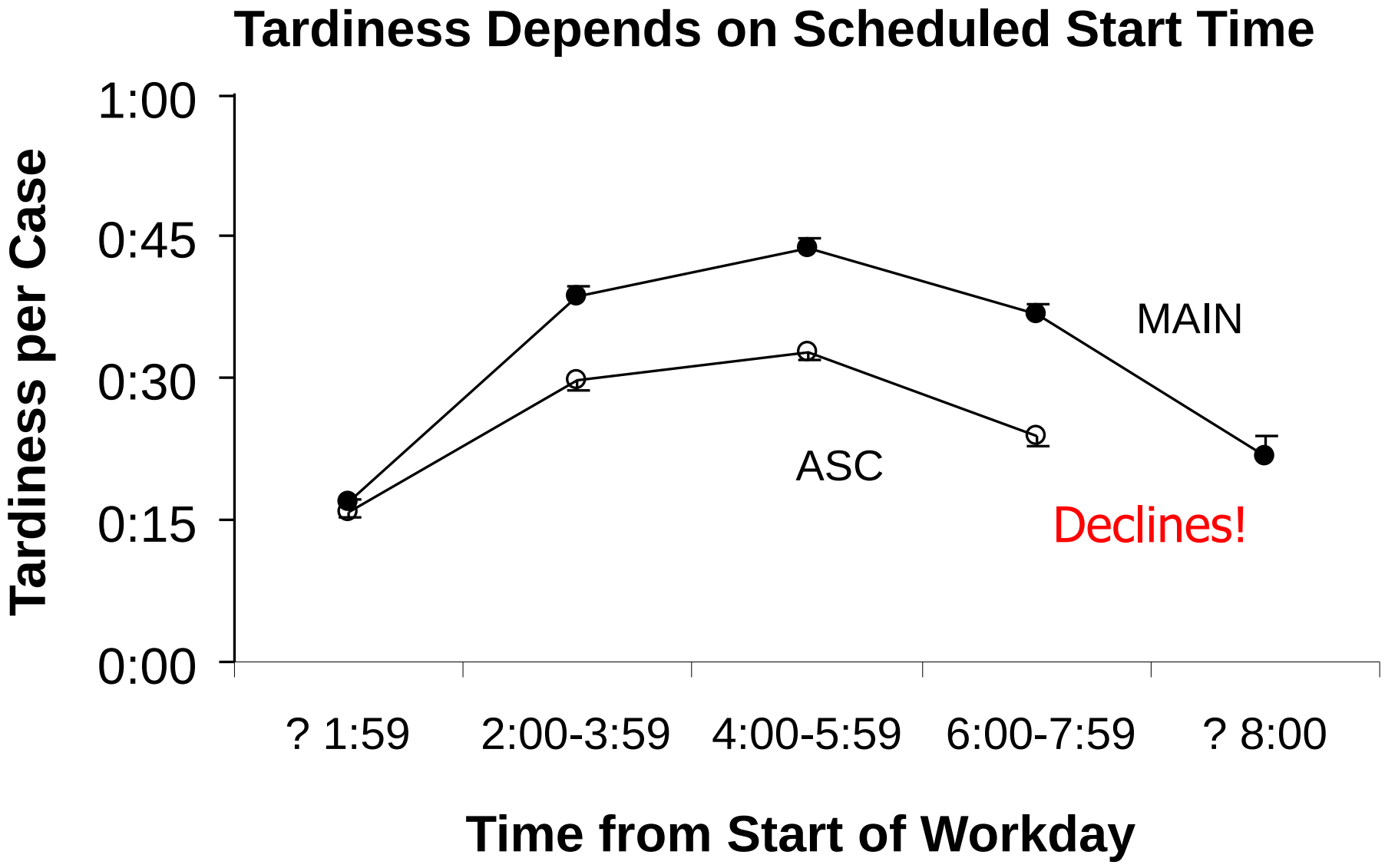
Wachtel RE, Dexter F. Anesth Analg 2007

Influence of Time of Day

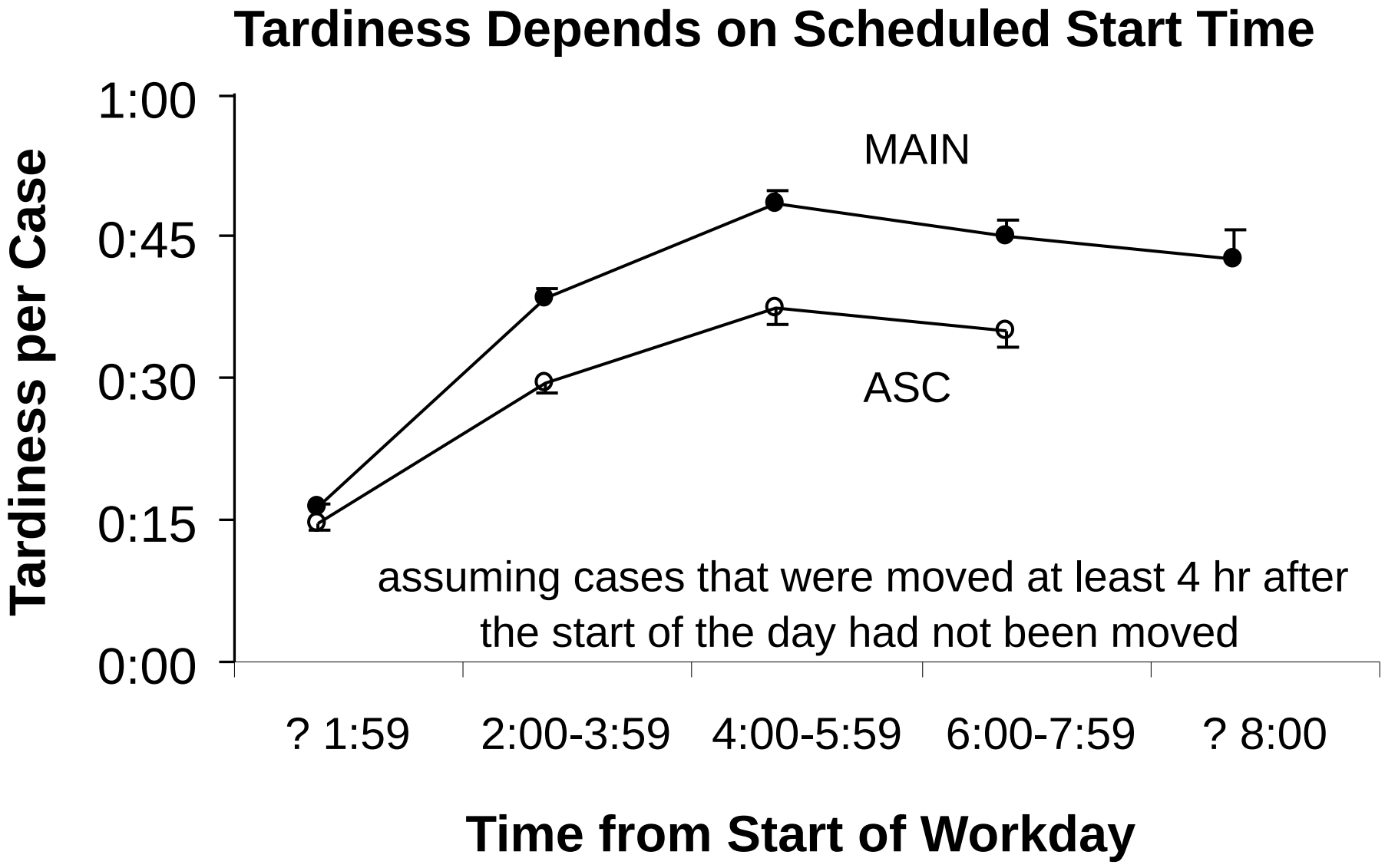
- Simulations of individual ORs
  - If case durations are estimated based on the mean of historical durations, slightly fewer than half of cases will take longer than estimated
  - Each increase in total duration of preceding cases will increase the uncertainty in the time to complete that preceding list of cases
  - ➢ Mean tardiness per case will increase progressively through the day

Dexter F et al. IFACS 2006

Influence of Time of Day



Influence of Time of Day



Moving Cases

- Moving cases greatly reduces the tardiness of those cases that get moved
  - MAIN suite 49% ± 2%
  - ASC suite 71% ± 2%
    - Different hospital, tardiness per case reduced by mean 29 ± 4 min

Wachtel RE, Dexter F. Anesth Analg 2009

Dexter F et al. J Clin Anesth 2019

Moving Cases

- However, few cases are moved
  - MAIN suite 3.3% ± 0.2% (1.6 cases per day)
  - ASC suite 4.4% ± 0.3% (1.0 cases per day)
    - Different hospital, 4.1% ± 1.4% of to-follow surgeons in the OR

Wachtel RE, Dexter F. Anesth Analg 2009

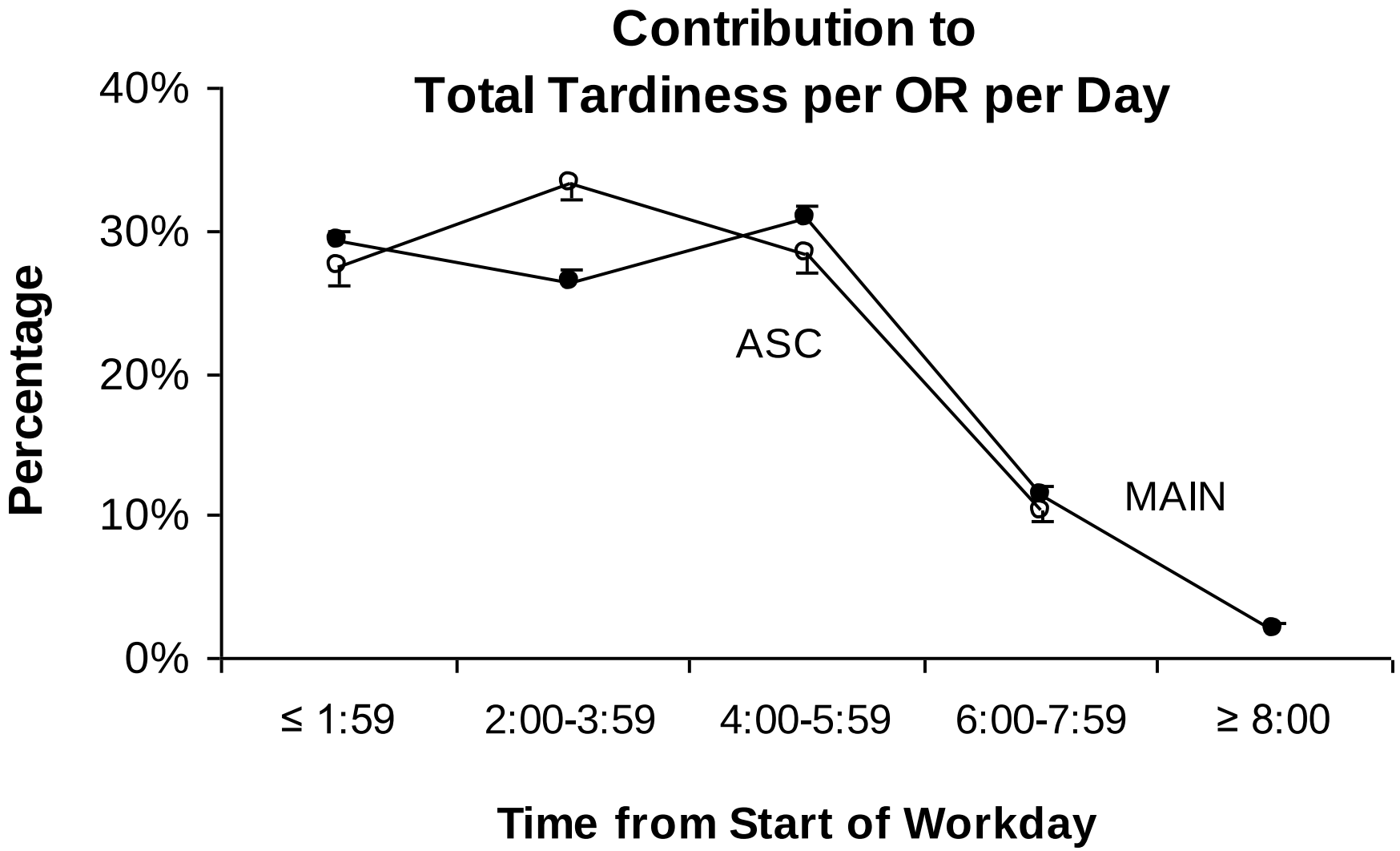
Dexter F et al. J Clin Anesth 2019

Moving Cases

- Moving cases greatly reduces the tardiness of those cases that get moved
  - MAIN suite 49% ± 2%
  - ASC suite 71% ± 2%
- However, few cases are moved
  - MAIN suite 3.3% ± 0.2% (1.6 cases per day)
  - ASC suite 4.4% ± 0.3% (1.0 cases per day)

➢ Overall reduction in mean tardiness only
  - MAIN suite 4 ± 1 min per OR per day
  - ASC suite 10 ± 1 min per OR per day

Benefit of Moving Cases Larger If Could be Done Earlier In Day



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Influence of Correcting for Lateness of First Cases of Day

- Mean lateness of starts of first cases of day
  - MAIN suite 8 ± 1 min
  - ASC suite 4 ± 1 min

Influence of Correcting for Lateness of First Cases of Day

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➢ Working day before surgery, for purposes of scheduling start times of subsequent cases, increase turnover time accordingly between first and second cases

Influence of Correcting for Lateness of First Cases of Day

- Mean lateness of starts of first cases of day
  - MAIN suite 8 ± 1 min
  - ASC suite 4 ± 1 min
- Working day before surgery, for purposes of scheduling start times of subsequent cases, increase turnover time accordingly between first and second cases
  - ➢ Result is that scheduled start times of to-follow cases are more accurate

Influence of Correcting for Lateness of First Cases of Day

- Changing start times should have *no effect whatsoever* on the choice of the date and OR into which each case is scheduled
  - Duration of workday (staffing) is unchanged, because allocated time should be calculated (based on minimizing efficiency of use of OR time) using observed ends of the workdays in each OR

McIntosh C et al. Anesth Analg 2006

Pandit JJ, Dexter F. Anesth Analg 2009

Influence of Correcting for Lateness of First Cases of Day

- Reduction in tardiness per OR per day
  - MAIN suite 9 ± 1 min (16 ± 1%)
  - ASC suite 8 ± 1 min (9 ± 1%)

Influence of Correcting for Lateness of First Cases of Day

- Reduction in tardiness per OR per day
  - MAIN suite 9 ± 1 min (16 ± 1%)
  - ASC suite 8 ± 1 min (9 ± 1%)
    - Modestly larger than the 6% (MOR) and the same as the 8% (ASC) reductions achieved by moving cases, since small benefit but realized by all cases

Usefulness of Correcting for Lateness of First Cases of Day

- Reduction in tardiness per OR per day
  - MAIN suite 9 ± 1 min (16 ± 1%)
  - ASC suite 8 ± 1 min (9 ± 1%)
    - Modestly larger than the 6% (MOR) and the same as the 8% (ASC) reductions achieved by moving cases, since small benefit but realized by all cases
      - ➢ Unlike moving cases, intervention can be done automatically

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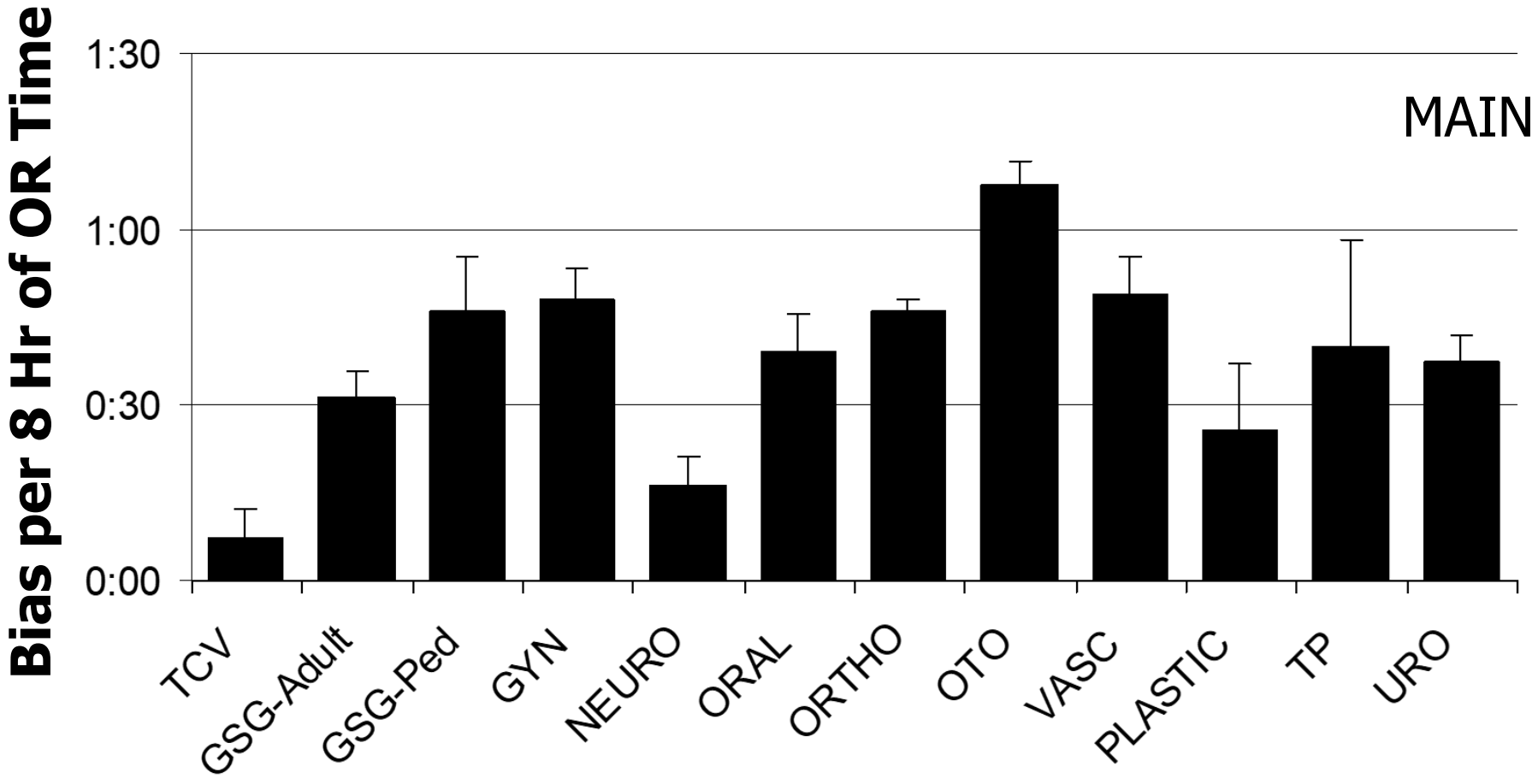
Measuring Case Duration Bias

- Each service's difference between actual and estimated OR times of cases, normalized to 8 hr of OR time

$$\frac{\Sigma\left(\text{actual OR times} - \text{scheduled OR times}\right)}{\Sigma\ \text{actual OR times}} \times 8\,\text{hr}$$

Dexter F et al. Can J Anesth 2005
McIntosh C et al. Anesth Analg 2006
Dexter F et al. J Clin Anesth 2007

Measuring Case Duration Bias



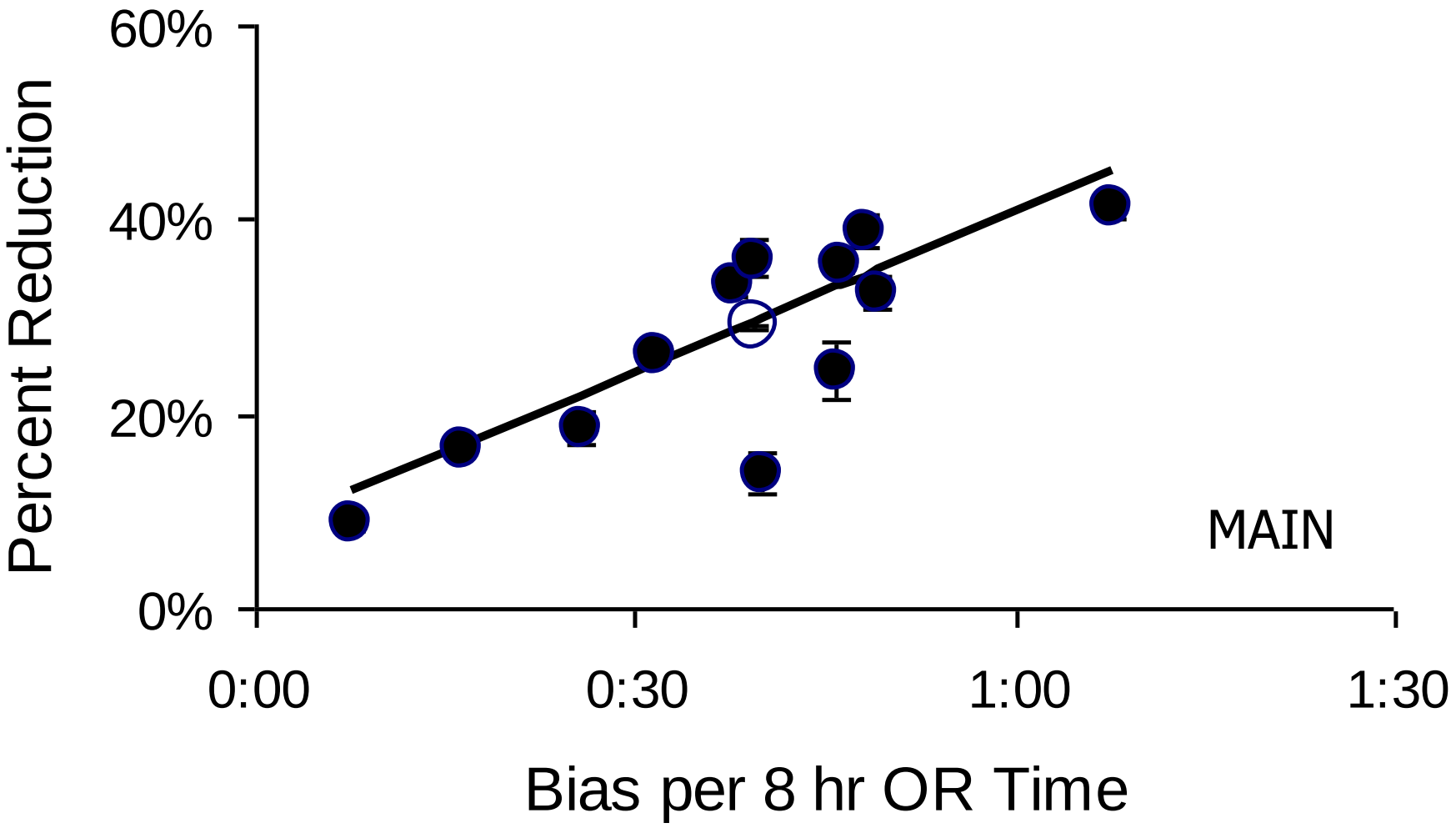
Correcting for Case Duration Bias

- Recalculation of OR schedule to correct for the bias reduces tardiness per OR per day
  - MAIN suite 18 ± 1 min (29 ± 1%)
  - ASC suite 24 ± 1 min (25 ± 1%)

Correcting for Case Duration Bias

- Recalculation of OR schedule to correct for the bias reduces tardiness per OR per day
  - MAIN suite 18 ± 1 min (29 ± 1%)
  - ASC suite 24 ± 1 min (25 ± 1%)
- Each increase in case duration bias among services is associated with increases in percentage reduction in tardiness per case
  - MAIN suite, $P < 0.0001$
  - ASC suite, $P < 0.0001$

Correcting for Case Duration Bias



Correcting for Lateness of First Cases & Case Duration Bias

- Simultaneously correcting for the mean lateness of start of the first cases of day
  - MAIN suite 22 ± 1 min (35 ± 1%)
  - ASC suite 29 ± 1 min (31 ± 1%)

Correcting for Lateness of First Cases & Case Duration Bias

- Simultaneously correcting for the mean lateness of start of the first cases of day
  - MAIN suite 22 ± 1 min (35 ± 1%)
  - ASC suite 29 ± 1 min (31 ± 1%)

➢ Striking versus reductions of 6% and 8% achieved by moving cases, which facilities do

Correcting for Lateness of First Cases & Case Duration Bias

- Electronic displays can correct automatically

Correcting for Lateness of First Cases & Case Duration Bias

- Electronic displays can correct automatically
  - Can even have the displays update the start times when revise case durations, such as at intraoperative briefing, time out, etc., and as cases progress

Dexter F et al. Anesth Analg 2009
Dexter EU et al. Anesth Analg 2010
Tiwari V et al. Anesth Analg 2013

Correcting for Lateness of First Cases & Case Duration Bias

- Electronic displays can correct automatically
  - Can even have the displays update the start times when revise case durations, such as at intraoperative briefing, time out, etc., and as cases progress

➢ Surgeons, anesthesiologists, and OR nurses effectively unaware that the displays have built in correction due to cognitive biases for small differences in scheduled start times

Dexter F et al. Anesth Analg 2007

Dexter EU et al. Anesth Analg 2009

Correcting for Lateness of First Cases & Case Duration Bias

- Among pediatric patients undergoing outpatient surgery, tardiness from scheduled start times matters, in that it accounts for more complaints than any other modifiable factor

Kynes JM et al. Anesth Analg 2013

Stepaniak PS, Dexter F. Anesth Analg 2013

Correcting for Lateness of First Cases & Case Duration Bias

- Among pediatric patients undergoing outpatient surgery, tardiness from scheduled start times matters, in that it accounts for more complaints than any other modifiable factor
  - Qualitative study of parents' dissatisfaction with outpatient surgery showed absence of relationship with perioperative complications, rather with waiting on the day of surgery

Brenn BR et al. Paediatr Anaesth 2016

Correcting for Lateness of First Cases & Case Duration Bias

- Negligible effect in satisfaction though among adult outpatient surgical patients
  - Sufficient sample size to detect a significant effect ($P < 0.001$) of substantial (> 30 minute) tardiness on satisfaction, but negligible mean difference: 3.91 versus 3.94 on 4-point scale

Kynes JM et al. Anesth Analg 2013

Tiwari V et al. Perioper Care Oper Room Manag 2017

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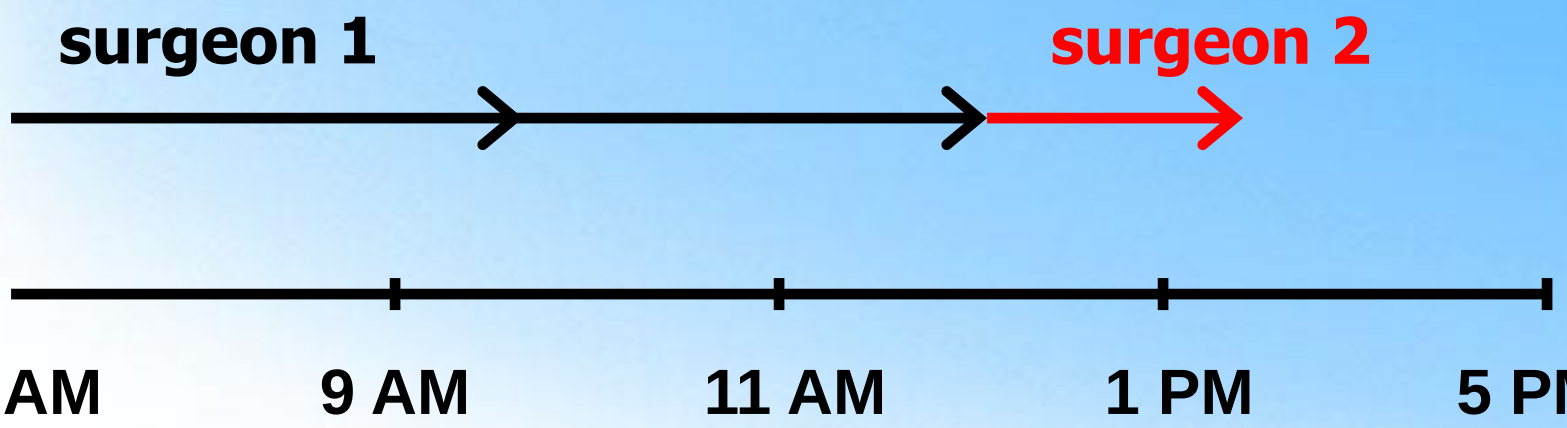
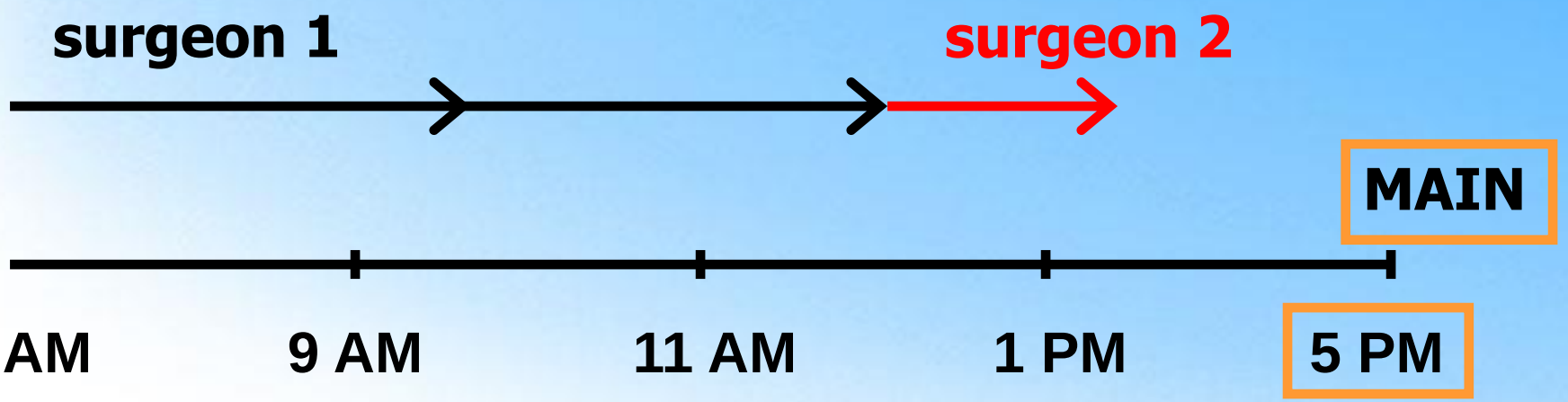
- ➢ Scheduling time gaps between surgeons

Influence of Scheduling Gaps Between Surgeons



Influence of Scheduling Gaps Between Surgeons



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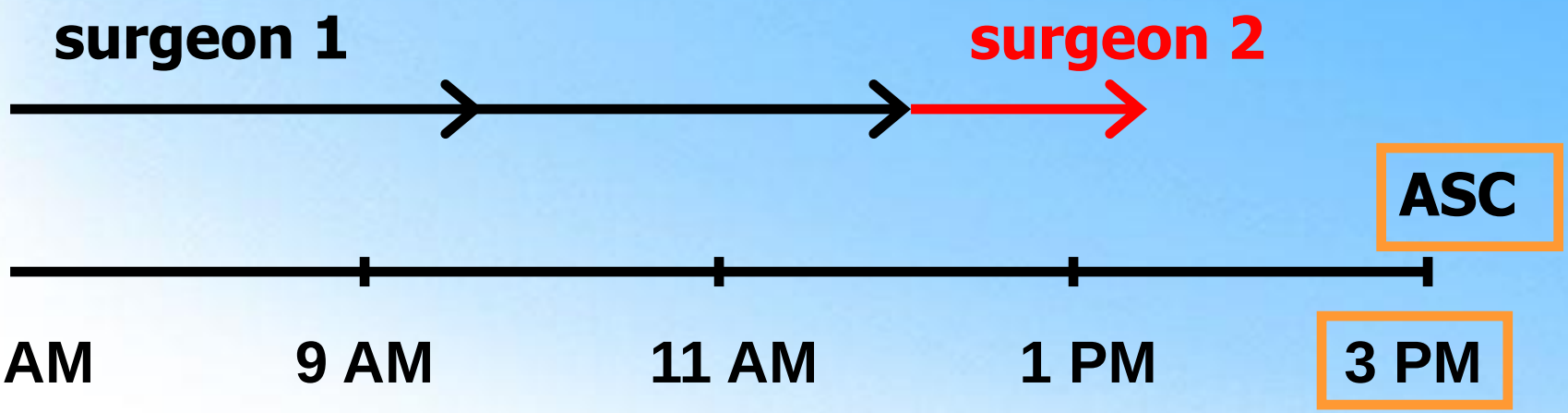

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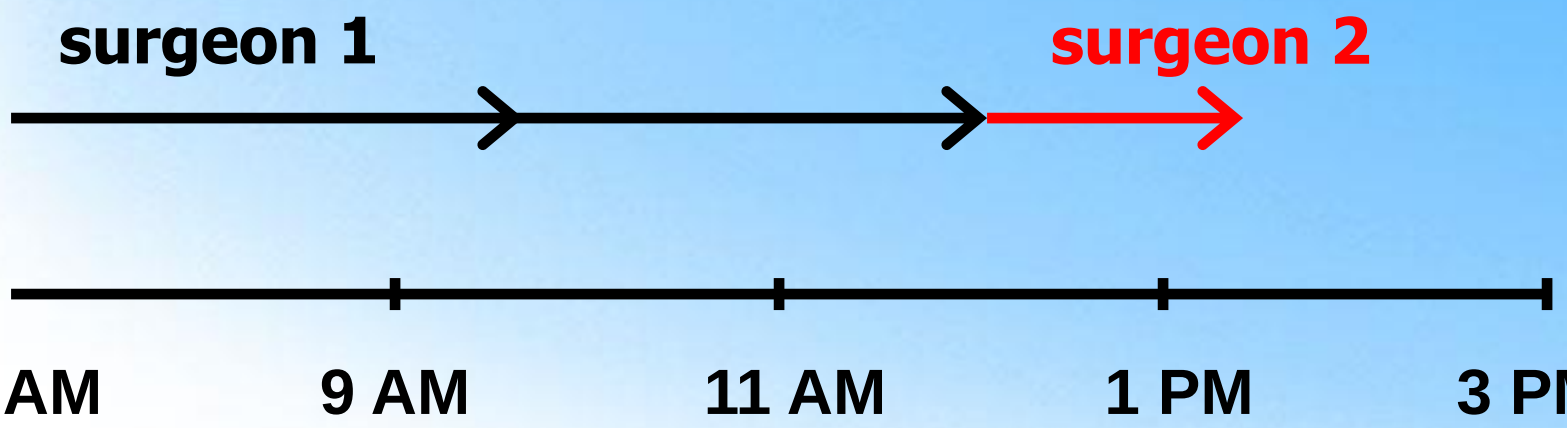

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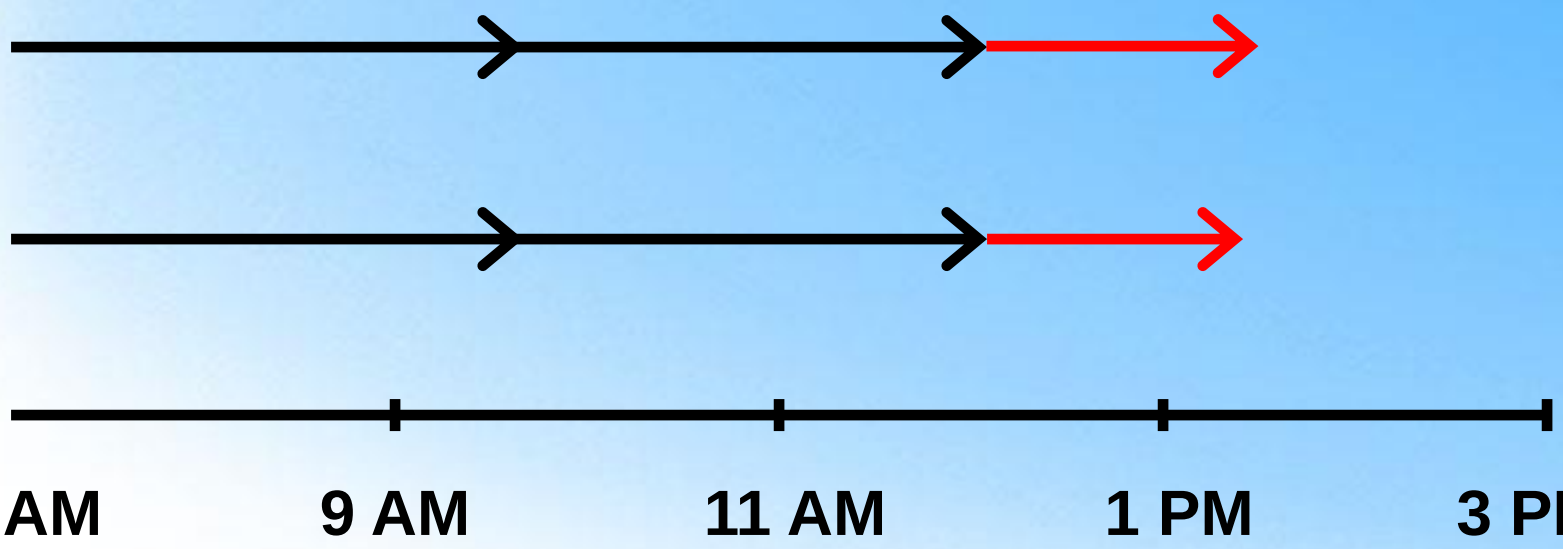

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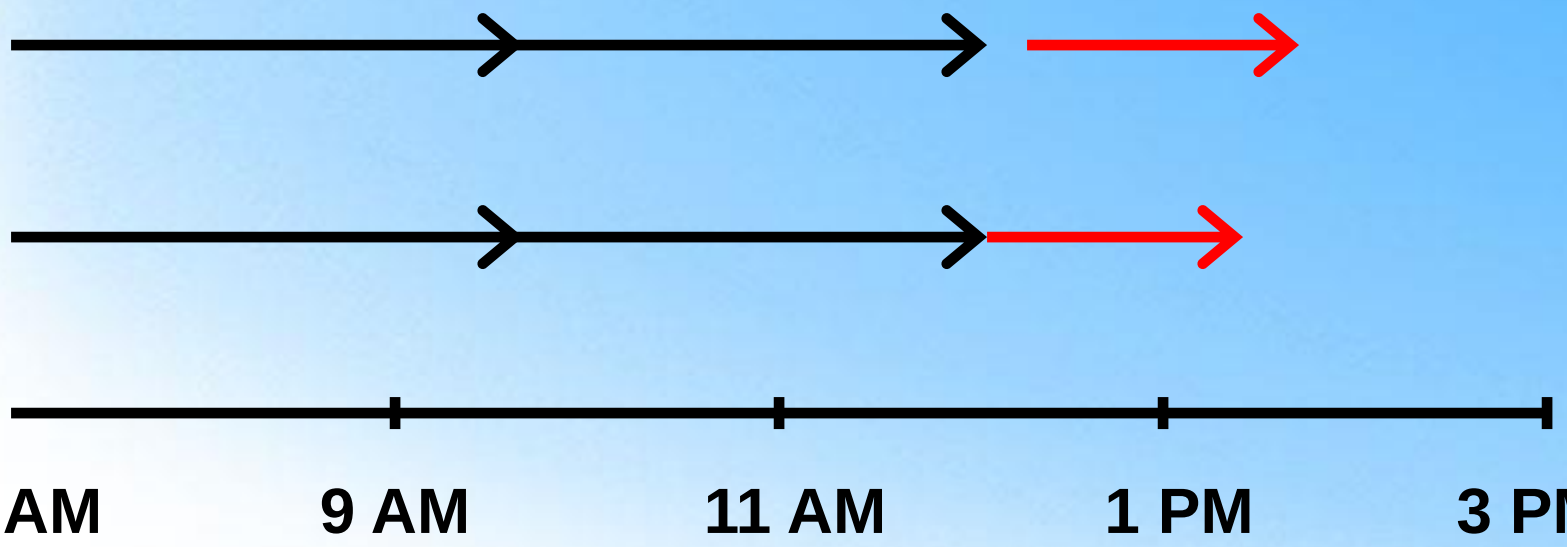

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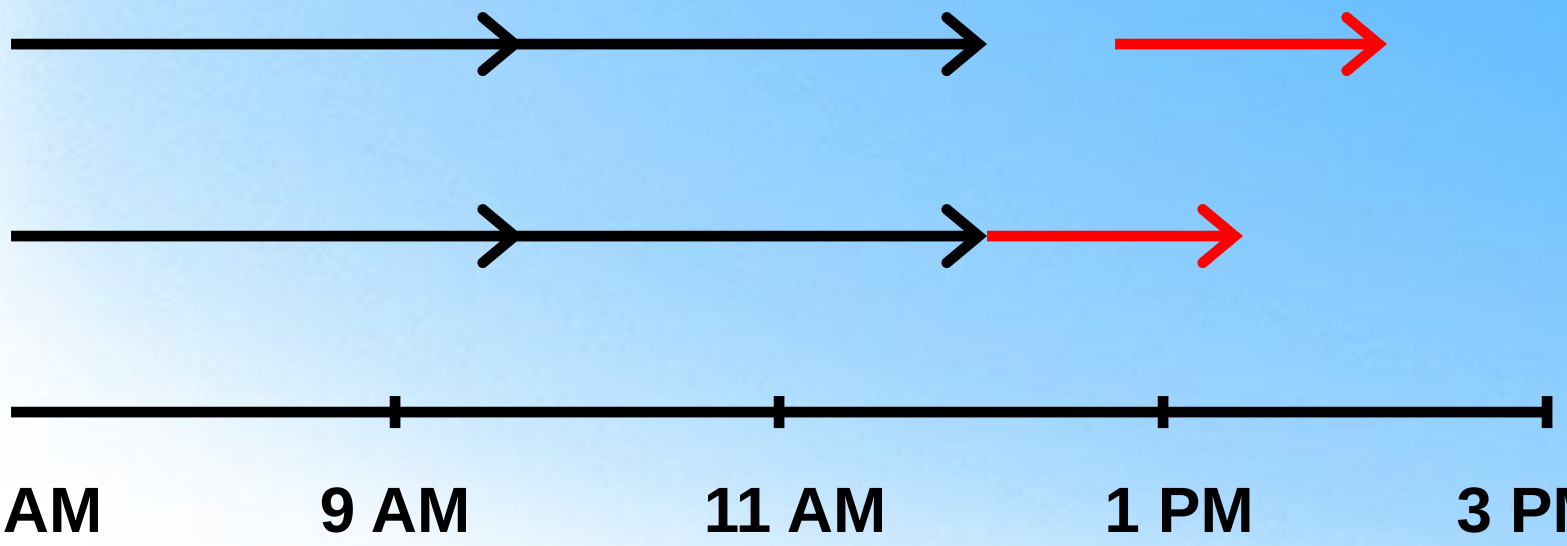

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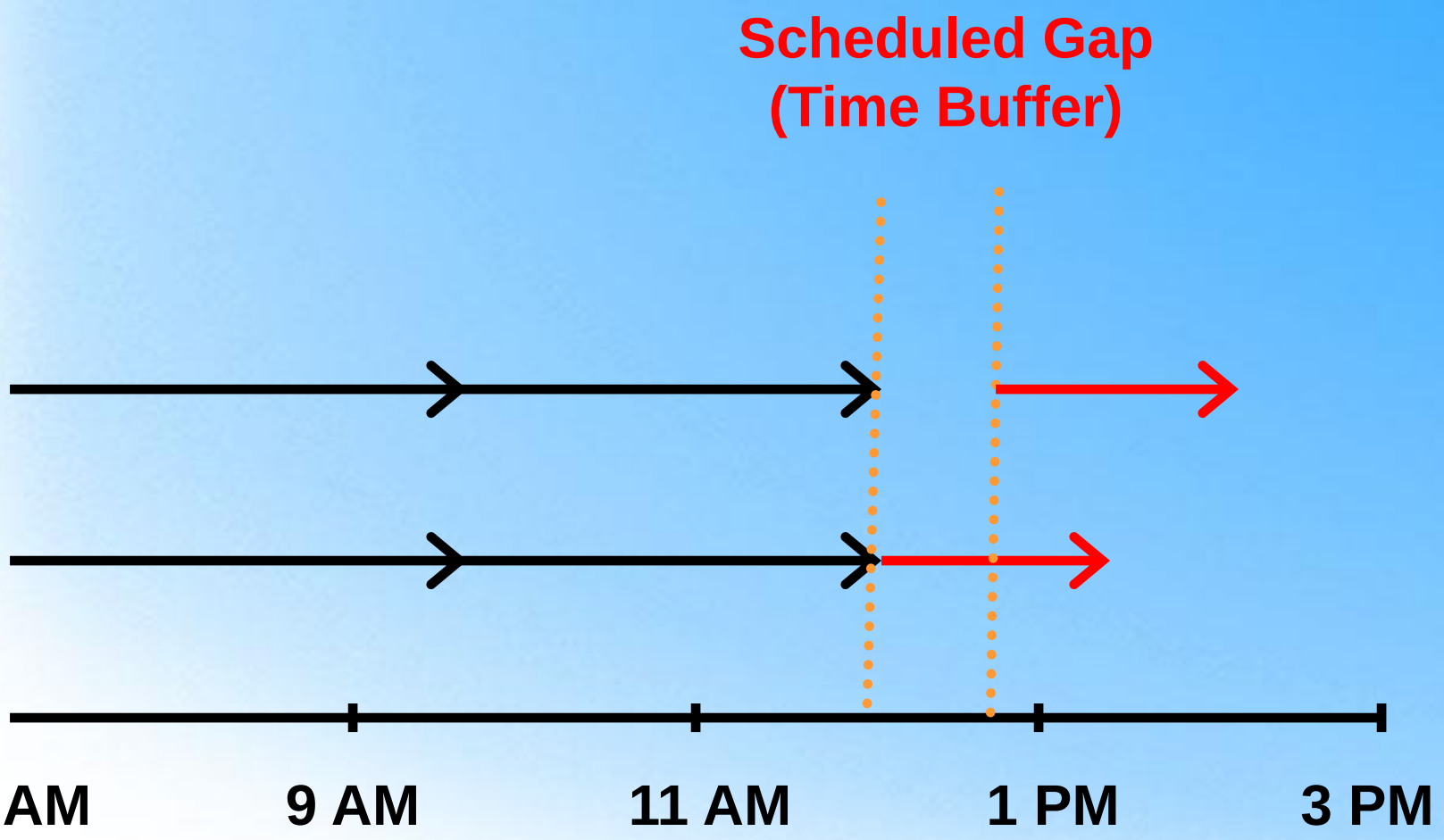
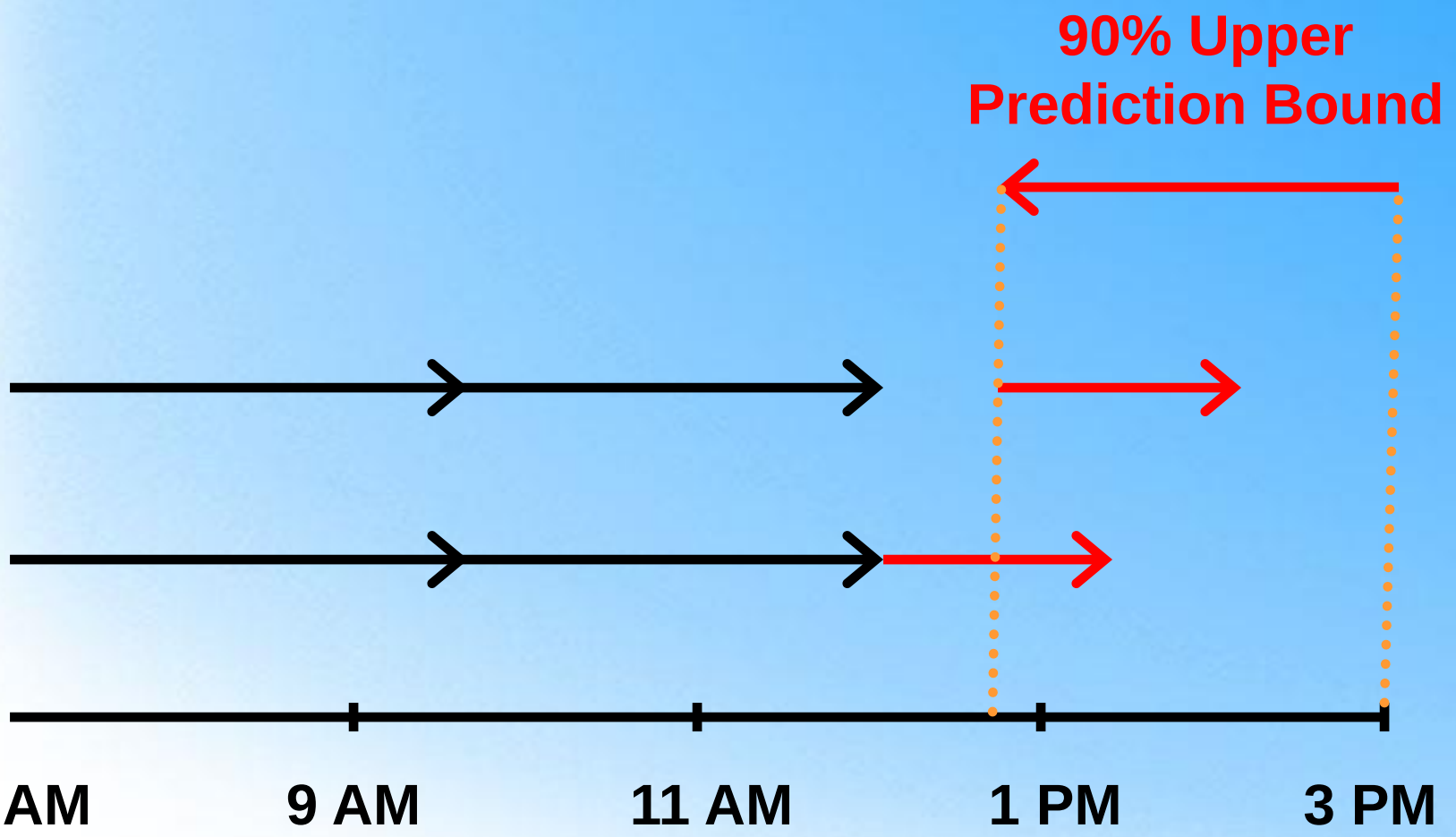


Prevent Over-Utilized OR Time While Adding the Time Gap



Prevent Over-Utilized OR Time While Adding the Time Gap

- 90% upper prediction bound on duration of case estimated very accurately using historical case duration data and estimated duration

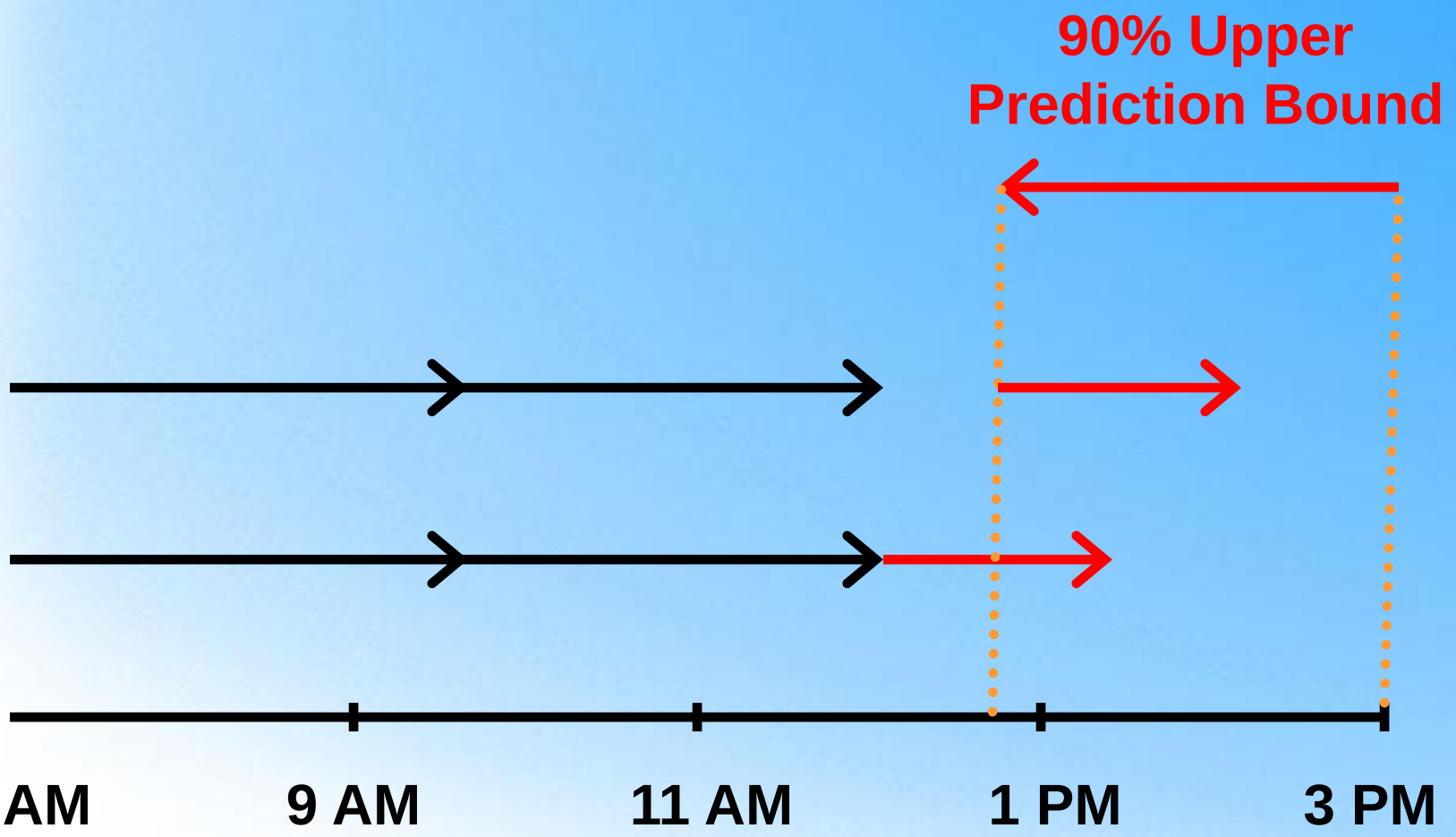
Zhou J, Dexter F. Anesthesiology 1999
Dexter F et al. Anesthesiology 2004
Dexter F, Ledolter J. 2005
Dexter F et al. Anesth Analg 2013

Prevent Over-Utilized OR Time While Adding the Time Gap

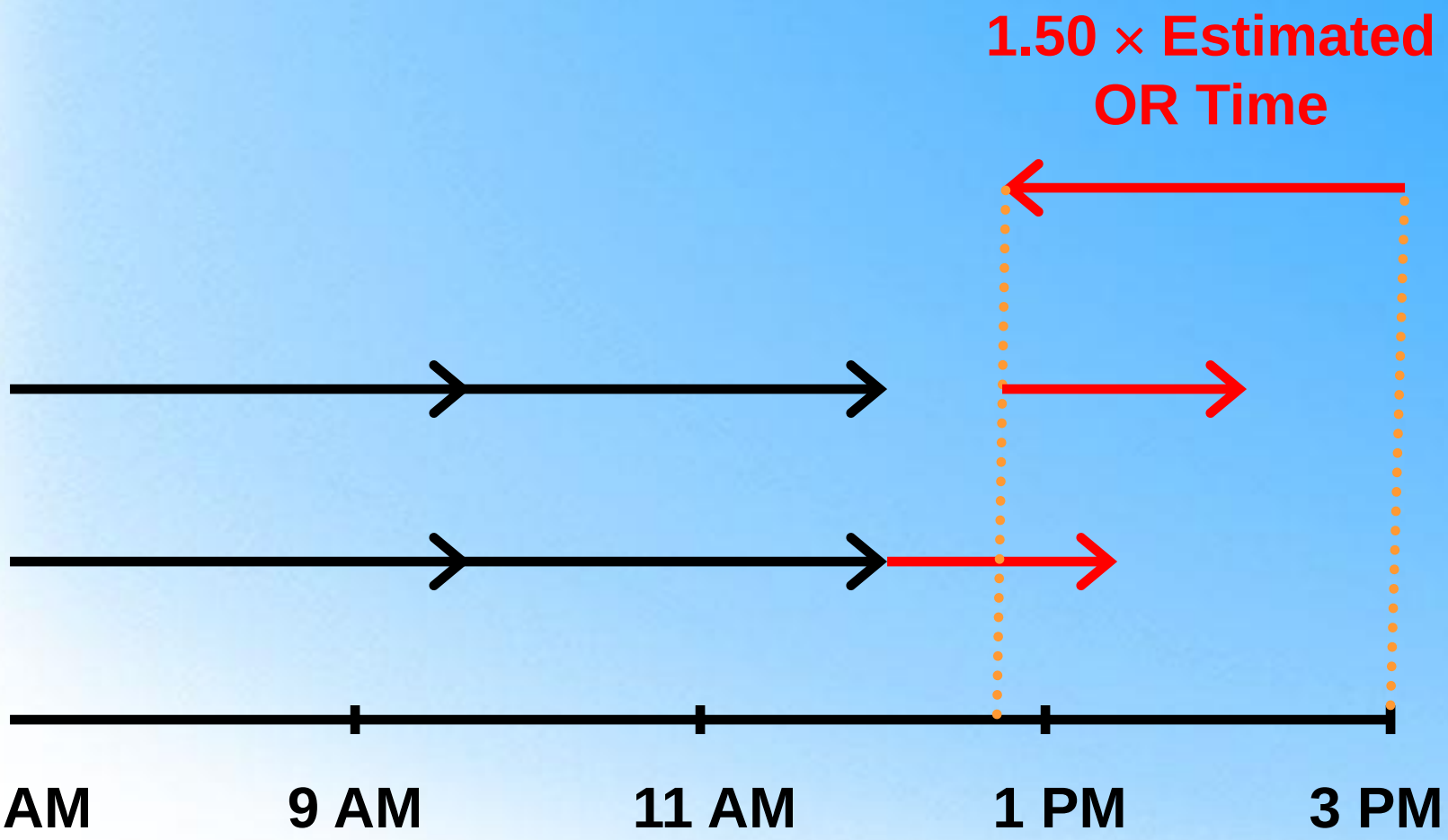
- 90% upper prediction bound on duration of case estimated very accurately using historical case duration data and estimated duration
- ➢ Good rule of thumb is that 90% upper prediction bound for one or more cases = 1.50 × estimated OR time for the list
  - MAIN suite 1.54 (95% CI 1.53 to 1.56)
  - ASC suite 1.45 (95% CI 1.43 to 1.48)

Dexter F, Ledolter J. Anesthesiology 2005
Wachtel RE, Dexter F. Anesth Analg 2009

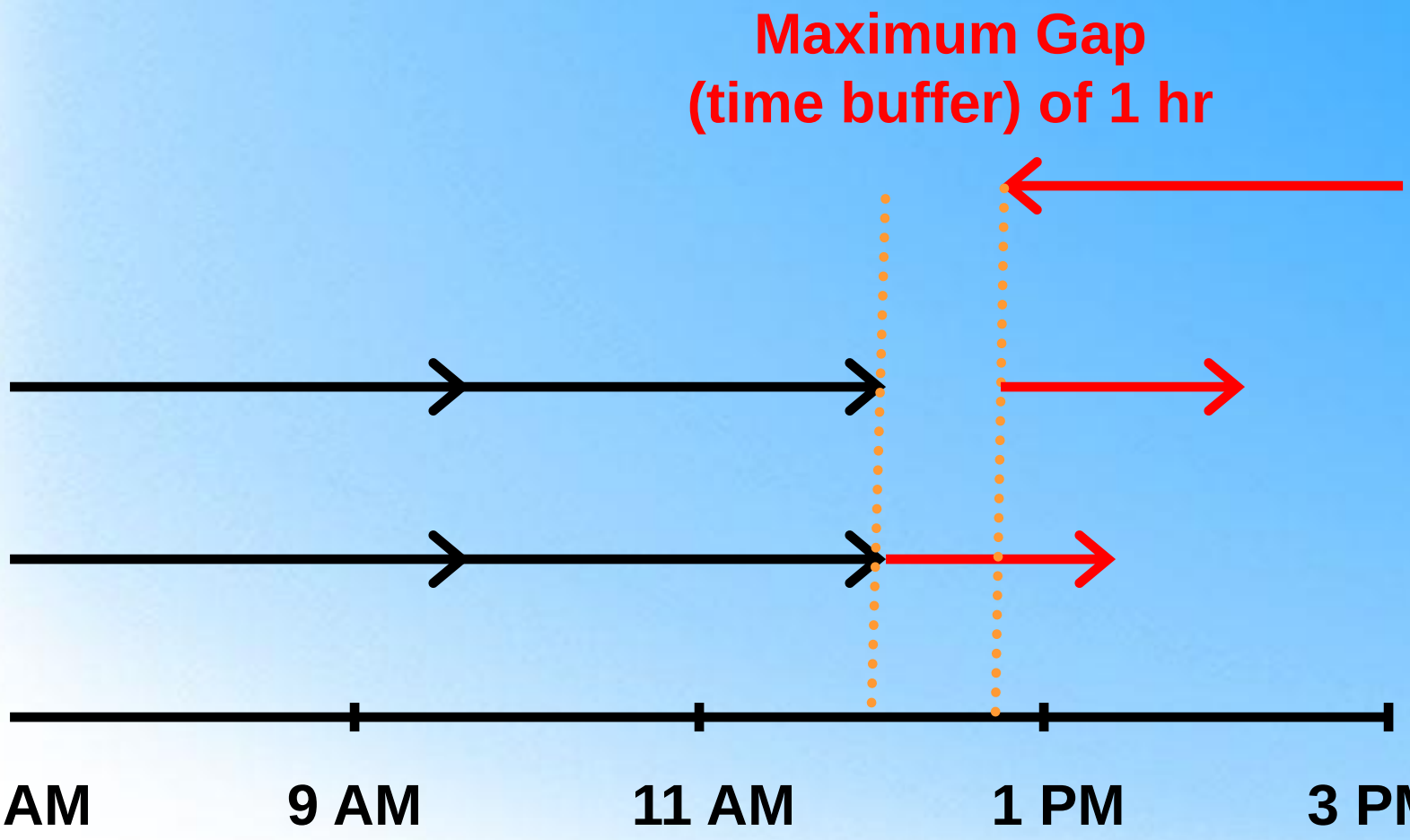
Prevent Over-Utilized OR Time While Adding the Time Gap



Prevent Over-Utilized OR Time While Adding the Time Gap



Influence of Scheduling Gaps Between Surgeons



Influence of Scheduling Gaps Between Surgeons

- Tardiness per case reduced for those cases for which a gap was scheduled
  - MAIN suite 52% ± 1%
  - ASC suite 62% ± 1%

Influence of Scheduling Gaps Between Surgeons

- Tardiness per case reduced for those cases for which a gap was scheduled ***(obvious result)***
  - MAIN suite 52% ± 1%
  - ASC suite 62% ± 1%

Influence of Scheduling Gaps Between Surgeons

- Tardiness per case reduced for those cases for which a gap was scheduled
  - MAIN suite 52% ± 1%
  - ASC suite 62% ± 1%
- However, small overall effect on tardiness
  - MAIN suite 4 ± 1 min per OR per day (8 ± 1%)
  - ASC suite 3 ± 1 min per OR per day (4 ± 1%)

Influence of Scheduling Gaps Between Surgeons

- Tardiness per case reduced for those cases for which a gap was scheduled
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    - ➢ Comparable to benefit of moving cases

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  - MAIN suite 4 ± 1 min per OR per day (8 ± 1%)
  - ASC suite 3 ± 1 min per OR per day (4 ± 1%)
    - Comparable to benefit of moving cases
    - ➢ Gaps inserted before 9.1 ± 0.1% MAIN cases
      3.8 ± 0.2% ASC cases

When to Schedule Gaps Between Surgeons

- Process variability is predictable source of variability in OR times of preceding case
  - Example: one day surgeon operated with surgical fellow and next day performed the same procedure with junior resident
  - Can mitigate this source of tardiness without gap
- Parameter uncertainty caused by too few data to estimate accurately how long preceding case will take, even when use Bayesian method
  - Consider scheduling gap between surgeons

Dexter F et al. Perioper Care Oper Room Manag 2018

Limitations to Scheduling Gaps Between Surgeons

- Calculations limited to elective (scheduled) cases, not add-on cases at end of the workday
  - Larger relevance to ASC than MAIN
- Larger benefit to using those staff available at end of workday to facilitate start of last case of day of the surgeon with a long lists of cases?
  - Facilities with largest anesthesia productivity have many (> 1/2) such surgeons and ORs

Sulecki L et al. Anesth Analg 2012

Not a Limitation to Scheduling Gaps Between Surgeons

- Surgeons same vs. different specialties does not influence tardiness; need not consider
  - Mean tardiness 0.1 ± 1.5 min longer
- Turnover times are longer when different specialty, mean 7.3 ± 0.4 min
- However, balanced versus less under-estimation of OR times (1.1 ± 1.2 min per case) when to-follow surgeon is of different specialty

Dexter F et al. J Clin Anesth 2019

Reducing Tardiness from Scheduled Start Times

- Not for the cases scheduled within 1 workday
- Definitions, examples, and methodology
- ✓ First case starts are most effective approach from perspective of start time of surgeons
- Moving cases
- Correcting for lateness of first cases of day
- Correcting for case duration bias
- Scheduling time gaps between surgeons

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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, anesthesia staffing, 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

Pretest Question #1

- Does making managerial decisions based on reducing the percentage of cases that start late result in better or worse decisions than decisions based on reducing the mean tardiness from scheduled start times?

Pretest Question #2

- What is the most effective intervention to reduce tardiness from scheduled start times of lists of cases (i.e., surgeon perspective)?

Pretest Question #3

- The management decision of moving cases among ORs results in overall < 10% reduced tardiness from scheduled start times?

Pretest Question #4

- Scheduling time gaps (e.g., 45 minute buffer) between successive surgeons in the same OR on the same day results in overall > 10% reduced tardiness from scheduled start times?

Pretest Question #5

- The working day before surgery, automatically updating scheduled start times to incorporate mean lateness of start of first cases of the day and bias in case duration predictions results in large (> 30%) overall reduced tardiness?

Answers to Pretest Questions

1. Worse decisions made if based on reducing the percentage of cases starting late
2. Have so many ORs that every surgeon gets a first case of the day start
3. Yes, ≤ 10% reduction from moving cases
4. No, ≤ 10% reduction from using time buffers
5. Yes, ≥ 30% by updating scheduled start times