

# Operating Room Financial Assessment for Tactical Decision Making (Allocating “Block Time”)

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# Operating Room Financial Assessment for Tactical Decision Making (Allocating “Block Time”)



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# Allocating OR Time Tactically (Over 1-2 Year Time Course)

- Background and definitions
- Allocating OR time to  $\uparrow$  OR utilization
  - Several reasons why this is a poor choice
- Allocating OR time to  $\uparrow$  contribution margin
  - Interpretation when not just fee for service
  - Linear programming
  - Analysis of facility's portfolio of surgeons
  - Linking tactical to operational decisions
  - Forecasting market growth



# 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)

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# Examples of Tactical versus Operational Decisions

- Tactical (focus of this talk)
  - We have contracted for 16 hours per day of OR time at an ASC starting in 6 months. Should we do hand surgery cases there?
    - If no OR time is allocated to hand surgery at the ASC, no hand surgery will be performed



# Examples of Tactical versus Operational Decisions

- Operational (not focus of this talk)
  - The hand surgery group has worked at our ASC for the past three years. Based on their historical workload, how many hours of OR time should we plan for them on Mondays during the next quarter?



# Examples of Tactical versus Operational Decisions

- Allocating OR time tactically involves changes in OR workload that occur over periods of months to years
- Allocating OR time operationally matches staffing to existing OR workload





# Examples of Tactical versus Operational Decisions

- Talk applies to annual budget meeting
  - Buy new microscope so hand surgeons can increase their surgical volume at the outpatient surgery center?
  - Reject increasing the number of knee implants purchased?
  - Tactically, OR allocations are linked closely to available equipment and specialized staff
    - Reason is that this applies to new cases



# Examples of Tactical versus Operational Decisions

- Inappropriate application of this talk to operational (daily) OR decision making
  - Nurse at OR desk decides hand case will be added to schedule, but not knee replacement, to improve the hospital's finances



# Examples of Tactical versus Operational Decisions

- If lack of OR time is **bottleneck** to growth of a subspecialty, then allocation of more OR time tactically is synonymous with ...
  - Recruiting another surgeon
  - Purchasing more equipment
  - Expanding clinic visits
  - Increasing ward and ICU usage
- “Yield management” with the decision at the level of the surgeon, not patient



# Tactical versus Operational

## Focus of End of Talk

- End of talk will focus on the implications of there being two stages to OR allocation: first tactical and then operational
- Fact that tactical decision is fine-tuned by later operational decisions influences how tactical decisions should be made
- Although I will put the issue aside for the next half hour, I will be showing that it has crucial implications for the tactical decision



# Will Limit Consideration to Elective Surgery

- Patients studied are those who underwent
  - Outpatient surgery
  - Admission on the day of elective surgery



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- Exclude patients admitted from emergency departments (non-elective surgery)





# Will Limit Consideration to Elective Surgery

- Patients studied are those who underwent
  - Outpatient surgery
  - Admission on the day of elective surgery
- Exclude urgent cases
  - Strategic decisions affecting numbers of such patients are made at a health system level
- Exclude patients admitted from emergency departments (non-elective surgery)
  - Strategic decisions affect emergency services, but surgeons and OR managers do not

# Attribute Each Elective Surgical Case to Its Surgeon

- Although objective is to analyze financial impact of different subspecialties, “surgeon” is a field in hospital databases
- Steps of analysis
  - Perform analysis by surgeon
  - Describe surgeon’s subspecialty based on procedures performed
  - Delete surgeon’s name if desired



# Attribute Each Elective Surgical Case to Its Surgeon

- As focus is subspecialty, near useless comparison is differences in OR time between teams doing tonsillectomy
  - Irrelevant to allocating OR time tactically
  - Very few hospitals have managerial cost accounting suitable for such comparisons
- Important comparison is outpatient pediatric otolaryngology versus minimally invasive general thoracic surgery



# Attribute Each Elective Surgical Case to Its Surgeon

- Not focusing on individual procedures
- OR time is not allocated to “knee replacement cases” but to the surgeon(s) who do knee replacement cases



# Fixed and Variable Costs

- Fixed costs
  - Do not change relative to volume of activity
  - What are examples of fixed costs?



# Fixed and Variable Costs

- Fixed costs
  - Do not change relative to volume of activity
  - What are examples of fixed costs?
    - Maintenance of building and grounds
    - Billing office and information systems
    - OR beds



# Fixed and Variable Costs

- Variable costs
  - Change relative to volume of activity
  - Examples
    - Salaries of healthcare providers
      - Employees' time considered a variable cost since numbers and shifts can be changed on tactical (long-term) basis
    - Implants
    - Disposable supplies
    - Medications



# Contribution Margin and Profit

- Contribution margin =  
revenue – variable costs
- Profit =  
revenue – variable costs – fixed costs
- Variable costs <  $\frac{1}{2}$  of fixed costs

Macario A et al. Anesthesiology 1995

Dexter F, Macario A. Anesthesiology 1996

Roberts RR et al. JAMA 1999





# Contribution Margin and Profit

- Contribution margin =  
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- Variable costs <  $\frac{1}{2}$  of fixed costs

*To increase profit with available OR time, do not focus on subspecialties providing large profit, but large contribution margin*



# Contribution Margin Data Should be From Each Facility

- Even for similar cases, contribution margins are sensitive to
  - Payer mix
  - Reimbursement levels
    - Wage index
    - Geographic adjustments



# Examples of Reimbursement

## Average Medicaid Payment Per User

	<u>Iowa</u>	<u>Illinois</u>
Physician Services	\$390	\$371
Inpatient Hospitalization	\$5,225	\$9,631



# Contribution Margin Data Should be From Each Facility

- Percentage fixed costs vary tremendously among non-profit facilities
  - Inconsistency of depreciating buildings and capital equipment
    - Cash based accounting
      - Expenses entire cost during first year
      - Advantageous publicly not to appear to have too much revenue relative to costs
- Since reimbursement tied to total costs, contribution margin varies markedly

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# OR Utilization is Frequently Used as Basis for OR Allocation

- “Ministry has prioritized joint replacement. Our two surgeons doing those cases have a 91% utilization. They will need more OR time.”
- “The two vascular surgeons have had a 60% utilization, since the intensive care units have been full. They don’t need as much time.”
- OR committee takes vascular surgery allocated time and gives it to joint replacement surgeons



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- OR committee takes vascular surgery allocated time and gives it to joint replacement surgeons

*Was that a good decision?*



# OR Utilization (Alone) is Poor Basis for Allocating OR Time

- Poorly related to patient waiting times
- Poorly related to contribution margin
- Efforts to increase utilization can ↓ margin
- Increasing utilization ↓ surgeon flexibility
- Poorly related to variable costs
- Questionable whether utilization can be estimated precisely for this application

Wachtel RE, Dexter F. Anesth Analg 2008





# OR Utilization (Alone) is Poor Basis for Allocating OR Time

- Poorly related to patient waiting times
  - Relevant to waiting lists and mission
- Poorly related to contribution margin
- Efforts to increase utilization can ↓ margin
- Increasing utilization ↓ surgeon flexibility
- Poorly related to variable costs
- Questionable whether utilization can be estimated precisely for this application



# Policy Goals Based on Patient Waiting Times, Not Utilization

- Politicians like to reduce the number of patients on waiting lists
- Public health goal is to reduce the average patient waiting time
- Allocating OR time based on utilization achieves neither objective



# Policy Goals Based on Patient Waiting Times, Not Utilization

- Politicians like to reduce the number of patients on waiting lists
  - Public health goal is to reduce the average patient waiting time
  - Allocating OR time based on utilization achieves neither objective
- Why not?



# Policy Goals Based on Patient Waiting Times, Not Utilization

Revenue  $\neq$  (value of each utilized OR hour)  
 $\times$  OR hours used

Revenue = (value of each patient)  
 $\times$  # of patients cared for

- Patients served per day achieves short waiting times
- Ideally do many short cases



# OR Utilization (Alone) is Poor Basis for Allocating OR Time

- Poorly related to patient waiting times
- Poorly related to contribution margin
  - Relevant to fee-for-service reimbursement
- Efforts to increase utilization can ↓ margin
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Wachtel RE, Dexter F. Anesth Analg 2008



# Difference Between OR Utilization and Cont. Margin

- Making decisions based on the following statistics gives different outcomes
  - OR utilization
  - Contribution margin

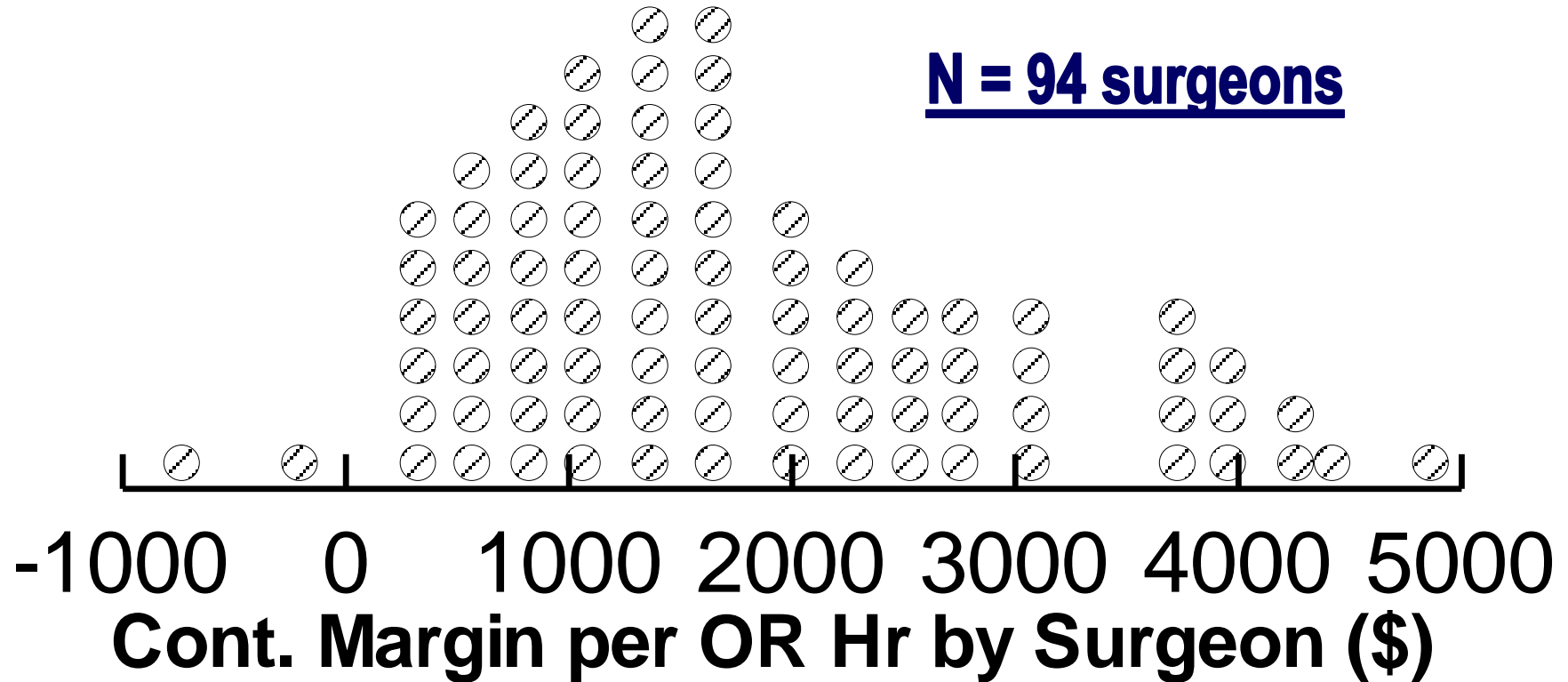


# Difference Between OR Utilization and Cont. Margin

- Making decisions based on the following statistics gives different outcomes
  - OR utilization
  - Contribution margin
- Write down your prediction
  - If two surgeons in different ORs of a tertiary surgical suite both do 7 hr of cases in 8 hr workday, by how much can contribution margin differ, after exclude outliers?

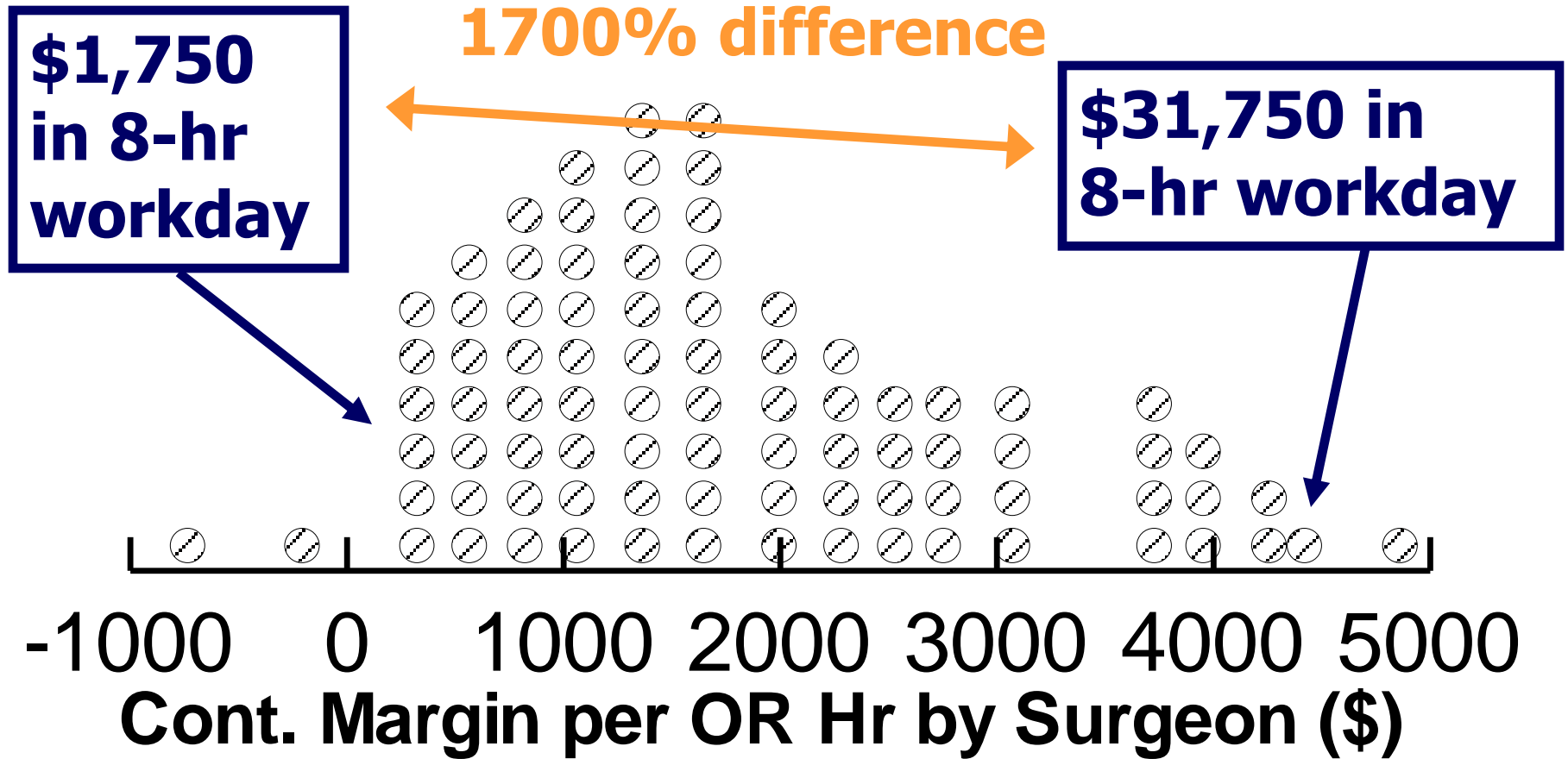


# OR Utilization Is Not an Accurate Surrogate for Contribution Margin

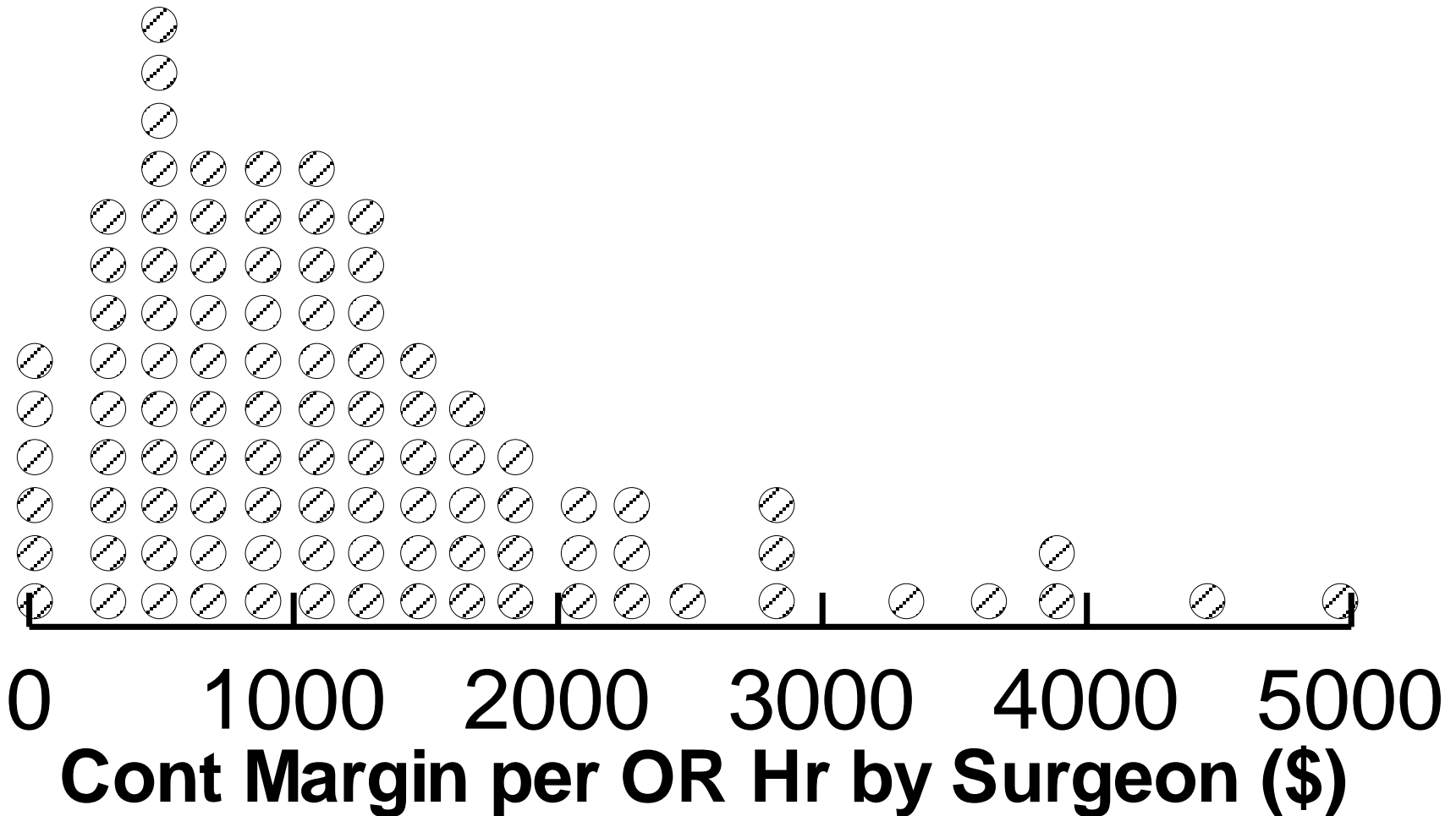




# OR Utilization Is Not an Accurate Surrogate for Contribution Margin



# Contribution Margin Per Hour Varies > 1000% Among Surgeons



# OR Utilization (Alone) is Poor Basis for Allocating OR Time

- Poorly related to patient waiting times
- Poorly related to contribution margin
- Efforts to increase utilization can ↓ margin
  - Efforts applied upstream of bottleneck
- Increasing utilization ↓ surgeon flexibility
- Poorly related to variable costs
- Questionable whether utilization can be estimated precisely for this application

Wachtel RE, Dexter F. Anesth Analg 2008



# Efforts to Increase Utilization Can Reduce Contribution Margin

- Common ways to increase surgical volume
  - Sign more contracts for “covered lives”
  - Add incentives for surgeons to do more cases
- Although these methods increase clinic visits, they do not increase surgery, OR utilization, or contribution margin

Dexter F et al. Anesth Analg 2001

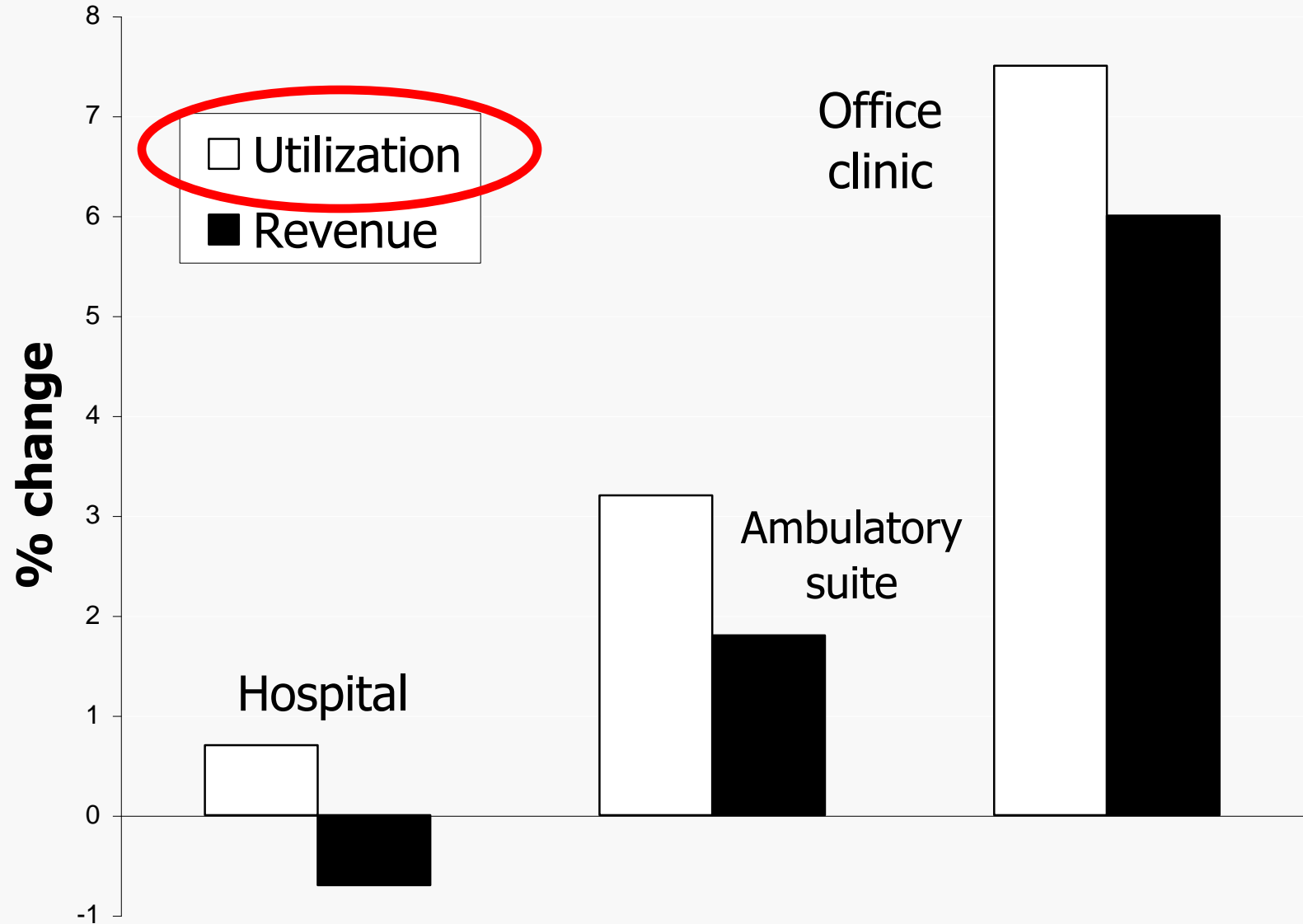


# Efforts to Increase Utilization Can Reduce Contribution Margin

- Hypothetical scenario
  - Adjusted operating room utilization is 90%
  - Sign 11% more covered lives
    - $11\% = (100\% - 90\%) \div 90\%$
  - Cases are scheduled provided they can be completed within available OR capacity



# Signing More Contracts Can Increase Volume of Short Cases



# Only Small Increase in Hospital OR Utilization Is Achieved

- Increasing patient volume by 11% increases utilization by ...
  - 7% for surgical clinics, very short cases
  - 4% for outpatient – medium duration cases
  - < 1% for hospital surgical suite – long cases



# Increasing Patient Volume May Not Increase OR Utilization

- Longer case durations “pack” less well
  - Hard to pack big suitcases into a car trunk
- Few cases can fit into remaining OR time
  - $(100\% - 90\%) \times 8\text{-hr} - 0.5\text{ hr turnover} = 0.3\text{ hr}$
  - 1<sup>st</sup> percentile of durations of hospital cases
- Each OR has few patients each day
  - Random variation in timing of patients’ requests has large proportional effect



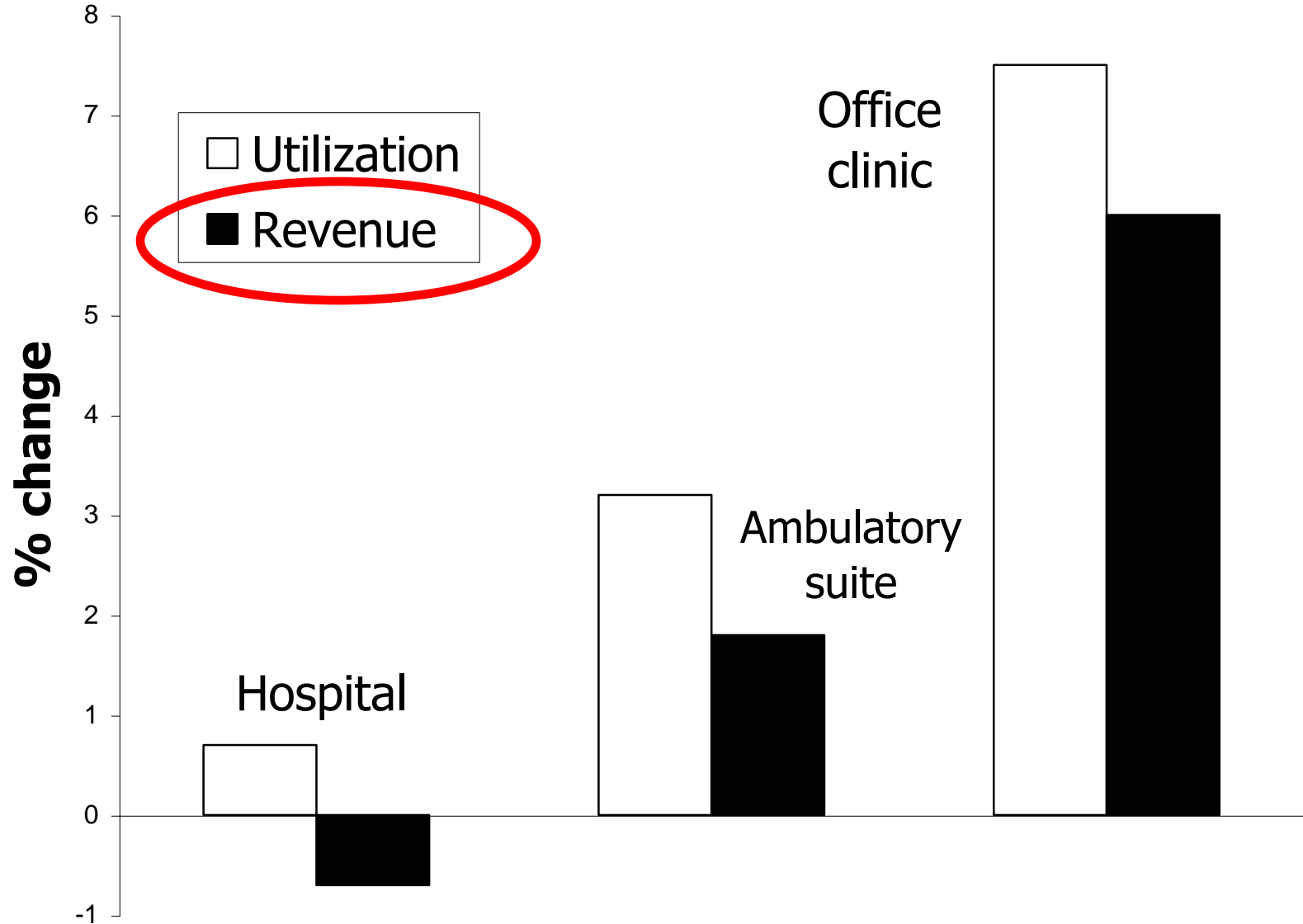


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# Impact of 15% Less Revenue Per Case for New Patients



# Why Not a Close Analogy to this Result in Manufacturing?

- Why is it hard to identify a close analogy of this problem to that of manufacturing?
  - Hint: do hospitals set price?



# OR Utilization (Alone) is Poor Basis for Allocating OR Time

- Poorly related to patient waiting times
- Poorly related to contribution margin
- Efforts to increase utilization can ↓ margin
- Increasing utilization ↓ surgeon flexibility
  - OR not bottleneck to growth for all subspecialties
- Poorly related to variable costs
- Questionable whether utilization can be estimated precisely for this application

Wachtel RE, Dexter F. Anesth Analg 2008



# Achieving High OR Utilization Reduces Surgeons' Flexibility

## Reduces Surgeons' Flexibility

- Increasing OR utilization to high levels reduces some surgeons' flexibility to be entrepreneurial and grow their practices



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  - Not unreasonable provided lack of OR time is the bottleneck to growth of surgical practices



# Achieving High OR Utilization Reduces Surgeons' Flexibility

- Increasing OR utilization to high levels reduces some surgeons' flexibility to be entrepreneurial and grow their practices
  - Not unreasonable provided lack of OR time is the bottleneck to growth of surgical practices
    - For some subspecialties, it is not



# Achieving High OR Utilization Reduces Surgeons' Flexibility

- For some subspecialties, lack of ICU time is the bottleneck, not a lack of OR capacity
- Because of variability in ICU length of stay, inaccurate predictions for ICU bed availability
- If bottleneck is downstream to OR, then “pull” system needed whereby OR time is available when there is downstream availability

Gallivan S et al. Brit Med J 2002

Ryckman FC et al. Jt Comm J Qual Patient Saf 2009

Meyfroidt G et al. BMC Med Inform Decis Mak 2011

Yang M et al. Crit Care Med 2013



# Achieving High OR Utilization Reduces Surgeons' Flexibility

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- Because of variability in ICU length of stay, inaccurate predictions for ICU bed availability
- If bottleneck is downstream to OR, then “pull” system needed whereby OR time is available when there is downstream availability
  - Tactical decision ***should accept*** lower OR utilization, higher operating expense per OR hr, etc., to give surgeons flexibility

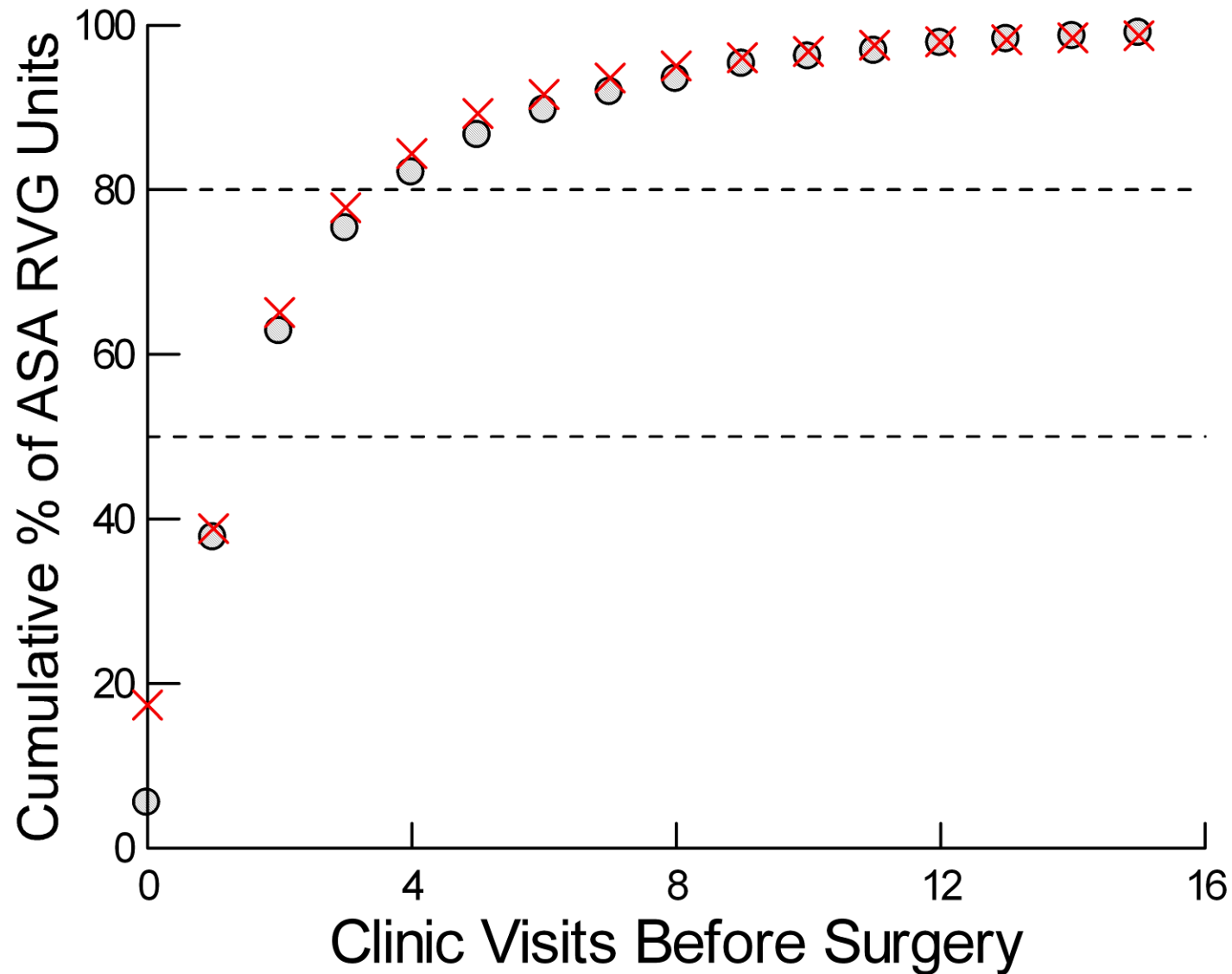
# Achieving High OR Utilization Reduces Surgeons' Flexibility

- For some subspecialties, lack of clinic capacity is the bottleneck, not a lack of OR capacity
- Consider all surgery of any type or urgency
  - Total workload measured by American Society of Anesthesiologists' Relative Value Guide
  - Outpatient (○) and/or tertiary (×) facility
  - For each patient, count prior appointments with surgeon including preoperative visit

O'Neill L et al. Anesthesiology 2009



# Achieving High OR Utilization Reduces Surgeons' Flexibility



# Achieving High OR Utilization Reduces Surgeons' Flexibility

<b>Procedure</b>	<b>% Cases</b>	<b>Median Visits (95% CI) by Units</b>	<b>Median Visits (95% CI) by Cases</b>
Cataract extraction	23%	2 (2 to 2)	2 (2 to 2)
Strabismus surgery	5.8%	2 (2 to 2)	2 (2 to 2)
Carpal tunnel	4.2%	2 (2 to 2)	2 (2 to 3)
Most common totaling 50% ASA RVG units	52%	2 (2 to 2)	2 (2 to 2)

# Achieving High OR Utilization Reduces Surgeons' Flexibility

- For some subspecialties, lack of clinic capacity is the bottleneck, not a lack of OR capacity
- Since most typical patient sees surgeon once before choosing surgery, growth depends on facilitating surgeons' flexibility in reducing days from referral to first appointment

Dexter F, Traub RD. Anesth Analg 2000

Vasilakis C et al. J Oper Res Soc 2007



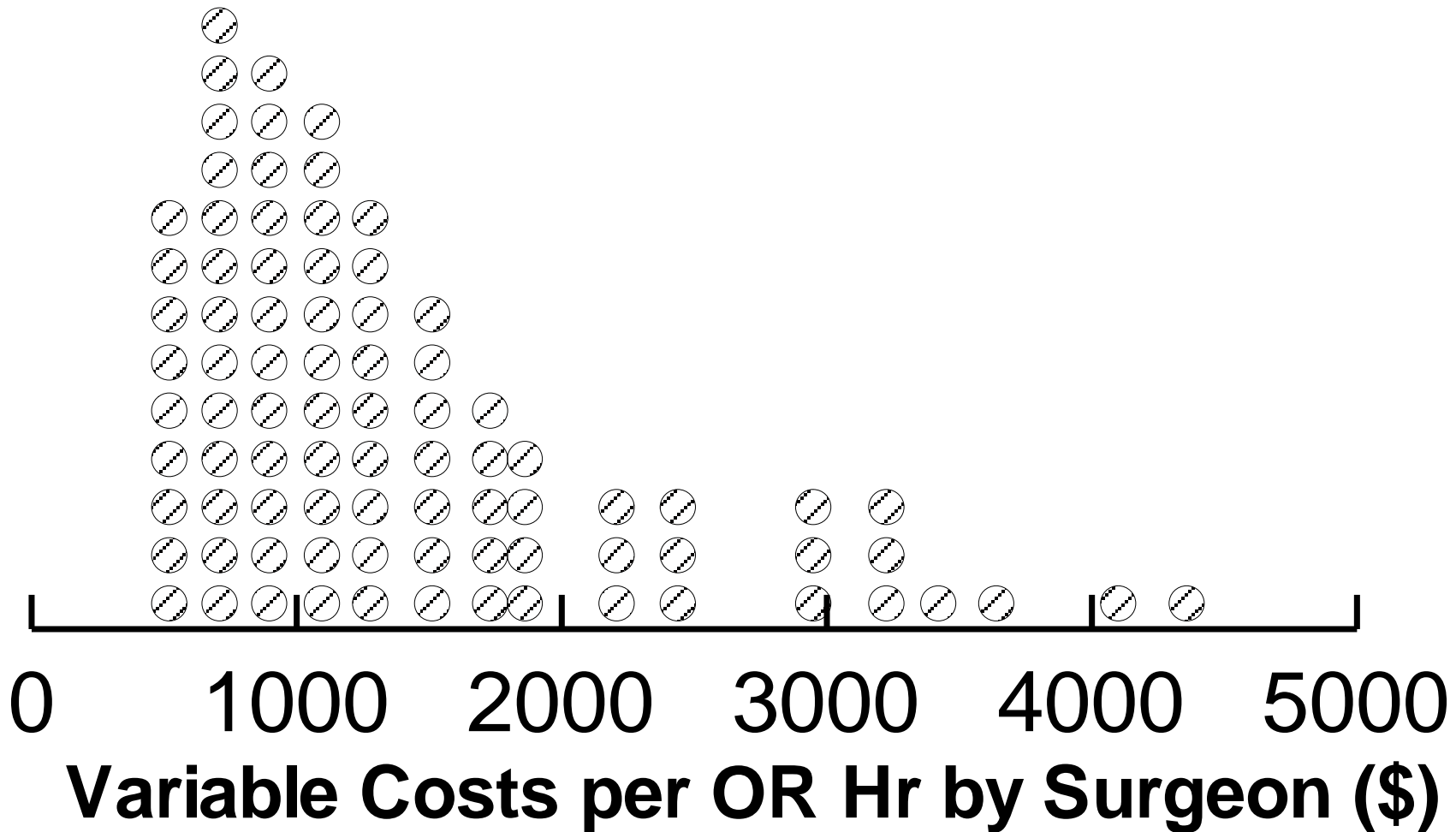
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  - Relevant to hospitals with fixed annual budget
- Questionable whether utilization can be estimated precisely for this application

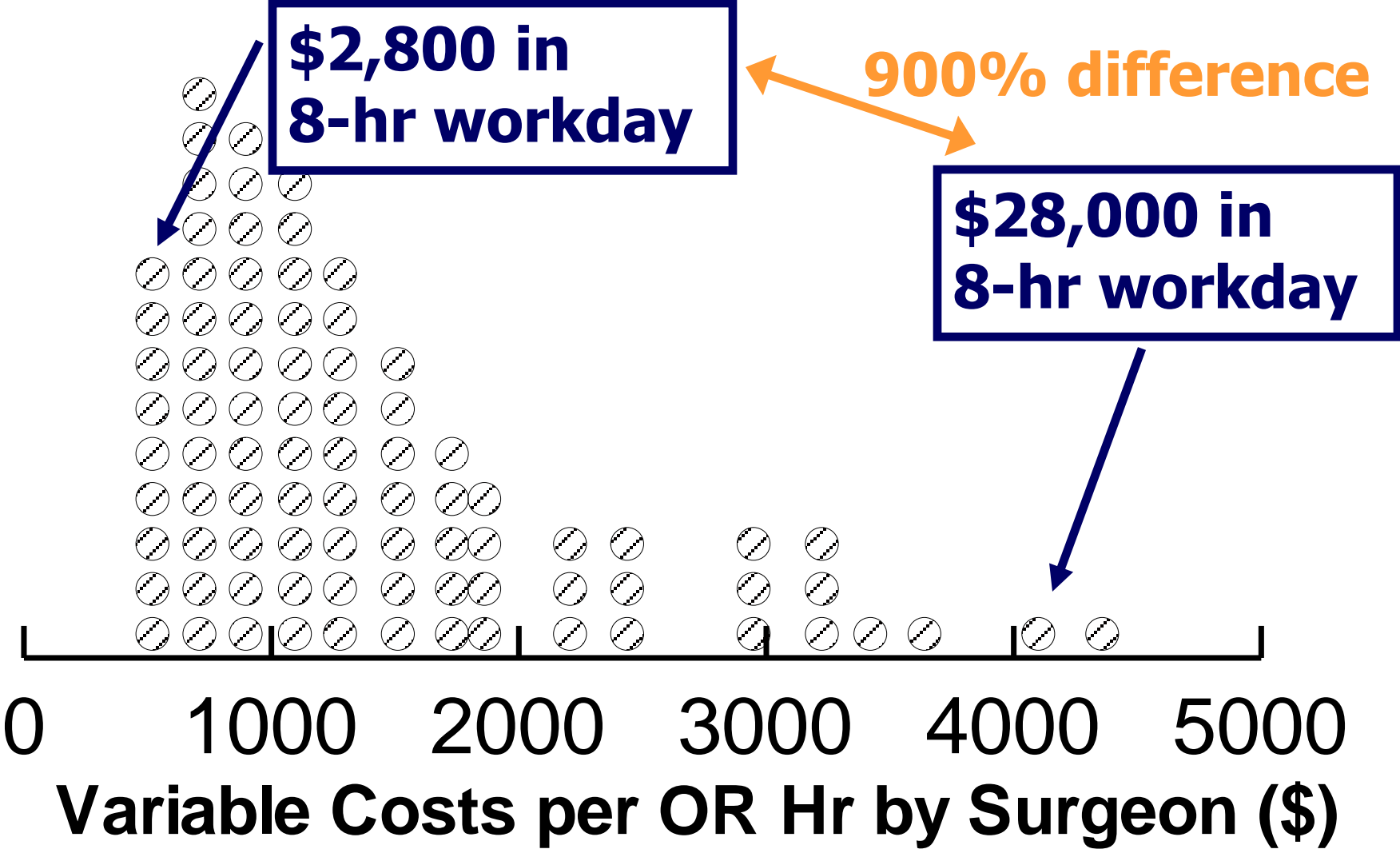
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# Utilization Is Not an Accurate Surrogate for Variable Costs



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# Surgeons with Equal Utilizations Have Different Variable Costs

- Lowest hospital variable costs per OR hour
  - Outpatient otology and breast surgery
- Highest hospital variable costs per OR hour
  - Joint replacement and spinal cord stimulators



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- Implication if small  $\uparrow$  in hospital budget



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  - $\uparrow$  1 OR every workday for inexpensive surgery has same financial effect as  $\uparrow$  1 OR every other week for expensive surgery



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- Lowest hospital variable costs per OR hour
  - Outpatient otology and breast surgery
- Highest hospital variable costs per OR hour
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- Implication if small  $\uparrow$  in hospital budget
  - $\uparrow$  1 OR every workday for inexpensive surgery has same financial effect as  $\uparrow$  1 OR every other week for expensive surgery
  - Harsh, but realistic, reality to be faced



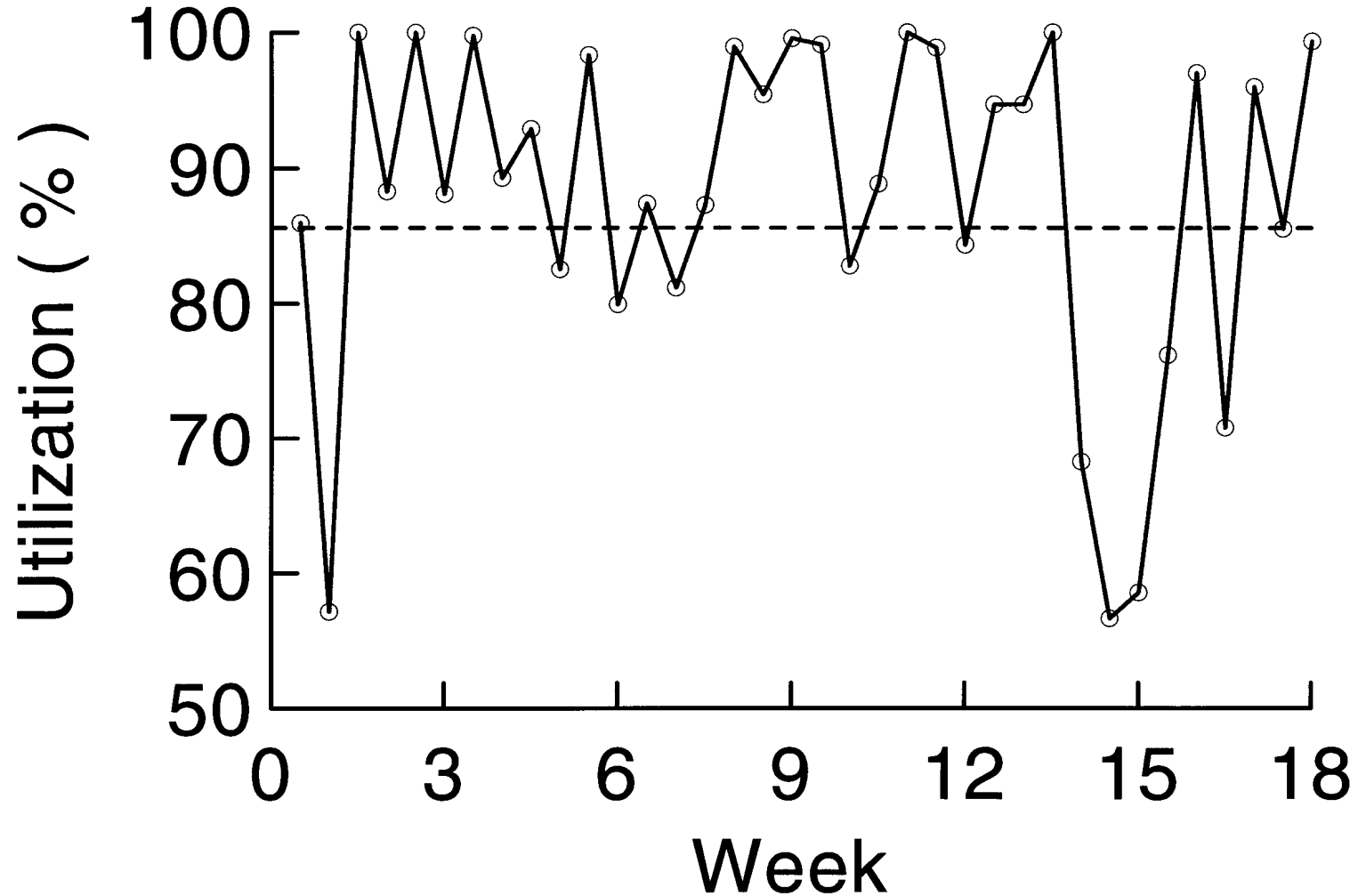
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- Efforts to increase utilization can ↓ margin
- Increasing utilization ↓ surgeon flexibility
- Poorly related to variable costs
- Questionable whether utilization can be estimated precisely for this application
  - Apply valid confidence intervals

Wachtel RE, Dexter F. Anesth Analg 2008



# Where Put Confidence Interval Bars Around Mean Utilization?



# OR Utilization Estimated Accurately Only for Groups

- Surgeon has an average adjusted utilization of 81%
- How many months of data are needed for measured utilization to be a sufficiently accurate estimate of adjusted utilization for practical use?

Dexter F et al. Anesth Analg 1999

Dexter F et al. Anesthesiology 2003



# OR Utilization Estimated Accurately Only for Groups

- Surgeon has an average adjusted utilization of 81%
- How many months of data are needed for measured utilization to be a sufficiently accurate estimate of adjusted utilization for practical use?
  - The answer can be  $> 10$  years





# Example Showing Implication for Allocating OR Time Tactically

- During previous quarter, Surgeon 1 has measured adjusted utilization = 65%
- During previous quarter, Surgeon 2 has measured adjusted utilization = 80%
- Reduce OR time planned for Surgeon 1 and give it to Surgeon 2?



# Example Showing Implication for Allocating OR Time Tactically

- 65% surgeon to an 80% surgeon?
- Probability that surgeons have the same average OR utilization is  $\geq 16\%$ !
  - Measured difference may be random chance



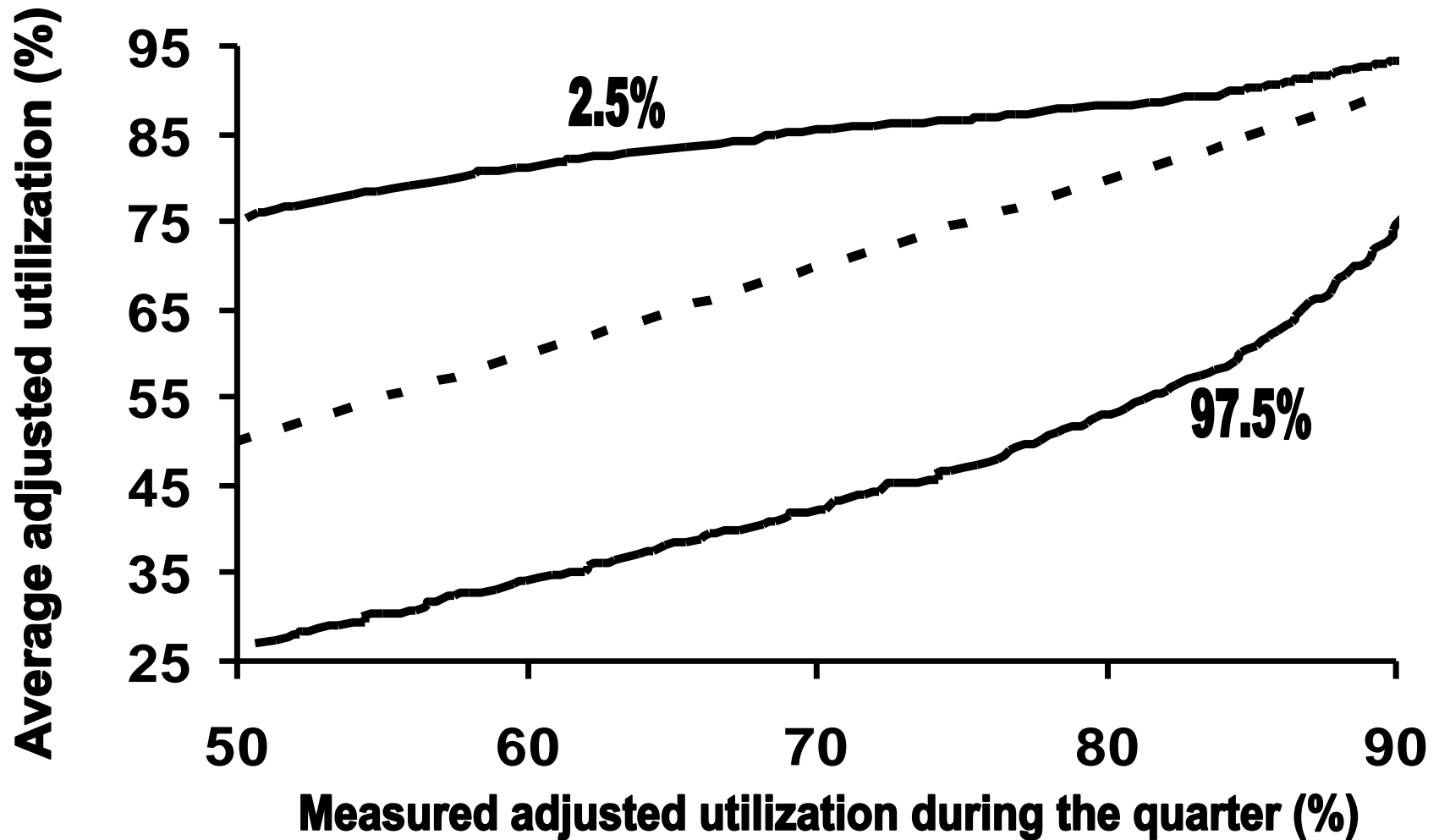
# Study of Underlying Cause of Need for Large Sample Size

- Predominant cause of wide confidence intervals is ...?

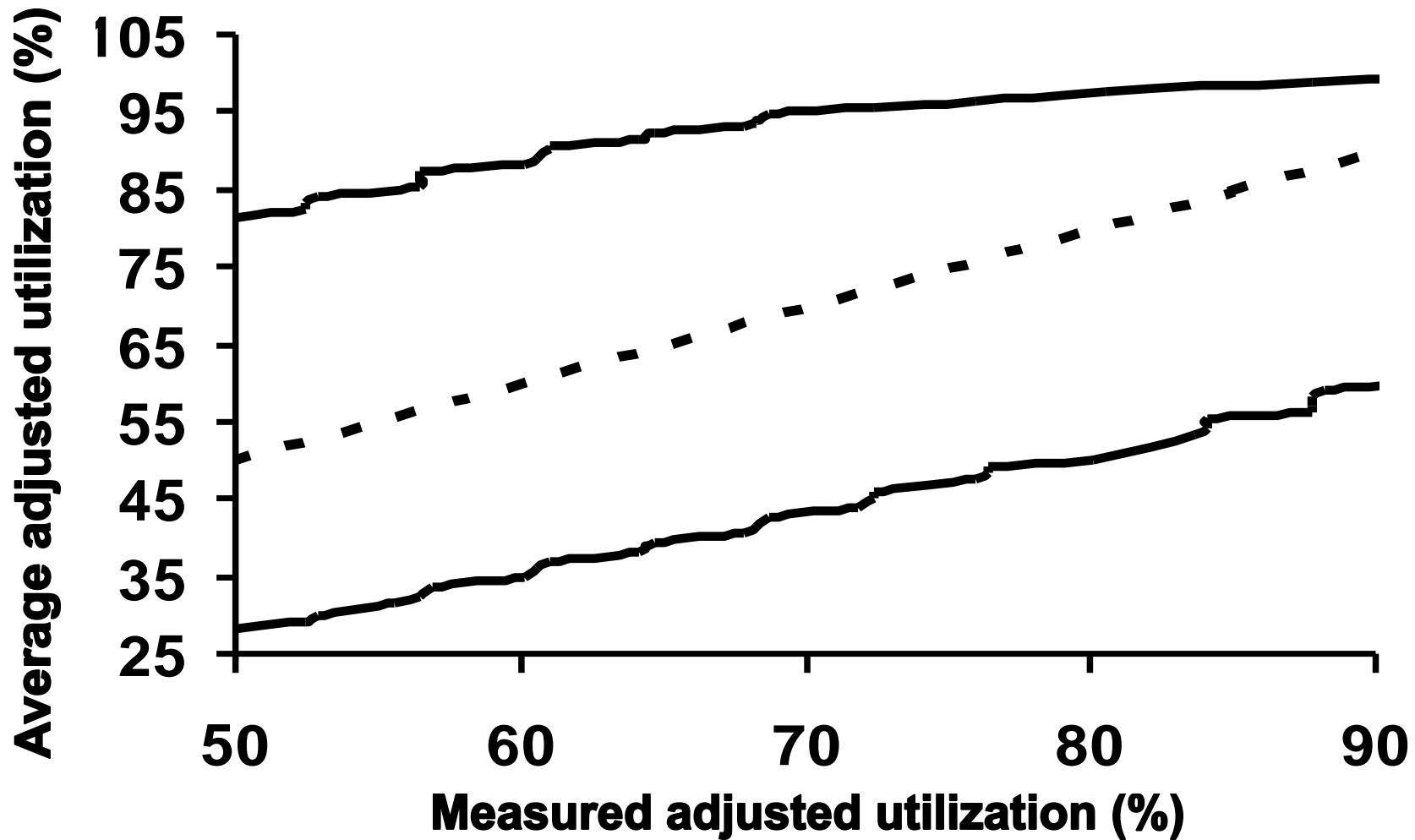
Dexter F et al. Anesthesiology 2003



# If Fall Quarter Utilization = 80%, 95% Confidence Interval Is 54-88%



# Scheduling Cases Taking Precisely 3.75 Hours Into 8 Hours



# Study of Underlying Cause of Need for Large Sample Size

- Predominant cause of wide confidence intervals is random variation in the numbers of patients each week requesting to be scheduled for surgery
  - 2, 3, or 4 patients is large % difference



# Study of Underlying Cause of Need for Large Sample Size

- Predominant cause of wide confidence intervals is random variation in the numbers of patients each week requesting to be scheduled for surgery
  - 2, 3, or 4 patients is large % difference
- What makes OR management so challenging, as compared to clinics, is the small numbers of patients most surgeons care for each day



# Study of Underlying Cause of Need for Large Sample Size

- Need for large sample size is a consequence of measuring utilization *by surgeon*
  - Issues do not arise when measuring utilization for a group or department
- By surgeon (i.e., subspecialty) is precisely what is needed for tactical decisions and monitoring success of those decisions





# Example Showing that Tactical Decisions are By Surgeon

- Regional Health Authority provides incremental revenue per case for cataract surgery, because of long waiting lists
- Hospital wants to meet community need, and benefit from the incremental revenue



# Example Showing that Tactical Decisions are By Surgeon

- Tactical decision is not whether to allocate more OR time to ophthalmology, but to the one, perhaps two, surgeons who would be doing the additional cataract surgery cases
- But, cannot accurately monitor utilization for the one or two surgeons!



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# OR Utilization is Common

## Tactical Basis for OR Allocations

- “Ministry has prioritized joint replacement. Our two surgeons doing those cases have a 91% utilization. They will need more OR time.”
- “The two vascular surgeons have had a 60% utilization, since the intensive care units have been full. They don’t need as much time.”
- OR committee takes vascular surgery allocated time and gives it to joint replacement surgeons

*Was that a good decision?*



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*Was that a good decision?  
Unknown. That’s the problem.*



# Review – Summarize the Facts of the Talk



# How Decide When to Staff Another Operating Room?



# How Decide When to Staff Another Operating Room?

1. Definitions, Tactical versus operational
2. Relevance of patient waiting times
3. Relationship with insurance contracts
4. Factor of surgeon flexibility
5. Financial impact on facility with no incremental revenue
6. Control chart monitoring of utilization





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# Allocating OR Time Tactically Based on Contribution Margin

- Allocation of OR time tactically based on contribution margin same conceptually as allocation based on OR utilization
  - Subject to what financial assumptions?



# Allocating OR Time Tactically Based on Contribution Margin

- Reimbursement or value is proportional to the hours of OR time used
  - Same rate for all surgeons
  - Not affected by ICU or hospital LOS
- During scheduled OR hours, reimbursement > variable costs
- After scheduled hours, reimbursement = variable costs



# Allocating OR Time Tactically Based on Contribution Margin

- Allocation of OR time tactically based on contribution margin same conceptually as allocation based on OR utilization
  - Subject to what financial assumptions?
    - Relatively absurd ones



# Allocating OR Time Tactically Based on Contribution Margin

- Allocation of OR time tactically based on contribution margin same conceptually as allocation based on OR utilization
  - Subject to what financial assumptions?
    - Relatively absurd ones
    - Reinforces why OR utilization is such a poor basis for allocating OR time tactically



# Rationale for Using Contribution Margin *per OR Hour*

- After tactical decisions, operational processes adjust OR allocations based on OR efficiency to match surgeons' achieved OR workload
  - Differences between a *per OR hour* basis versus a *per allocated OR hour* basis are controlled by OR managers based on how they make their operational decisions



# Contribution Margin Achieved by Hospital and/or Physicians

- Analysis using revenue and variable costs of:
  - Hospital
  - Hospital & anesthesia group
  - Hospital, anesthesia group, & surgical groups
  - Anesthesia group & surgical groups
  - Surgical groups
  - Anesthesia group

Kuo PC et al. JACS 2003

Wachtel RE et al. Anesthesiology 2005



# Allocating OR Time Tactically (Over 1-2 Year Time Course)

- Background and definitions
- Allocating OR time to  $\uparrow$  OR utilization
  - Several reasons why this is a poor choice
- Allocating OR time to  $\uparrow$  contribution margin
  - Interpretation when not just fee for service
    - Linear programming
    - Analysis of facility's portfolio of surgeons
    - Linking tactical to operational decisions
    - Forecasting market growth





# Hospitals Not Receiving an Incremental Revenue Per Patient

- Contribution margin principles apply fully to tactical decision-making at hospitals without incremental revenue
  - Fixed, exogenously determined, budget
    - Maximizing contribution margin per OR hour
    - = minimizing variable costs per OR hour

Dexter F et al. Anesthesiology 2002



# Hospitals Not Receiving an Incremental Revenue Per Patient

- Fixed annual (global) budget
- Provincial Health Authority makes special funds available for joint replacement
- Allocate additional OR time tactically for joint replacement surgeons?
  - Remainder of talk considers factors to consider in making the decision
- Set revenue term = 0 for all cases other than joint replacement



# Incorporate Other Organizational Objectives in the Revenue Term

- What is the value to a cancer hospital of caring for one additional cancer patient?
  - Aid group decision-making by using a spreadsheet to permit *What-if* analysis
    - Generate dollar figures that include intangible value

Wachtel RE, Dexter F. Anesth Analg 2008



# Incorporate Other Organizational Objectives in the Revenue Term

- What is the value to a cancer hospital of caring for one additional cancer patient?
  - Aid group decision-making by using a spreadsheet to permit *What-if* analysis
    - Generate dollar figures that include intangible value
- Intangibles
  - ✓ Growth in specialties matching strategic focus
  - ✓ Reduce waiting times
  - ✓ Reduce waiting lists



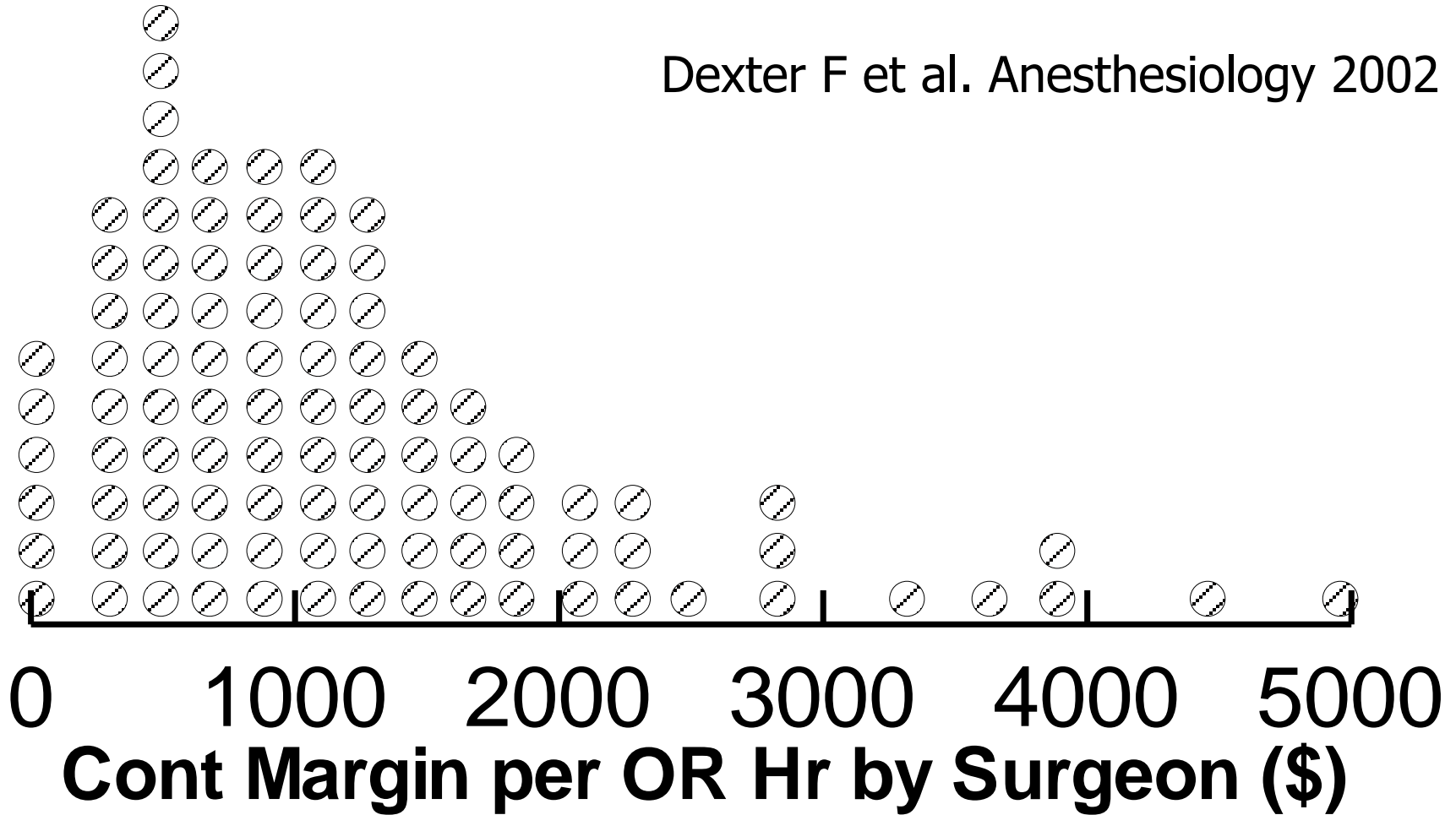
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    - **Linear programming**
      - Analysis of facility's portfolio of surgeons
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# Data by Surgeon for Outpatient and Same Day Admit (Elective) Cases

Dexter F et al. Anesthesiology 2002



# Simplistic Allocation of More OR Time

- Sort surgeons in descending order of their contribution margins per OR hour

Macario A et al. Anesth Analg 2001



# Simplistic Allocation of More OR Time

- Sort surgeons in descending order of their contribution margins per OR hour
- Increase OR time for surgeon at top of the list by maximum allowable amount





# Simplistic Allocation of More OR Time

- Sort surgeons in descending order of their contribution margins per OR hour
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- Increase OR time for the next highest surgeon by the maximum amount



# Simplistic Allocation of More OR Time

- Sort surgeons in descending order of their contribution margins per OR hour
- Increase OR time for surgeon at top of the list by maximum allowable amount
- Increase OR time for the next highest surgeon by the maximum amount
- Continue until there is no extra OR time available (with concomitant resources)



# Simplistic Allocation of More OR Time

- In my experience, this simplistic method is used by many hospitals that have gone so far as to estimate contribution margins



# Simplistic Allocation of More OR Time

- What is wrong with this simplistic algorithm?



# Simplistic Allocation of More OR Time

- What is wrong with this simplistic algorithm?
  - Method is reasonable only if the constraint on increased OR workload is limited to OR time and OR resources

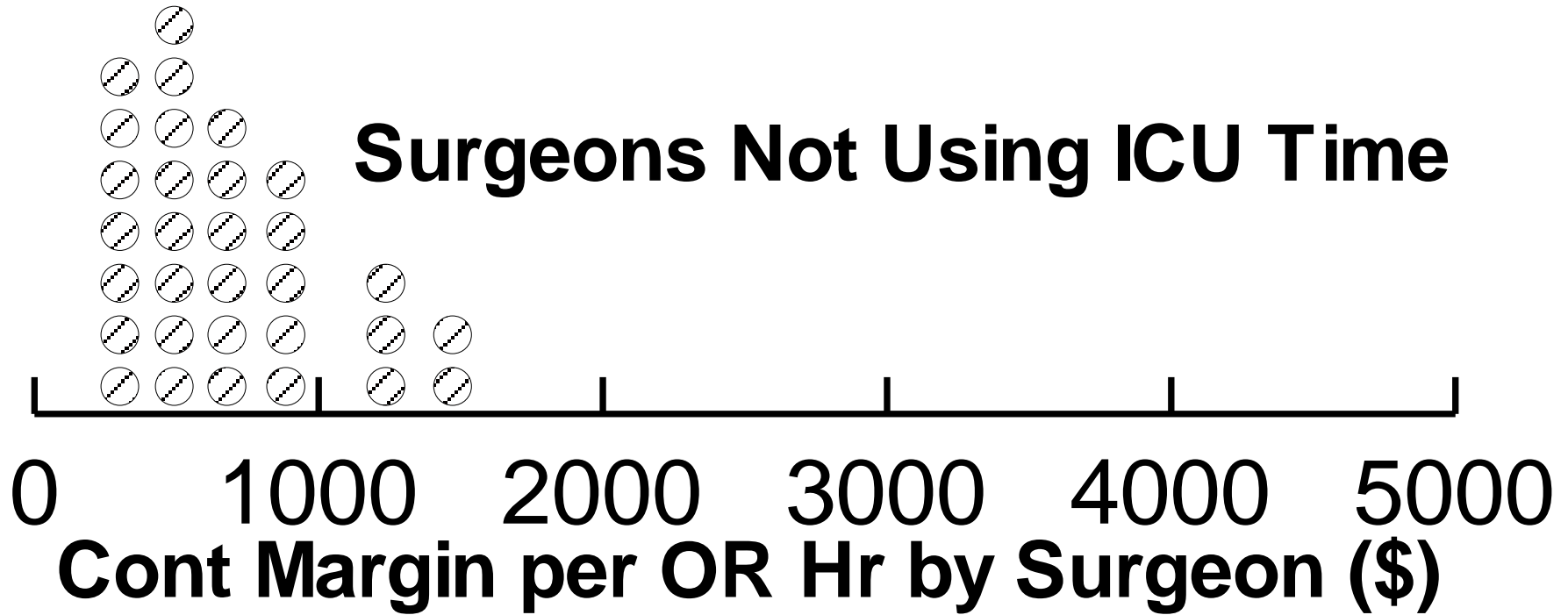


# Simplistic Allocation of More OR Time

- What is wrong with this simplistic algorithm?
- Method is reasonable only if the constraint on increased OR workload is limited to OR time and OR resources
  - Ignores ICUs, ward beds, surgeons, etc.



# Limited ICU Time Constraints Achievable Contribution Margin



# Limited ICU Time Constraints

## Achievable Contribution Margin

- At this hospital, OR time was not the sole constraint on OR workload
  - If ignore lack of ICU time, get *wrong* answer
    - Surgeons would have cases cancelled on day of surgery from lack of ICU beds
  - Good analysis provides positive net present value of expanding both OR and ICU capacity





# Linear Programming to Include Constraints Other than OR Time

- Performing analysis using Microsoft Excel
  - Tools
  - Solver
    - Add-in comes complimentary with Excel
  - Linear programming option

Dexter F et al. Anesth Analg 2002



# Cost Accounting for Tactical OR Allocation

- Elective cases (included)
  - Cost accounting starts with a single date for each outpatient visit or hospitalization
  - Subsequent costs of hospitalization, if any, can be attributed to the initial decision to perform surgery
- Emergent or urgent cases (excluded)
  - Could be multiple trauma victim who generates numerous costs unrelated to original surgical procedure



# Cost Accounting for Tactical OR Allocation

- Variable costs can be estimated sufficiently accurately, for allocating OR time tactically, by taking sum for each patient of these items
  - OR hours  $\times$  cost per hour of OR time
  - Ward days  $\times$  cost per day of ward time
  - ICU days  $\times$  cost per day of ICU time
  - Implant costs



# Cost Accounting for Tactical OR Allocation

- Simple per diem rates plus implant costs predict 97% of the variance in variable costs among surgeons
- As OR allocations are changed (tactically), unexpected changes in hospital's total surgical variable costs are likely to be less than 3%

Dexter F et al. Anesthesiology 2002



# Cost Accounting for Tactical OR Allocation

- Little need for accurate accounting to compare costs of carpal tunnel to lung lobectomy
  - Since objective is not to compare two surgeons of same subspecialty, but among subspecialties
  - Since analysis is not by product line
- Cost of disposable surgical supplies is proportional to OR time when considered over many different procedures

Toyabe S et al. Health Policy 2005



# Cost Accounting for Tactical OR Allocation

- Little need for accurate accounting to compare costs of carpal tunnel to lung lobectomy
  - Since objective is not to compare two surgeons of same subspecialty, but among subspecialties
  - Since analysis is not by product line
- Cost of disposable surgical supplies is proportional to OR time when considered over a wide range of procedures
  - Not true for individual procedures



# Cost Accounting for Tactical OR Allocation

- Reasonable argument can be made that labor costs are relatively independent of small changes in OR workload
  - (service-specific staffing based on minimizing inefficiency of use of OR time)
  - Accuracy of cost accounting is then even more reliable for purpose of allocating OR time tactically



# Cost Accounting for Tactical OR Allocation

- Reasonable argument can be made that labor costs are relatively independent of small changes in OR workload
  - (service-specific staffing based on minimizing inefficiency of use of OR time)
  - Accuracy of cost accounting is then even more reliable for purpose of allocating OR time tactically
- Must have good cost accounting for implants and other drugs and supplies not proportional to OR time, ICU days, etc.

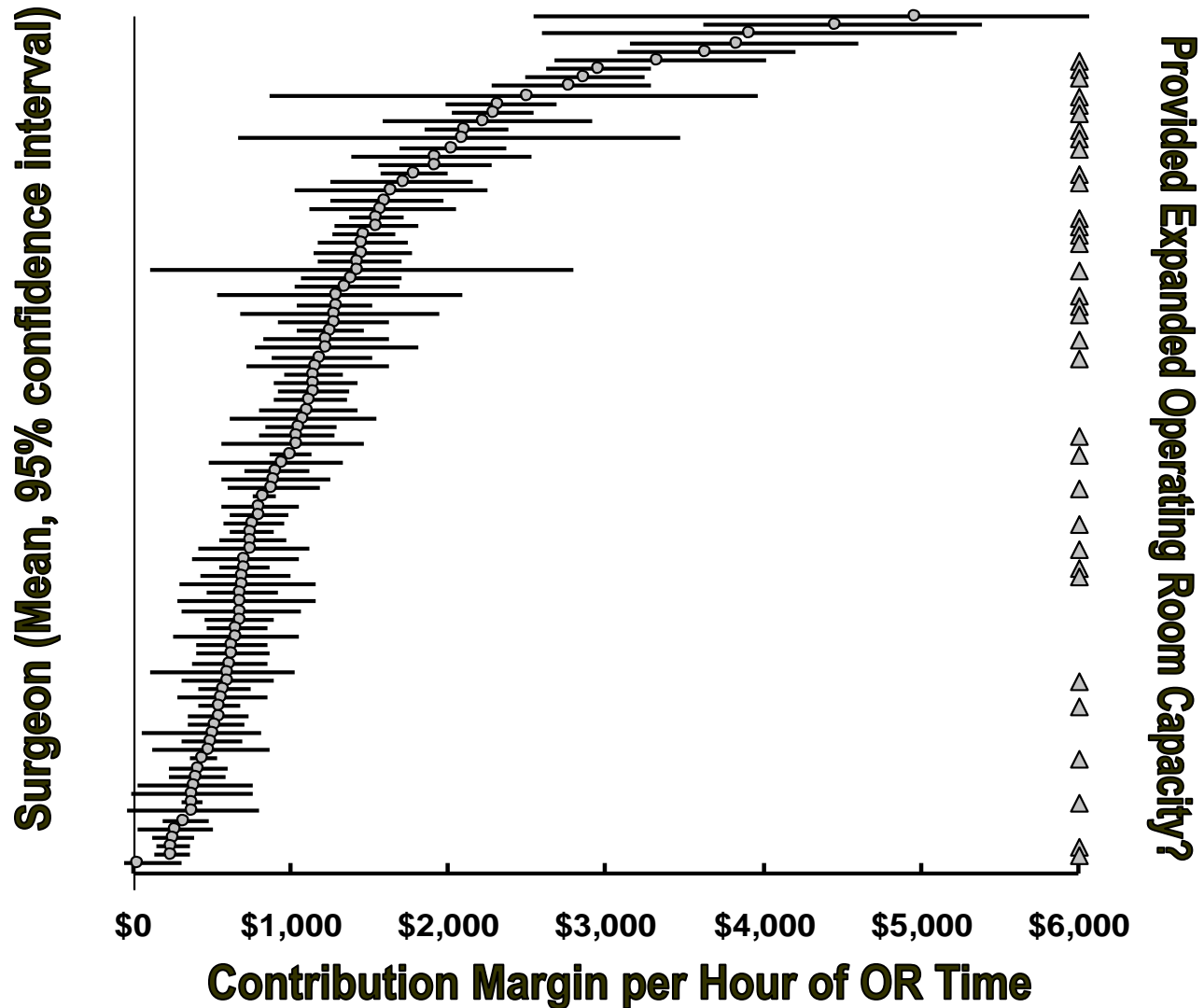


# Allocating OR Time Tactically (Over 1-2 Year Time Course)

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# Wide Confidence Intervals for Contribution Margin per OR Hour



Dexter F et al.  
Anesth Analg  
2002

# Portfolio of Surgeons

- Each surgeon is analogous to stock holdings in one company

Dexter F, Ledolter H. Anesth Analg 2003



# Portfolio of Surgeons

- Each surgeon is analogous to stock holdings in one company
- Differences in portfolios of surgeons



# Portfolio of Surgeons

- Each surgeon is analogous to stock holdings in one company
- Differences in portfolios of surgeons
  - Different surgeons



# Portfolio of Surgeons

- Each surgeon is analogous to stock holdings in one company
- Differences in portfolios of surgeons
  - Different surgeons
  - Different numbers of surgeons



# Portfolio of Surgeons

- Each surgeon is analogous to stock holdings in one company
- Differences in portfolios of surgeons
  - Different surgeons
  - Different numbers of surgeons
  - Differences in the OR time allocated to each surgeon



# Portfolio of Surgeons

- Each surgeon is analogous to stock holdings in one company
- Differences in portfolios of surgeons
  - Different surgeons
  - Different numbers of surgeons
  - Differences in the OR time allocated to each surgeon
- Facility's current *portfolio* is the current OR allocation for each of its surgeons





# Change Portfolio Based on Each Surgeon's Past Performance

- Forecast of future performance
  - Total contribution margin
  - Want this to be as large as possible



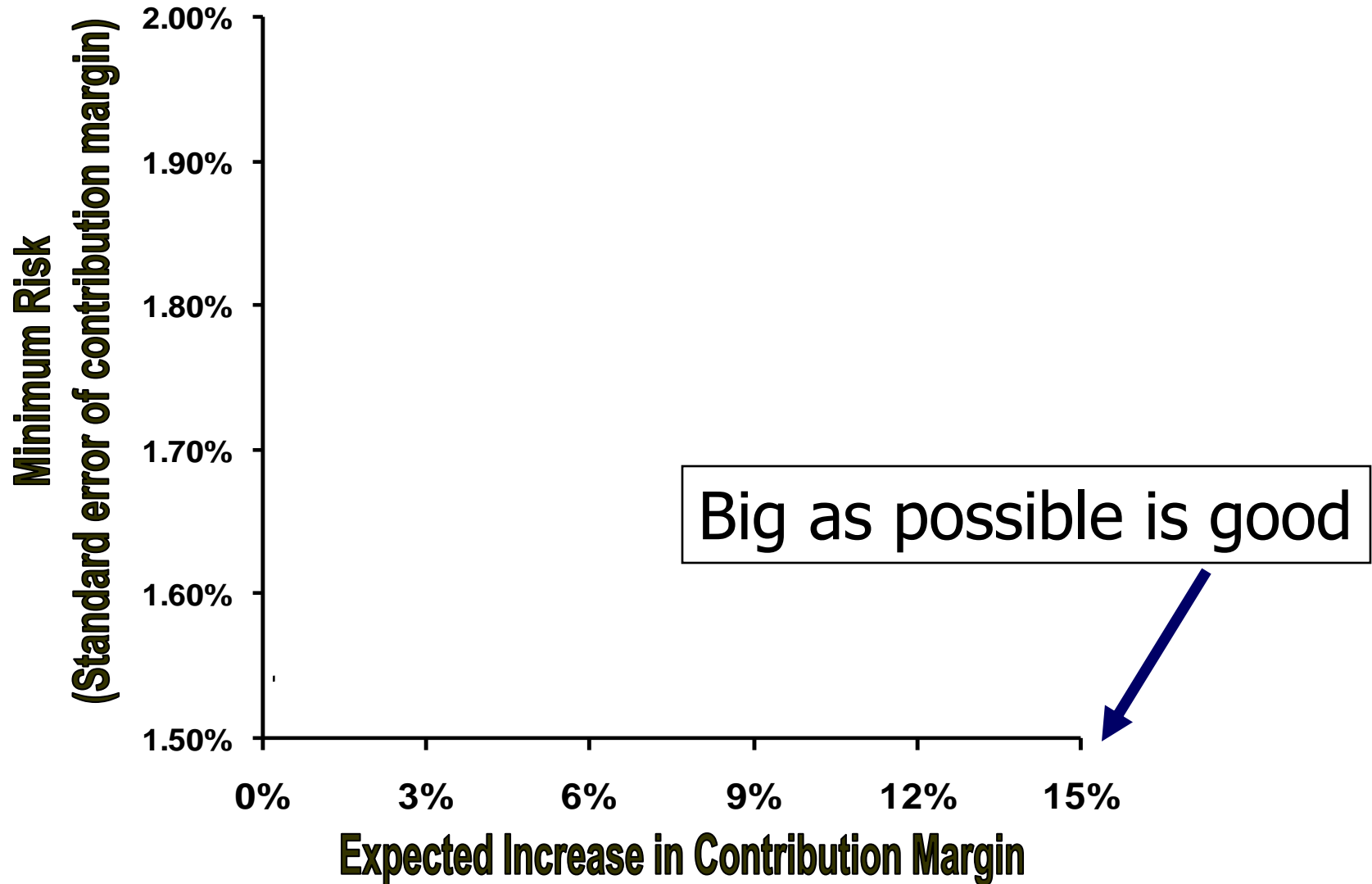
# Change Portfolio Based on Each Surgeon's Past Performance

- Forecast of future performance
  - Total contribution margin
  - Want this to be as large as possible

***Just like picking a portfolio of stocks, you want to achieve maximal future return***



# Change Portfolio Based on Each Surgeon's Past Performance



# Change Portfolio Based on Each Surgeon's Past Performance

- Uncertainty in forecast
  - Standard error of the mean contribution margin per OR hour
  - Seen in wide confidence intervals for each surgeon's contribution margin per OR hour
  - Want this to be as small as possible



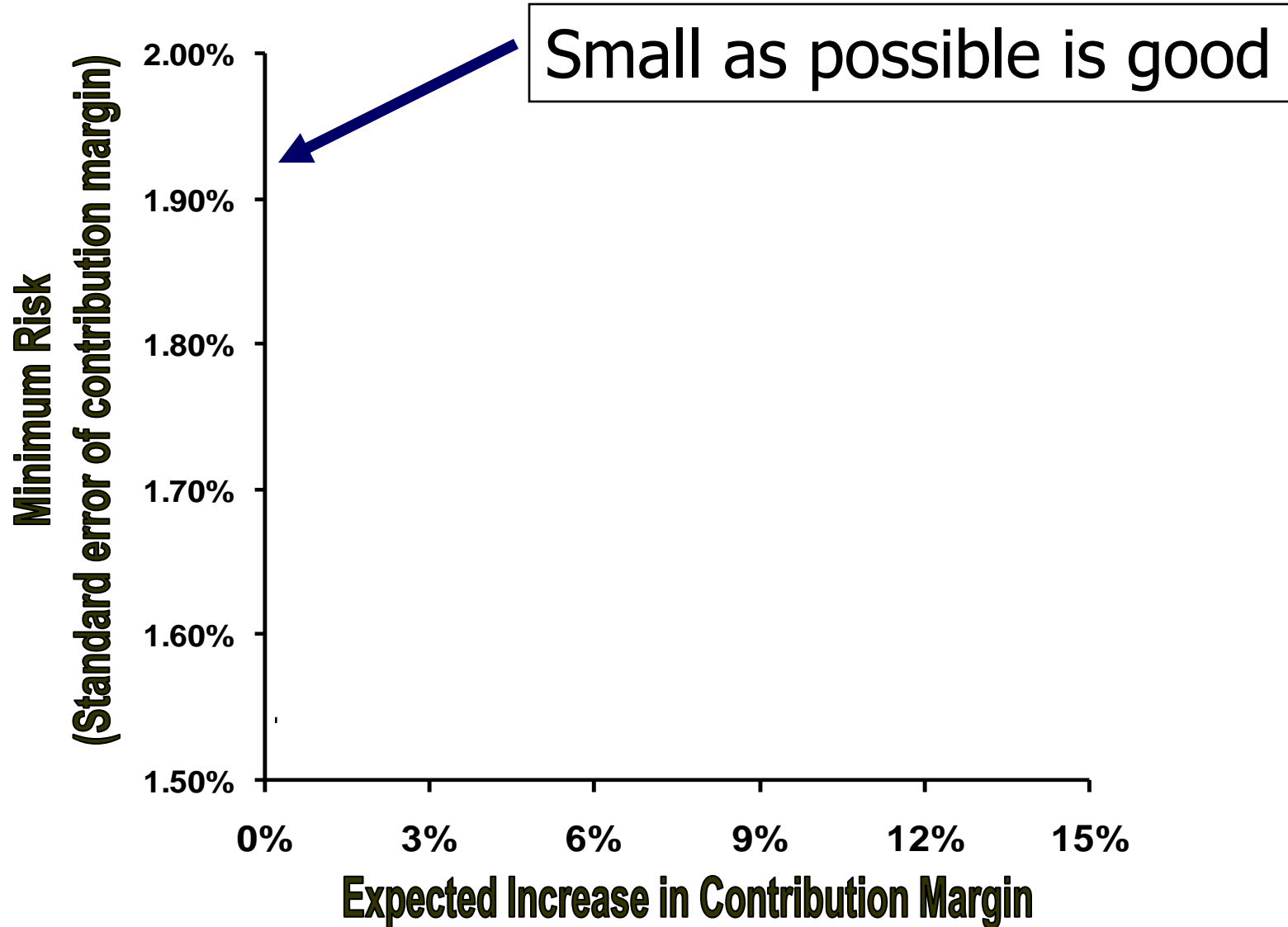
# Change Portfolio Based on Each Surgeon's Past Performance

- Uncertainty in forecast
  - Standard error of the mean contribution margin per OR hour
  - Seen in wide confidence intervals for each surgeon's contribution margin per OR hour
  - Want this to be as small as possible

***Just like when choosing stocks – you would prefer a portfolio with low risk***



# Change Portfolio Based on Each Surgeon's Past Performance

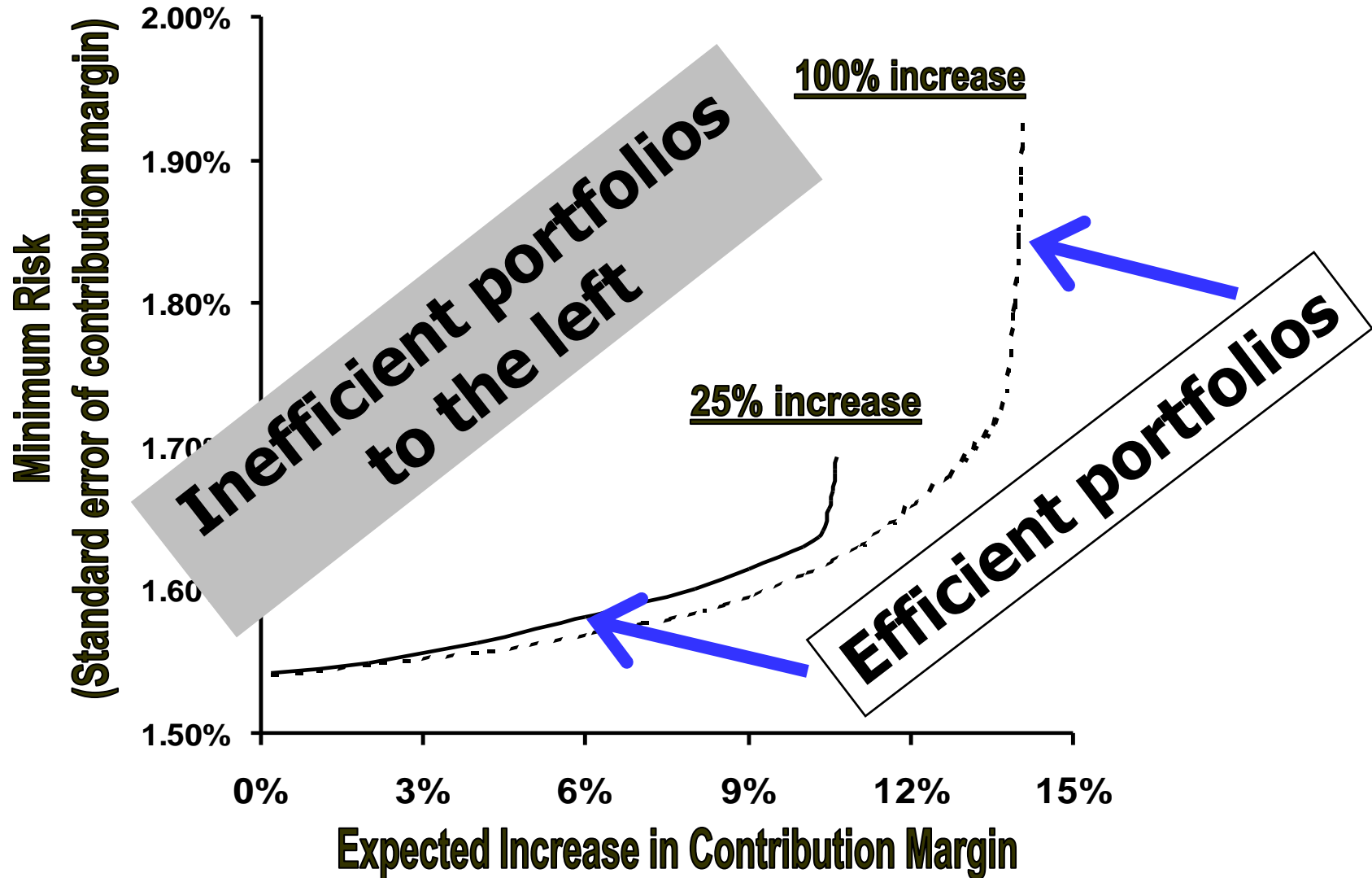


# Definition of Efficient Portfolio

- Portfolio is *efficient* if no other portfolio with the same return has a lesser risk
  - Risk is quantified by the standard deviation of expected return



# Definition of Efficient Portfolio





# Definition of Efficient Portfolio

- Efficient frontier is the collection of all efficient portfolios of surgeons
- All other portfolios of surgeons lie above and to the left of the efficient frontier
  - They have higher risk for the same return



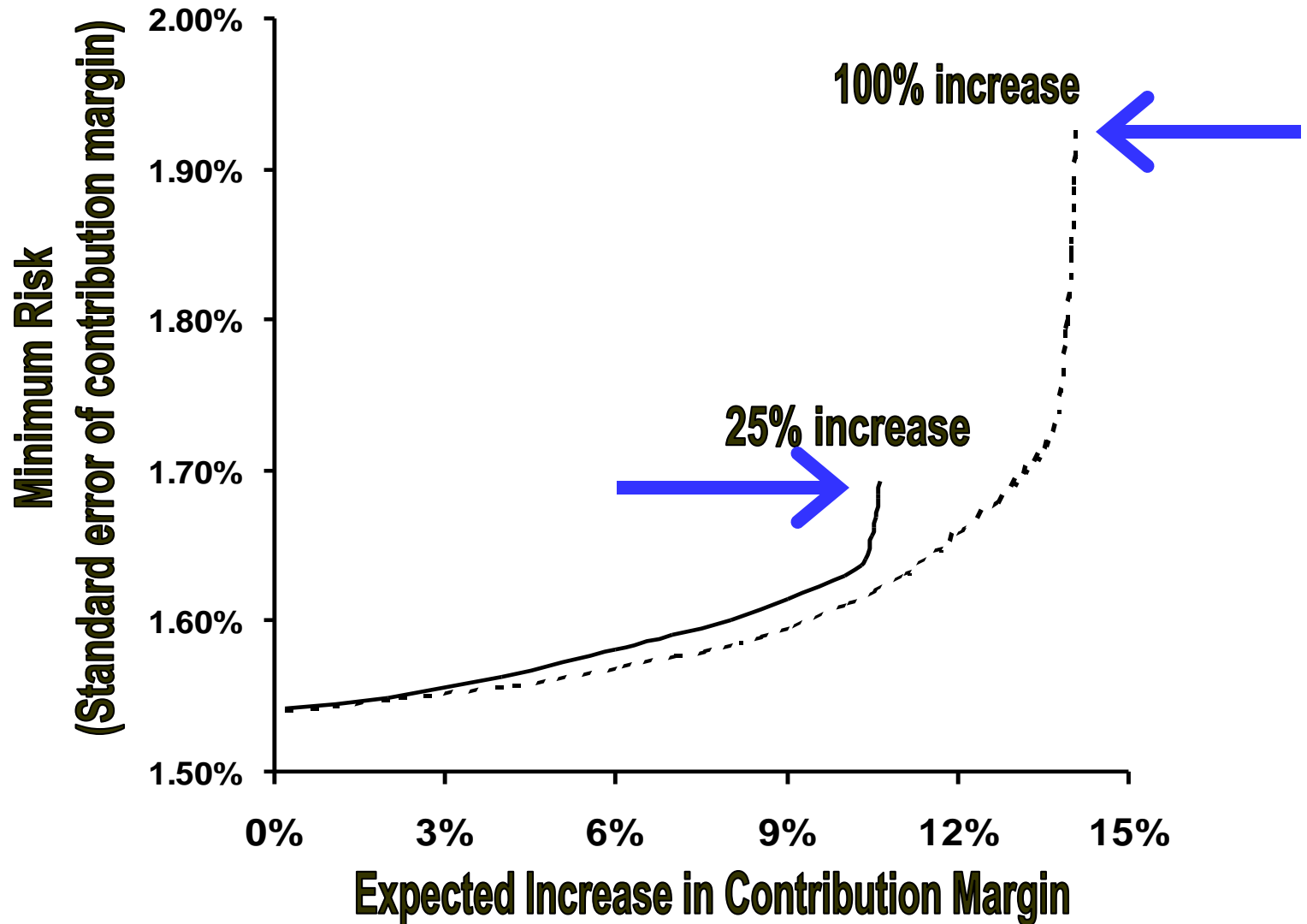
# Surgeons' Maximum Percentage Increase in Allocated OR Time

- Maximum expansion of 25% represents a feasible expansion of OR allocations without recruiting more surgeons
- Maximum expansion of 100% represents hiring a new surgeon modeled after a surgeon currently practicing at the hospital
  - My experience is that 100% makes sense to people as upper bound on growth in 1-2 years

Dexter F et al. Anesthesiology 2002



# Efficient Frontier Has a Peak



# Peak of the Efficient Frontier of Portfolios of Surgeons

- Portfolio of surgeons at peak of the efficient frontier guarantees maximum expected contribution margin, but at the expense of more risk



# Peak of the Efficient Frontier of Portfolios of Surgeons

- Portfolio of surgeons at peak of the efficient frontier guarantees maximum expected contribution margin, but at the expense of more risk
- The peak is obtained by linear programming

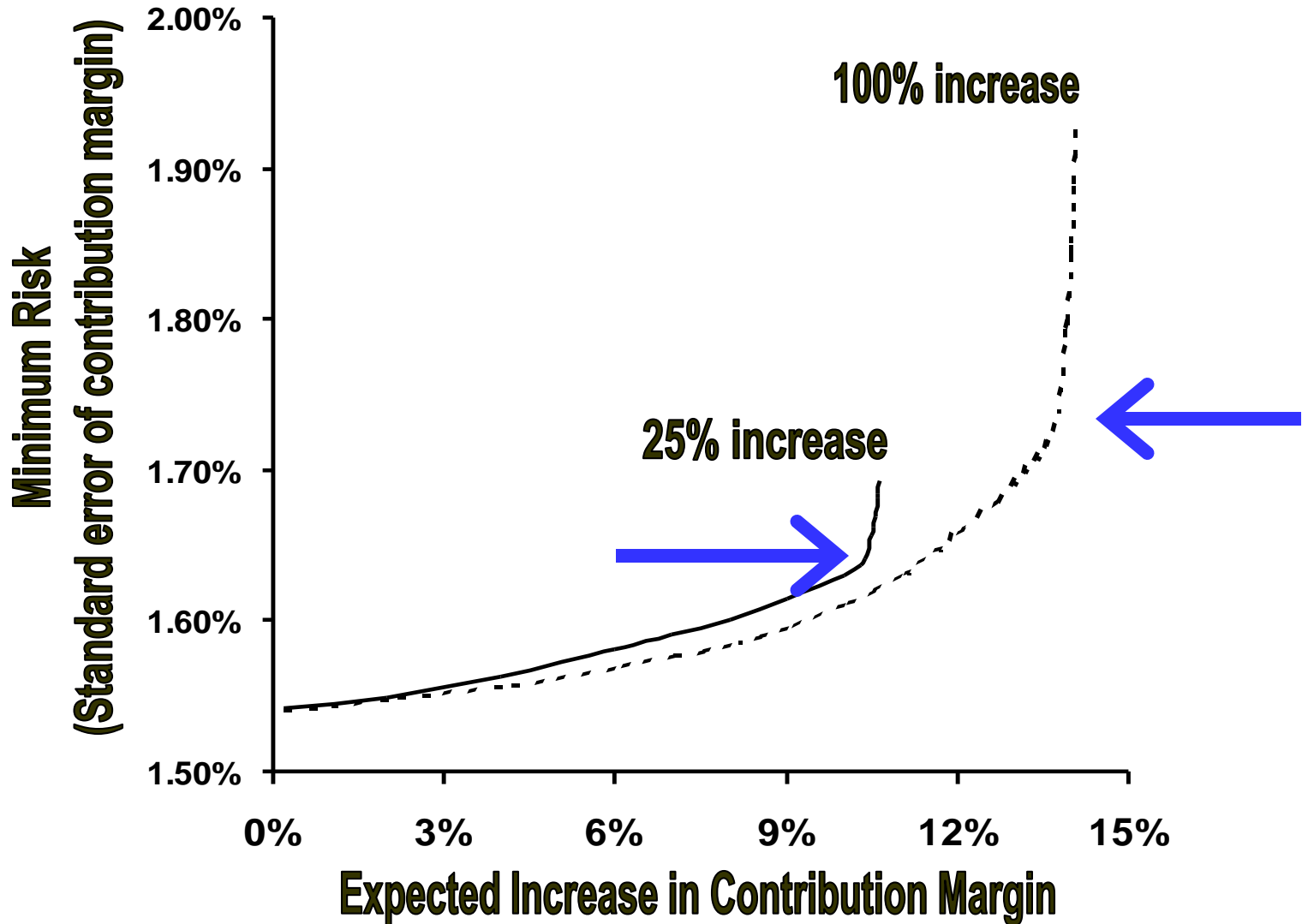


# Peak of the Efficient Frontier of Portfolios of Surgeons

- Portfolio of surgeons at peak of the efficient frontier guarantees maximum expected contribution margin, but at the expense of more risk
- The peak is obtained by linear programming
  - Ignores uncertainty in each surgeon's contribution margin per OR hour



# Choose Point Along Curve Where Initial Steepness Levels Off



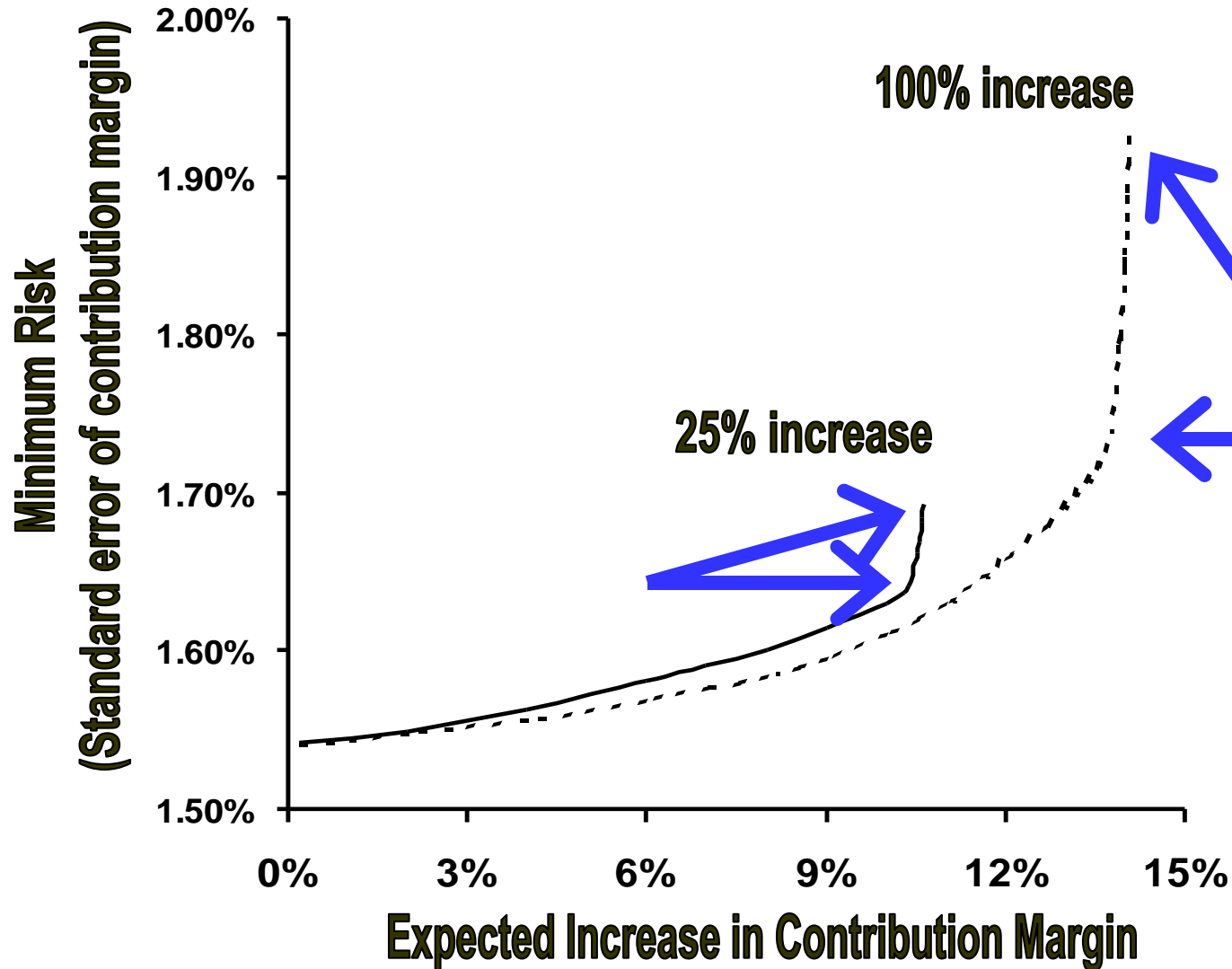
# Why Pick Portfolio of Surgeons Where Steepness Levels Off?

- Portfolio has acceptable expected increase in total hospital contribution margin, but with appreciably lower risk than portfolio at peak of the efficient frontier to the right
- Portfolio achieves significantly higher total hospital contribution margin than portfolios to the left, but without large increase in risk





# Compare Portfolios at Peak vs. Where Steepness Levels Off



# Compare Portfolios of Surgeons for Balance of Return and Risk

- Example with the 100% maximum increase
  - Portfolio at peak increases allocated OR time for 16 surgeons
  - Portfolio at point where slope levels off increases allocated OR time for 14 surgeons
  - The two excluded surgeons had the largest uncertainties in the mean contribution margin per OR hour of all the surgeons

Dexter F, Ledolter H. Anesth Analg 2003



# Compare Portfolios of Surgeons for Balance of Return and Risk

- The surgeons had inflated contribution margins per OR hour from outlier patients
  - Spuriously high/low contribution margins per OR hour from unusual medical situations



# Compare Portfolios of Surgeons for Balance of Return and Risk

- The surgeons had inflated contribution margins per OR hour from outlier patients
  - Spuriously high/low contribution margins per OR hour from unusual medical situations
- The portfolio analysis reduces the chance of making tactical OR time allocation decisions based on spurious information



# Identifying Outlier Patients Affecting Tactical Decision

- Tools
- Solver
  - Add-in comes complimentary with Excel
- Quadratic programming option

Dexter F, Ledolter H. Anesth Analg 2003



# Review – Summarize the Facts of the Talk



# Summary of Characteristics of Subspecialties to Target



# Summary of Characteristics of Subspecialties to Target

1. Contribution margin per OR hour above average
2. OR time is bottleneck, not a downstream location such as full intensive care unit
3. Observed contribution margin per OR hour not spuriously high because of outlier patients
4. Sufficient workload that can fill an OR
5. Appropriate procedures for the new OR time
6. Sufficient market demand to grow workload





# Allocating OR Time Tactically (Over 1-2 Year Time Course)

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  - Analysis of facility's portfolio of surgeons
    - Linking tactical to operational decisions
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# Allocating OR Time is a Two-Stage Process

- Tactical decisions determine initial increases in OR time allocations for each subspecialty
  - Not reductions, just increases or no changes
- Operational decisions based on OR efficiency fill the OR time once actual workload known
  - Schedule cases based on OR efficiency
  - Release allocated but unused OR time
  - Adjust staffing

Dexter F et al. Anesth Analg 2005



# Allocating OR Time is a Two-Stage Process

- Surgeons (subspecialties) without tactical increases in OR time can, and often will, receive additional OR time operationally
  - Often fully fill their allocated OR time, and have more cases to schedule
    - OR time of other subspecialties is released
  - OR allocations will be increased to match staffing to their actual OR workloads, thereby increasing OR efficiency



# Allocating OR Time is a Two-Stage Process

- Surgeon (subspecialty) without more OR time allocated tactically can still grow OR workload on his or her (their) own
  - Choosing not to foster that growth by allocating more OR time tactically based on the hope that there may be extra cases available



# Allocating OR Time is a Two-Stage Process

- Surgeon (subspecialty) without more OR time allocated tactically can still grow OR workload on his or her (their) own
  - Choosing not to foster that growth by allocating more OR time tactically based on the hope that there may be extra cases available
- Because two-stage process, good decision not to allocate more OR time tactically to some surgeons (subspecialties)



# Subspecialties For Which No Tactical Increase is Optimal

- Such low workload that would not fill an OR
  - Inappropriate procedures for new OR time
  - Below average contribution margin per OR hour

Dexter F et al. Anesth Analg 2005



# Low Workload Subspecialties – Hypothetical Scenario

- Strategic decision made to allocate an extra 8 hour of OR time 3 days a week at a free-standing outpatient surgery center
- Surgeon with the highest contribution margin per OR hour is a dermatologist who does 10 hour of cases a year at that site
- Would you have marketing survey performed for potential growth in dermatologic surgery?



# Low Workload Subspecialties – Hypothetical Scenario

- Strategic decision made to allocate an extra 8 hour of OR time 3 days a week at a free-standing outpatient surgery center
- Surgeon with the highest contribution margin per OR hour is a dermatologist who does 10 hour of cases a year at that site
- Would you have marketing survey performed for potential growth in dermatologic surgery?
  - No – limit consideration to subspecialties filling at least 1 OR every other week



# Subspecialties For Which No Tactical Increase is Optimal

- Such low workload that would not fill an OR
- Inappropriate procedures for new OR time
- Below average contribution margin per OR hour

Dexter F et al. Anesth Analg 2005



# Inappropriate Procedures – Hypothetical Scenario

- Strategic decision made to allocate an extra 8 hours of OR time 3 days a week
  - Space available at hospital's outpatient ORs
- Surgeon at the hospital with the highest contribution margin per OR hour is a pediatric neurosurgeon doing craniotomies on infants
- Allocate some of the new OR time to pediatric neurosurgery?



# Inappropriate Procedures – Hypothetical Scenario

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  - Space available at hospital's outpatient ORs
- Surgeon at the hospital with the highest contribution margin per OR hour is a pediatric neurosurgeon doing craniotomies on infants
- Allocate some of the new OR time to pediatric neurosurgery?
  - No, because so few of their cases would be suitable for the new ORs



# Subspecialties For Which No Tactical Increase is Optimal

- Such low workload that would not fill an OR
- Inappropriate procedures for new OR time
- Below average contribution margin per OR hour

Dexter F et al. Anesth Analg 2005



# Below Average Contribution Margin per OR Hour

- Second operational stage fills allocated OR time without regard for CM/OR hour
  - Achieves the overall average CM/OR hour
- Allocating OR time tactically to surgeons (subspecialties) with below average CM/OR hour is disadvantageous financially



# Below Average Contribution Margin per OR Hour

- Second operational stage fills allocated OR time without regard for CM/OR hour
  - Achieves the overall average CM/OR hour
- Allocating OR time tactically to surgeons (subspecialties) with below average CM/OR hour is disadvantageous financially
- Additional OR time should not be allocated at the tactical stage to surgeons with below average CM/OR hour



# Below Average Contribution Margin per OR Hour

- Second operational stage fills allocated OR time without regard for CM/OR hour
  - Achieves the overall average CM/OR hour
- Allocating OR time tactically to surgeons (subspecialties) with below average CM/OR hour is disadvantageous financially

➤ Additional OR time should not be allocated at the tactical stage to surgeons with below average CM/OR hour



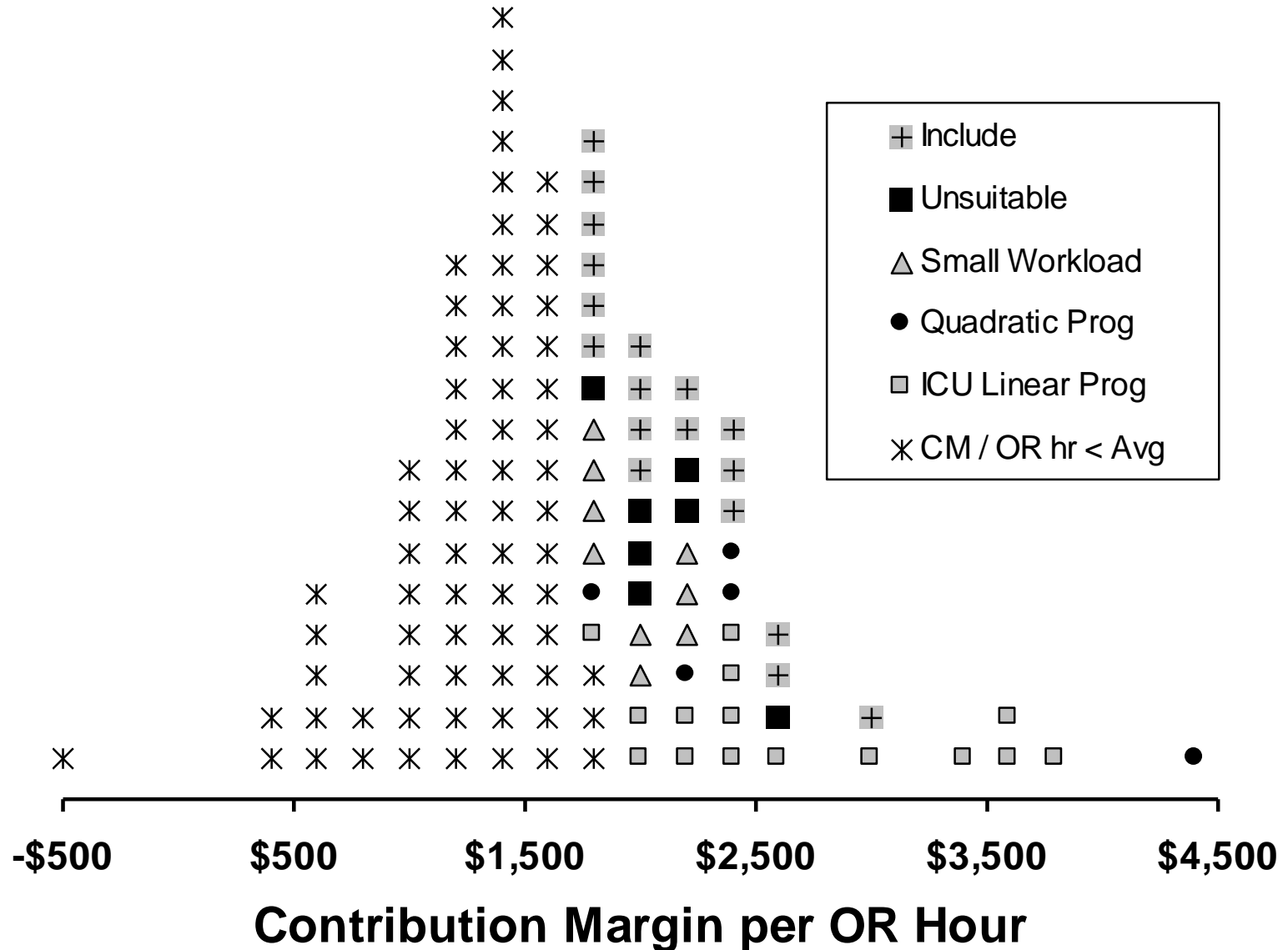
# Below Average Contribution Margin per OR Hour

- What do if facility will not be considering contribution margin per OR hour when allocating OR time tactically to surgeons
- Then facility maximizes its contribution margin not by allocating extra OR time tactically to surgeons but using it as first-come first-served unblocked open overflow OTHER time
  - Once the time used then assigned to surgeons as extra block time as described in Lecture 9





# Incremental Selection of Sub-specialties to Target



# Implants Can Drive the Below Average Contribution Margins

- Hospital and professional fees/costs
- Overall findings for Cont Margin per OR hour
  - 90% \$2500                      50% \$1600
  - 75% \$2100                      25% \$1300
  - Avg \$1800                      5% \$ 600
- The patients with back or spine DRG and implant charges exceeding \$10,000
  - Overall contribution margin \$15 per OR hour

Wachtel RE et al. Anesthesiology 2005



# Important Healthcare Lesson Based on the *Why*

- If the tactical decision was considered independent of the subsequent operational decision, result different and incorrect
  - Excluding surgeons with below average contribution margin per OR hour applies only when considered in the context of a second operational stage based on OR efficiency

Dexter F et al. Anesth Analg 2005



# Important Healthcare Lesson Based on the *Why*

- If the tactical decision was considered independent of the subsequent operational decision, result different and incorrect
  - Excluding surgeons with below average contribution margin per OR hour applies only when considered in the context of a second operational stage based on OR efficiency
  - Even though a CM/OR analysis, principal determinant of OR allocations is operational decisions based on actual OR workload



# Important Healthcare Lesson Based on the *Why*

- If the tactical decision was considered independent of the subsequent operational decision, result different and incorrect
  - Excluding surgeons with below average contribution margin per OR hour applies only when considered in the context of a second operational stage based on OR efficiency
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# Market Forecasts Needed for What % of Subspecialties?

- Start with 122 subspecialties (surgeon's data)
- Exclude 68 based on CM/OR hour
- Exclude 15 more based on ICU usage
- Exclude 5 more based on estimate uncertainty
- Exclude 7 more based on unsuitability
- Exclude 9 more based on low workload
- Remainder is 18 of 122 or **15%**

Dexter F et al. Anesth Analg 2005



# Accuracy of Forecasts of Potential Subspecialty Growth

- Perform marketing database analysis

O'Neill L, Dexter F. Anesth Analg 2007





# Accuracy of Forecasts of Potential Subspecialty Growth

- Perform marketing database analysis
- Consult surgeons and practice managers to solicit expert opinions about future expansion



# Accuracy of Forecasts of Potential Subspecialty Growth

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- Important to estimate demand accurately?
  - No, because subsequent operational decisions based on OR efficiency using actual workload will correct and compensate for inaccuracies in the estimates of future demand



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# Accuracy of Forecasts of Potential Subspecialty Growth

- Perform marketing database analysis
- Consult surgeons and practice managers to solicit expert opinions about future expansion
- Important to estimate demand accurately?
  - No, because subsequent operational decisions based on OR efficiency using actual workload will correct and compensate for inaccuracies in the estimates of future demand
    - To achieve good tactical decision making, it is crucial for operational decision making to be sound mathematically

# Quality of Use of Forecasts of Potential Subspecialty Growth



# Quality of Use of Forecasts of Potential Subspecialty Growth

- Even if forecasts are good, surgical committee may make politically based decisions
- However, suppose that at the hospital:
  - Specialties effectively have open access to OR time on any future workday for cases
  - Cases are not scheduled into over-utilized OR time unless there are no safe alternatives
- Can tactical decisions substantively reduce the efficiency of use of OR time by its influence on eventual case scheduling?



# Quality of Use of Forecasts of Potential Subspecialty Growth

- Schedule each case into its service's time that day either to start as early or late in the day as possible, but not into over-utilized OR time
- At hospital and outpatient facility, latest start time has only 2.6 min and 0.4 min extra over-utilized OR time per OR per day, respectively

Dexter F, Traub RD. Anesth Analg 2002





# Quality of Use of Forecasts of Potential Subspecialty Growth

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- At hospital and outpatient facility, latest start time has only 2.6 min and 0.4 min extra over-utilized OR time per OR per day, respectively
  - Irrelevantly small difference

Dexter F, Traub RD. Anesth Analg 2002



# Quality of Use of Forecasts of Potential Subspecialty Growth

- Schedule each case into its service's time
  - As early in the day as possible
  - Using bin packing (see "Day of Surgery" lecture)
  - Method that incorporates uncertainty in case duration
- Difference among the three was just 0.5 min of under-utilized OR time per OR per day

# Quality of Use of Forecasts of Potential Subspecialty Growth

- Schedule each case into its service's time
  - As early in the day as possible
  - Using bin packing (see "Day of Surgery" lecture)
  - Method that incorporates uncertainty in case duration
- Difference among the three was just 0.5 min of under-utilized OR time per OR per day
  - Irrelevantly small and similar to other paper

# Quality of Use of Forecasts of Potential Subspecialty Growth

- Moral
  - Although discussing forecasts of future growth and increases in allocations tactically
  - These decisions are of small importance compared to the importance of not scheduling a case into over-utilized OR time when there is an alternative start time option available (which is almost always true)
    - Decisions made 2 to 3 months and 0 to 2 workdays before the day of surgery



# Quality of Use of Forecasts of Potential Subspecialty Growth

- Moral (restated)
  - Service is about the ORs (e.g., equipment), anesthesia providers, and nurses
  - By knowing service's allocated time, can predict whether there is convenient (under-utilized) OR time available for a surgeon who wants to do a case on a date



# Quality of Use of Forecasts of Potential Subspecialty Growth

- Moral (restated)
  - Service is about the ORs (e.g., equipment), anesthesia providers, and nurses
  - By knowing service's allocated time, can predict whether there is convenient (under-utilized) OR time available for a surgeon who wants to do a case on a date
  - Not directly influenced substantively by surgeons' block time



# How and When Do Market Research for Surgical Growth?

- If market research is needed only after other analyses, is there a rational reason to do market research for those subspecialties?



# One Outcome for the Hospital with 122 Surgeons

- What if none of the 18 remaining surgeons is of a subspecialty with potential for market expansion exceeding 1 extra case per week?





# One Outcome for the Hospital with 122 Surgeons

- What if none of the 18 remaining surgeons is of a subspecialty with potential for market expansion exceeding 1 extra case per week?
- How to allocate the extra OR time tactically?



# One Outcome for the Hospital with 122 Surgeons

- What if none of the 18 remaining surgeons is of a subspecialty with potential for market expansion exceeding 1 extra case per week?
- How to allocate the extra OR time tactically?
  - Allocate it as first-come first-served open overflow OTHER OR time, for use when a subspecialty has filled its allocated OR time and has another case to schedule

Dexter F et al. Anesth Analg 2000



# One Outcome for the Hospital with 122 Surgeons

- What if none of the 18 remaining surgeons is of a subspecialty with potential for market expansion exceeding 1 extra case per week?
- How to allocate the extra OR time tactically?
  - Allocate it as first-come first-served open overflow OTHER OR time, for use when a subspecialty has filled its allocated OR time and has another case to schedule
  - Subspecialty using it often will get it allocated to them operationally, then tactically next year



# Second Outcome for the Hospital with 122 Surgeons

- What if have estimated the maximum possible market expansion for the 18 remaining surgeons (subspecialties)?



# Second Outcome for the Hospital with 122 Surgeons

- What if have estimated the maximum possible market expansion for the 18 remaining surgeons (subspecialties)?
- When allocating the extra OR time tactically, need to consider the statistical uncertainty in the estimate for future market demand

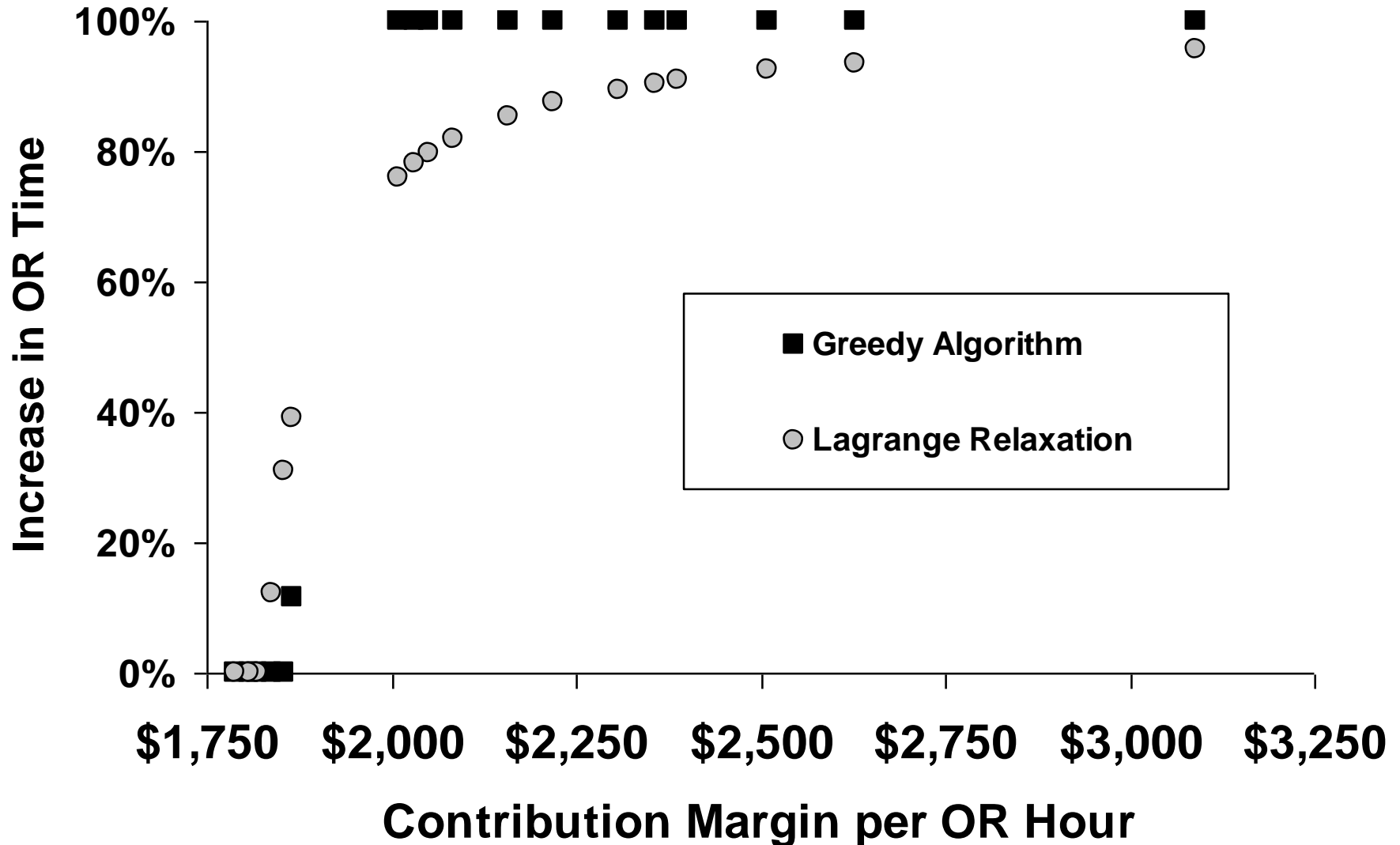


# Second Outcome for the Hospital with 122 Surgeons

- To prevent clutter, excluded the 104 surgeons from the figure who should not have tactical increases in OR allocations
- To show graphically, pretended that estimate was potential doubling of OR workload in one year for all 18 of the included surgeons
- Greedy algorithm discussed previously is the corresponding mathematical method ignoring uncertainty in future surgical demand



# Do Not Effectively Use Greedy Algorithm with Financial Data



# Do Not Effectively Use Greedy Algorithm with Financial Data

- Lagrange Relaxation gives correct answer
- Perform in Excel using worksheet functions
  - Equations in Appendix of paper

Dexter F et al. Anesth Analg 2005





# Review – Summarize the Facts of the Talk



# Summary of Characteristics of Subspecialties to Target



# Summary of Characteristics of Subspecialties to Target

1. Contribution margin per OR hour above average
2. OR time is bottleneck, not a downstream location such as full intensive care unit
3. Observed contribution margin per OR hour not spuriously high because of outlier patients
4. Sufficient workload that can fill an OR
5. Appropriate procedures for the new OR time
6. Sufficient market demand to grow workload



# Additional Information on Operating Room Management

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