

# Showing Differences Among Hospitals and their Surgical Practices

- This talk includes many similar slides
  - Paging through produces animation
  - View with Adobe Reader for **mobile**: iPad, iPhone, Android
- Slides were tested using Adobe Acrobat
  - You can select View and then Full Screen
    - First optimize your settings
    - Select Edit, then Preferences, then Full Screen, and then No Transition
- Other PDF readers suitable if scrolling can be disabled
  - Google Chrome PDF Viewer has Select Fit to Page, and then use the right/left arrow keys

Updated 04/27/17



# Differentiating Among Hospitals and Surgical Practices



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# Financial Disclosure

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

# Examples from the University of Iowa

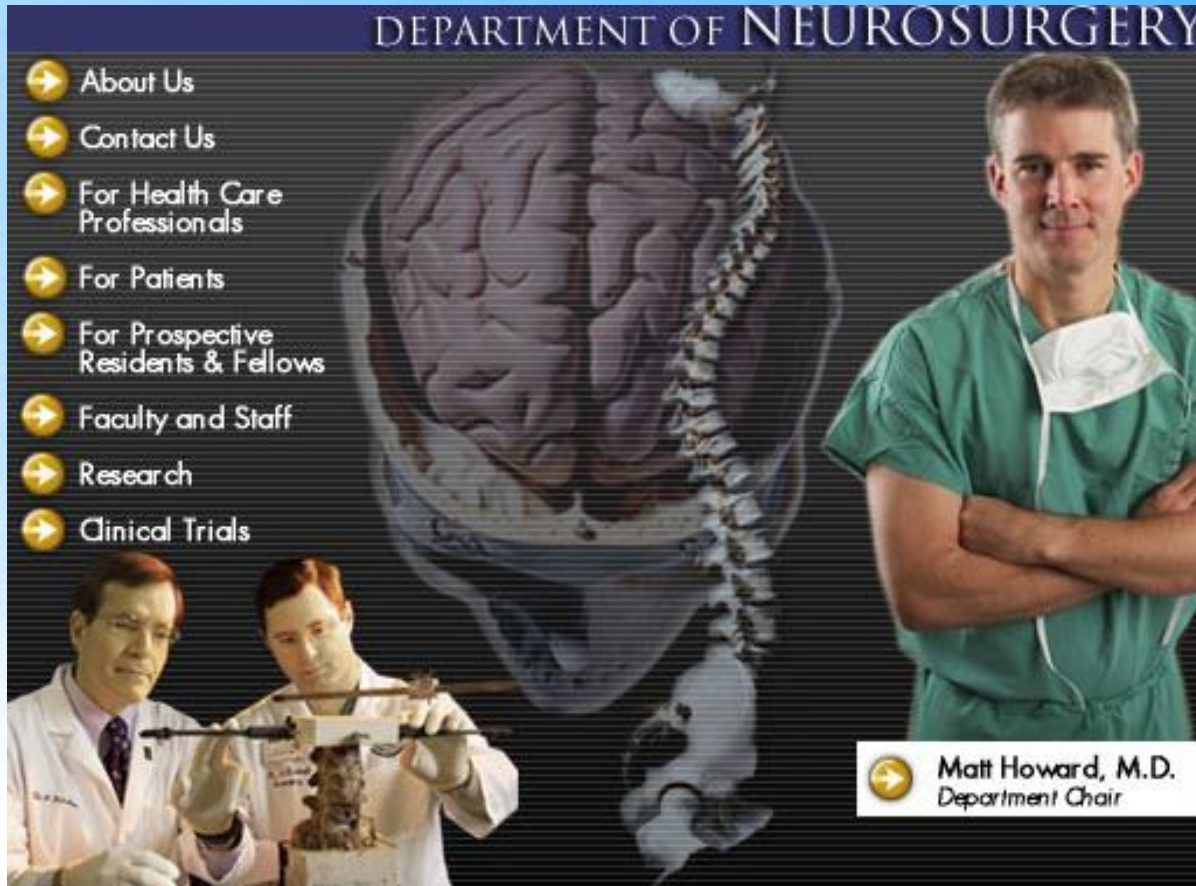
“The academic difference is what makes UI Hospitals and Clinics an incomparable resource to families in Iowa and beyond. It sets us apart. It is who we are.”



# Examples from the University of Iowa

DEPARTMENT OF NEUROSURGERY

- ➔ About Us
- ➔ Contact Us
- ➔ For Health Care Professionals
- ➔ For Patients
- ➔ For Prospective Residents & Fellows
- ➔ Faculty and Staff
- ➔ Research
- ➔ Clinical Trials



Matt Howard, M.D.  
Department Chair

# Examples from the University of Iowa

- What statements and graphics reflect reality of the hospital's (prior) strategic position?
  - Prior since deliberately referring to old data
- What are the operational and tactical consequences for perioperative management of the hospital's strategic position and plan?



# Examples from the University of Iowa

- What statements and graphics reflect reality of the hospital's (prior) strategic position?
  - Prior since deliberately referring to old data
- What are the operational and tactical consequences for perioperative management of the hospital's strategic position and plan?
  - Strategy appropriately is extremely influential



# This Lecture Will Teach You

- Government vocabulary is difficult to interpret
- Discharge abstract data can be useful
- Marketing can be statistically valid
- Results are consistently non-intuitive
- Hospitals and practices often do not know their *quantitatively important* peers and competitors
- Rare procedures and far distances traveled can have substantial operational importance





# Sources of Information

- National Center for Health Statistics
- State discharge abstract databases
  - Iowa Hospital Association
- Available through HCUP and AHRQ
  - Healthcare Cost & Utilization Project
  - Agency for Healthcare Research & Quality



# State Inpatient Databases

- 40 states
- Each data set contains the universe of that state's discharge abstracts
- Represent  $\cong 90\%$  of all U.S. community hospital discharges



# Fields in Database

- Some patient demographics
  - Age
  - Gender
  - Race
  - Insurance
  - County/zip code of patient residence



# Fields in Database

- Hospital
- Physician
- Diagnosis codes
- Procedure codes
- Hospital charges
- Hospital LOS



# Study Operative Procedures

- Use discharge abstract data to study operative procedures statewide
  - Example of State of Iowa, Jan-June 2001
  - Operating room or anesthesia charge
  - ICD-9-CM below 87.0  
( $\geq 87.0$  are “diagnostic” procedures)
  - Incision
  - Closure not required



# Incision Required

- Excluded based on requirement for incision
  - Cardiopulmonary bypass (39.61)
  - Iridotomy (12.12)
  - Suture of tracheal laceration (31.71)
- Included even though no closure occurs
  - Myringotomy with insertion of tube (20.01)
  - Insert lens at cataract extraction (13.71)



# Comparing Hospitals

- Volume
- Diversity of procedures
- Number and types of physiologically complex procedures
- Number and types of rare procedures
- Traveling for surgery



# Comparing Hospitals

- Volume
- Diversity of procedures
- Number and types of physiologically complex procedures
- Number and types of rare procedures
- Traveling for surgery

- Series of examples, many from one hospital
- Strategic decision-making, unlike operational and tactical, varies among health systems





# Comparing Hospitals

## ➤ Volume

- Diversity of procedures
- Number and types of physiologically complex procedures
- Number and types of rare procedures
- Traveling for surgery



# CHI



- Part of academic medical center
- Performs surgery on infants and young children 0-2 years old



DEPARTMENT OF PEDIATRICS



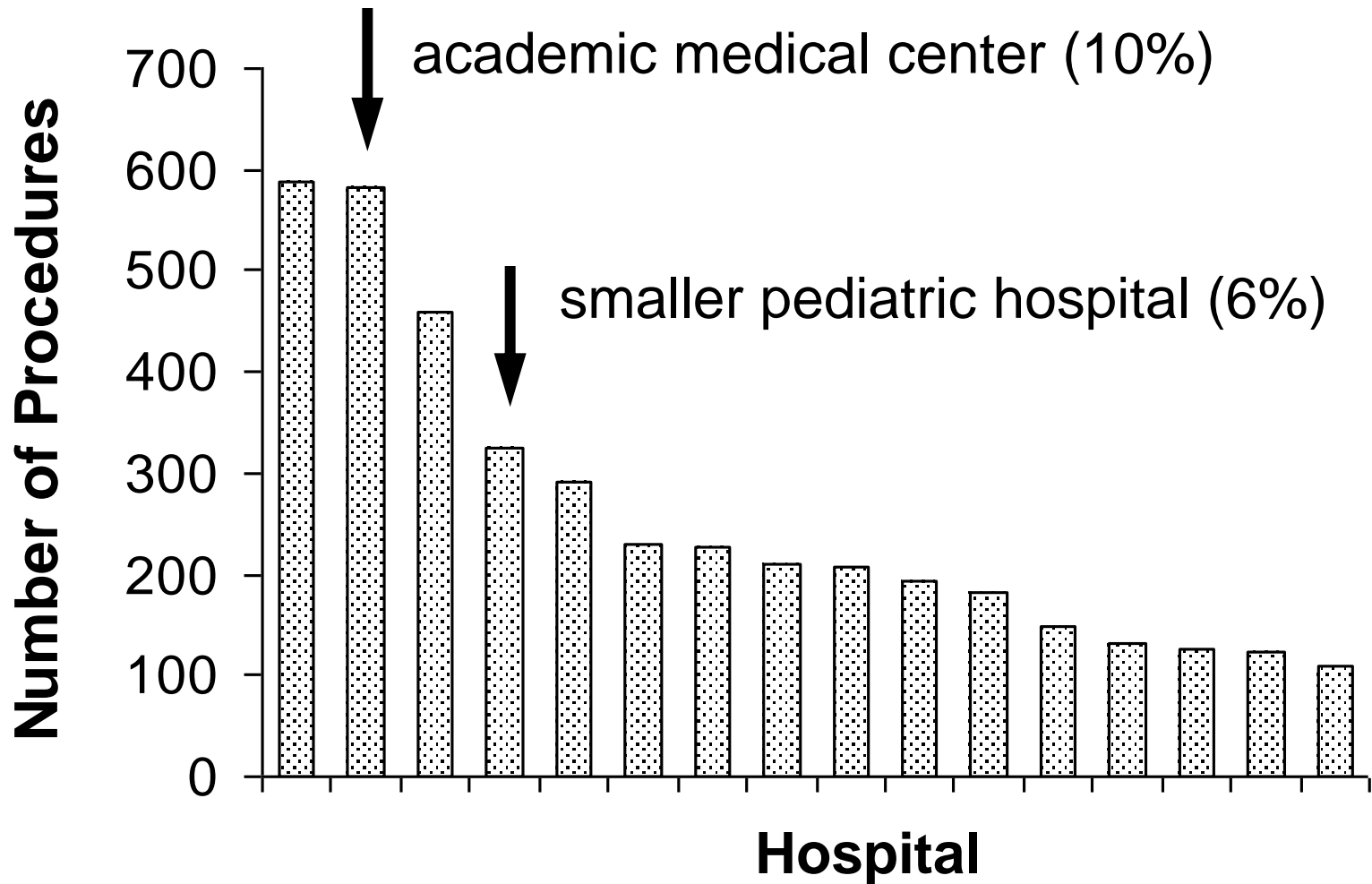
# High Volume Hospitals

- Only 16 of 93 facilities in Iowa performed at least 100 procedures in 6-month period
  - Average of at least 4 per week
- Number of cases is even fewer, because each case can include  $>1$  procedure

Dexter F et al. Anesthesiology 2003



# 16 High Volume Hospitals



# Volume – Depends on Stakeholders

- Pediatric hospitals
  - Do not perform most of the pediatric surgery in the State
  - Would argue that volume alone is not best criterion for comparison
- Non-pediatric high volume hospitals
  - Would argue that volume is good criterion for comparison



# Volume Alone not Meaningful

- Volume alone does not accurately reflect the capabilities of a hospital in providing specialized care for infants and young children
  - Disaster planning
  - Complex or rare procedures

Kanter RK, Dexter F. J Pediatr 2005



# Comparing Hospitals

- Volume
- Diversity of procedures
- Number and types of physiologically complex procedures
- Number and types of rare procedures
- Traveling for surgery



# Diversity of Procedures

- Number of different types
- Number of different types performed more often than at any other hospital
- Internal Herfindahl within a hospital
- Similarity index between hospitals

Dexter F et al. Anesthesiology 2003

Dexter F et al. Anesth Analg 2016





# Diversity: Number of Different Types

- 90 facilities: 1-15 types of procedures
- 3 facilities: >15 types of procedures
  - Academic medical center
  - Smaller pediatric hospital
  - Non-pediatric hospital doing cardiac surgery

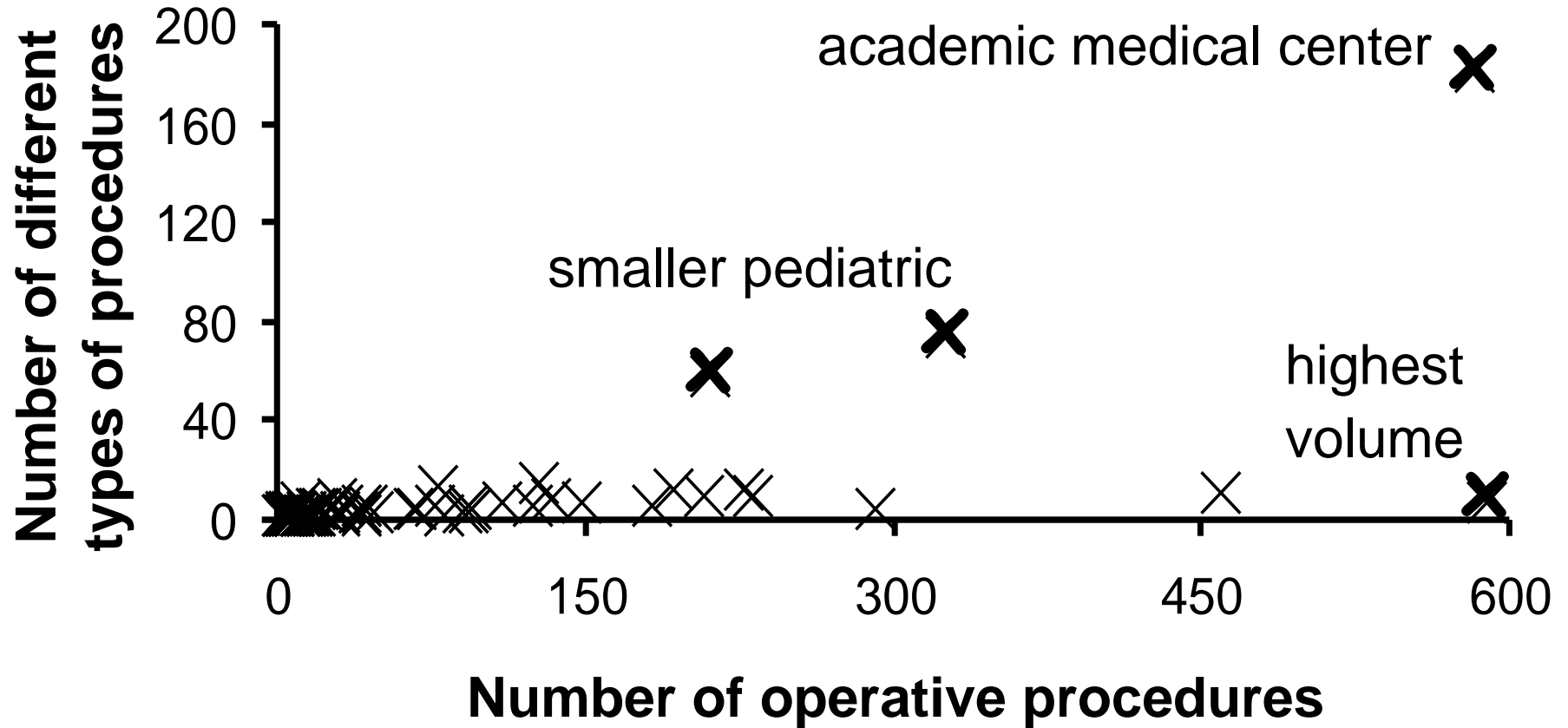


# Number of Different Types

- 246 types of procedures statewide
  - 181 at academic medical center
  - 73 at smaller pediatric hospital
  - 58 at non-pediatric hospital
  - 7 at highest volume facility
    - 99% myringotomy tube placement, adenoidectomy, and/or tonsillectomy



# Number of Different Types



# Diversity: Number Types Performed More Often

- Among the 246 types of procedures performed statewide
  - 165 types performed more often at academic medical center than any other facility
  - 44 at smaller pediatric hospital
  - 32 at non-pediatric hospital
  - 5 at highest volume facility



# Diversity: Internal Herfindahl Index

- Sum of squares: proportions of each type of procedure performed at a hospital
- Equals the probability that if two procedures are selected at random, both will be the same type of procedure

Dayhoff DA, Cromwell J. Health Serv Res 1993



# Diversity: Internal Herfindahl Index

- Sum of squares: proportions of each type of procedure performed at a hospital
- Equals the probability that if two procedures are selected at random, both will be the same type of procedure

$$\sum [p_1^2 + p_2^2 + \dots + p_i^2]$$



# Example of Internal Herfindahl Index

- 3 types of procedures at hospital:
  - 75% myringotomy with insertion of tube
  - 15% adenoidectomy without tonsillectomy
  - 10% tonsillectomy with adenoidectomy
- Internal Herfindahl index is 0.60

$$0.60 = (0.75)^2 + (0.15)^2 + (0.10)^2$$



# Example of Internal Herfindahl Index

- 100 types of procedures at hospital:
  - All performed with equal frequency
- Internal Herfindahl index is 0.01

$$0.01 = (0.01)^2 \times 100$$





# Example of Internal Herfindahl Index

- 1 type of procedure at hospital:
  - Only performs one type
- Internal Herfindahl index is 1.0

$$1.0 = (1)^2$$



# Internal Herfindahl Index

- Low value of index (e.g., 0.22)
  - Greater variety of procedures
  - Each at low frequency
- High value of index (e.g., 0.95)
  - Only a few types of procedures
  - Each performed many times



# Internal Herfindahl Index

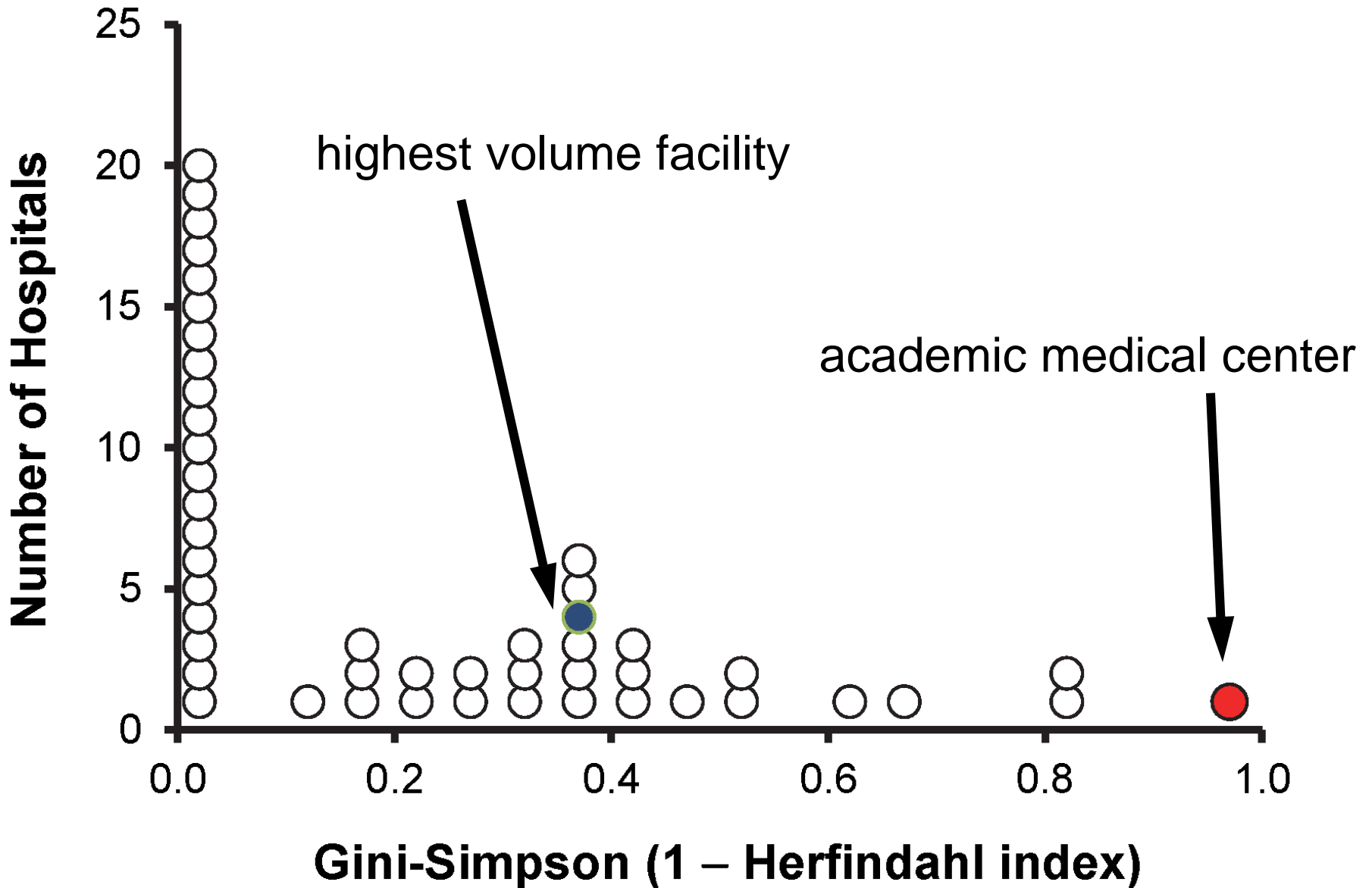
- Can calculate standard errors
  - Academic medical center:  
 $0.07 \pm 0.01$
  - Smaller pediatric hospital:  
 $0.22 \pm 0.02$
  - Highest volume facility:  
 $0.66 \pm 0.02$

Taplin RH. Abacus 2003

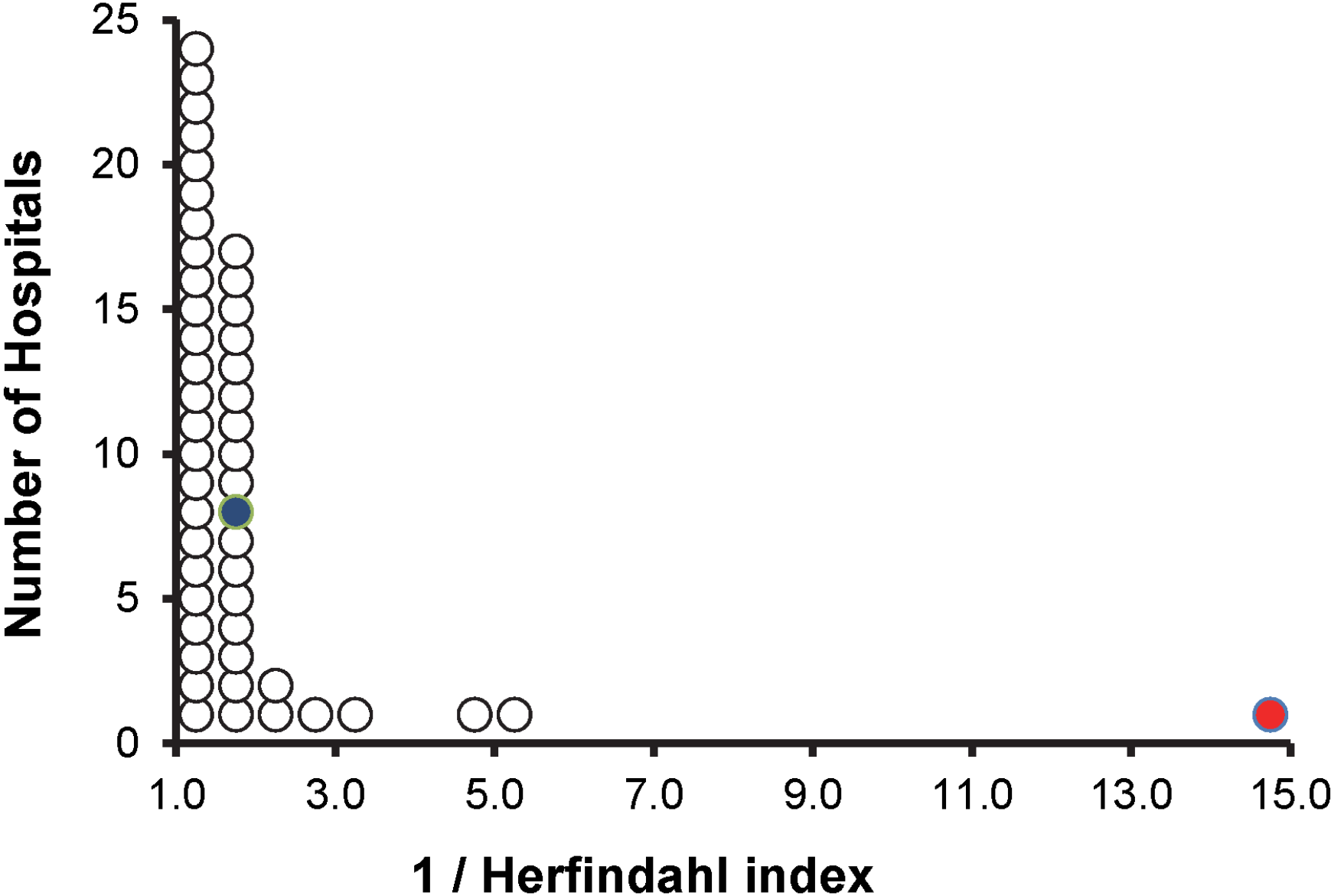
Dexter F et al. Anesth Analg 2016



# Internal Herfindahl Index



# Inverse of Herfindahl Index



# Inverse of Herfindahl Index

- Each increase in number of different types of procedures results in an increase in the inverse of the internal Herfindahl
  - Effective number of common types of procedures

Dexter F et al. Anesth Analg 2016

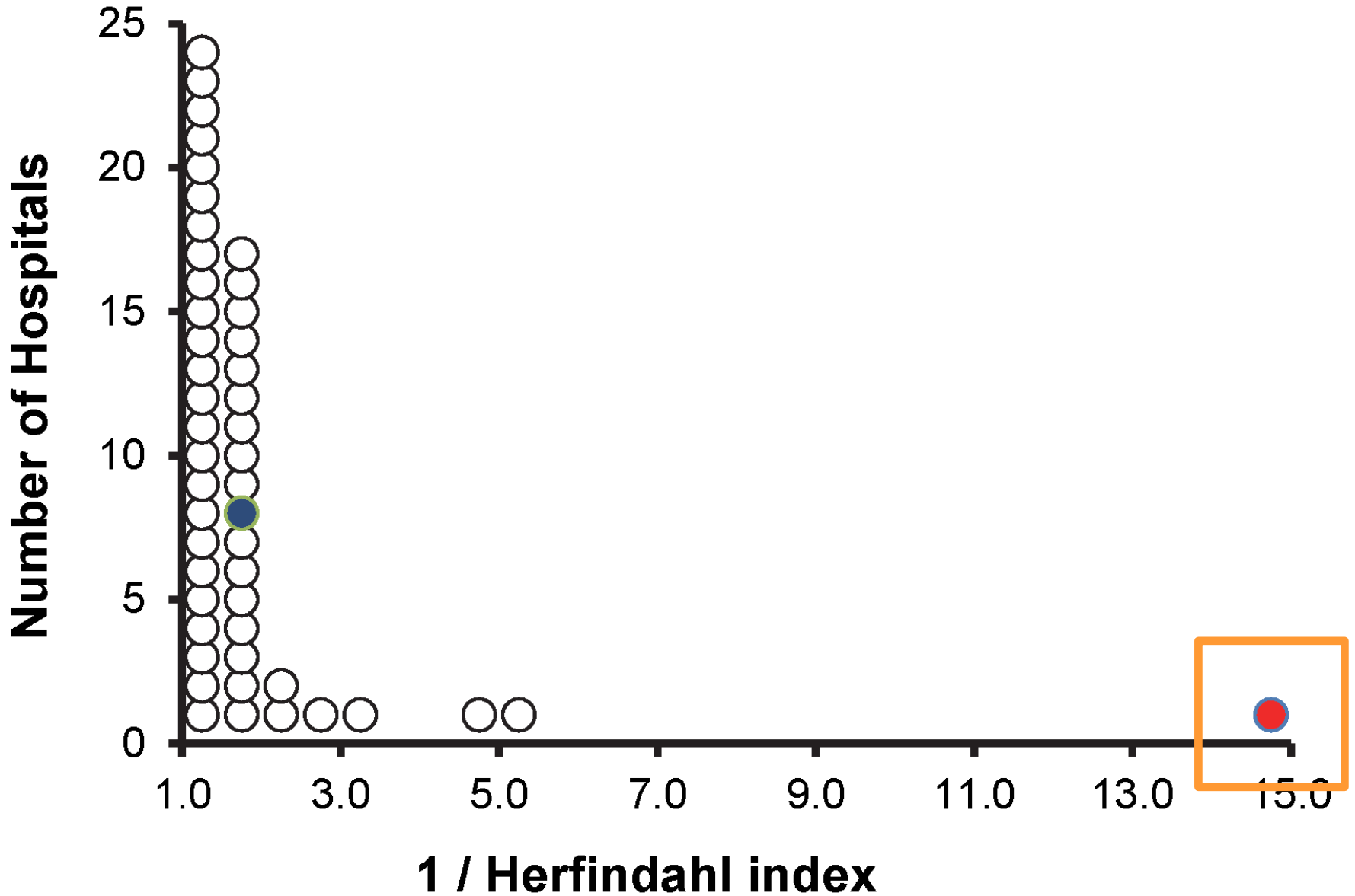


# Inverse of Herfindahl Index

- Each increase in number of different types of procedures results in an increase in the inverse of the internal Herfindahl
  - Effective number of common types of procedures
    - **Large** operational (“efficiency”) importance



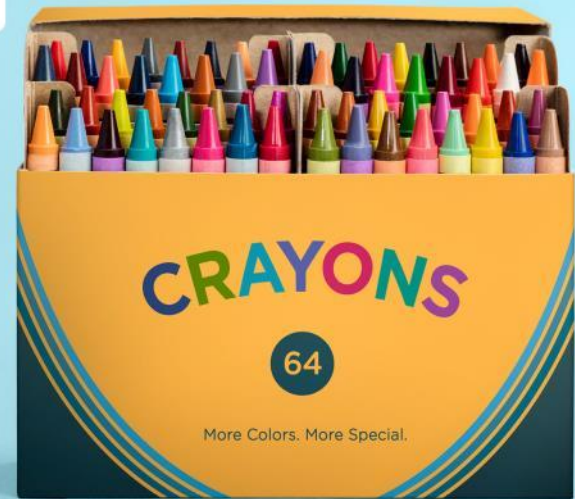
# Large Marketing Importance





# Large Marketing Importance

MORE OPTIONS FOR YOUR CHILD.



# Large Marketing Importance

“As Iowa’s only **comprehensive** academic medical center, we constantly ask the tough questions, push the boundaries of medicine, and provide the most up-to-date treatments.”



# Inverse of Herfindahl Index

- Each increase in number of different types of procedures results in an increase in the inverse of the internal Herfindahl
  - Effective number of common types of procedures
    - **Large** operational (“efficiency”) importance
- Effective number of anesthesia providers at a hospital is calculation that compensates for part-time work and/or administrative activities without knowing those hours



# Diversity: Similarity Index

- Analogous to internal Herfindahl
  - Compares diversity or dissimilarity of two hospitals based on relative frequencies with which different types of procedures were performed
  - Correlation coefficient
  - Varies between 0 and 1

Dexter F et al. Anesthesiology 2003

Dexter F et al. Anesth Analg 2016



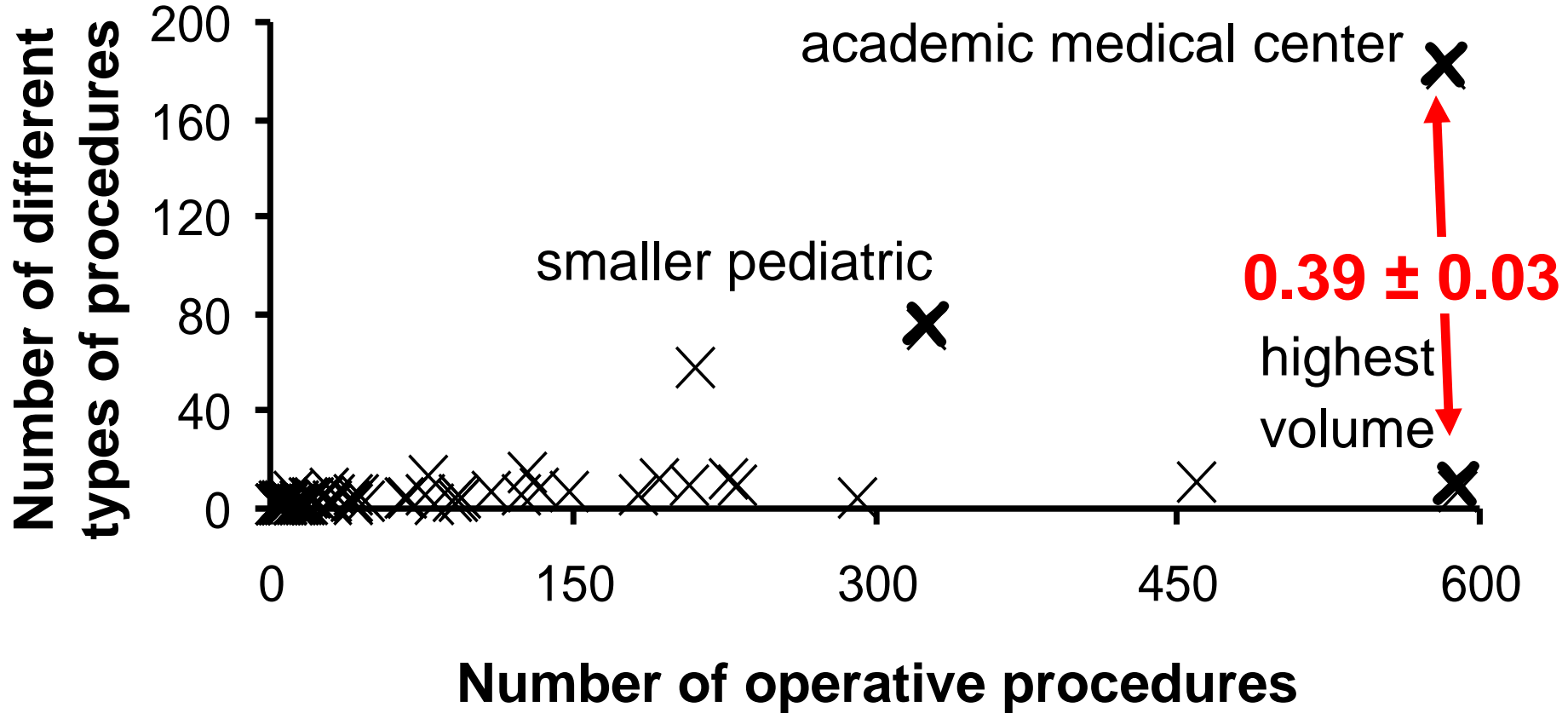
# Similarity Index

- $p$  = proportion of procedures that are of the  $i^{\text{th}}$  type at hospital A or hospital B
- $N$  = number of different types of procedures

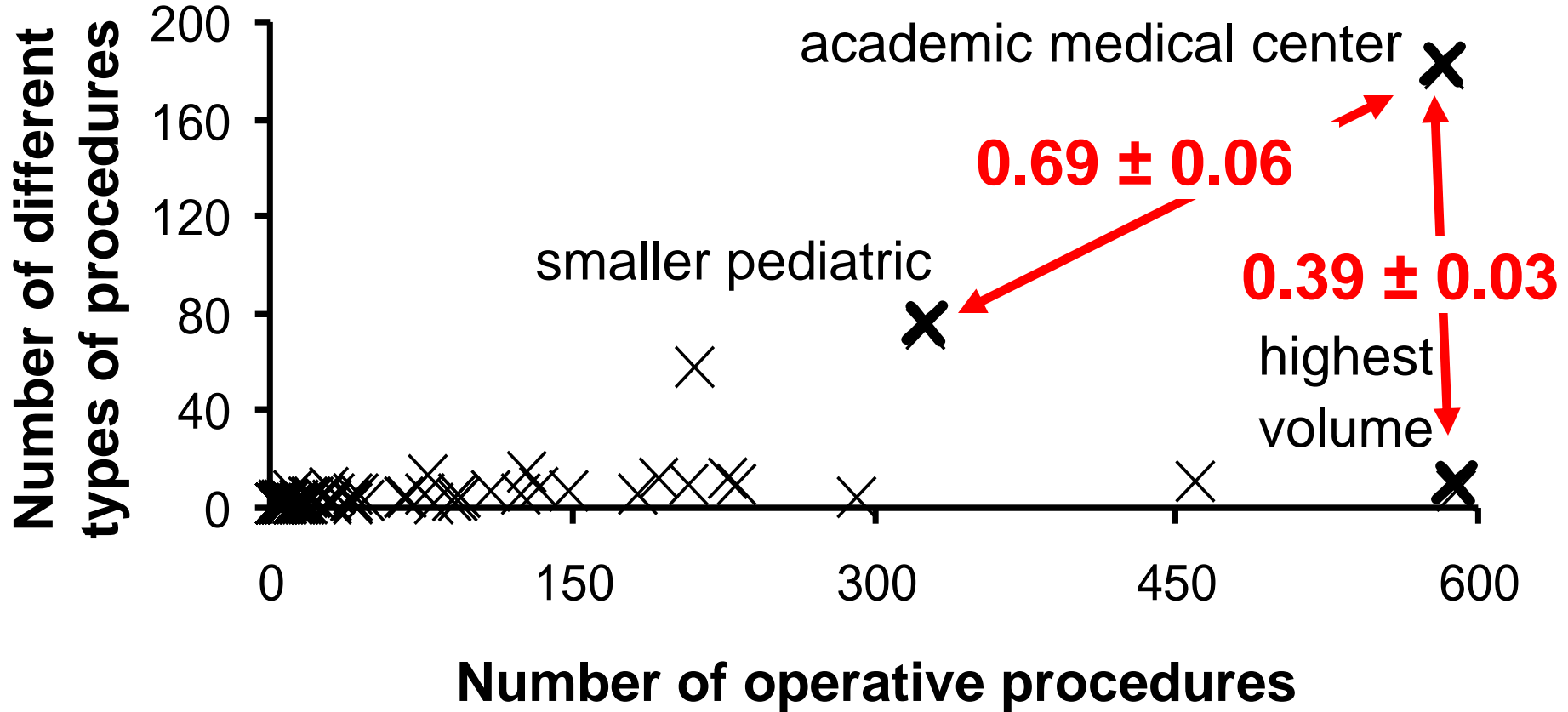
$$\frac{\sum_{i=1}^N p_{Ai} p_{Bi}}{\sum_{i=1}^N p_{Ai} p_{Bi} + \sum_{i=1}^N (p_{Ai} - p_{Bi})^2}$$



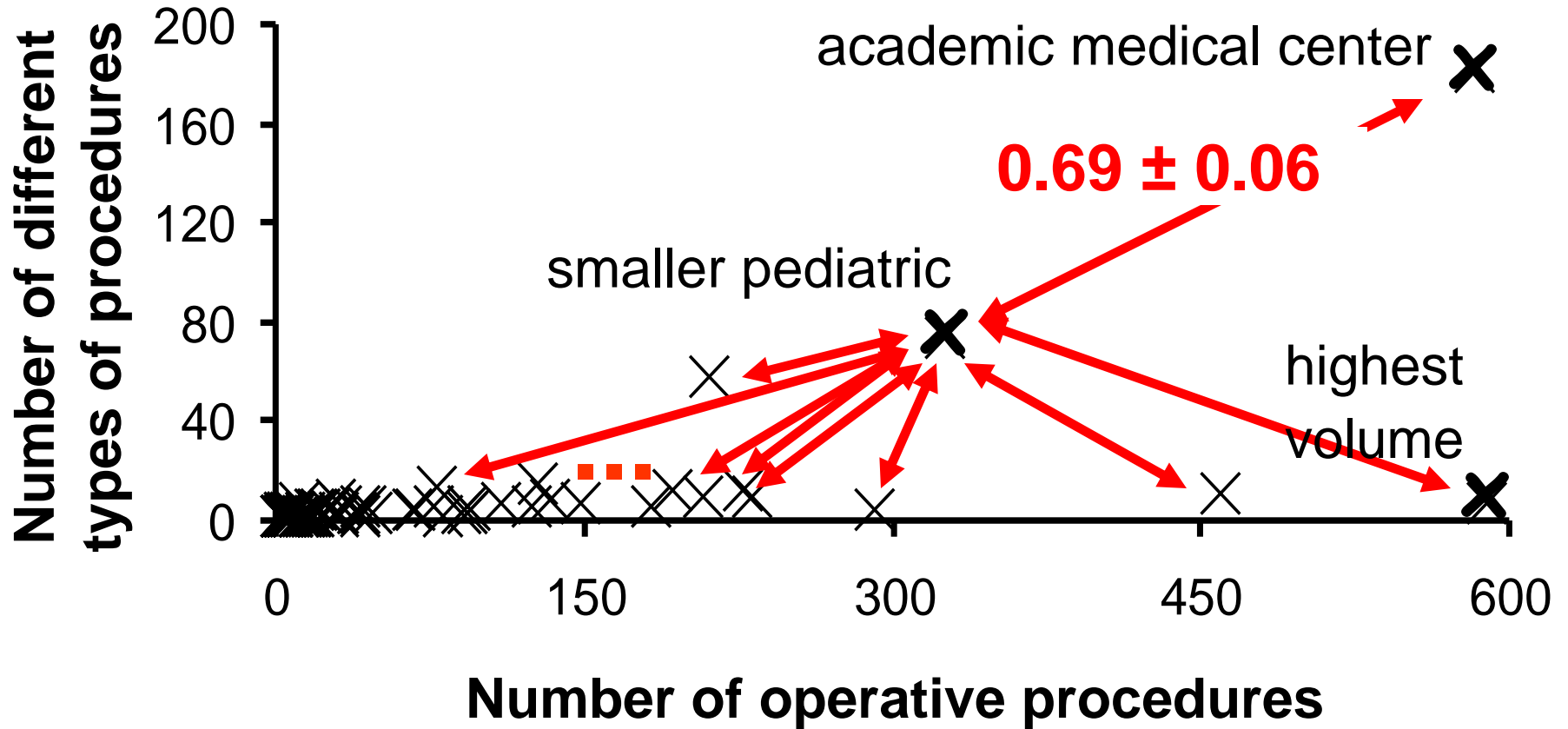
# Low Value of Similarity Index



# Higher Value of Similarity Index



# Similarity





# Preceding Figure Shows ...

- Academic medical center and smaller pediatric hospital were no more similar to each other than smaller pediatric hospital was to other hospitals in state combined
  - Academic medical center and smaller pediatric hospital  $0.69 \pm 0.06$
  - Smaller pediatric hospital and other hospitals combined  $0.74 \pm 0.04$
  - Difference  $-0.06 \pm 0.08$



# More Examples About Similarity Index Because So Practical

Wachtel RE et al. Anesth Analg 2010

Dexter F et al. Anesth Analg 2016



# More Examples About Similarity Index Because So Practical

- Hospital A in same city as Hospital B
- Many small hospitals 0 to 100 miles away
- Hospital A considers B its principal competitor
- Finding: similarity index =  $0.30 \pm 0.01$
- Moral: Principal competition is not B, but the collective action of many other hospitals, no one of which is in same size community, is geographically close, or as large

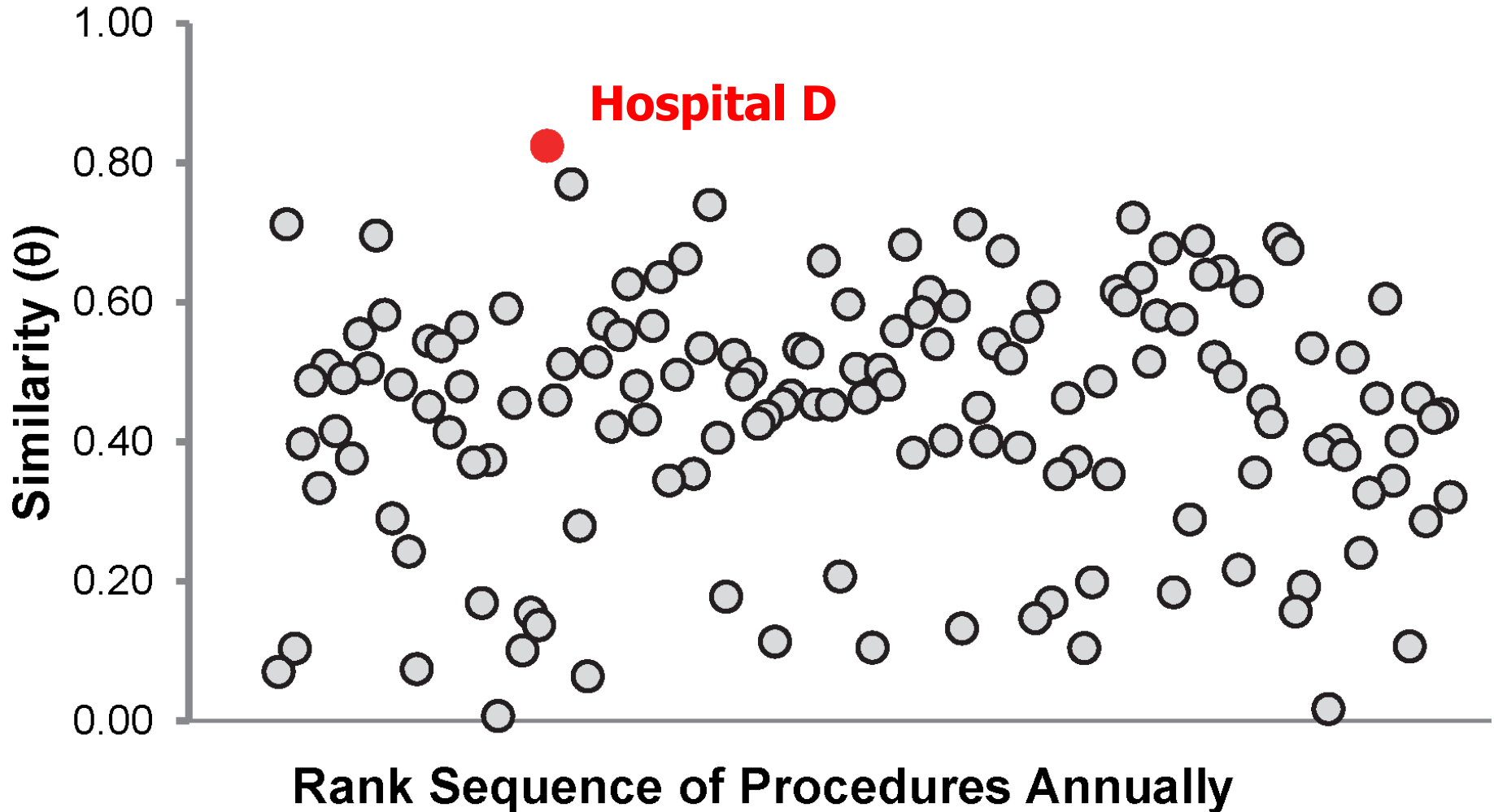


# More Examples About Similarity Index Because So Practical

- Hospital C in county with one other Hospital D
- Adjacent county has large city with several nationally known tertiary hospitals
  - Hospital C requests similarity index between residents of its county having procedures performed within versus outside of its county
- When compared similarity of Hospital C to 134 other hospitals, largest was D ( $0.82 \pm 0.03$ )



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- When compared similarity of Hospital C to 134 other hospitals, largest was D ( $0.82 \pm 0.03$ )
- Moral: Principal competition literally next door



# More Examples About Similarity Index Because So Practical

- Similarity analysis run for Hospital B
- Hospital B was unexpectedly highly dissimilar to all other small hospitals in its state
- Hospital B was moderately similar to a metropolitan hospital with web site touting its cardiac and transplantation programs
  - Both hospitals' most common procedures were knee and hip arthroplasty
- Moral: focus not on what hospitals tout, but quantitative assessments of procedures

# More Examples About Similarity Index Because So Practical

- Data: 2 columns  $\times$  many ( $\cong$  1 million) rows

<u>HOSPITAL</u>		<u>PROCEDURE</u>
219	,	"4501"
219	,	"8152"
219	,	"2001"
•		•
•		•
•		•
712	,	"8051"
712	,	"0780"
•		•
•		•
•		•
219	,	"562"





# More Examples About Similarity Index Because So Practical

- Data: 2 columns  $\times$  many ( $\cong$  1 million) rows
- Limitations

Wachtel RE, Dexter F. Anesthesiology 2004

Wachtel RE et al. Anesth Analg 2007

O'Neill L, Dexter F. Anesth Analg 2007



# More Examples About Similarity Index Because So Practical

- Data: 2 columns  $\times$  many ( $\cong$  1 million) rows
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  - Hospital data, not patient data, and thus if patient travels across border to another state or province, often their data are not known



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  - Hospital data, not patient data, and thus if patient travels across border to another state or province, often their data are not known
  - Inpatient procedures, and when outpatient procedures are available, generally only from hospital outpatient departments
  - If code appears 10 times in 1 million rows, and each at different hospitals, rare procedure or inaccurate coding?



# Summary – Used Several Measures of Diversity

- Number of different types
- Number of different types performed more often than at any other hospital
- Internal Herfindahl within a hospital
- Similarity index between hospitals



# Summary – Diversity of Procedures

- Academic medical center ...
  - Performs greatest diversity of procedures, provides the most comprehensive pediatric surgical services statewide, by far
  - Unlike any other hospital statewide



# Review – Summarize the Facts of the Talk



# What is the Competition?

## Heterogeneity Among our Sites?

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# What is the Competition?

## Heterogeneity Among our Sites?

1. Volume
2. Diversity of procedures
3. Number and types of physiologically complex procedures
4. Number and types of rare procedures
5. Traveling for surgery



# Comparing Hospitals

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- Volume
- Diversity of procedures
- Number and types of physiologically complex procedures
- Number and types of rare procedures
- Traveling for surgery

# Physiologically Complex Procedures

- Anesthesiologists' reimbursement for a case depends on:
  - ① time ② intensity
- Intensity factor for each type of procedure based on American Society of Anesthesiologists' Relative Value Guide



# Physiologically Complex Procedures

- Intensity factor = base units
- Procedure is physiologically complex if  $>7$  ASA RVG base units

Dexter F et al. Anesth Analg 2002  
Dexter F, Thompson E. AANA J 2001



# Physiologically Complex Procedures

## ASA RVG base units

- 3 Repair of syndactyly
- 4 Repair of inguinal hernia
- 5 Adenoidectomy
- 7 Pyloromyotomy
- 8 Repair of myelomeningocele
- 10 Creation of ventriculoperitoneal shunt
- 11 Craniectomy for craniosynostosis
- 13 Posterior segmental instrumentation
- 15 Blalock-Taussig shunt
- 20 Complex pediatric cardiac surgery repairs

*physiologically  
complex*

# Physiologically Complex Procedures

- Percentage of all procedures that are physiologically complex:
  - 26% at academic medical center
  - 7% at smaller pediatric hospital
  - 27% at non-pediatric hospital
  - 0.1% at remaining 90 facilities
  - 0% at highest volume facility



# Physiologically Complex Procedures

- Vast majority of hospitals do not perform physiologically complex surgery in infants and young children
- Physiologically complex surgery is a significant fraction of procedures at only 2 hospitals



# Physiologically Complex Procedures

- 64% of all complex procedures statewide performed at the academic medical center





# Physiologically Complex Procedures

- Insurers cannot exclude hospital from preferred provider network (organization)
- Donors and benefactors can appreciate unique expertise



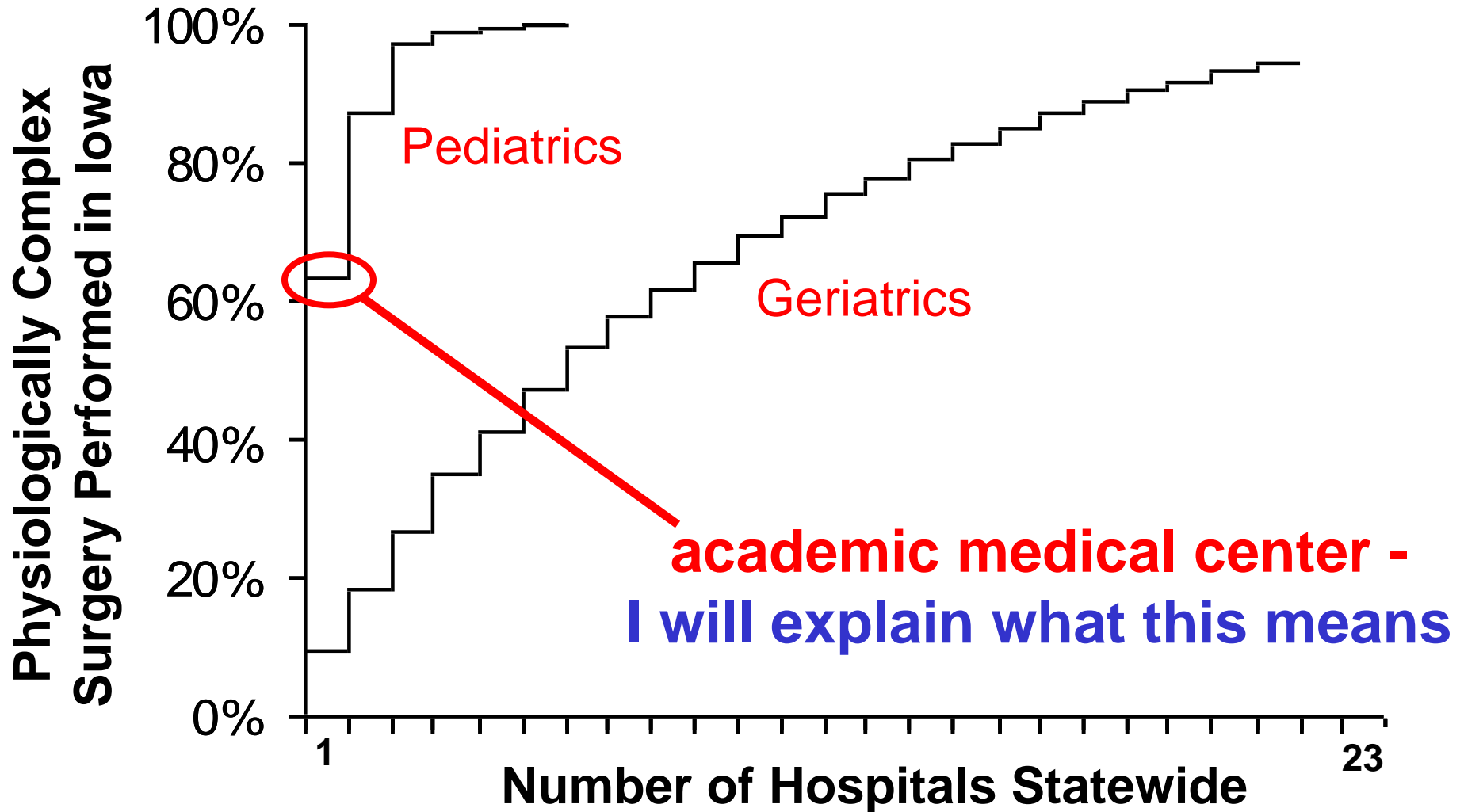
# Physiologically Complex Procedures

Will illustrate graphically the dominance of the academic medical center in performing 64% of physiologically complex procedures in the state in infants and young children

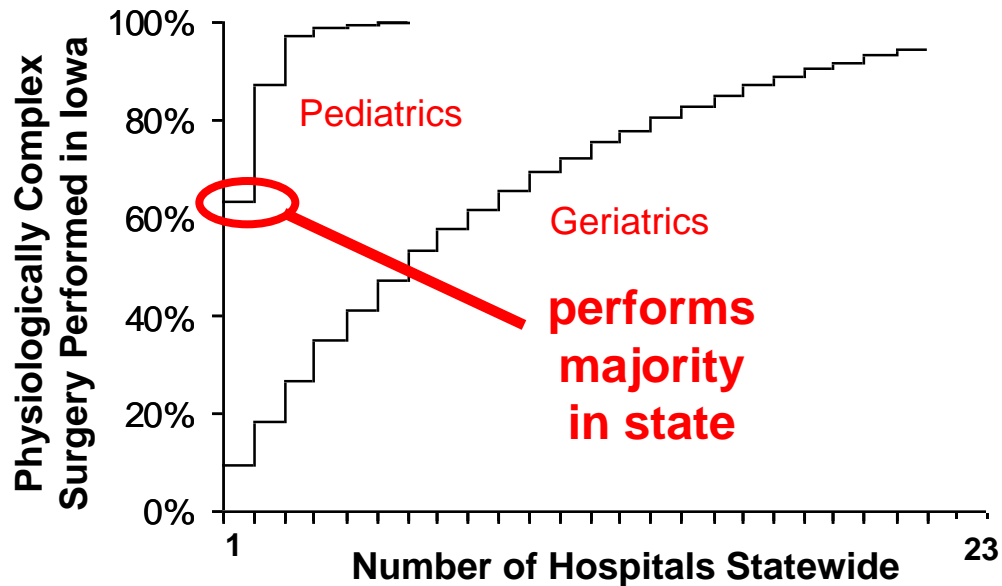
Wachtel RE, Dexter F. Anesthesiology 2004



# Physiologically Complex Procedures

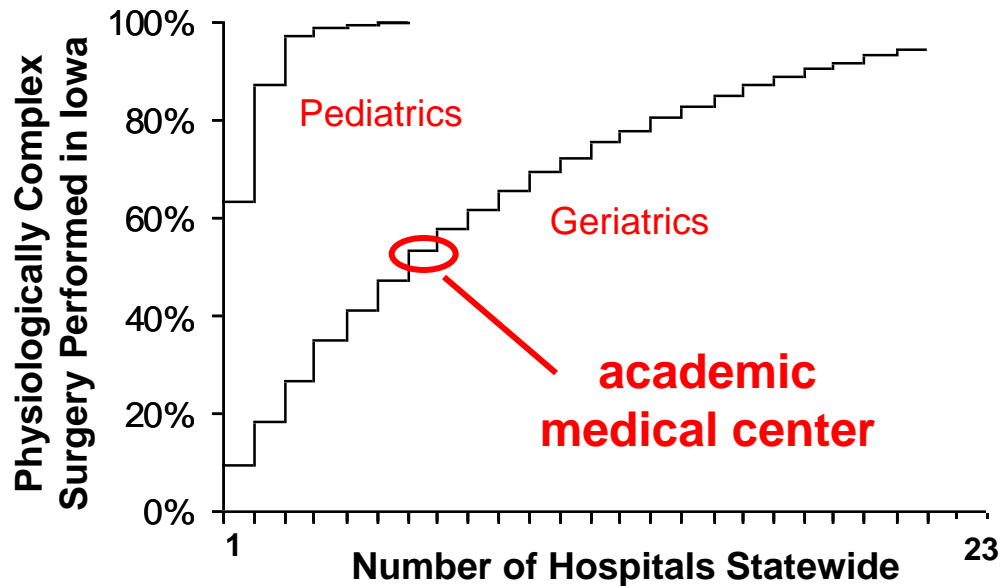


# Physiologically Complex Procedures



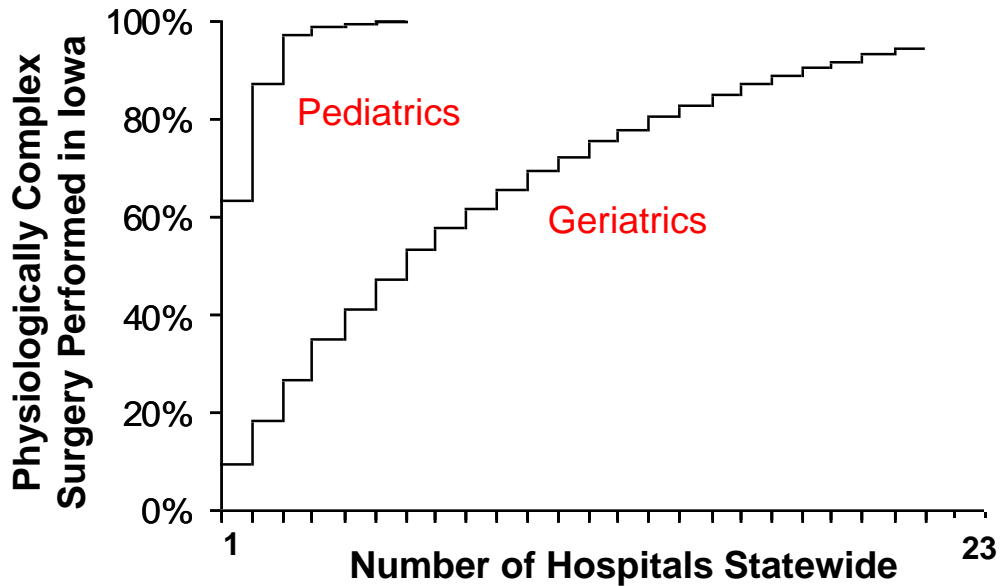
- cumulative distribution plots
- sort hospitals in decreasing order of percentage performed
- contribution of each hospital is shown as step
- graph represents cumulative percentage as each successive hospital is added to total

# No Similar Dominance for Geriatrics



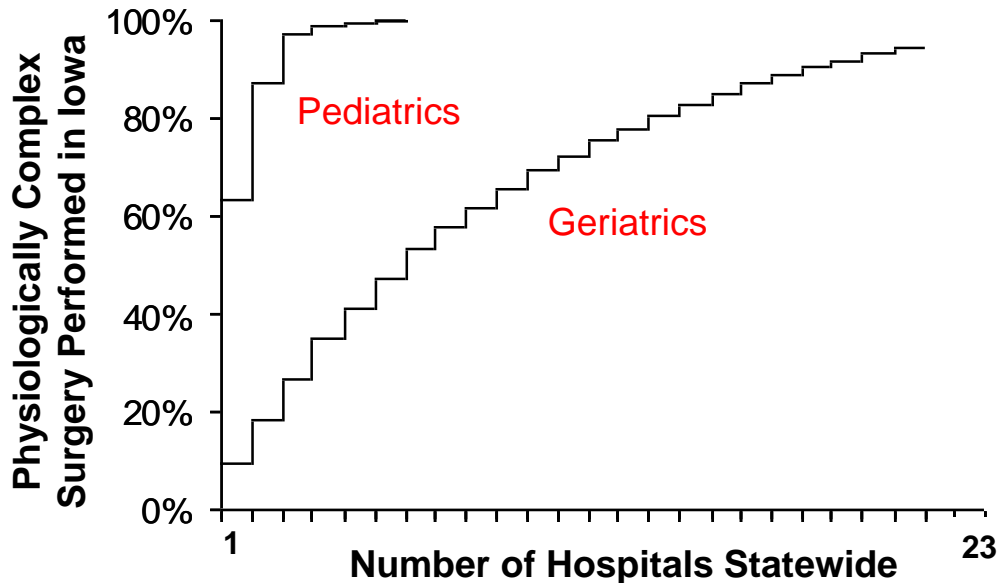
- for pediatrics (0-2 yr), one hospital performed 64% of complex procedures in state
- geriatrics ( $\geq 80$  yr) shown for comparison
  - no single hospital dominated
  - serves as control group to show pediatric results not artifact
  - makes pediatric results seem even more impressive

# Methodology



- cumulative distribution plots illustrate Kolmogorov-Smirnov method for comparing shapes of two distributions
- $P < 10^{-5}$

# Methodology



- cumulative distribution plots illustrate Kolmogorov-Smirnov method for comparing shapes of two distributions
- $P < 10^{-5}$

standard in stats packages,  
found on web site calculators

# Methodology

- Another method for comparing distributions
  - Herfindahl-Hirschman index
  - Similar to internal Herfindahl, but applied externally

Baker LC. Health Serv Res 2001





# Previous Example of Internal Herfindahl Index

- 3 types of procedures at hospital:
  - 75% myringotomy with insertion of tube
  - 15% adenoidectomy without tonsillectomy
  - 10% tonsillectomy with adenoidectomy
- Internal Herfindahl index is 0.60

$$0.60 = (0.75)^2 + (0.15)^2 + (0.10)^2$$



# Example of Herfindahl-Hirschman Index

- 4 different hospitals (A, B, C, and D) do physiologically complex pediatric surgery:
  - 64% at A
  - 24% at B
  - 10% at C
  - 2% at D
- Herfindahl-Hirschman index is 0.48
$$0.48 = (0.64)^2 + (0.24)^2 + (0.10)^2 + (0.02)^2$$



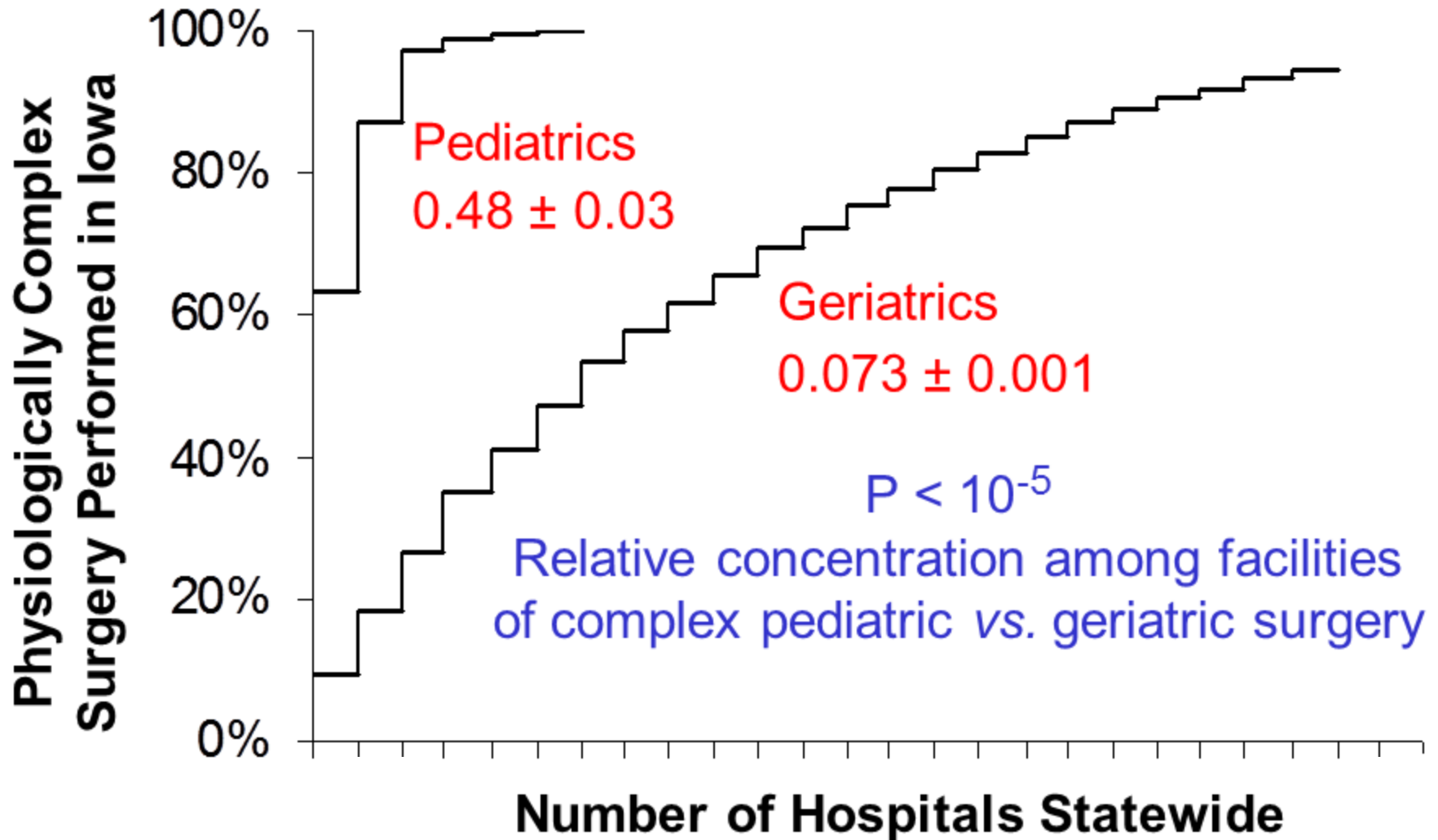
# Applying Herfindahl-Hirschman Index

- Physiologically complex pediatric surgery statewide:  
 $0.48 \pm 0.03$
- Physiologically complex geriatric surgery statewide:  
 $0.073 \pm 0.001$

Taplin RH. Abacus 2003



# Applying Herfindahl-Hirschman Index



# Geriatrics

- Previously examined pediatric surgery at academic medical center
- How do we distinguish ourselves with regard to geriatrics?
- Is there anything about geriatric surgery that is special?

Wachtel RE, Dexter F. Anesthesiology 2004



# Comparing Hospitals

- Volume
- Diversity of procedures
- Number and types of physiologically complex procedures
- Number and types of rare procedures
- Traveling for surgery



# Rare Types of Procedures

- Performed, on average, less than once per workday statewide
  - < 250 times per year is intuitive
  - Applicable to any region
    - City
    - Part of state (e.g., Central NY)
    - State
  - In Iowa, < 0.06% of all procedures, both operative and non-operative



# Rare Types of Procedures

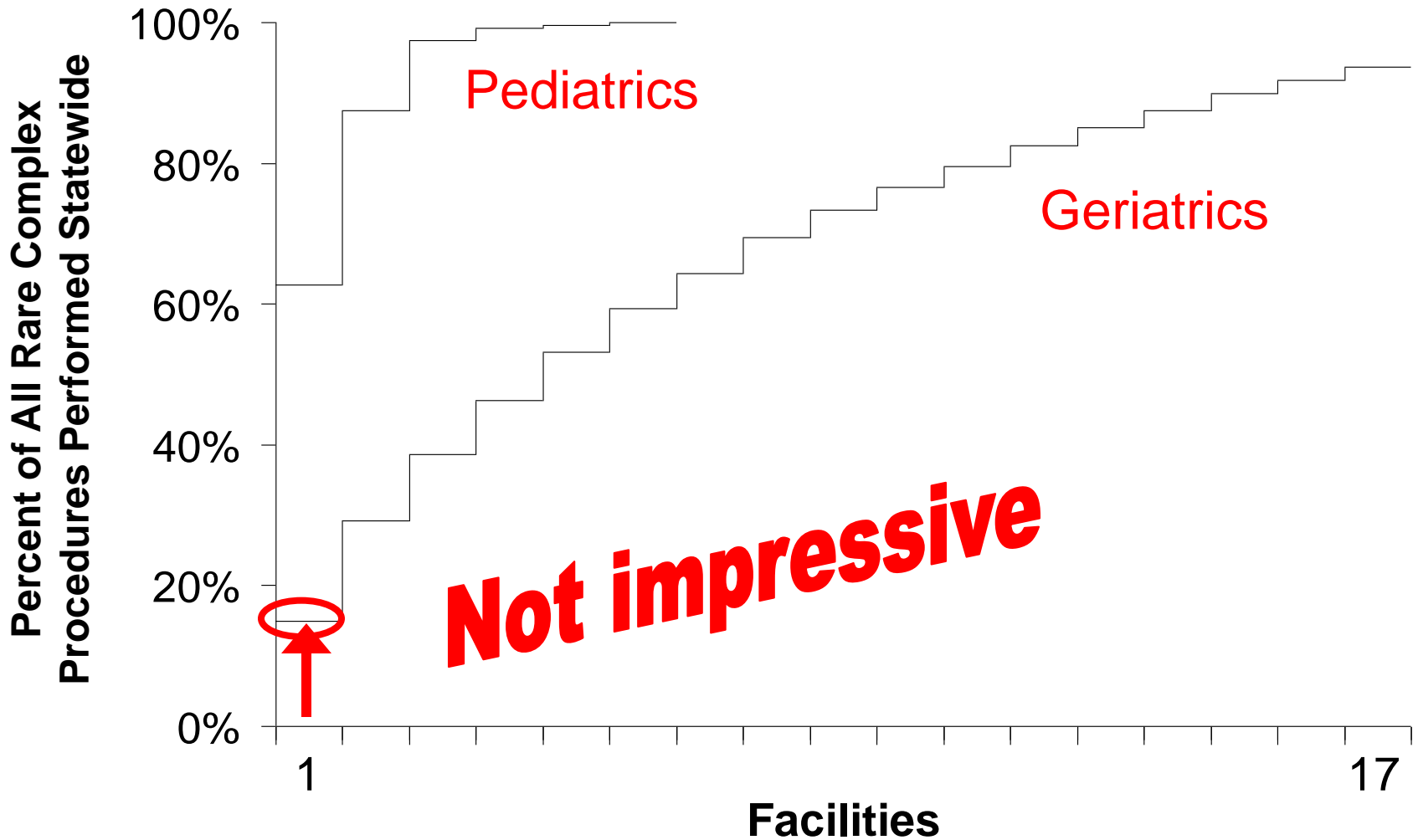
- Consider only rare procedures that are physiologically complex
  - Consume more resources than procedures that are not physiologically complex
  - ICD-9-CM chapter with most types of procedures is that for hand surgery and podiatry (i.e., many different bones)

Wachtel RE, Dexter F. Anesthesiology 2004

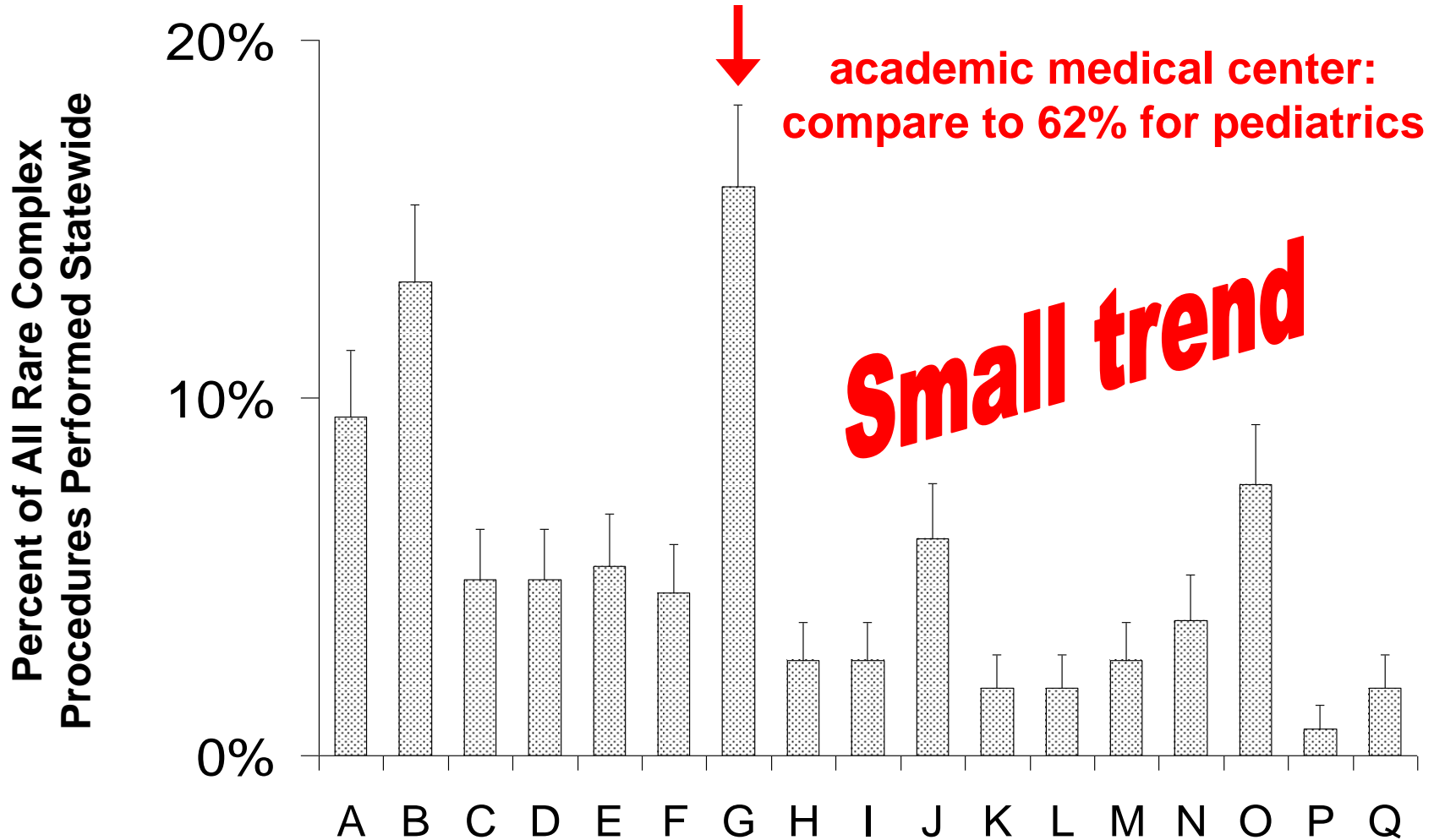




# Rare Types of Procedures

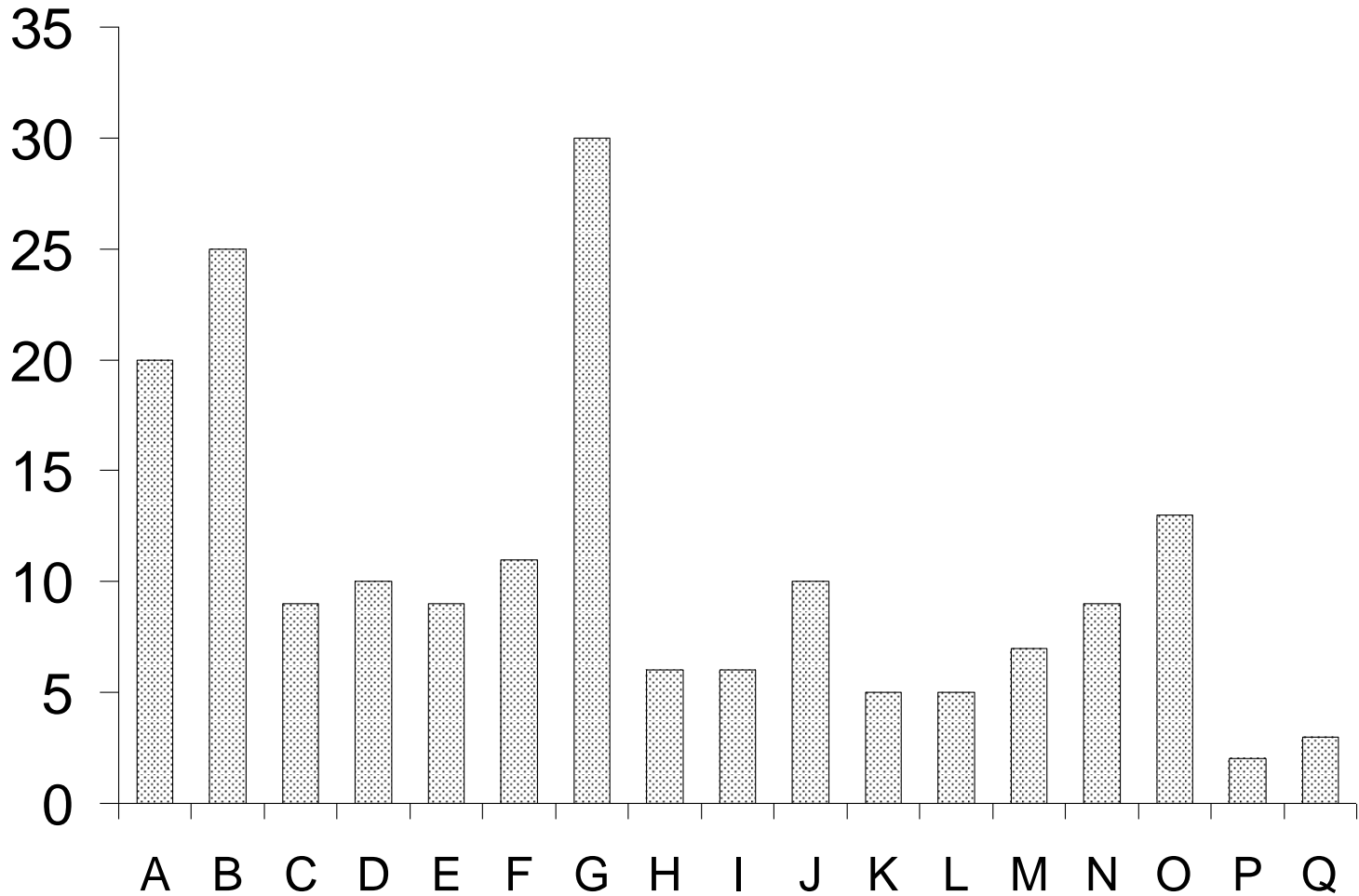


# Same Data as Previous Slide



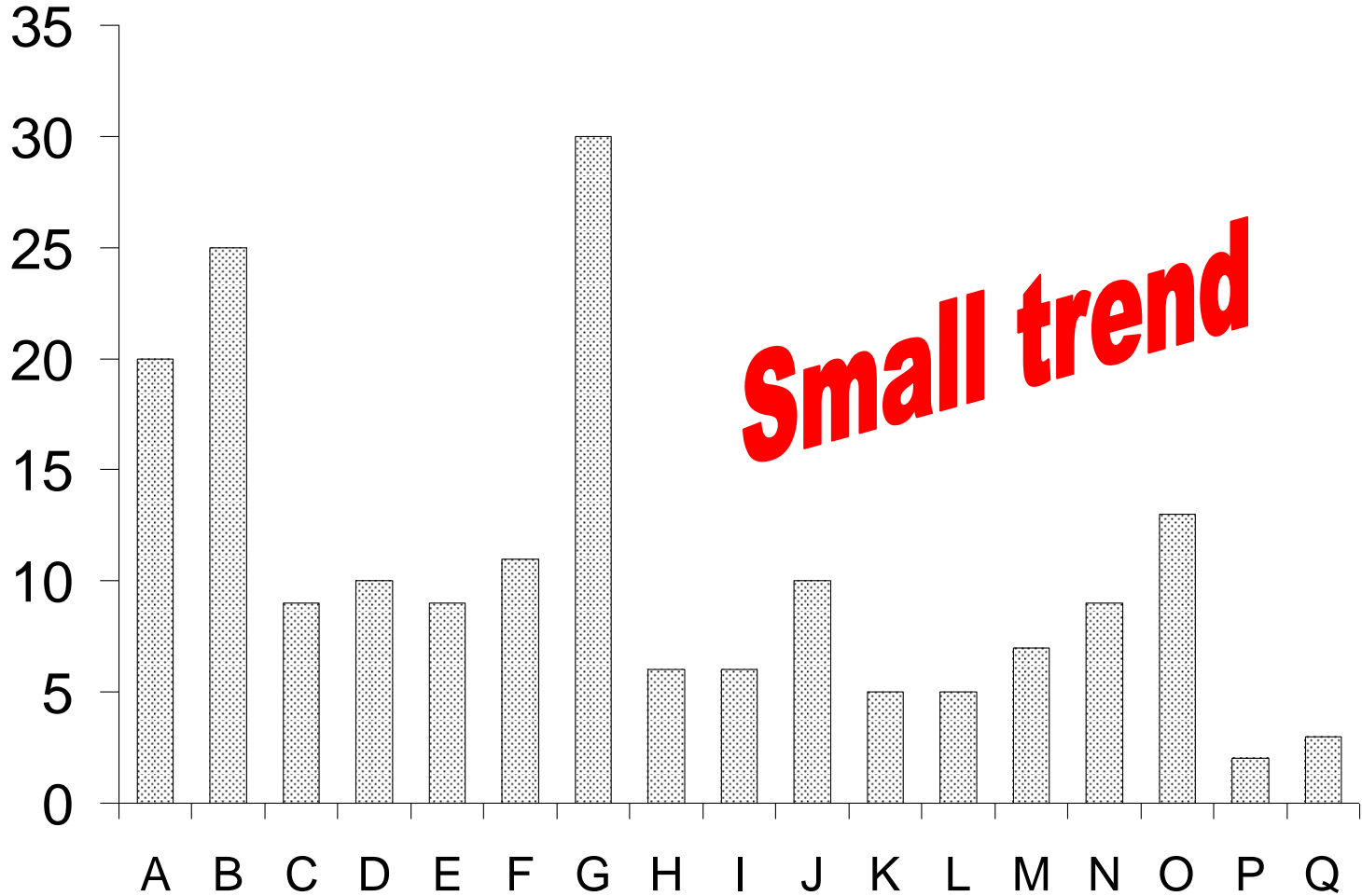
# Rare Procedures in Geriatric Patients

Number of Different Types of Procedures Considered Rare



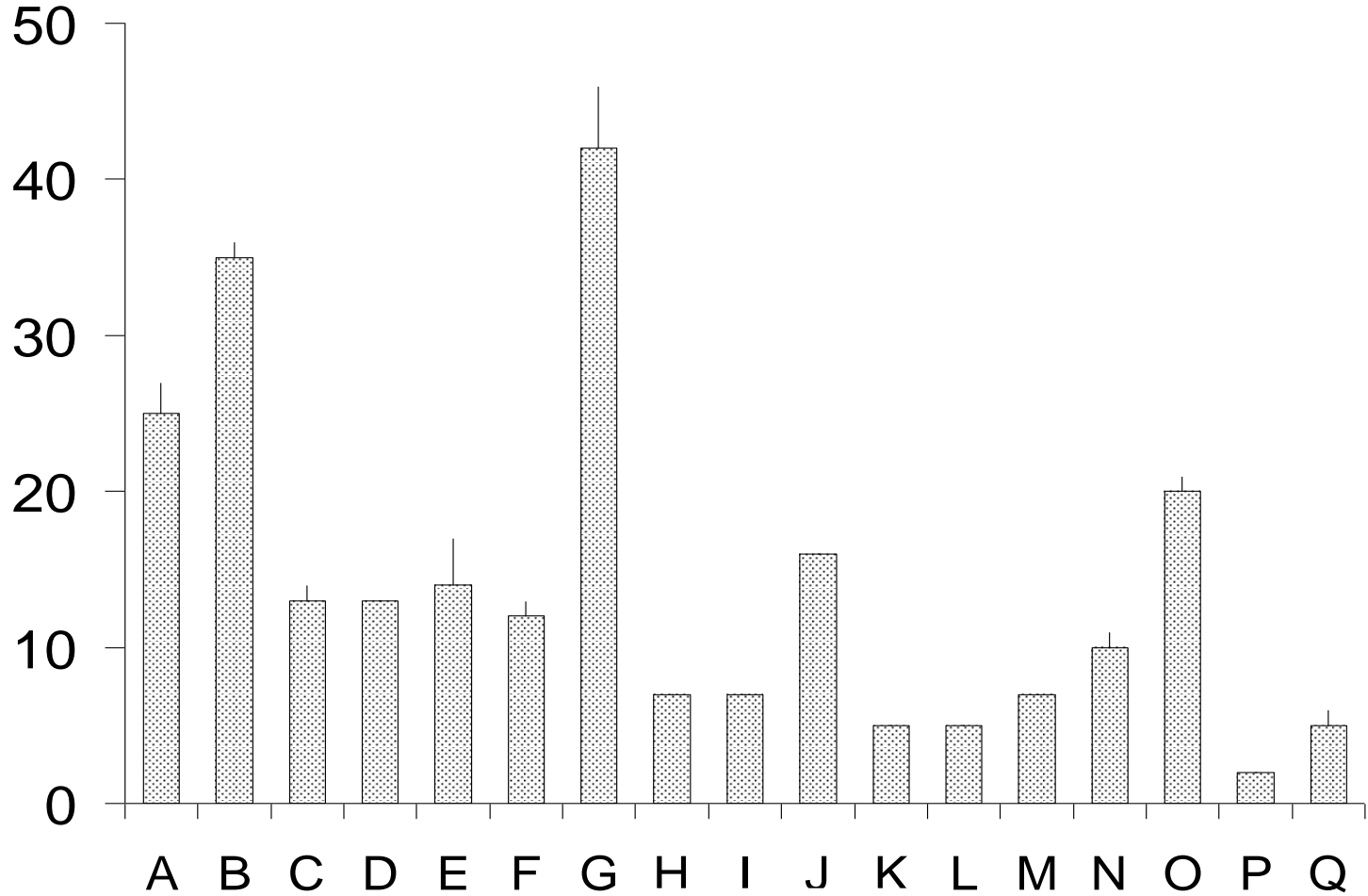
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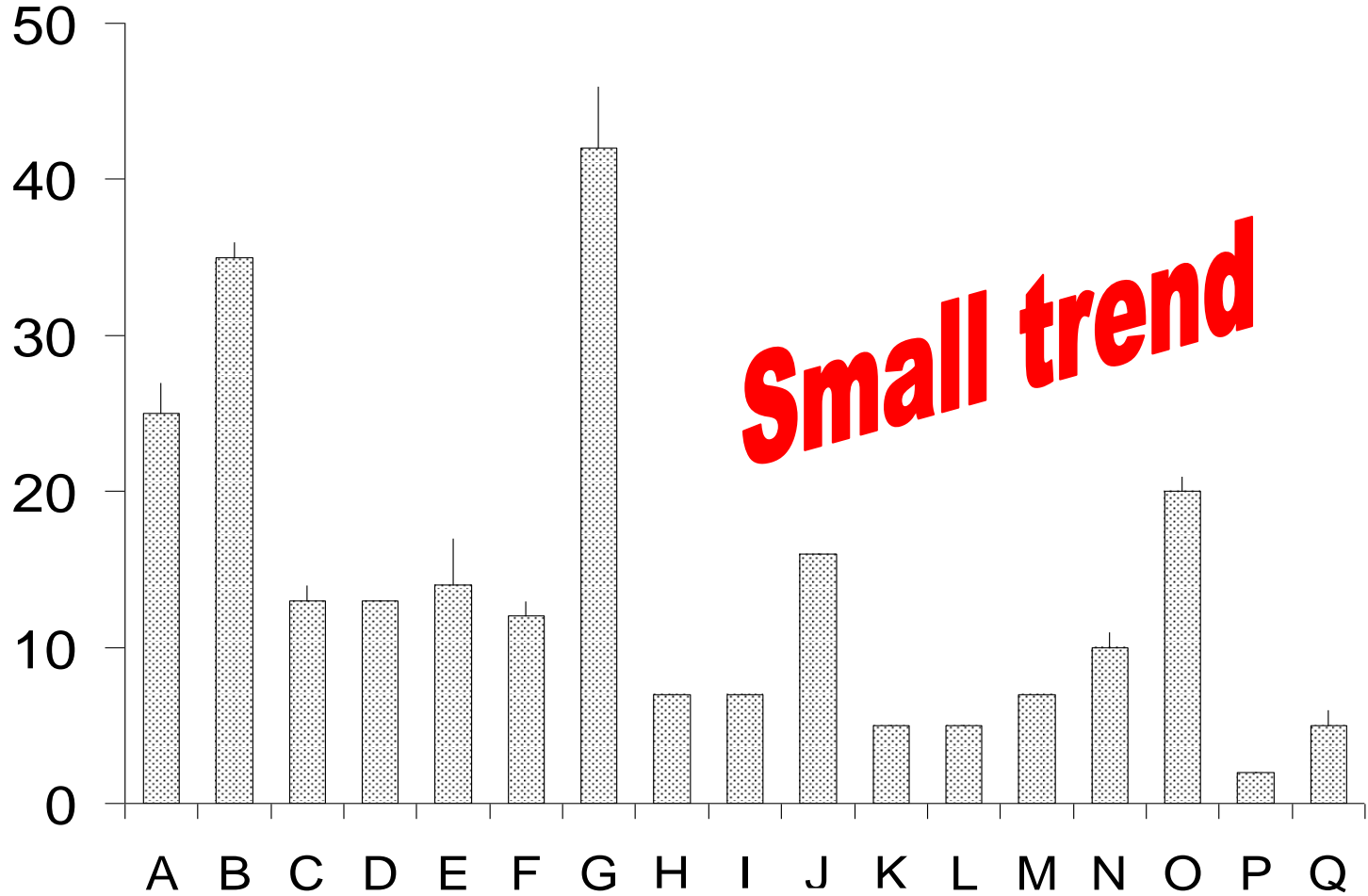
# Rare Procedures in Geriatric Patients

Total Number of Procedures Considered Rare

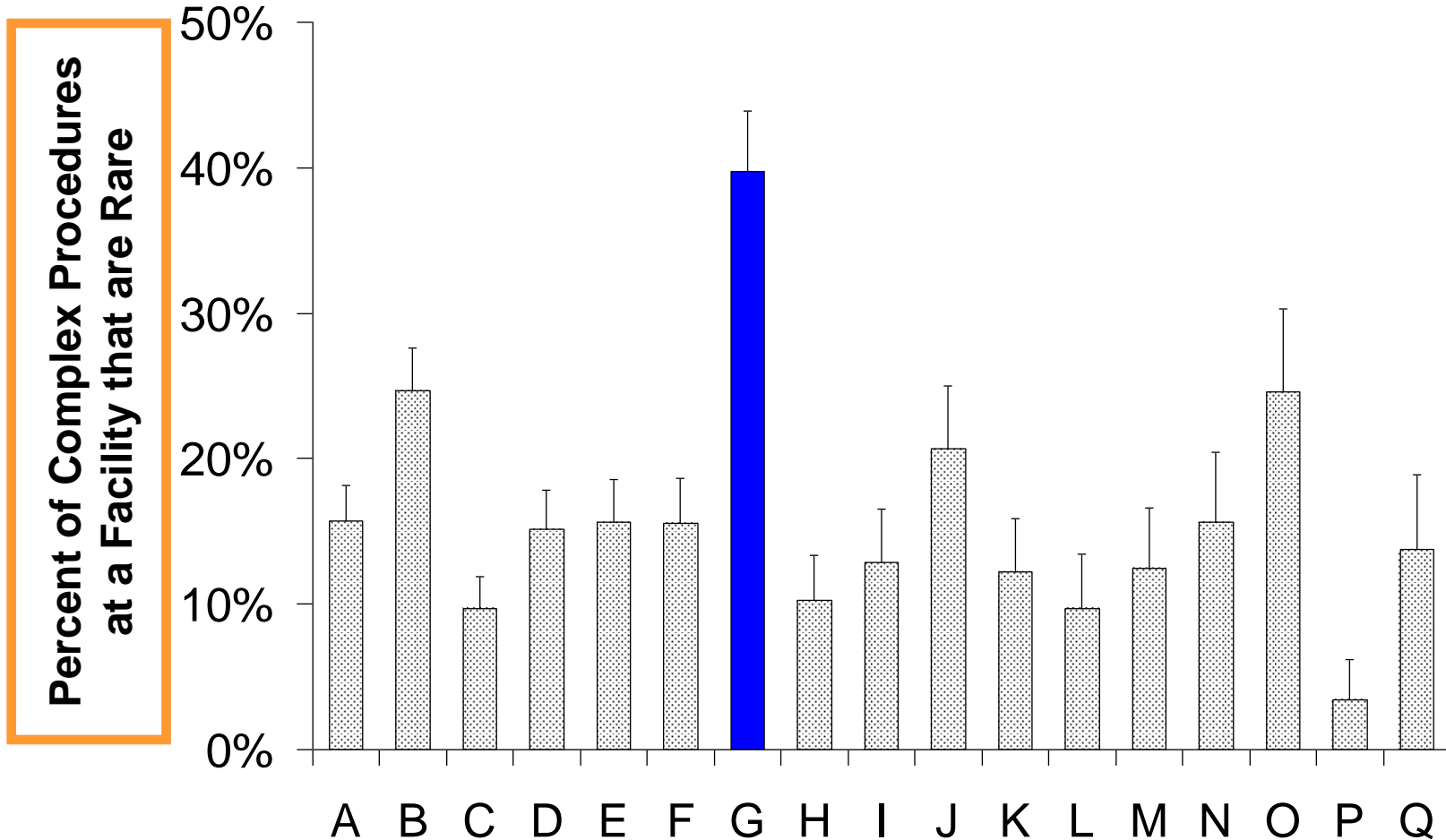


# Rare Procedures in Geriatric Patients

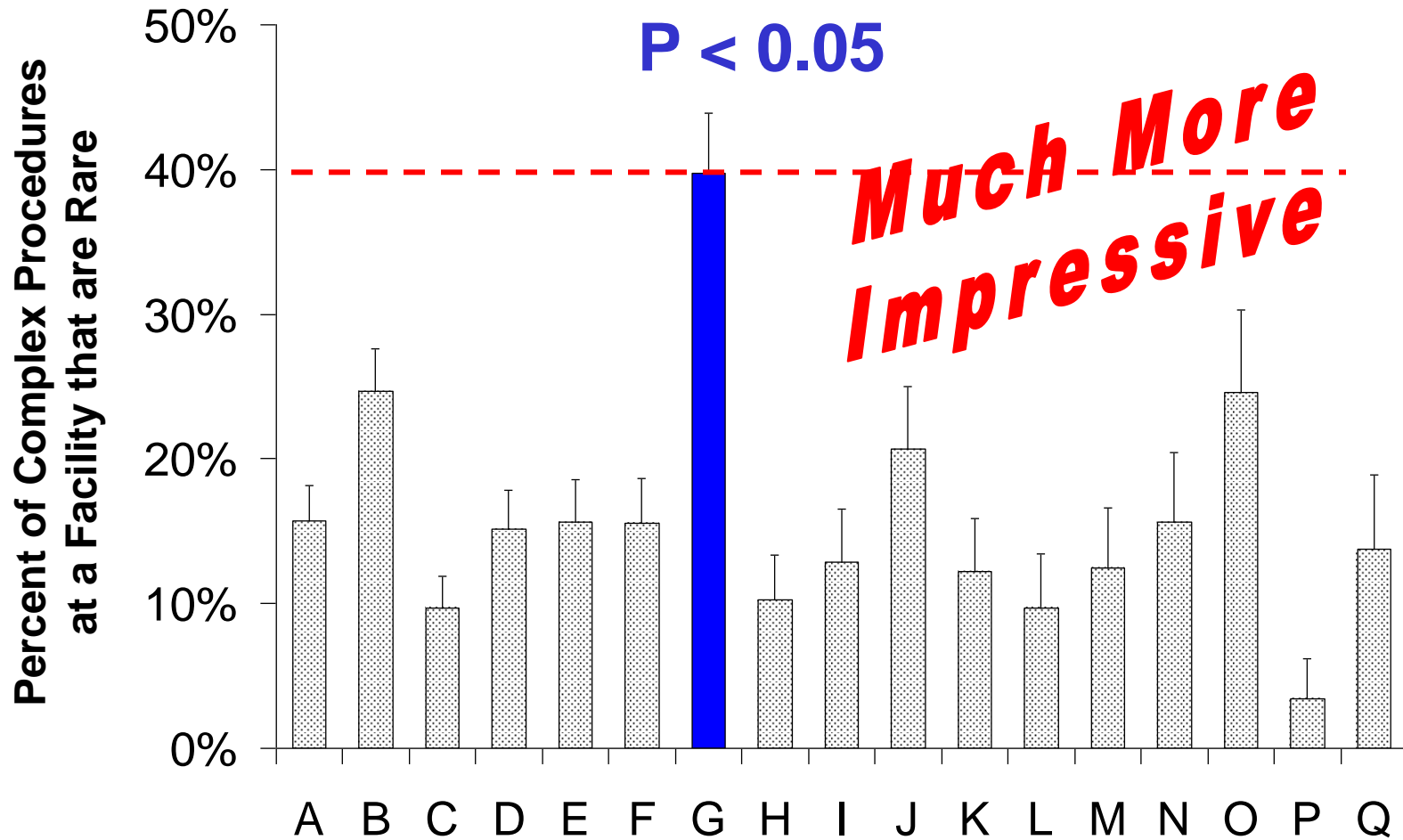
Total Number of Procedures Considered Rare



# Rare Procedures in Geriatric Patients



# Rare Procedures in Geriatric Patients





# Rare Procedures

“When compared to other hospitals, a much higher proportion of our physiologically complex procedures in elderly patients are rare.”

“We specialize in rare procedures.”

# Rare Procedure: "Kaylee's Story"

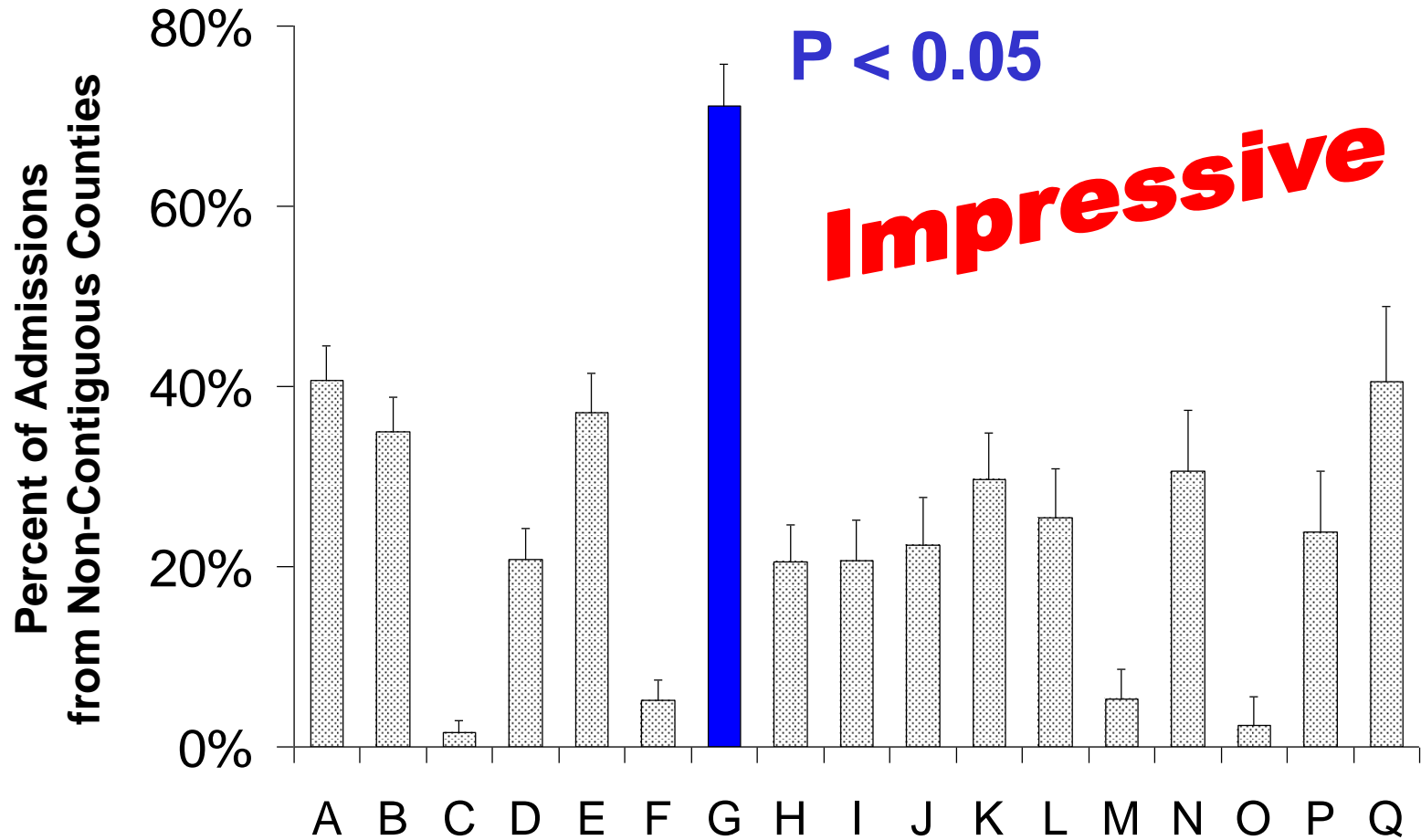


# Comparing Hospitals

- Volume
- Diversity of procedures
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- Number and types of rare procedures
- Traveling for surgery



# Traveling for Surgery



# Traveling for Surgery

- Data show that patients statewide want option of going to academic medical center
  - “Revealed preference”
- Insurance plans need to provide access to academic hospital, even though it may be hundreds of miles away



# Traveling for Surgery

“Compared to other hospitals, a much higher percentage of patients have traveled outside their home (or nearby) counties to reach us.”



# Traveling for Surgery

- “Compared to other hospitals, a much higher percentage of patients have traveled outside their home (or nearby) counties to reach us.”
- *Not* a limitation of such results that people locally may use hospital less often since they have better knowledge of its features



# Prior Surgical Experience Not Influencing Where Care

- Outpatient surgery center and hospital
  - 94% ASA RVG units and cases, patients had zero or one previous case at facility
  - 78% ASA RVG units and 76% of cases, patient had zero previous case at facility
- Different outpatient center and hospital
  - 82% of patients for outpatient or same day admit surgery had zero previous case at facility

O'Neill L et al. Anesthesiology 2009

Dexter F et al. Anesth Analg 2012





# Patient Perceptions of the Services Provided

- At the academic medical center (Hospital G), 4/5<sup>th</sup> of ambulatory surgery patients resided at home the night before and night of surgery
- Most cataract surgery patients would travel at least 52 min longer for each option:
  - Surgery in the morning
  - Combined first visit with surgeon and surgery,
  - Patient chooses date of surgery (i.e., a surgeon must be available each Monday to Friday)



# Review – Summarize the Facts of the Talk



# What is the Competition?

## Heterogeneity Among our Sites?

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# What is the Competition?

## Heterogeneity Among our Sites?

1. Volume
2. Diversity of procedures
3. Number and types of physiologically complex procedures
4. Number and types of rare procedures
5. Traveling for surgery



# Additional Information on Operating Room Management

- [www.FranklinDexter.net/education.htm](http://www.FranklinDexter.net/education.htm)
  - Example reports with calculations
  - Lectures on drug and supply costs, day of surgery decision making, PACU staffing, OR allocation and staffing, anesthesia staffing, and financial analyses
- [www.FranklinDexter.net](http://www.FranklinDexter.net)
  - Comprehensive bibliography of peer reviewed articles in operating room and anesthesia group management

