Economics of Anesthetic Agents

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Updated 04/26/21

Economics of Anesthetic Agents

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Economics of Anesthetic Agents

- Reducing drug wastage is simplest
- Changing practice relies on individual feedback and appropriate case adjustment
- Choice of agent influences anesthetic times
- Translation of time into $ is sensitive to the percentage of costs that are fixed
- Predictions require simulation analysis
  - Examples from ICU, PACU, and OR
  - Exceptions are changes in type of anesthesia

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)

Financial Disclosure

- Much of the work presented in this lecture has been funded by consulting done by the University of Iowa (i.e., me) for companies (partial list)
  - Aspect Medical Systems
  - Organon
  - Baxter
  - Merck

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Reducing Fresh Gas Flow Rates Is Simple Conceptually

- Providing feedback to anesthetists of their overall mean fresh gas flows reduced consumption by 15% and 26%

Lubarsky DA et al. Anesthesiology 1997

Body SC et al. Anesthesiology 1999

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  - Most of the benefit is from small reductions in flows for the many cases with rates < 3 liters per minute, not from changing the behavior of few providers with very big flows

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Dexter F et al. Anaesth Intensive Care 2011

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  - Most of the benefit is from small reductions in flows for the many cases with rates < 3 liters per minute, not from changing the behavior of few providers with very big flows
  - ➢ Can use automated, real time recommendations

Lubarsky DA et al. Anesthesiology 1997
Body SC et al. Anesthesiology 1999
Dexter F et al. Anaesth Intensive Care 2011
Luria I et al. Anesth Analg 2013

Reducing Fresh Gas Flow Rates Is Simple Conceptually

- Consider education on importance of induction, because median 27% of total fresh gas used during the initial high-flow phase

Kennedy RR et al. Anaesthesia 2019

Reducing Opened and Unused Drugs Is Simple Conceptually

- FY96, $9.60 per case (acquisition costs)
  - 28% of total anesthesia drug costs
- FY98, $13.27 per case
  - 26% of total anesthesia drug costs
- FY00, $10.86 per case
- FY13, $ 3.90 per case

Dexter F et al. Anesthesiology 1998
Gillerman RG, Browning RA. Anesth Analg 2000
Weinger MB. J Clin Anesth 2001
Atcheson CLH et al. J Clin Anesth 2016

Reducing Opened and Unused Drugs Is Simple Conceptually

- I recommend starting with this change
  - Easy to quantify
  - Easy to understand that wasting drugs is counter-productive
  - No adverse consequence for patients
  - Reducing fresh gas flows not only reduces wastage of volatile anesthetics, but may also help the environment

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➢ Still, though, will need analysis and software

Example 1 of Reducing Wastage

- Costs and benefits of program to reduce wastage of intravenous drugs using instead commercially prepared syringes is simple to measure
  - Cost of commercial syringe
  - Cost of standard syringe
  - Reduced wastage

Armoiry X et al. Acta Anaesthesiol Scand 2016
Atcheson CLH et al. J Clin Anesth 2016
Jelacic S et al. J Clin Anesth 2017
Barbariol F et al. Anesth Analg 2021

Example 1 of Reducing Wastage

- Which of the following provides the cheapest total cost?
  - Ephedrine 30 mg drawn by anesthesiologist
  - Ephedrine 30 mg obtained commercially
  - No way to know without measuring wastage across multiple hospitals and doing the inventory-control mathematics

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➢ Let the pharmacy decision-analyst with software figure it out

Example 2 of Reducing Wastage

- Which of the following provides the cheapest total cost for maintenance?
  - Desflurane with 4.0 liter fresh gas flow
  - Desflurane with 3.0 liter fresh gas flow
  - Desflurane with 2.0 liter fresh gas flow
  - Desflurane with 1.0 liter fresh gas flow

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  - Desflurane with 1.0 liter fresh gas flow

➢ It really is that simple conceptually
(plus newer anesthesia machines have automated control of low-flow delivery)

Tay S et al. Anaesth Inten Care 2013

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Education Alone Does Not Influence Anesthesia Providers

- Poor cost consciousness of anesthesia providers, particularly for expensive drugs

Schlunzen L et al. Acta Anaesthesiol Scand 1999

Wax DB et al. J Clin Anesth 2009

Education Alone Does Not Influence Anesthesia Providers

- Poor cost consciousness of anesthesia providers, particularly for expensive drugs
  - ➢ Price stickers and education significantly enhance cost-consciousness

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Wax DB et al. J Clin Anesth 2009

Snyder-Ramos SA et al. Der Anaesthesist 2003

Education Alone Does Not Influence Anesthesia Providers

- Poor cost consciousness of anesthesia providers, particularly for expensive drugs
- Price stickers and education significantly enhance cost-consciousness
- ➢ However, that does not change drug usage for equivalent drugs

Schlunzen L et al. Acta Anaesthesiol Scand 1999

Wax DB et al. J Clin Anesth 2009

Snyder-Ramos SA et al. Der Anaesthesist 2003

Horrow JC, Rosenberg H. Can J Anaesth 1994

Provider-Specific Feedback Needs to be Patient Specific

- Determining appropriate patients for anti-emetics relies on logistic regression
  - Female gender
  - Prior history of PONV or motion sickness
  - Nonsmoking
  - Postoperative opioids

Junger A et al. Anesth Analg 2001

Apfel CC et al. Anesthesiology 1999

Provider-Specific Feedback Needs to be Timely

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- Risk-adjusted outcome feedback increases percentage of patients receiving protocol-driven nausea/vomiting therapy
  - Every 1 month: absolute increase 29%
  - Every 3 months: absolute increase 12%

Overdyk FJ et al. J Clin Anesth 1999

Cohen MM et al. Anesthesiology 1996

Provider-Specific Feedback Needs to be Timely

- Risk-adjusted outcome feedback increases percentage of outpatients bypassing the phase I post-anesthesia care unit
  - Every week: absolute increase 43%
  - Every day: absolute increase 83%

Apfelbaum JL et al. Anesthesiology 2002

Duncan PG et al. Can J Anaesth 2001

Provider-Specific Feedback Needs to be Timely

- Provide immediate feedback when using drug that is not part of protocol for the patient
  - Reduced intravenous anesthetic costs 51%
  - Reduced neuromuscular blocker costs 47%

Lubarsky DA et al. Anesthesiology 1997

Freund PR et al. Anesthesiology 1997

Provider-Specific Feedback Needs to be Timely

- Provide immediate feedback when using drug that is not part of protocol for the patient
  - Reduced intravenous anesthetic costs 51%
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- ➢ Can provide using either drug dispensing system or using anesthesia information management system (AIMS)

Epstein RH et al. Anesth Analg 2016 (× 2)

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- Provide immediate feedback when using drug that is not part of protocol for the patient
  - Reduced intravenous anesthetic costs 51%
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- Can provide using either drug dispensing system or using anesthesia information management system (AIMS)
- ➢ Advantages to delivering by e-mail include appropriate lack of regulatory requirements and ease of maintenance

Epstein RH et al. Anesth Analg 2015

Provider-Specific Feedback on Costs Need to be Adjusted

- American Society of Anesthesiologists' Relative Value Guide (ASA RVG) were known for every case that was billed (i.e., for every case)
  - Case duration: use ASA RVG time units
  - Type of procedure: use ASA RVG base units
- Explained 54% of variation in costs
  - Corrected for variation in anesthetic drug costs among sub-specialties

Dexter F et al. Anesthesiology 1998

Provider-Specific Feedback Can Also Include Time

- Monitor the 15% of AIMS' cases with prolonged extubation times (≥ 15 min)
  - Direct cost of the time focus of rest of talk
  - Intangible cost of the time shown by these cases' having mean 4.9 min longer times from out of OR to start of surgery of surgeon's next case (95% CI 2.7 min to 7.1 min, $P < 0.0001$)

Dexter F et al. Anesth Analg 2010

Masursky D et al. Anesth Analg 2012

Provider-Specific Feedback Can Also Include Time

- Incidence of prolonged extubation times is composite end point for reductions in both:
  - Average (mean)
  - Variability (standard deviation)

Dexter F et al. Anesth Analg 2010

Provider-Specific Feedback Can Also Include Time

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  - Variability (standard deviation)

➢ Mostly variability

  - Prolonged 39% University of Iowa (N=785) vs. 6% Kameda Medical Center (N=685)
  - Means 10 vs. 9 minutes (P = 0.68)
  - Standard deviations 40 vs. 4 min (P < 0.0001)

Sugiyama D et al. Anesth Analg 2021

Provider-Specific Feedback Can Also Include Time

- Can reduce incidence prolonged extubation
- Examples using desflurane
  - Reduces incidence 75% versus sevoflurane
  - Reduces incidence 95% versus isoflurane

Dexter F et al. Anesth Analg 2010

Agoliati A et al. Anesth Analg 2010

Provider-Specific Feedback Can Also Include Time

- Ambulatory surgery center OR
  - 1000 general anesthetics per year × 5% rate of prolonged extubation times = 1 event per week
  - 75% reduction results in 1 event per month
- Hospital OR
  - 750 general anesthetics per year × 20% rate of prolonged extubation times = 3 events per week
  - 95% reduction results in < 1 per month

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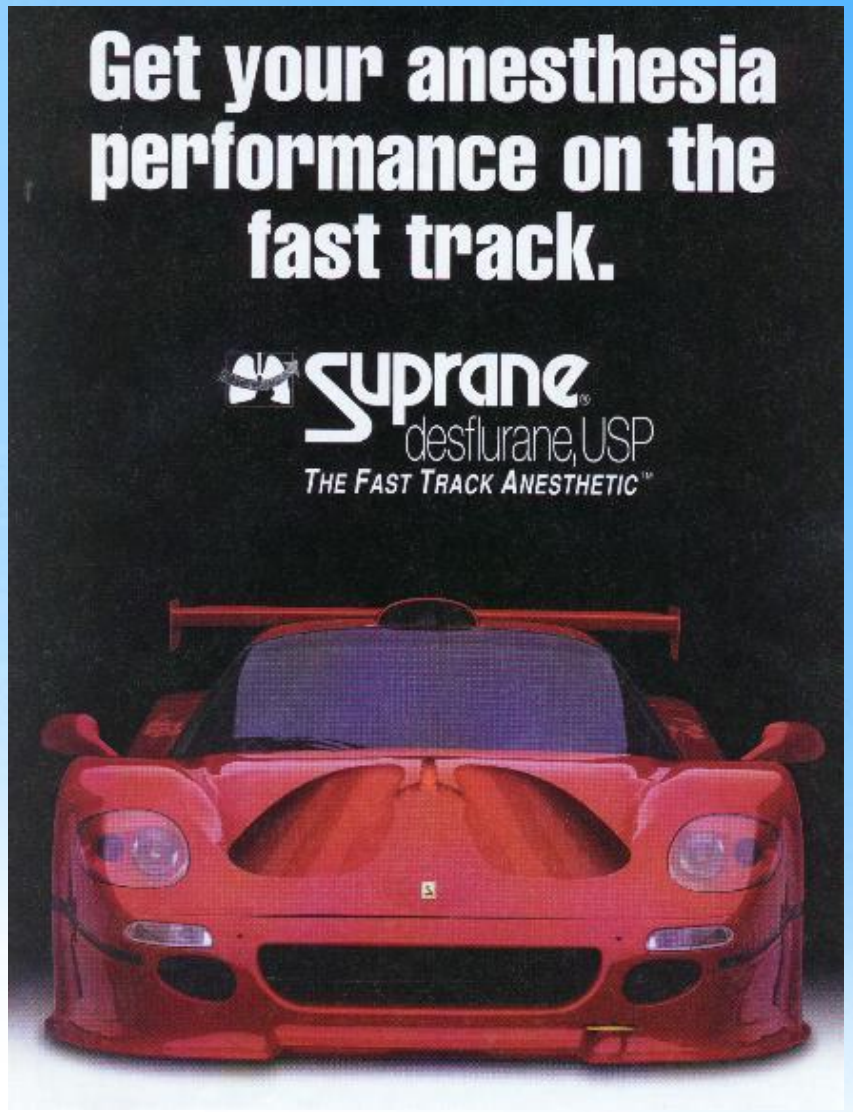
Matters That Drugs Influence Anesthetic Times



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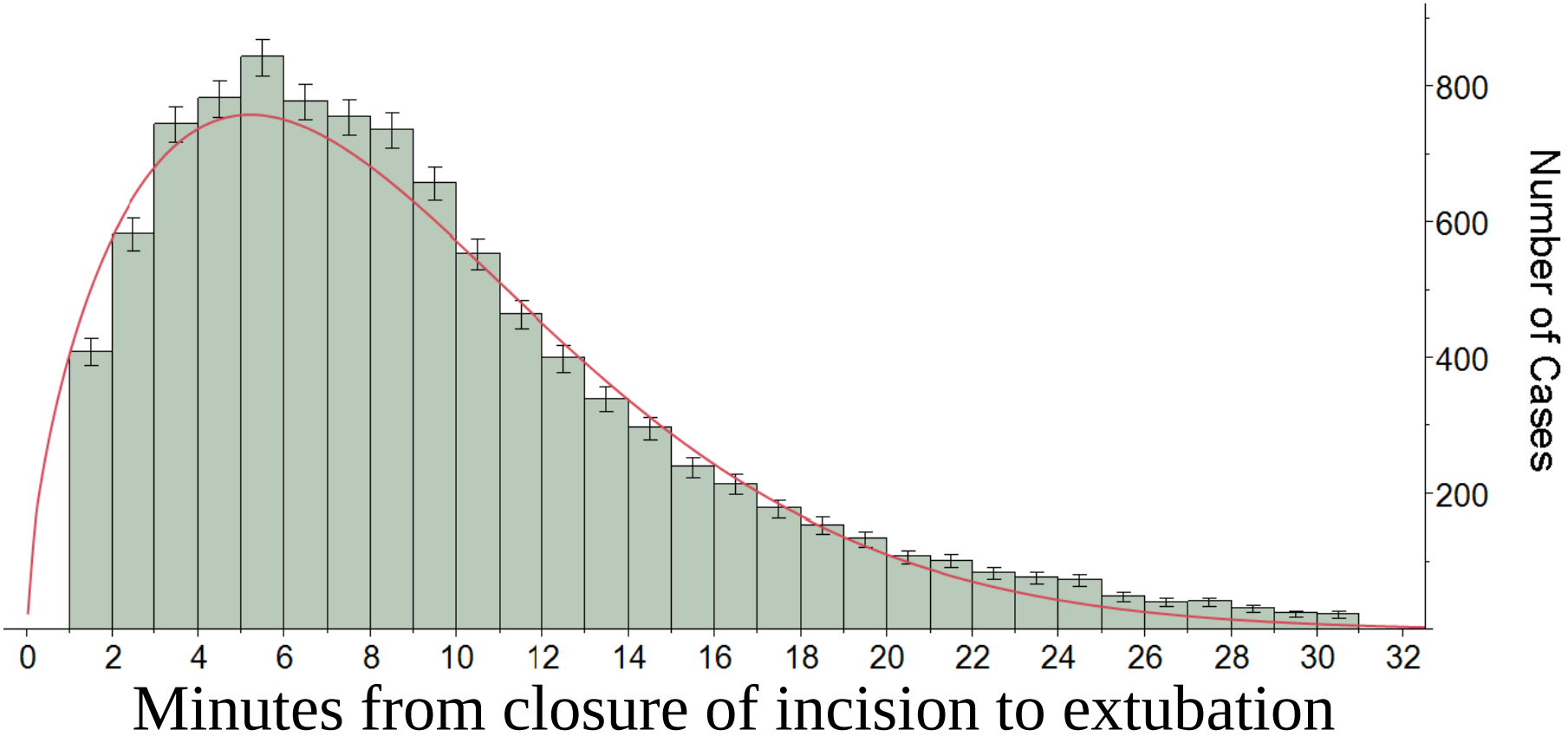

House et al. J Anaesthesiol Clin Pharmacol 2016

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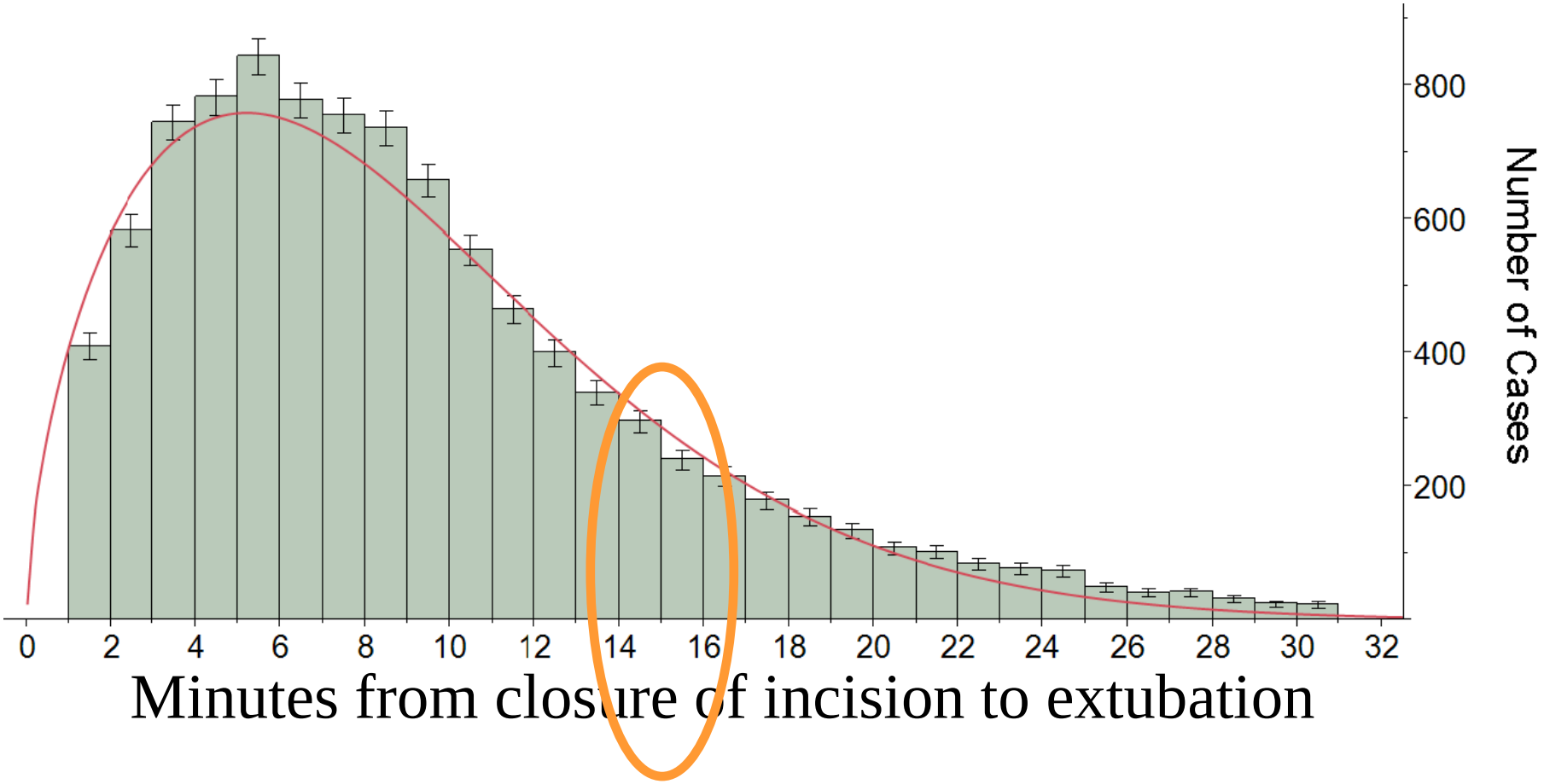

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Matters That Drugs Influence Anesthetic Times

- Prolonged extubations cause increase in times from end of surgery to OR exit?
  - No, not significantly, other concurrent processes influence time of OR exit
  - Yes, significantly, but just 1 to 2 minutes
  - Yes, significantly, on average ≅ 5 minutes
  - Yes, significantly, on average > 10 minutes

Dexter F, Epstein RH. Anesth Analg 2013

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- Prolonged extubations cause increase in times from end of surgery to OR exit
  - Mean 13.0 ± 0.1 minutes (SE) when stratified by duration of surgery and prone or not
    - Longer than 10 minutes, $P < 0.0001$
  - Absolute % increase in risk of case taking longer than scheduled is 11.0% ± 0.5%

Dexter F, Epstein RH. Anesth Analg 2013

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➢ Monitoring prolonged extubations is valid

Masursky D et al. Anesth Analg 2012
Bayman EO et al. Anesthesiology 2016

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- Monitoring prolonged extubations is valid
  - Unlike time from end of surgery to OR exit, since increased by factors unrelated to anesthetic such as the PACU being full

Matters That Drugs Influence Anesthetic Times

- Drugs with a higher acquisition costs can truly be cheaper by reducing time

Tyler DC, Orr RJ. Am J Anesthesiol 1999

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  - Anesthesiologists give poor rating to recovery from anesthesia when prolonged extubation

Tyler DC, Orr RJ. Am J Anesthesiol 1999

Apfelbaum JL et al. Anesth Analg 1993

Matters That Drugs Influence Anesthetic Times

- Drugs with a higher acquisition costs can truly be cheaper by reducing time
- Anesthesiologists give poor rating to recovery from anesthesia when prolonged extubation
- ➢ Anesthesiologists perceive strong production pressure to work quickly

Tyler DC, Orr RJ. Am J Anesthesiol 1999

Apfelbaum JL et al. Anesth Analg 1993

Gaba DM et al. Anesthesiology 1994

Chai JX, Chong SY. Singapore Med J 2018

Matters That Drugs Influence Anesthetic Times

- Drugs with a higher acquisition costs can truly be cheaper by reducing time
- Anesthesiologists give poor rating to recovery from anesthesia when prolonged extubation
- Anesthesiologists perceive strong production pressure to work quickly
  - Cognitive bias (i.e., immutable to education)

Tyler DC, Orr RJ. Am J Anesthesiol 1999

Apfelbaum JL et al. Anesth Analg 1993

Gaba DM et al. Anesthesiology 1994

Dexter F et al. Anesth Analg 2007

Ledolter J et al. Anesth Analg 2010

Chai JX, Chong SY. Singapore Med J 2018

Wang J et al. Anesth Analg 2013

Matters That Drugs Influence Anesthetic Times

- Surgeons scored importance of 25 attributes of anesthesiologists, using scale from 0 "no importance" to 4 "a factor that would make me switch groups/ hospitals"
- For example, as expected, mean score 4.0 for "ability to calmly manage a crisis."

Vitez TS, Macario A. J Clin Anesth 1998

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- For example, as expected, mean score 4.0 for "ability to calmly manage a crisis."
  - Mean score 3.9 for "patient quick to awaken."

Vitez TS, Macario A. J Clin Anesth 1998

Measuring Reductions in Time is Straight-Forward

- Results well summarized by meta-analyses
- Example of mean time to extubation
  - Desflurane 25% quicker than sevoflurane
    95% confidence interval 17% to 32%
    Typical corresponding value is 2.5 min

Dexter F et al. Anesth Analg 2010

Small Time Savings per Case Do Not Simply Add Up

- A hospital estimates its variable costs of OR time to be $20 per minute
  - From cost accounting system
- Desflurane reduces time to following commands by an average of 2.5 minutes
- Savings = $50 per case
  - $50 = $20 per min × 2.5 min per case

Dexter F et al. Anesthesiology 2002

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- Desflurane reduces time to following commands by an average of 2.5 minutes
- Savings = $50 per case
  - $50 = $20 per min × 2.5 min per case
    - ➢ Absurd! Use of desflurane did not save $50

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Operating Room Labor is a Step Cost

- Cost accounting system models the variable cost of:
  OR time ≅ (cost of the patient care labor) ÷ (direct patient care time during one quarter)

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  - ➢ Assumption is reasonable for an OR allocation analysis that may result in closing an OR

Macario A, Dexter F. AORN J 2000

Operating Room Labor is a Step Cost

- Cost accounting system models the variable cost of:
  OR time ≅ (cost of the patient care labor) ÷ (direct patient care time during one quarter)
- Assumption is reasonable for an OR allocation analysis that may result in closing an OR
  - Assumption is not reasonable when considering impact of an anesthetic agent

Operating Room Labor is a Step Cost

- Fixed costs
  - Do not change relative to volume of activity
  - Capital equipment and snow removal
- Variable costs
  - Change relative to volume of activity
  - Vials of propofol
- Step costs
  - Staffing is fixed over narrow ranges of volume of activity, but beyond that must increase

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- Cost accounting system assumes that staff time is a variable cost
- If close an OR, then will have fewer full-time staff, and so the assumption is reasonable over a time course of several months
- ➢ If one anesthesiologist decides today to do something different and reduces OR time, then assumption may not be appropriate

Example – Change in Practice Today by One Anesthesiologist

- 20 anesthesiologist MD group practices at a hospital's main OR & ambulatory surgery center
- Every Monday, ORs start 1-hr late for nursing training and the anesthesia group's meeting
- This Monday, hospital manager provides the anesthesiologists with data showing need to reduce drug costs, PACU costs, and OR costs
- Anesthesia group agrees to set up a committee to collaborate with hospital on future changes

Example – Change in Practice Today by One Anesthesiologist

- One of the anesthesiologists, though, wants to affect change immediately
- She is doing five short cases today
- To reduce drug costs, she draws up drugs into small syringes, and reduces wastage
- To reduce PACU costs, she uses BiS and runs a patient light, bypassing phase I PACU
- To reduce OR costs, she administers a spinal instead of an epidural anesthetic, cutting OR time by around 12 minutes

Example – Change in Practice Today by One Anesthesiologist

- For which interventions did she really cut costs?
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Long-Term Change in Practice by Many Anesthesiologists

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  - All 3 of them

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Example 1 of Cardiac Surgery Scenario

- Dr. Jones is a cardiac anesthesiologist
- Off-pump CPB case with extubation in OR
  - Remifentanil anesthetic
- Patient leaves ICU early that evening
- Have ICU nursing costs been reduced?
  - Yes, because every hour of ICU time costs hundreds of dollars
  - No, generally not, because ICU nurses are scheduled a month or so ahead of time

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Example 2 of Cardiac Surgery Scenario

- All cardiac anesthesiologists at the hospital
- After off-pump CPB, 90% of patients are extubated in the OR after surgery
- All patients leave ICU in 6 hours
- ICU nursing costs may be reduced
  - Depends on characteristics of the ICU

Straka Z Ann Thorac Surg 2002

Purpose of the Simulation (Economic) Analysis

- Determine whether a reduction in staffing costs can likely be achieved at specific facility
- Facility specific answer depends on …
  - Whether costs fixed, varies among facilities
    - Reduction in costs if they are not fixed

      Not (mean minutes saved) ×
      (total costs) / (total facility minutes)
  - Cost of drug (or device) at the facility

Healy WL et al. J Arthroplasty 1998

Taheri PA et al. J Am Coll Surg 2000

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Early Tracheal Extubation of Cardiac Surgery Patients

- Early tracheal extubation, achieved with propofol, reduced mean time to extubation from 19 hours to 4 hours, resulting in a reduction in mean ICU LOS of 5.1 hour
- Mean reduction in costs of part-time ICU nurses was $1,012 per patient

Cheng DCH et al. Anesthesiology 1996

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Sensitivity of Early Extubation Results to ICU Characteristics

- Cost reduction sensitive to patient flow from scheduling to OR to ICU to hospital ward to long-term care and/or home
  - Specifically, reduction in ICU nursing costs sensitive to number of elective CABG cases performed each year at the hospital and the method of compensating ICU nurses

Dexter F et al. J Clin Anesth 1998

Sensitivity of Early Extubation Results to ICU Characteristics

- 830 per year ≅ 3-4 elective CABG per day
  - 5 hr reduction in ICU time reliably represents 1 less ICU nurse each day
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  - Savings are particularly reasonable, because many part-time nurses
- Median elective CABG per day at US hospitals
  - 1 per day with few part-time ICU nurses
  - ➢ Reducing ICU time for 0-1 patients per day for 5 hours unlikely to reduce costs

Two Broad Messages From That ICU Example

- Reductions in time from changing anesthetic drugs *can*, not do, reduce costs
- There needs to be, on that day of the week, a consistently large number of patients who receive the intervention
  - When staff provide care to many patients, only some of whom receive an intervention, the intervention is less likely to reduce costs

Economics of Anesthetic Agents

- Reducing drug wastage is simplest
- Changing practice relies on individual feedback and appropriate case adjustment
- Choice of agent influences anesthetic times
- Translation of time into $ is sensitive to the percentage of costs that are fixed
- Predictions require simulation analysis
  - ➢ Examples from ***ICU***, PACU, and OR
  - – Exceptions are changes in type of anesthesia

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Methodologies to Simulate Effect of Drugs on PACU Costs

- Dexter F, Tinker JH. Analysis of strategies to decrease post anesthesia care unit costs. Anesthesiology 1995
- Dexter F et al. Computer simulation to determine how rapid anesthetic recovery protocols to decrease the time for emergence or increase the phase I post anesthesia care unit bypass rate affect staffing of an ambulatory surgery center. Anesth Analg 1999
- Dexter F et al. Statistical analysis by Monte-Carlo simulation of the impact of administrative and medical delays in discharge from the post-anesthesia care unit on total patient care hours. Anesth Analg 2001

Important Point is Simply that the Methodologies Exist

- Result, of this type of science, is …
  - Not an answer to the question: "Does X drug reduce costs"
  - Development and validation of methods to be used with each facility's own data
- Second of the papers includes Tables that are sufficient for a facility to screen an intervention to decide whether an analysis of its own data is worthwhile

Methodologies to Simulate Effect of Drugs on PACU Costs

- Future slides will focus on some broad, bottom-line, principles from the simulations

Impact of Nausea and Vomiting

- Observations from the University of Iowa's Ambulatory Surgery Center in 1993
  - 69% of patients received general anesthesia
  - 8% of patients having general anesthesia suffered nausea and vomiting in the PACU
  - Among patients undergoing general anesthesia, nausea or vomiting increased the mean length of stay by 63%

Dexter F, Tinker JH. Anesthesiology 1995

Impact of Nausea and Vomiting

- Can use these numbers to estimate the decrease in total length of stay that is achievable by reducing nausea and vomiting
  - 69% general
  - 8% of general patients with N & V
  - If N & V, 63% increase in PACU LOS

Impact of Nausea and Vomiting

- Simple estimation
  - Staffing impact = (Incidence) × (Impact)
  - Eliminating nausea and vomiting would decrease total length of stay by 3.4%

3.4% = (69% receiving general × 8% of those receiving general having nausea and/or vomiting) × (63% prolongation of length of stay)

Impact of Nausea and Vomiting

- An argument in favor of the aggressive prophylactic treatment of nausea and vomiting is that patients with nausea and vomiting have long PACU stays
- However, …

Impact of Nausea and Vomiting

- An argument in favor of the aggressive prophylactic treatment of nausea and vomiting is that patients with nausea and vomiting have long PACU stays
  - PACU patients tend to be in one big room

Impact of Nausea and Vomiting

- An argument in favor of the aggressive prophylactic treatment of nausea and vomiting is that patients with nausea and vomiting have long PACU stays
  - PACU patients tend to be in one big room
    - Even if there is a subgroup of patients with a high incidence of nausea and vomiting, staffing impact is based on incidence and impact of all patients

Impact of Eliminating Adverse Events Observed in PACU

- Eliminate all adverse events in the PACU including all nausea and vomiting
  - Reducing incidence in half would result in 4.8% reduction in mean nursing workload
  - Elimination of all adverse events would reduce overall mean length of stay by 6.7% among ambulatory surgery patients in 1999

Cohen MM et al. Anesthesiology 1999

Chung F, Mezei G. Anesth Analg 1999

Impact of Eliminating Adverse Events Observed in PACU

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  - Reducing incidence in half would result in 4.8% reduction in mean nursing workload
  - Elimination of all adverse events would reduce overall mean length of stay by 6.7% among ambulatory surgery patients in 1999
  - ➢Reduce by 1.8% all types of patients in 2018

Cohen MM et al. Anesthesiology 1999
Chung F, Mezei G. Anesth Analg 1999
Liu S et al. J PeriAnesth Nurs 2020

Examples So Far Have Shown Four Broad Principles

- Reductions in time from anesthetic drugs
  - *Can* reduce costs, not do reduce costs
- Cost reductions, achieved from time reductions, are sensitive to characteristics of the facility studied:
  - Method of staff compensation
  - Average numbers of patients receiving care at the facility on that day of the week
  - Percentage of patients who would receive drug and benefit from time reduction

Examples So Far Have Shown Four Broad Principles

- Economics of drug sensitive to context of use
  - Mostly issue of patients not receiving drug
  - Method of staff compensation
  - Average numbers of patients receiving care at the facility on that day of the week
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Examples So Far Have Shown Four Broad Principles

- Economics of drug sensitive to context of use
  - Mostly issue of patients not receiving drug
- ➢ As study a drug (or device), also investigate for future potential users what variables should be considered about each facility:
  - Method of staff compensation
  - Average numbers of patients receiving care at the facility on that day of the week
  - Percentage of patients who would receive drug and benefit from time reduction

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Fixed or Variable Cost of OR Time at 6 OR Surgical Suite

- A 6 OR ambulatory surgery center is staffed fully from 7 AM to 5 PM
- Average number of ORs in use, being cleaned, or being setup are as follows:

1 PM	6.0	4 PM	2.8
2 PM	5.7	5 PM	0.3
3 PM	4.9		

Fixed or Variable Cost of OR Time at 6 OR Surgical Suite

- Ambulatory surgery center has more staffed hours than needed to complete the cases
  - Maybe to encourage increased volume
  - Maybe provides lowest possible costs
  - Maybe a collective bargaining agreement
- Regardless of why the staffing is as it is, reducing OR time will not reduce costs

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  - Maybe to encourage increased volume
  - Maybe provides lowest possible costs
  - Maybe a collective bargaining agreement
- Regardless of why the staffing is as it is, reducing OR time will not reduce costs
- ➢ In this example, OR staffing costs are a fixed cost of the number of ORs that are being run

Fixed or Variable Cost of OR Time at 6 OR Surgical Suite

- If the facility were to change staffing to be a mixture of 8 hr and 10 hr ORs,
  - By specialty by day of the week calculated based on maximizing the efficiency of use of OR time
- Then, reducing OR time would substantially reduce costs

McIntosh C et al. Anesth Analg 2006

More examples
www.franklindexter.net/Lectures/TurnoverTime.pdf

Dependency is Very Well Understood – Science is Mature

- Question showing little knowledge: "Does reducing OR time by 7 min save money?"
- Not because science is not well developed, but since conditions differ among facilities
  - Relationship can be predicted with each facility's own data

McIntosh C et al. Anesth Analg 2006

Epstein RH et al. Can J Anesth 2013

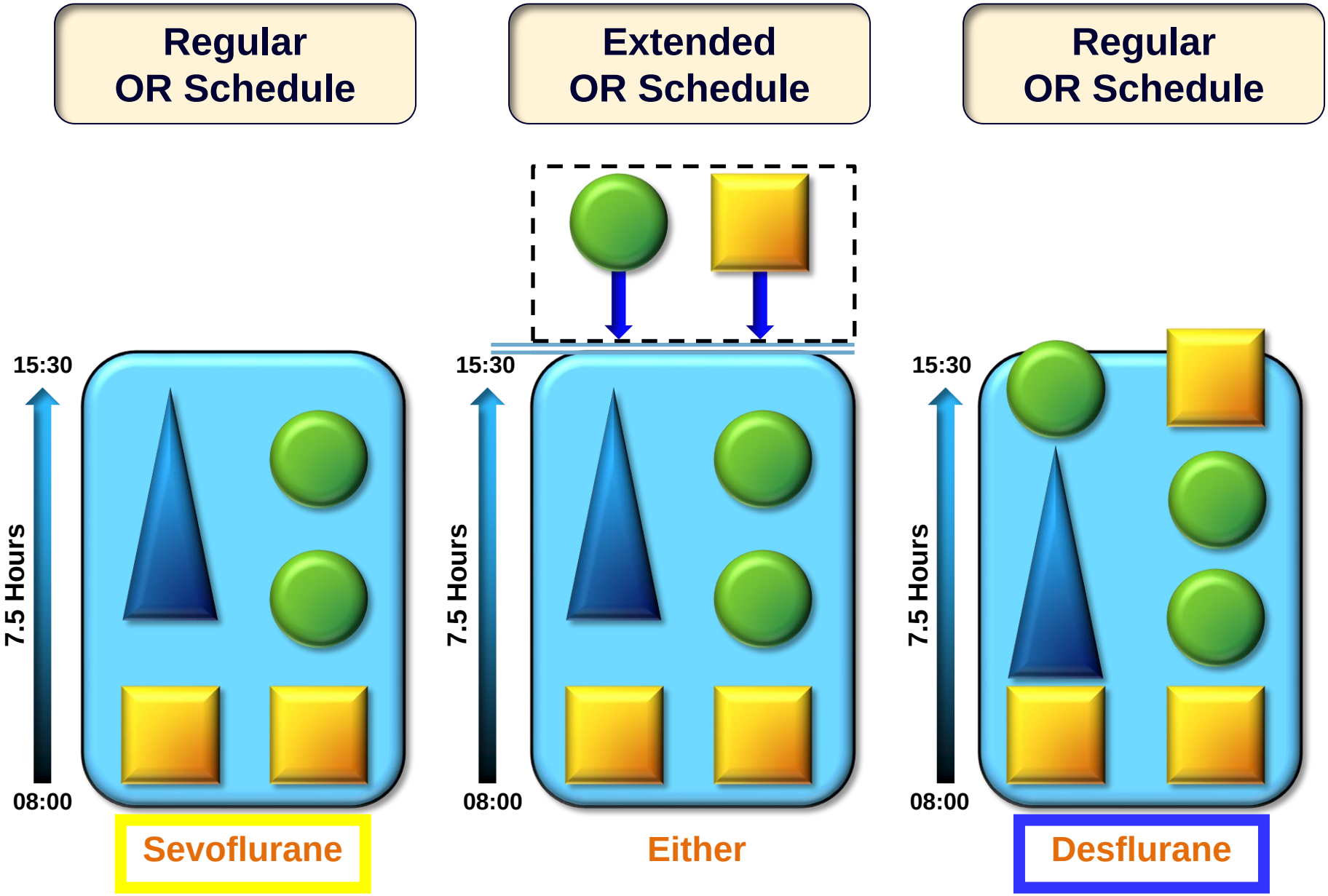
Dependency is Very Well Understood – Science is Mature

- Principle that can be used for purposes of screening to decide whether to apply methods
  - For ORs with < 8 hr of cases, assume OR time is a fixed cost
  - For ORs with > 8 hr of cases, treat each reduction of 1 min OR time as resulting in savings of 1.1 min to 1.2 min of labor time

Dexter F et al. Anesth Analg 1999

Dexter F et al. Anesth Analg 2009 & 2010

Epstein RH et al. Can J Anesth 2013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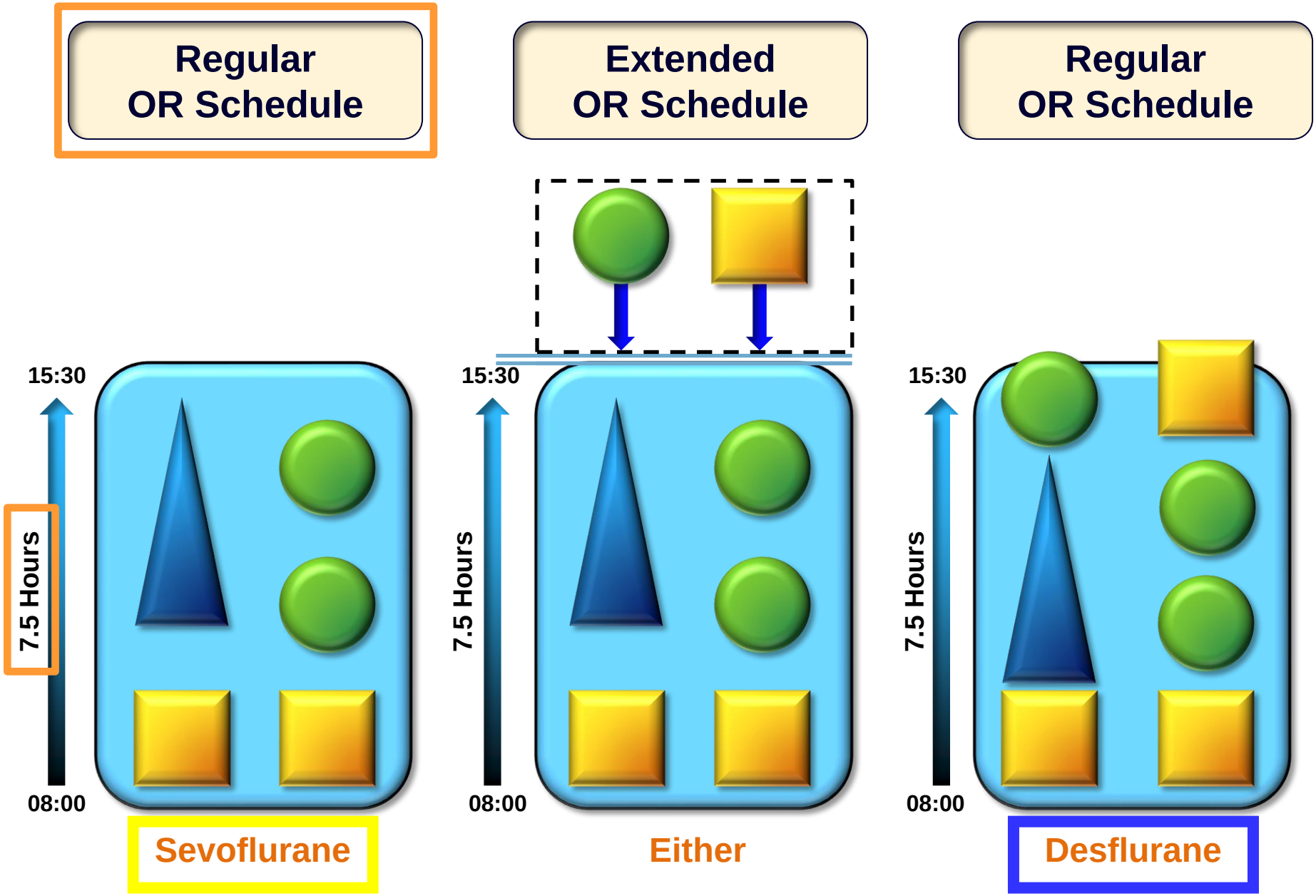
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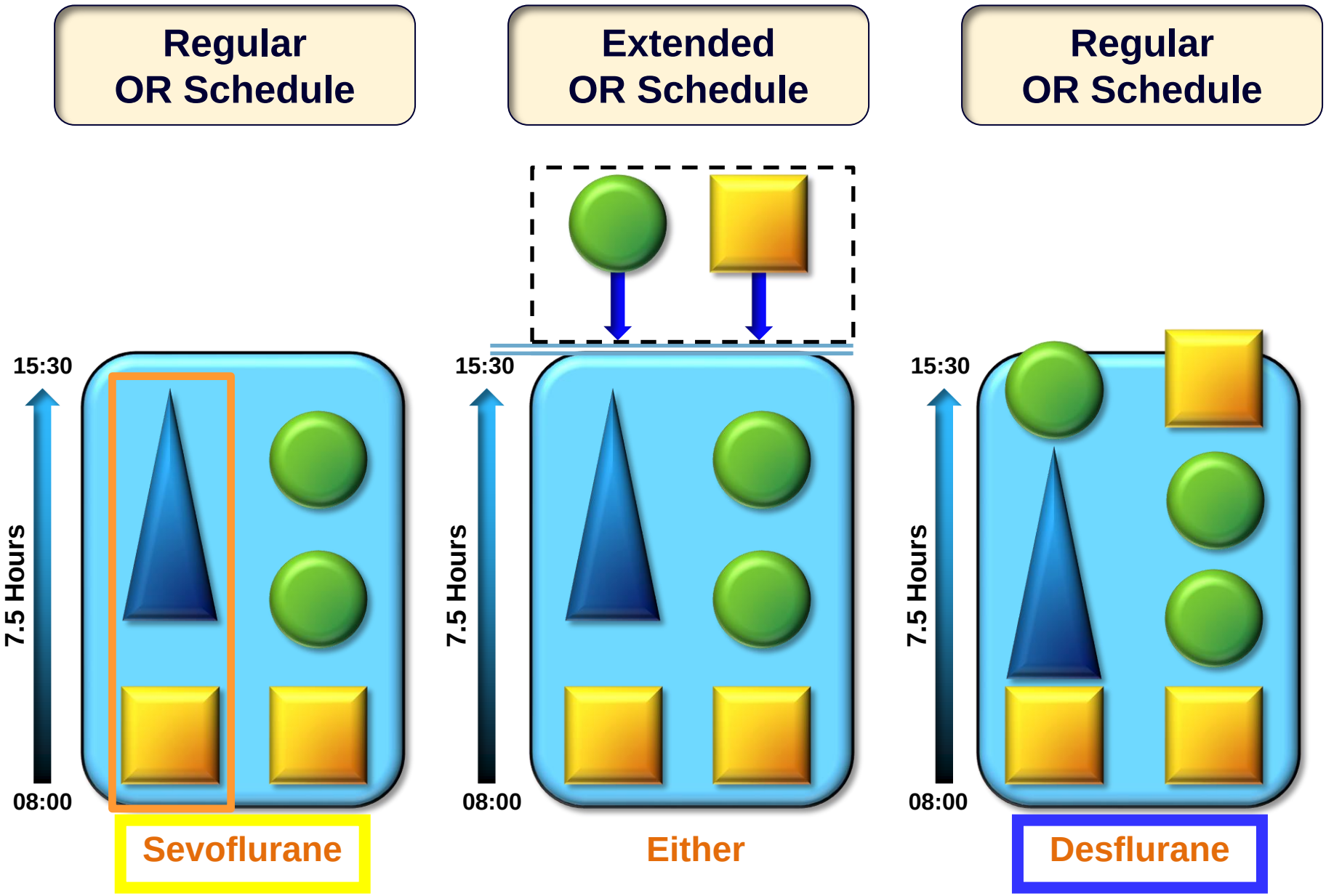
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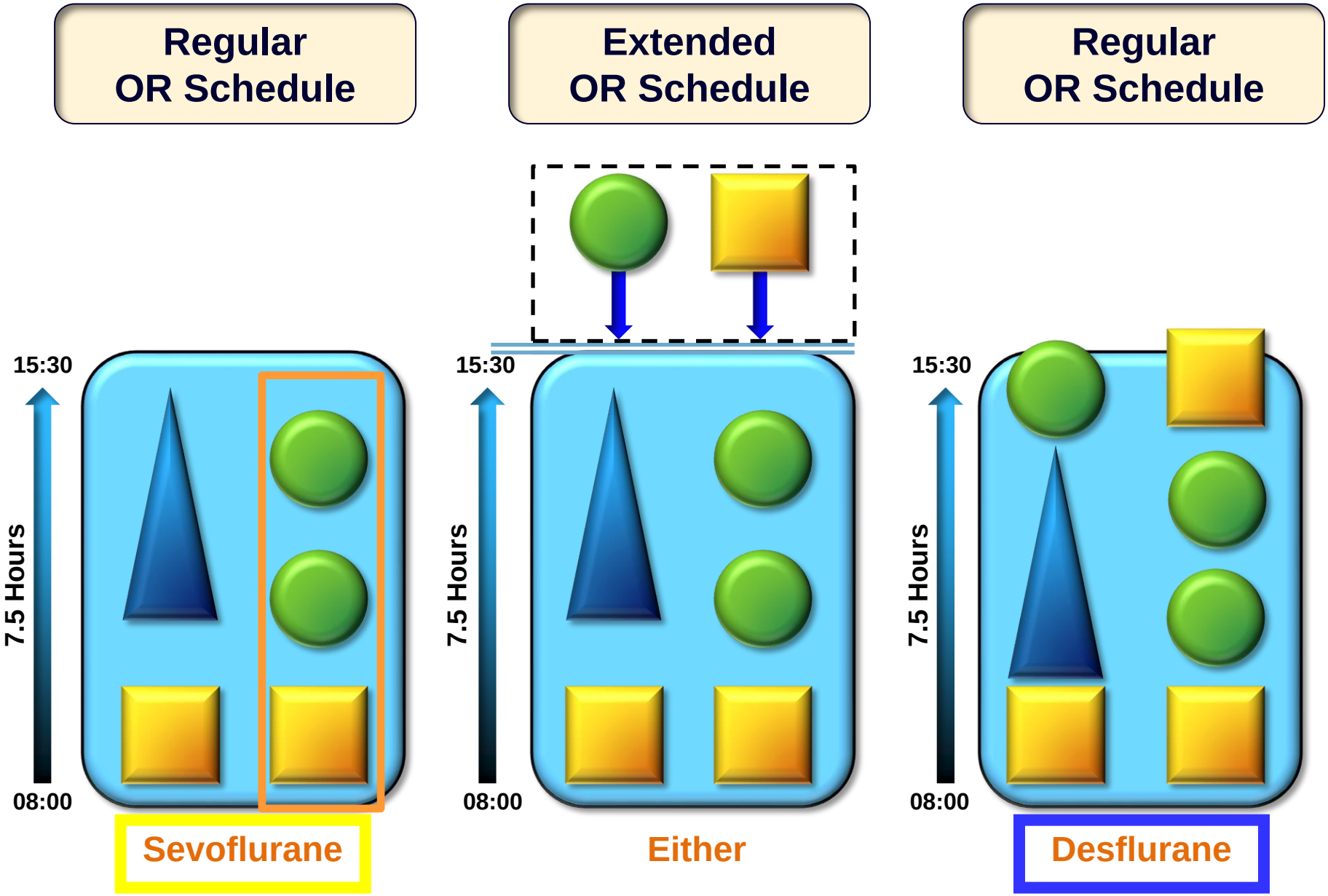
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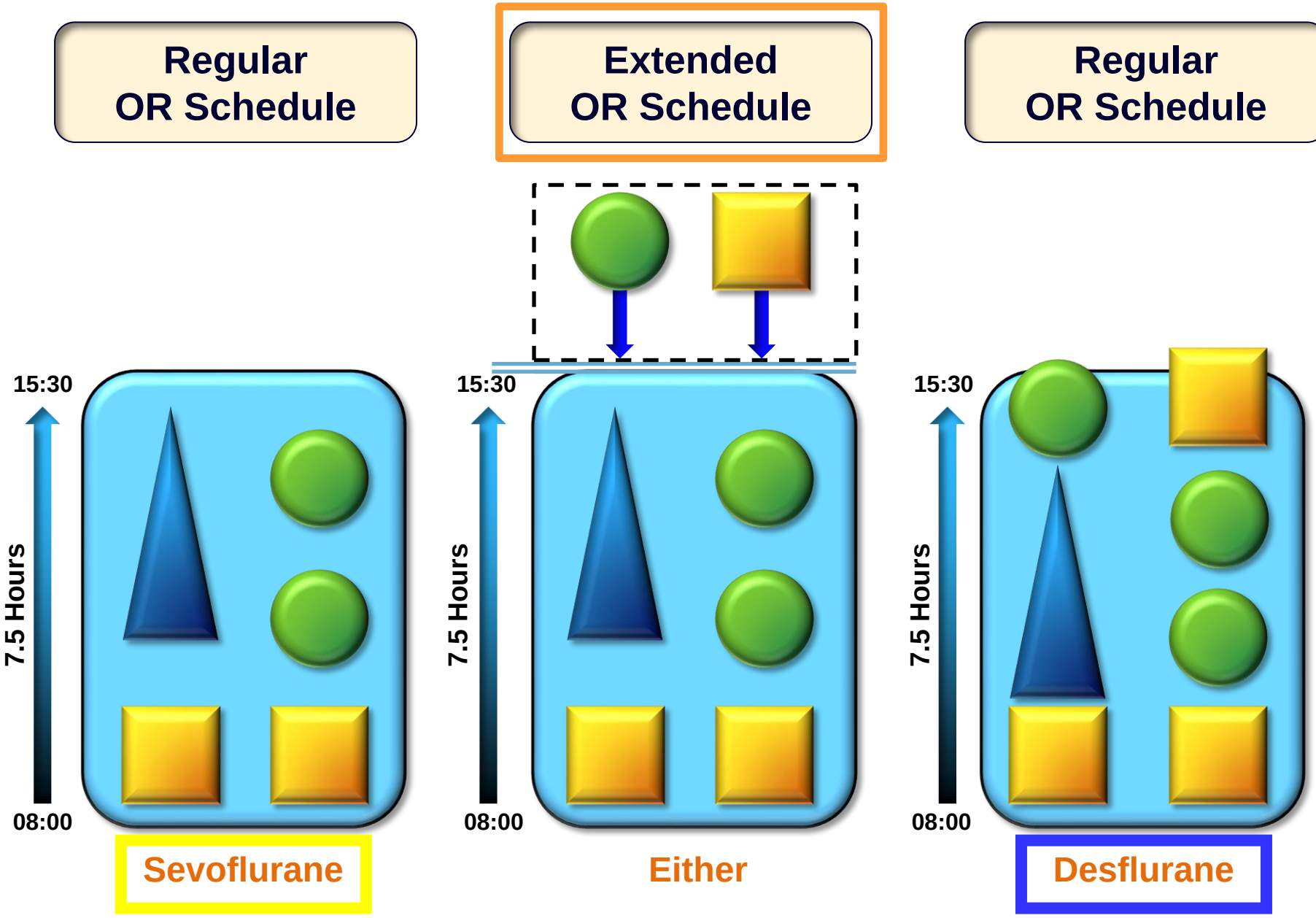
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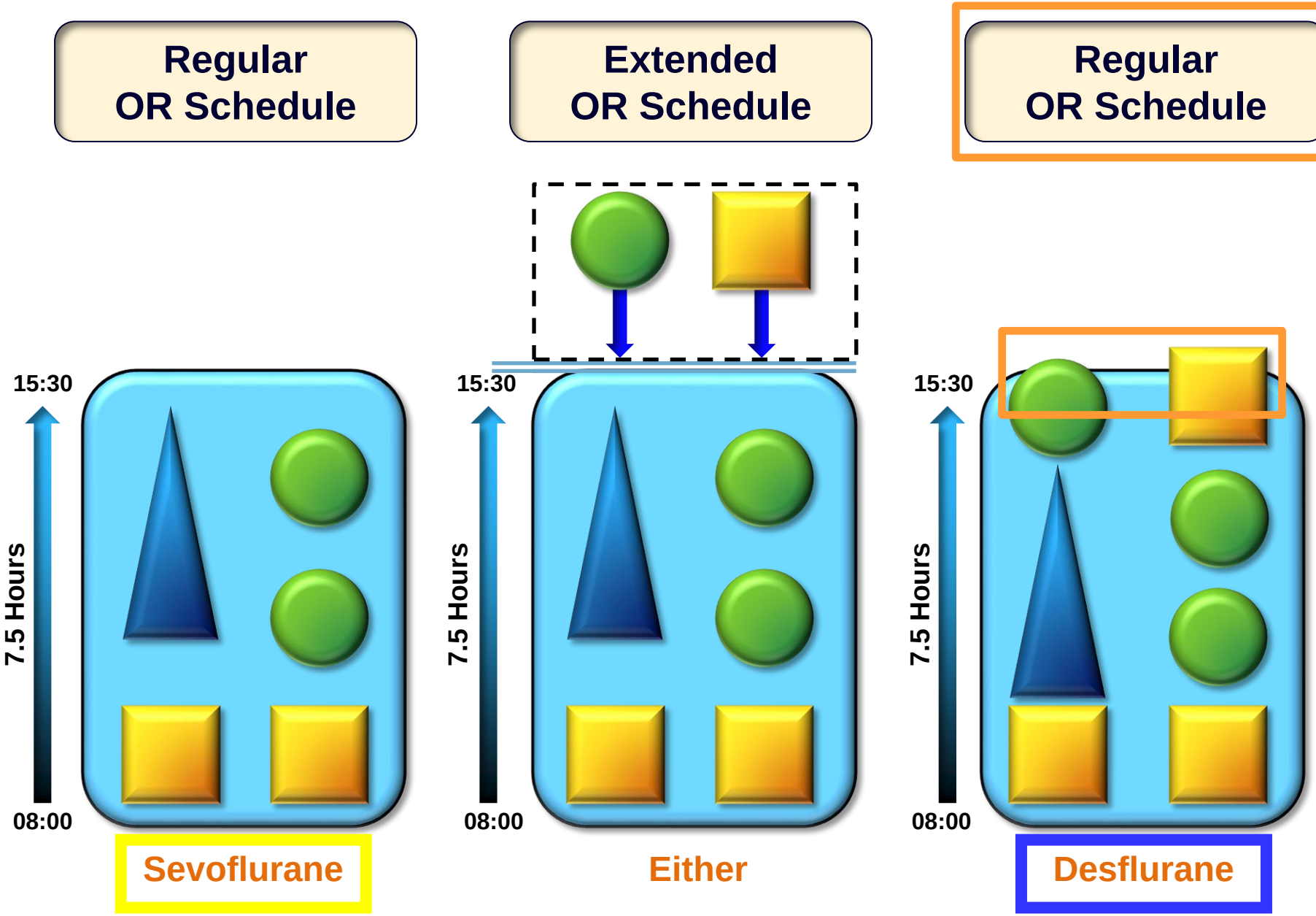
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Some Interventions' Benefits So Big That No Need for Simulation

- Change the type of anesthesia performed
- Example
  - Phase I PACU bypass rate for monitored anesthesia care patients was 90% at multiple ambulatory surgery centers
  - Monitored anesthesia care also reduced drug administration versus general anesthesia

Apfelbaum JL et al. Anesthesiology 2002

More Local Anesthesia

- Hand surgery cases requiring no more equipment than 2 surgical trays and 1 all-inclusive "hand pack"
  - Example: endoscopic carpal tunnel release
- Local anesthesia cases' non-surgical times (turnover + anesthesia-controlled time) averaged 18 minutes less than general anesthetic and 7 minutes less than monitored anesthesia care cases (both $P < 0.001$)

Caggiano NM et al. J Hand Surg Am 2015

More Regional Anesthesia

- At facilities where regional nerve block for one patient can be performed outside of OR while preceding case is being done

Brown MJ et al. Int J Health Care Qual Assur 2014

Gleicher Y et al. Reg Anesth Pain Med 2017

More Regional Anesthesia

- At facilities where regional nerve block for one patient can be performed outside of OR while preceding case is being done

➢ Regional for outpatient knee surgery

  – ?
  – ?
  – ?

} Ways potentially to reduce costs

More Regional Anesthesia

- At facilities where regional nerve block for one patient can be performed outside of OR while preceding case is being done
- Regional for outpatient knee surgery
  - Drug costs are less [definitely no more]
  - Averaged 9 minutes less anesthesia controlled time than general anesthesia
  - 87% of patients bypassed phase I PACU

Williams BA et al. Anesthesiology 2000 and 2002

Impact of the Reduced Anesthesia-Controlled Time

- 9 min ↓ anesthesia controlled time vs. GA
- No difference in surgical time versus GA
- Overall reduction unlikely large enough to reduce OR costs
- Definitely no increase in OR costs

Dexter F et al. Anesth Analg 1995, 2003
Dexter F et al. Reg Anesth Pain Med 1998
Williams BA et al. Anesthesiology 2000

Impact of 87% of Patients Bypassing Phase I PACU

- Reduced costs not just by reducing time to discharge by 34 min, but by each nurse caring for 3 rather than 2 patients
- Such reductions more than enough to result in financially important reductions in PACU staffing costs when done on a long-term basis

Williams BA et al. Anesthesiology 2002

Dexter F et al. Anesth Analg 1999

Hospitals 100% Patients Bypass Because no Phase I PACU

- 16 successive patients for laparoscopic gynecologic surgery with endotracheal intubation for general anesthesia at typical Japanese hospital with no phase I PACU versus University of Iowa

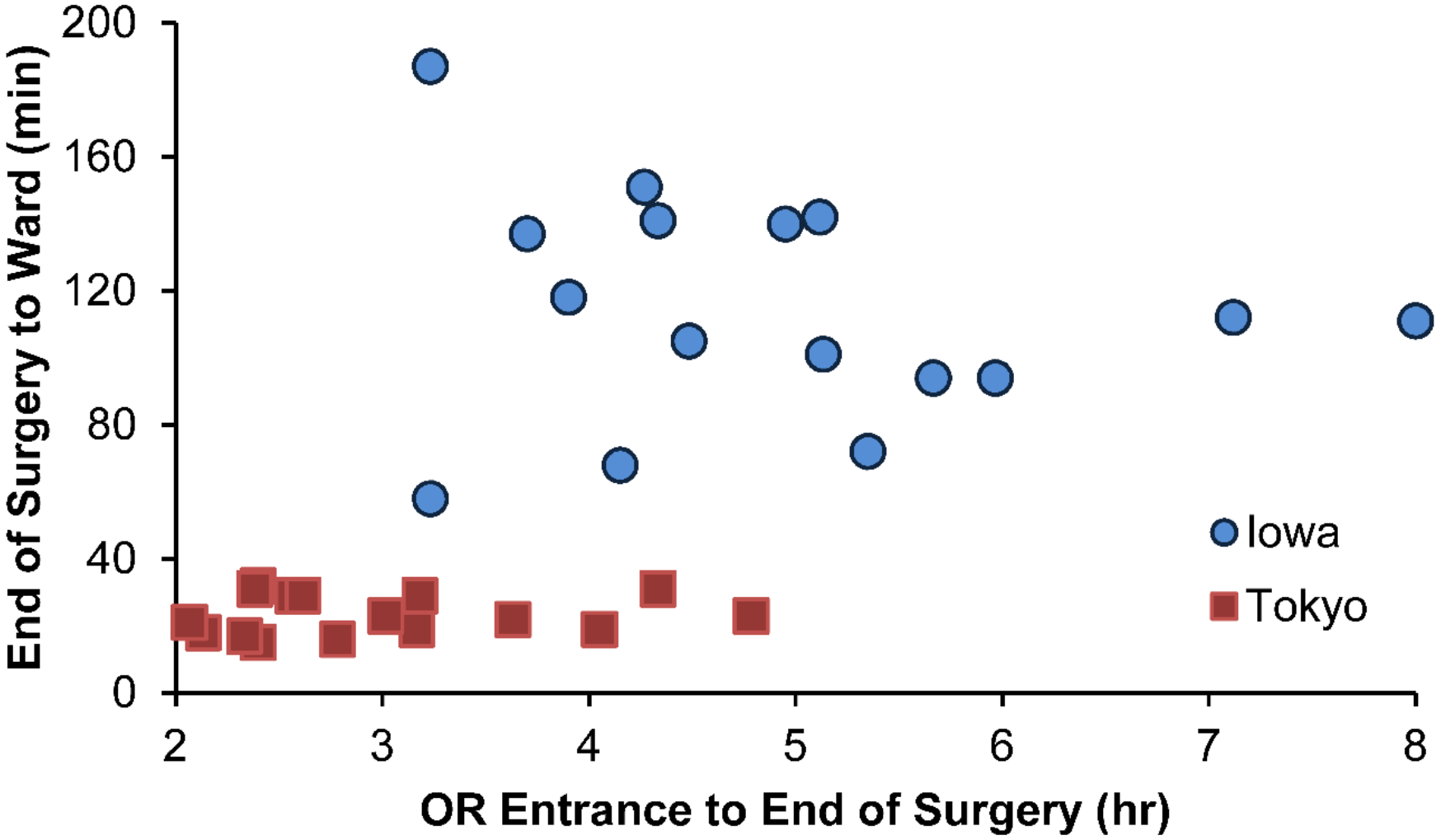
Thenuwara KN et al. Can J Anesth 2018

Hospitals 100% Patients Bypass Because no Phase I PACU

- 16 successive patients for laparoscopic gynecologic surgery with endotracheal intubation for general anesthesia at typical Japanese hospital with no phase I PACU versus University of Iowa
  - ➢ Every patient Shin-yurigaoka General Hospital had briefer time from end of surgery to ward than every such patient at University of Iowa ($P < 0.001$)

Thenuwara KN et al. Can J Anesth 2018

Hospitals 100% Patients Bypass Because no Phase I PACU



Hospitals 100% Patients Bypass Because no Phase I PACU

- While controlling for duration of surgery, estimated mean recovery time at the Tokyo hospital was 81.2% faster than at University of Iowa (95% CI 72.7% to 87.1%, P < 0.001)

Thenuwara KN et al. Can J Anesth 2018

Hospitals 100% Patients Bypass Because no Phase I PACU

- While controlling for duration of surgery, estimated mean recovery time at the Tokyo hospital was 81.2% faster than at University of Iowa (95% CI 72.7% to 87.1%, P < 0.001)
  - BIS monitor, target-controlled propofol infusion, and remifentanil versus sevoflurane or isoflurane and hydromorphone

Thenuwara KN et al. Can J Anesth 2018

Hospitals 100% Patients Bypass Because no Phase I PACU

- Mean times from end of surgery to OR exit 1.9 minutes briefer at different Japanese hospital than University of Iowa ($P < 0.0001$)
- However, 100% of N=699 patients discharged from OR directly to surgical ward versus Iowa 97% of N=785 to phase I PACU, rest to ICU
  - No phase I PACU care even though all patients' gynecological surgery duration $\geq$ 4 hours

Sugiyama D et al. Anesth Analg 2021

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- However, 100% of N=699 patients discharged from OR directly to surgical ward versus Iowa 97% of N=785 to phase I PACU, rest to ICU
  - Prolonged extubations were 6% versus 39%, respectively, and same among subset patients with desflurane/remifentanil versus neither

Review – Summarize the Facts of the Talk

List Priorities to Monitor to Assess Anesthesia Efforts at Reducing Costs

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Additional Information on Operating Room Management

- www.FranklinDexter.net/education.htm
  - Example reports with calculations
  - Lectures on day of surgery decision making, PACU staffing, OR allocation and staffing, anesthesia staffing, financial analysis, comparing surgical services among hospitals, and strategic decision making
- www.FranklinDexter.net
  - Comprehensive bibliography of peer reviewed articles in operating room and anesthesia group management