Showing Differences Among Hospitals and their Surgical Practices

- This talk includes many similar slides
  - Paging through produces animation
  - Use right/ left arrow keys, → and ←
- PDF viewers
  - Adobe Acrobat will open directly into Single Page
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Updated 06/02/21

Differentiating Among Hospitals and Surgical Practices

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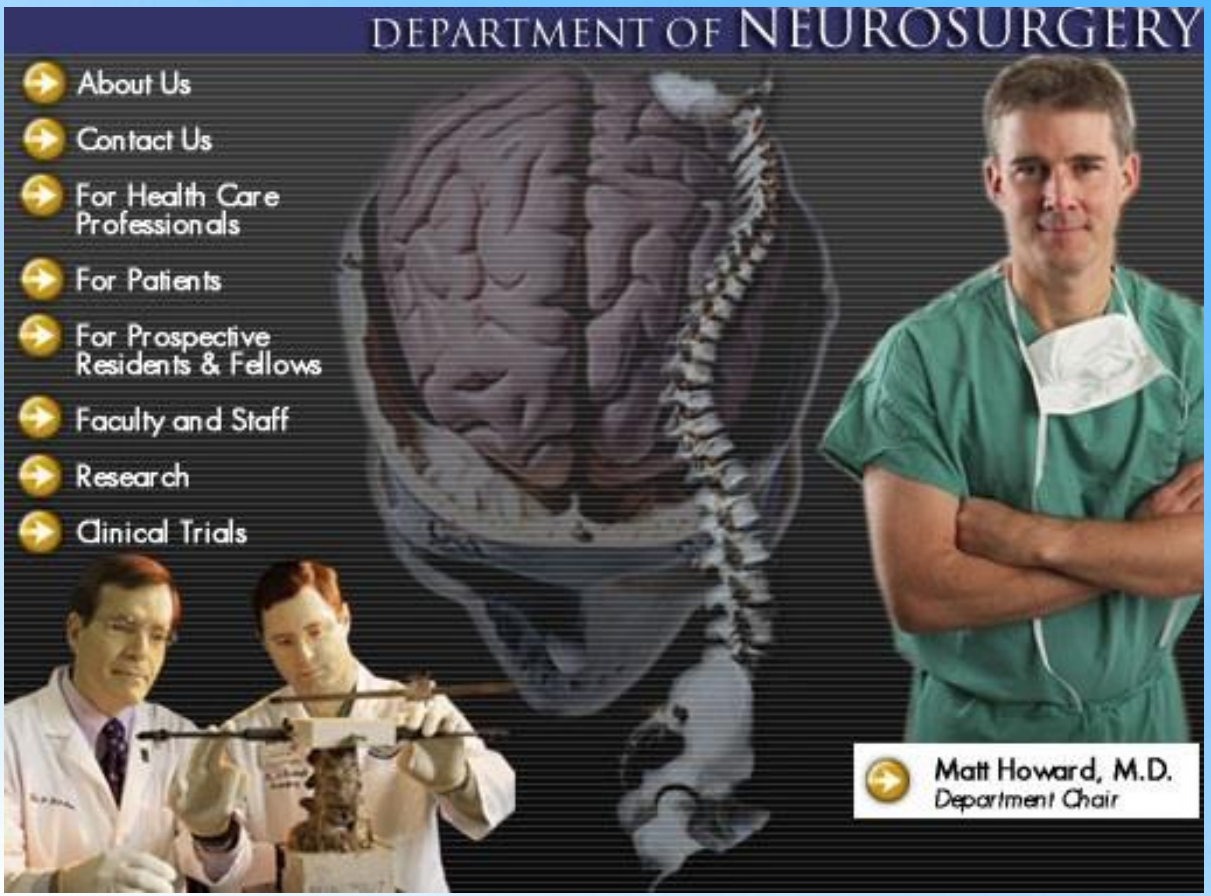
Financial Disclosure

- 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)

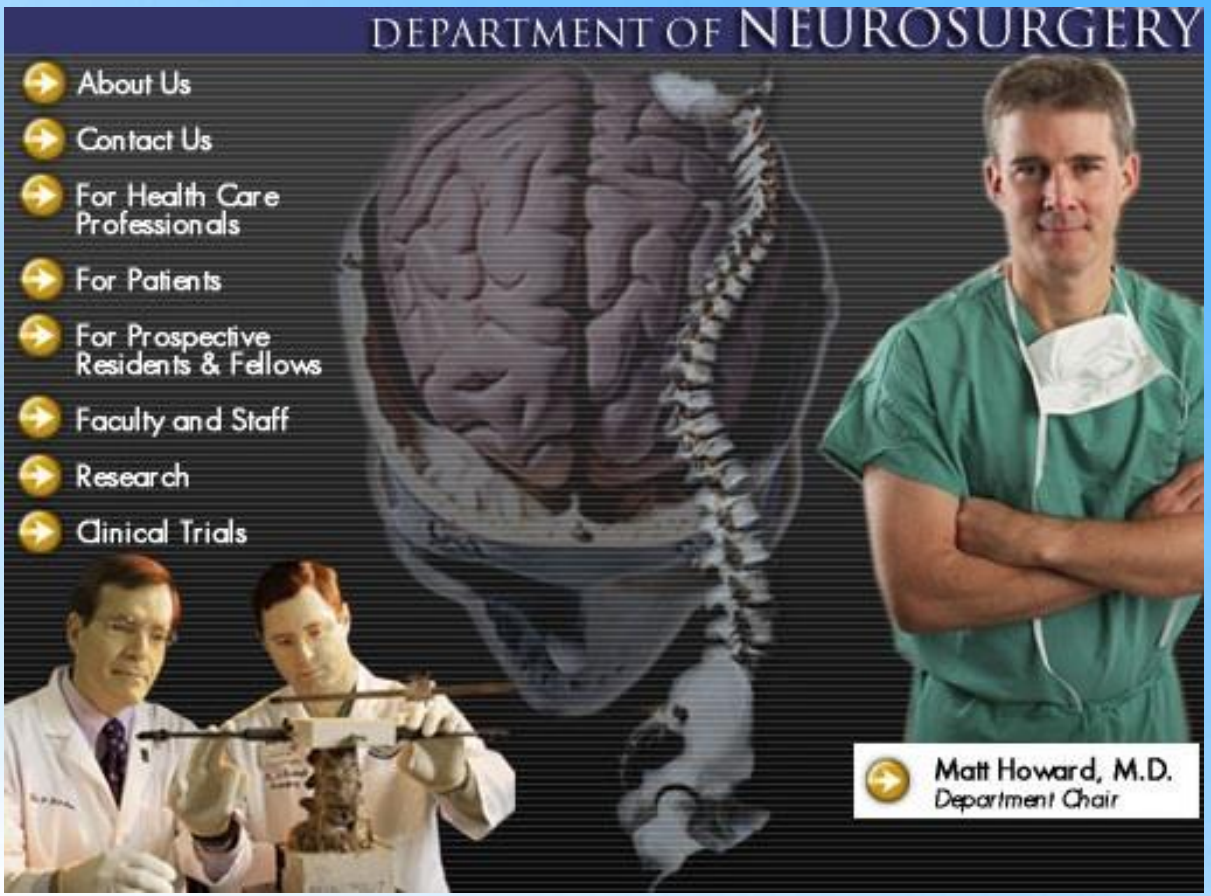
Examples from the University of Iowa

"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



Examples from the University of Iowa



Eichberg DG et al. Cureus 2020

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

Comparing Hospitals

- Volume
- Diversity of procedures
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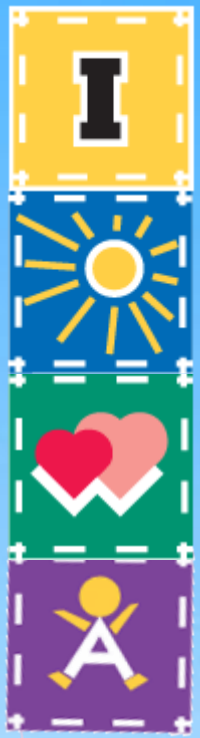
CHI

CHILDREN'S HOSPITAL of IOWA

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

Children's Miracle Network
the alliance of premier hospitals for children

DEPARTMENT OF PEDIATRICS

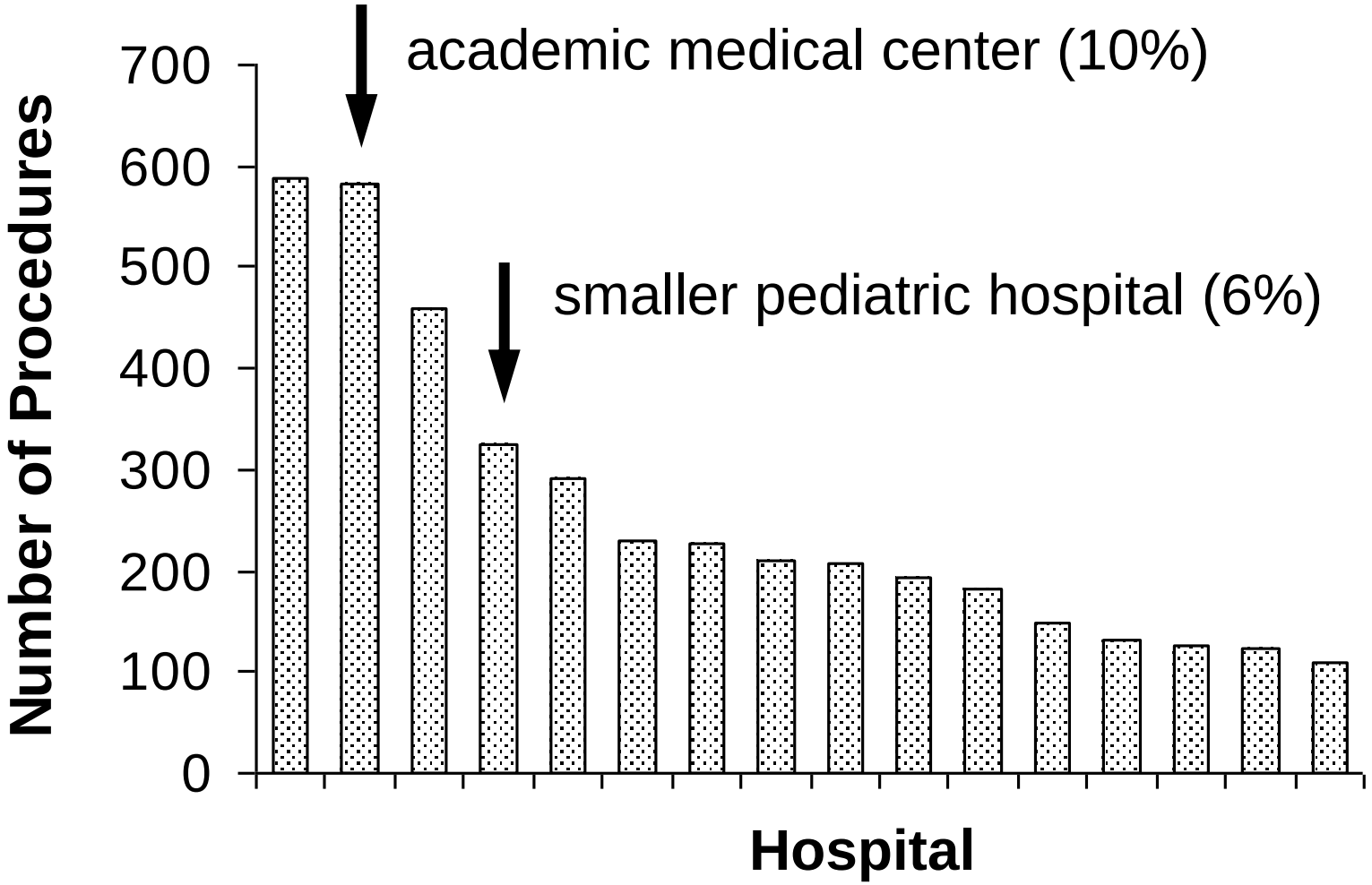


High Volume Hospitals

- 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

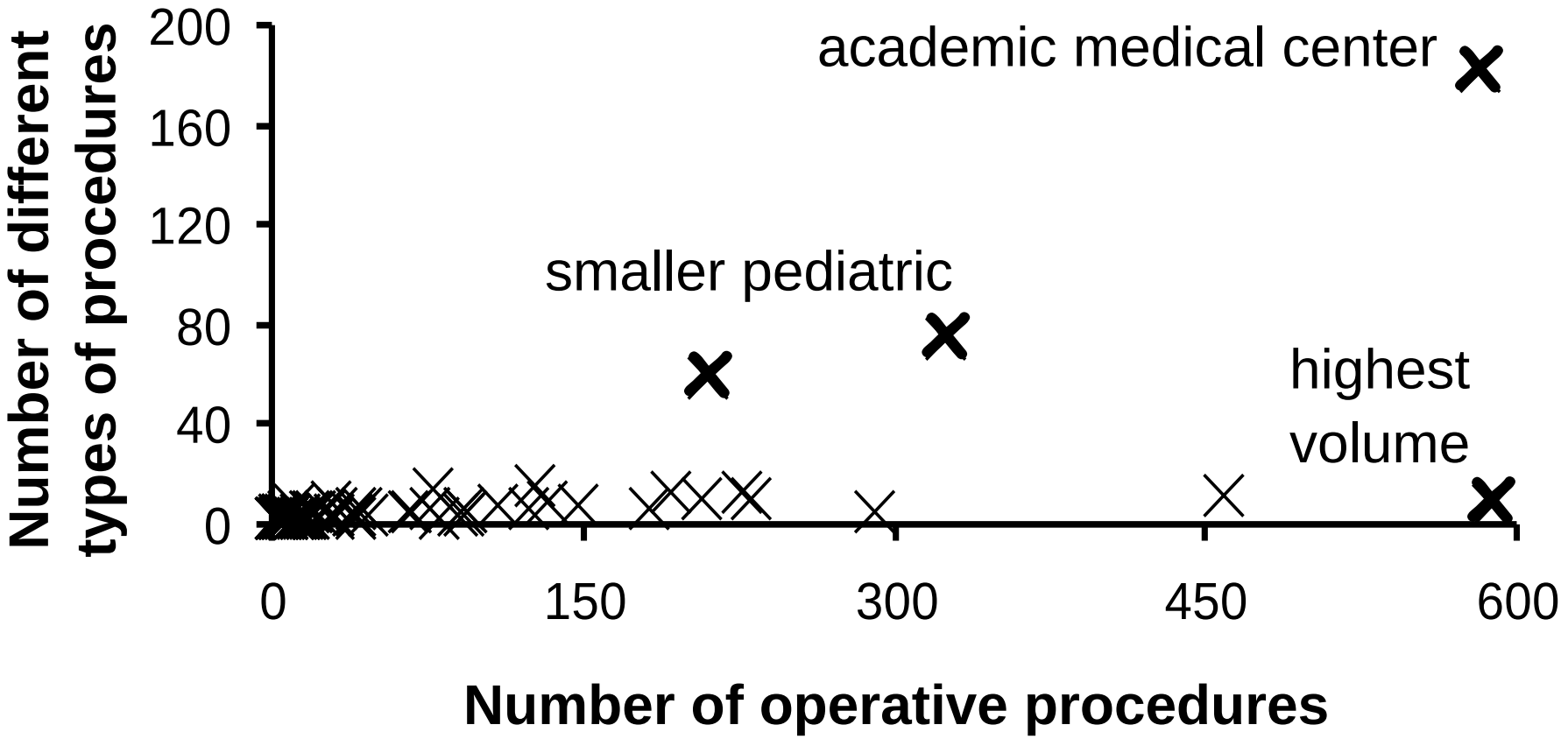
- 90 facilities: 1-15 types of procedures
- 3 facilities: >15 types of procedures
  - Academic medical center
  - Smaller pediatric hospital
  - Non-pediatric hospital doing cardiac surgery

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

Dexter F et al. Anesthesiology 2003

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

$$\sum \left[p_1^{\,2} + p_2^{\,2} + \ldots + p_i^{\,2} \right]$$

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

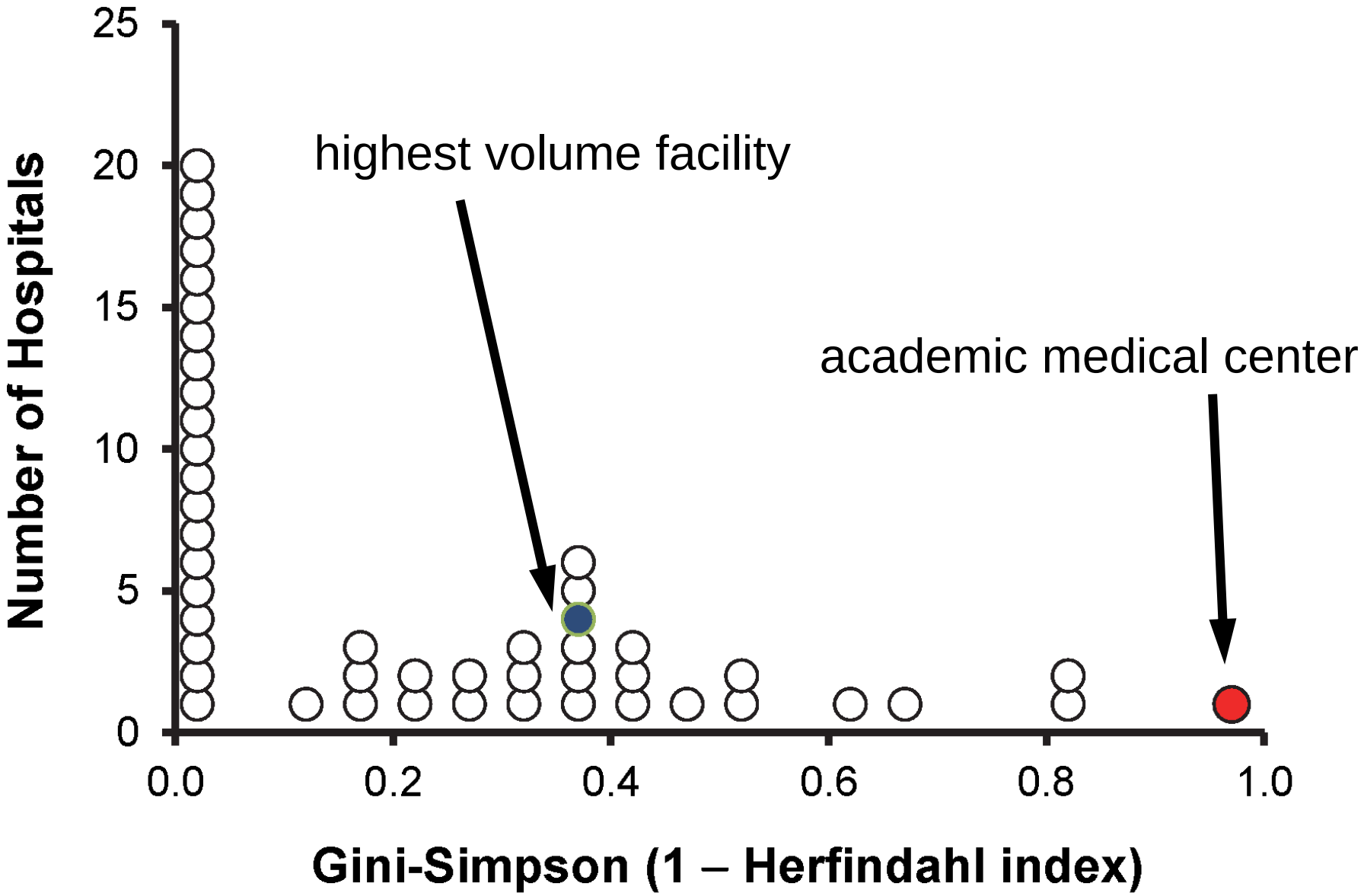
Internal Herfindahl Index

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

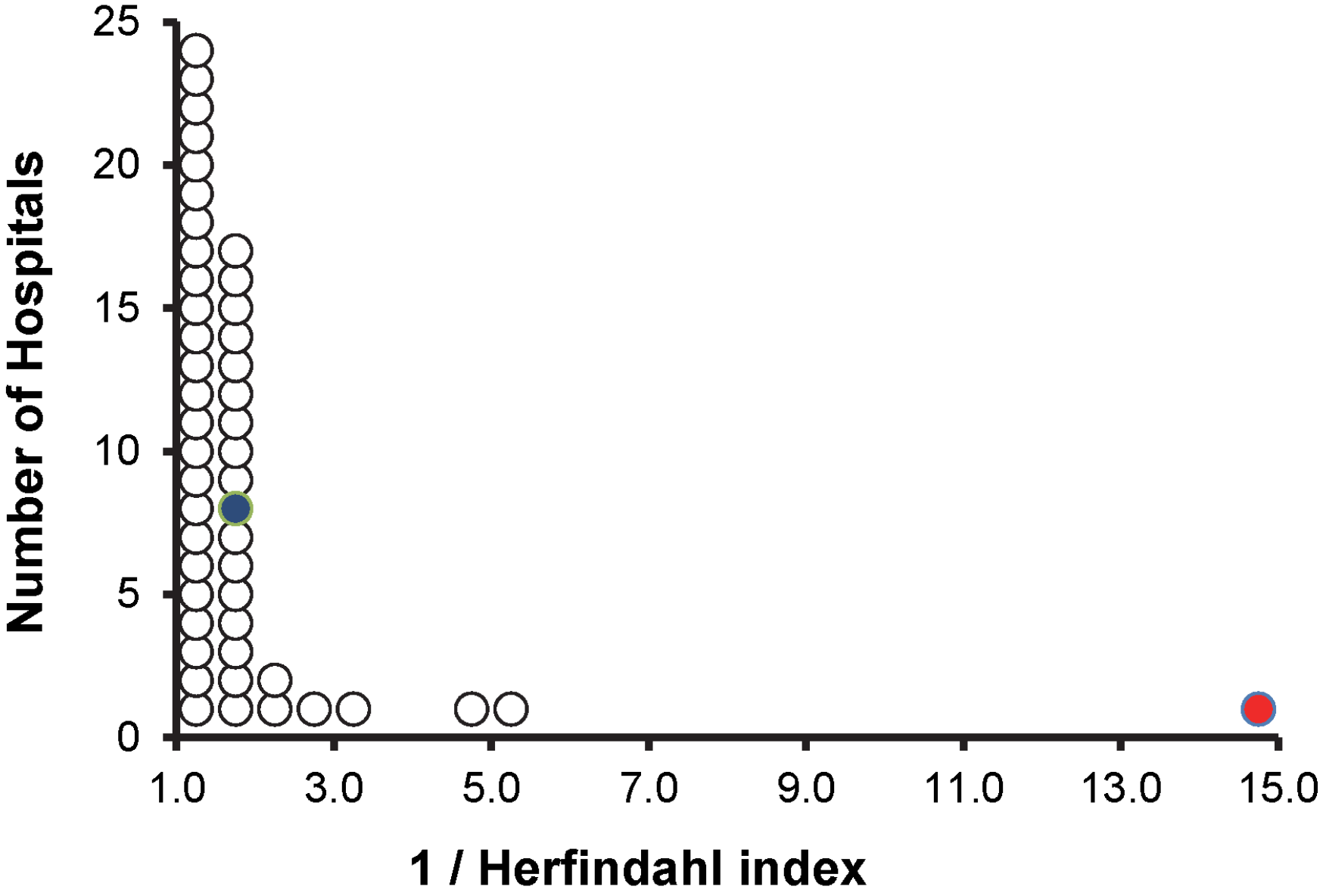
Taplin RH. Abacus 2003

Dexter F et al. Anesth Analg 2016

Internal Herfindahl Index



Inverse of Herfindahl Index

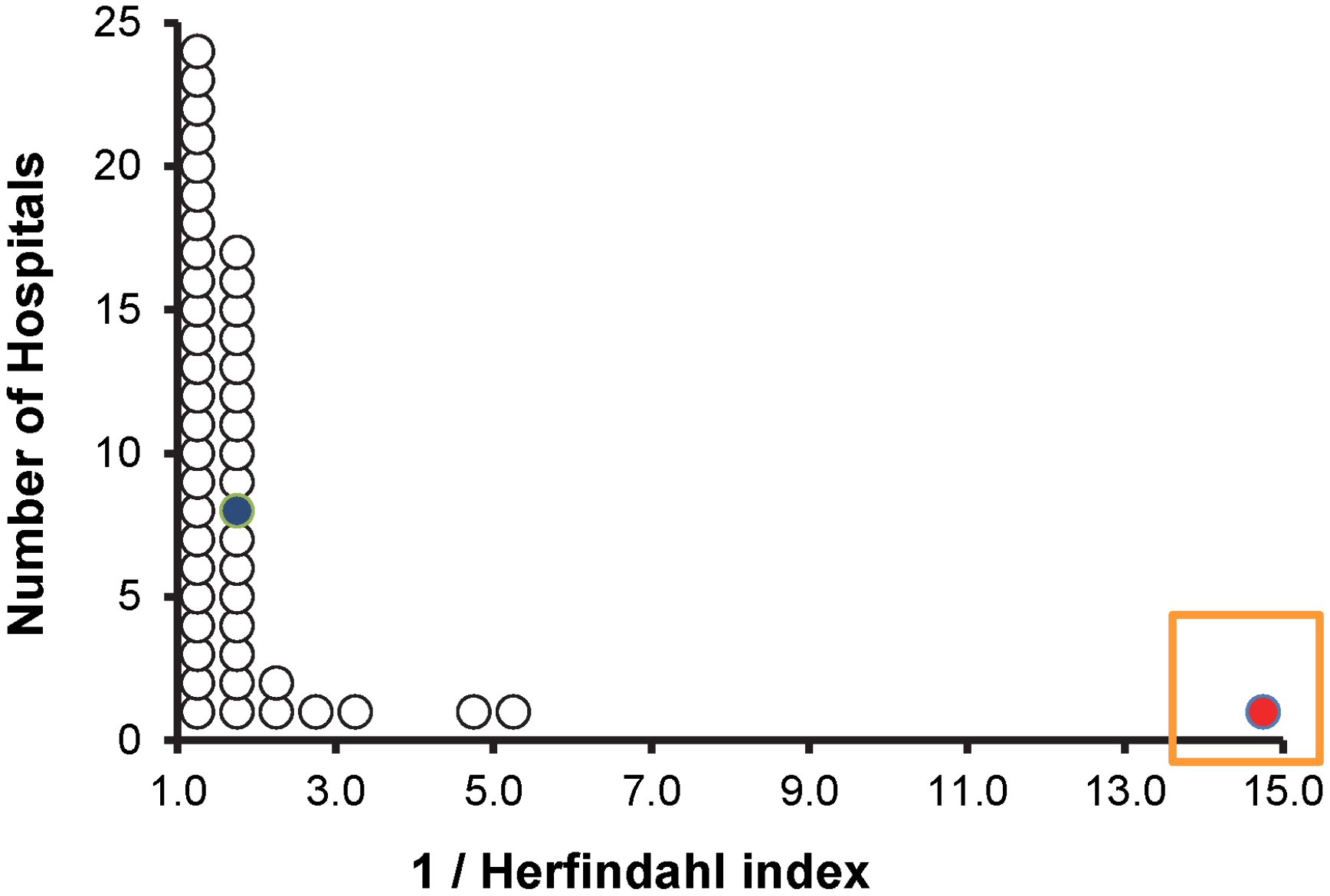


Inverse of Herfindahl Index

- 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

Large Operational Importance
Easy to Explain to Stakeholders

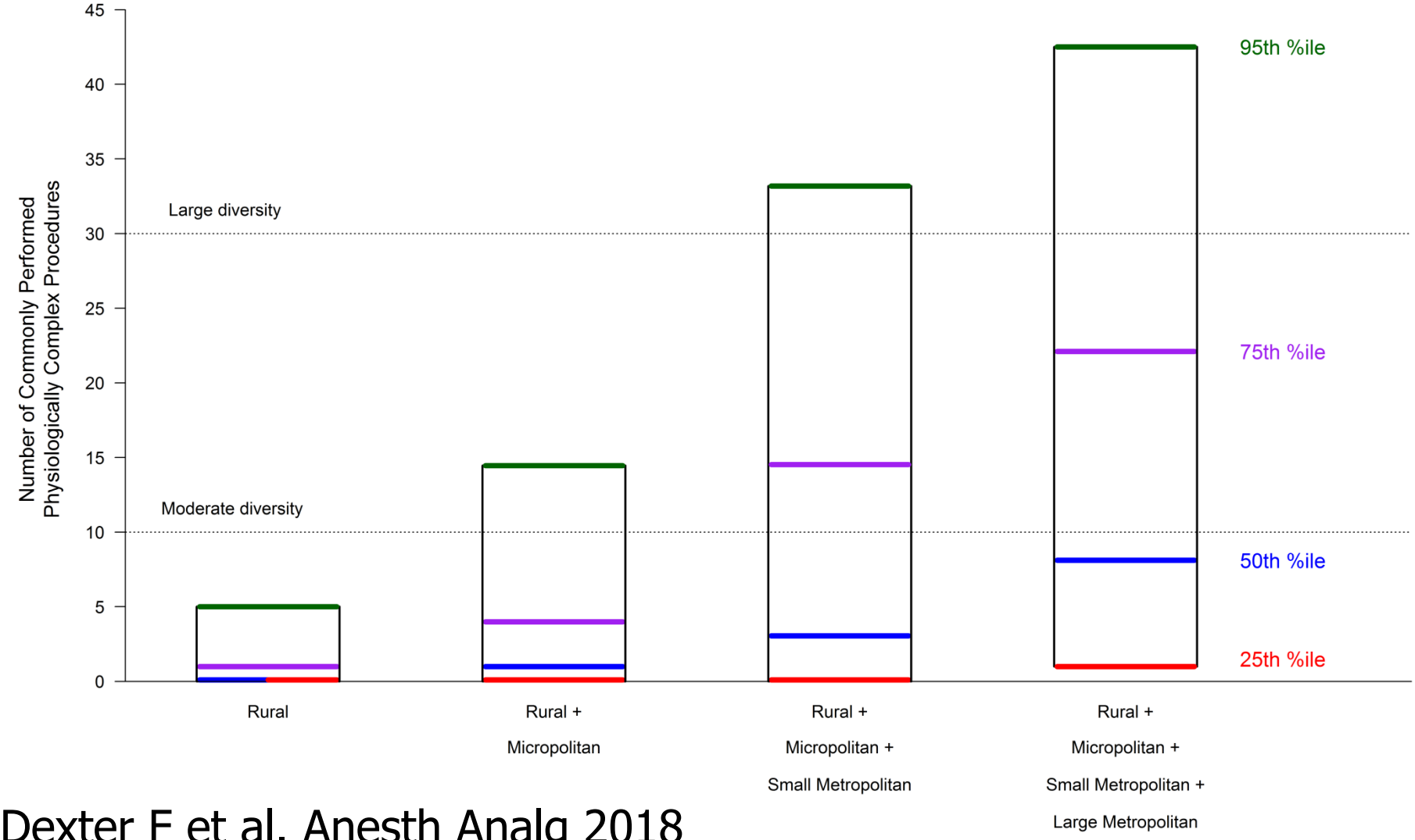


Large Operational Importance
Easy to Explain to Stakeholders

Large Operational Importance Easy to Explain to Stakeholders

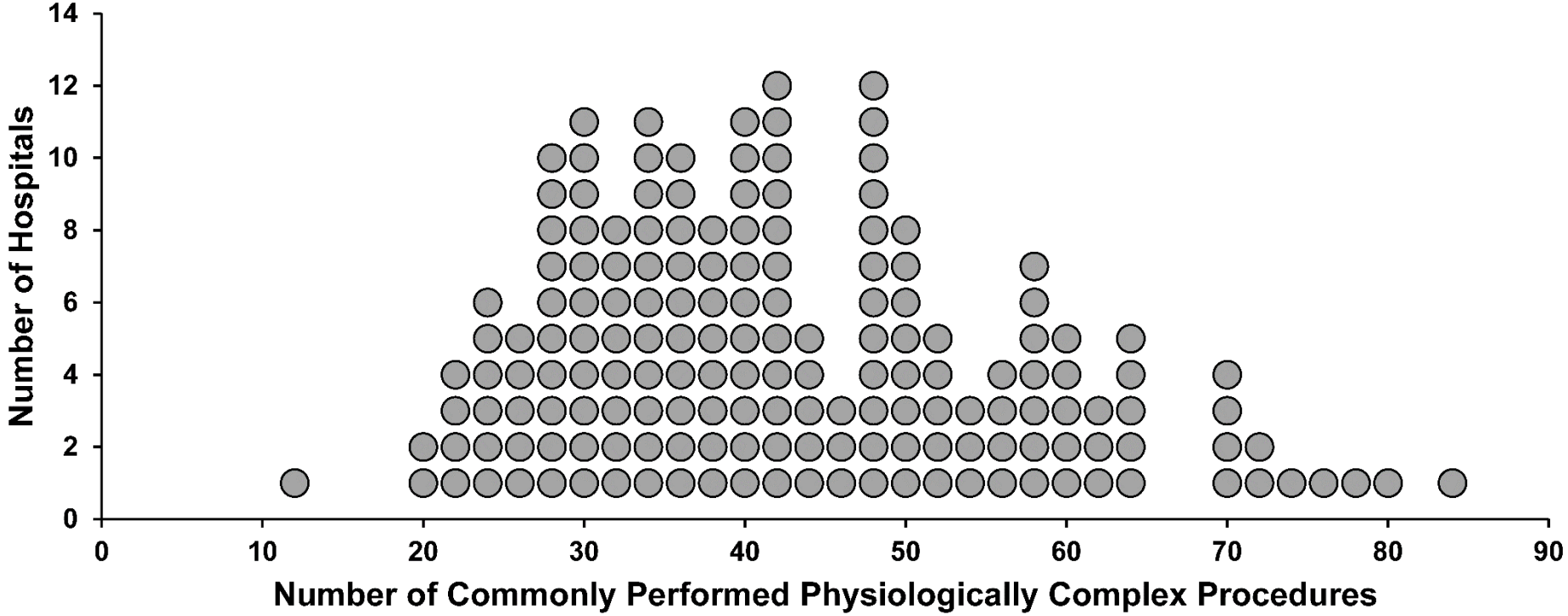
"As Iowa's only comprehensive academic medical center, we constantly ask the tough questions, push the boundaries of medicine, and provide the most up-to-date treatments."

Diversity Differs Among Hospitals Nationally



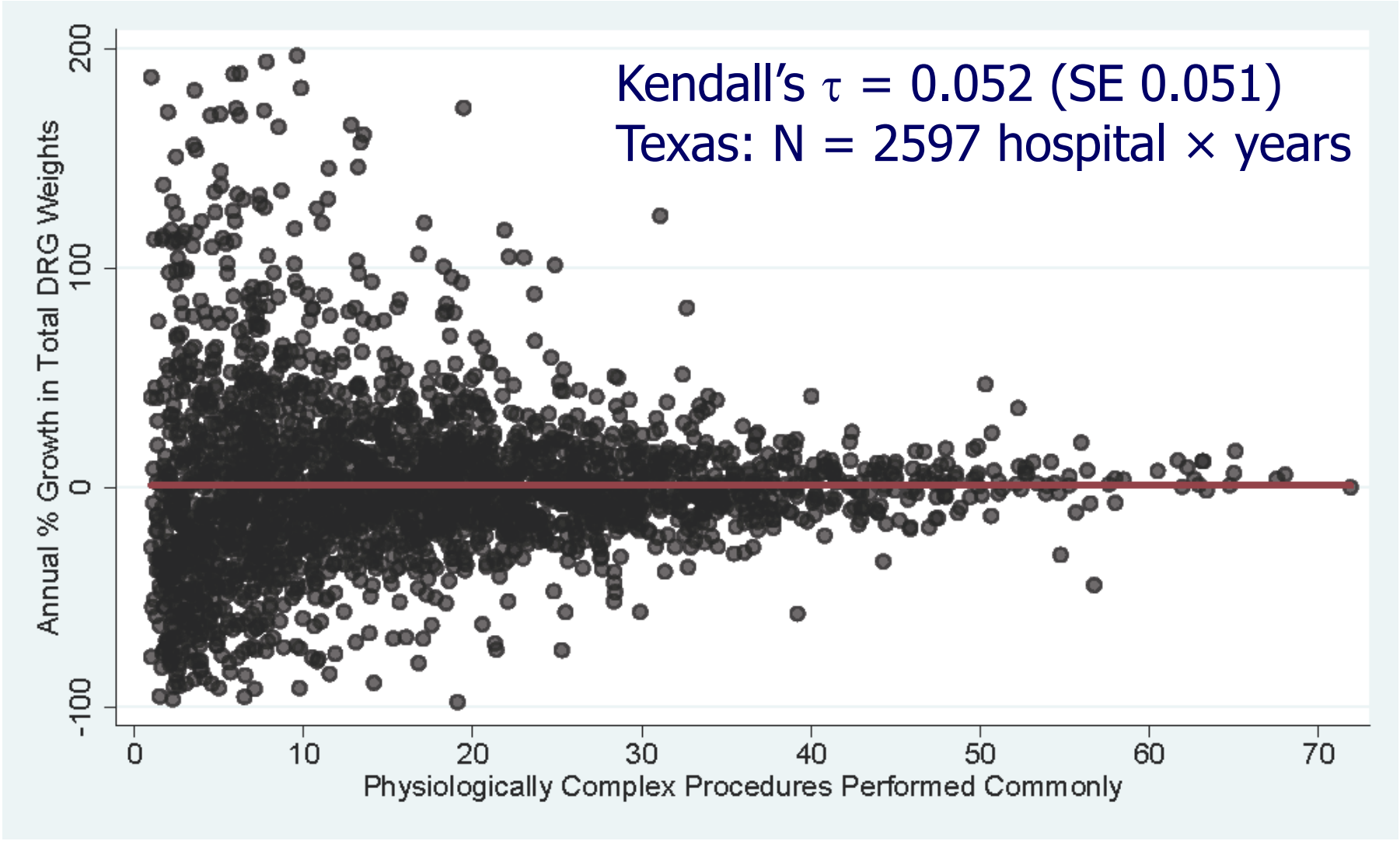
Dexter F et al. Anesth Analg 2018

Diversity Differs Among Teaching Hospitals Nationally



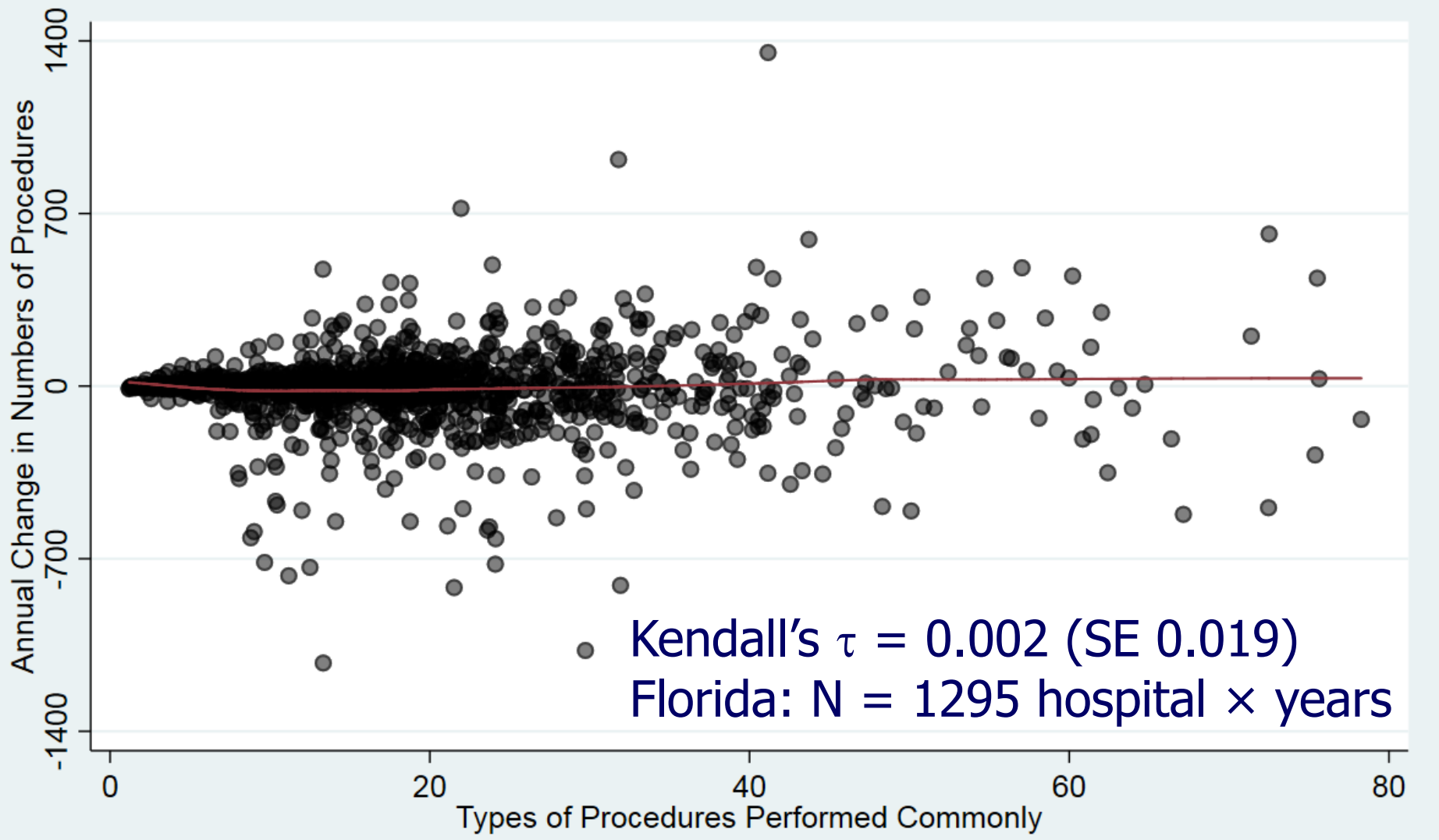
Dexter F et al. Anesth Analg 2018

Diversity Not Associated with Surgical Growth



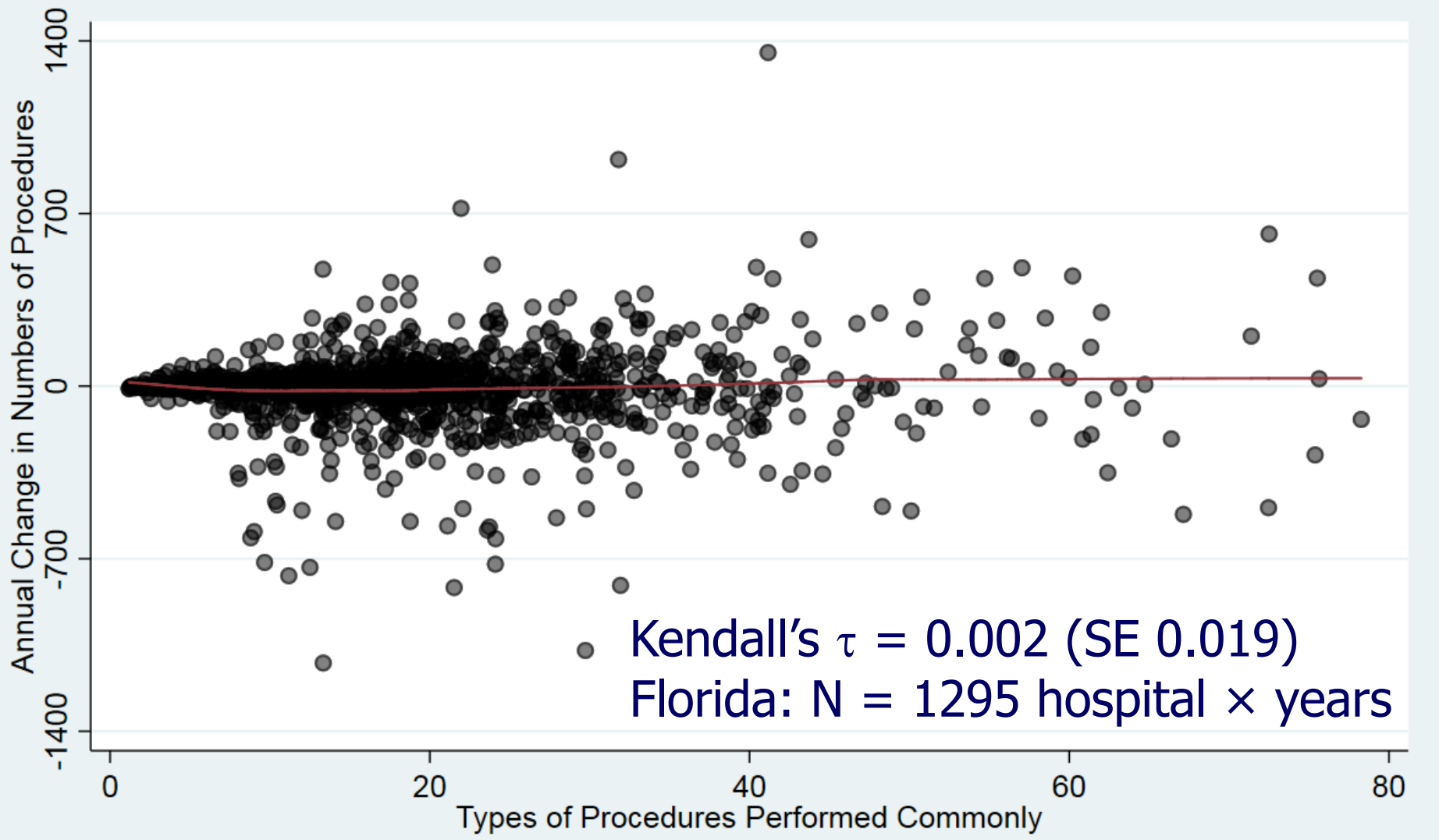
Dexter F et al. Perioper Care Oper Room Manag 2019

Diversity Not Associated with Surgical Growth



Dexter F et al. J Clin Anesth 2018

Large Operational Importance Easy to Explain to Stakeholders



Dexter F et al. J Clin Anesth 2018

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
    - Effective number of anesthesia providers at a hospital is calculation that compensates for part-time work and/or administrative activities without knowing those hours

Dexter F et al. Anesth Analg 2016

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

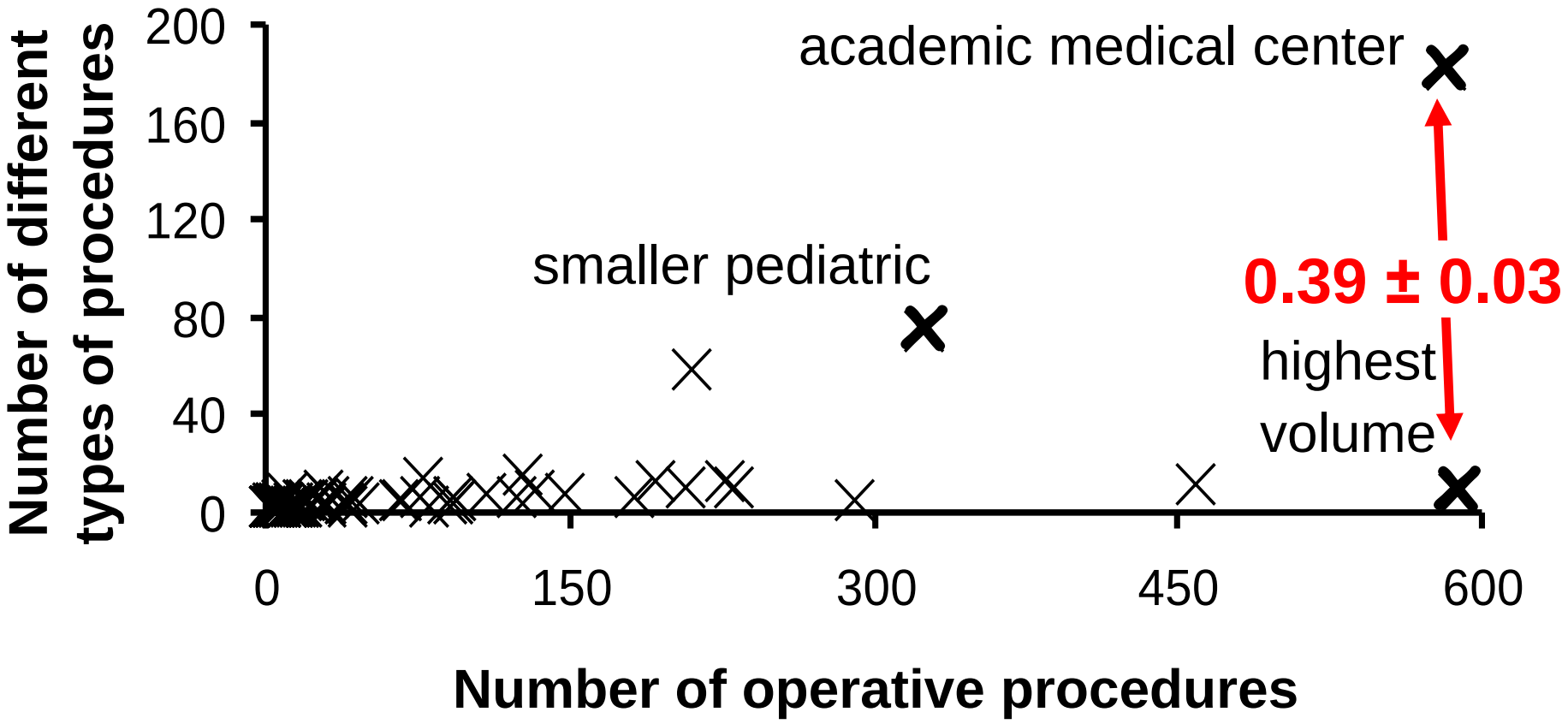
Dexter F et al. Anesthesiology 2003
Dexter F et al. Anesth Analg 2016

Similarity Index

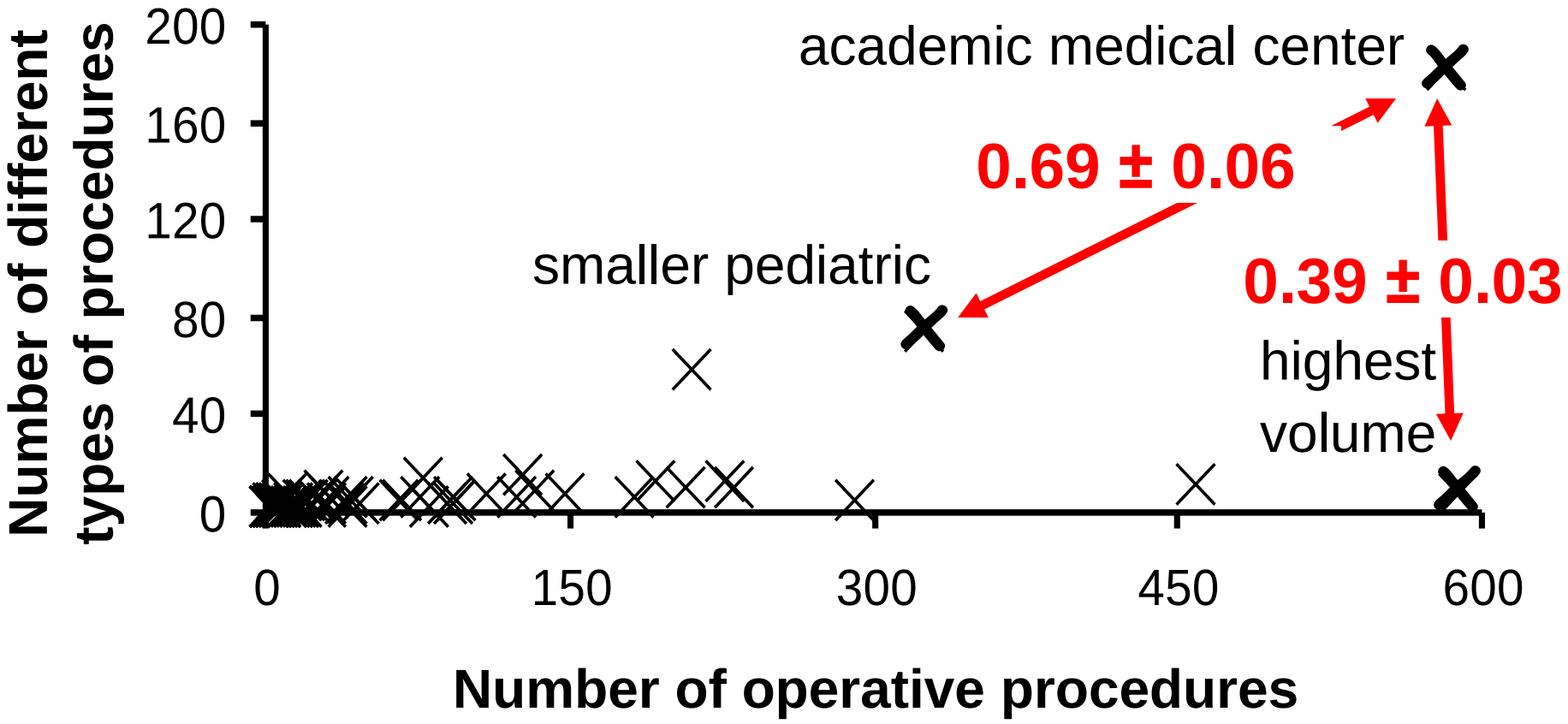
- p = proportion of procedures that are of the i^{th} type at hospital A or hospital B
- N = number of different types of procedures

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

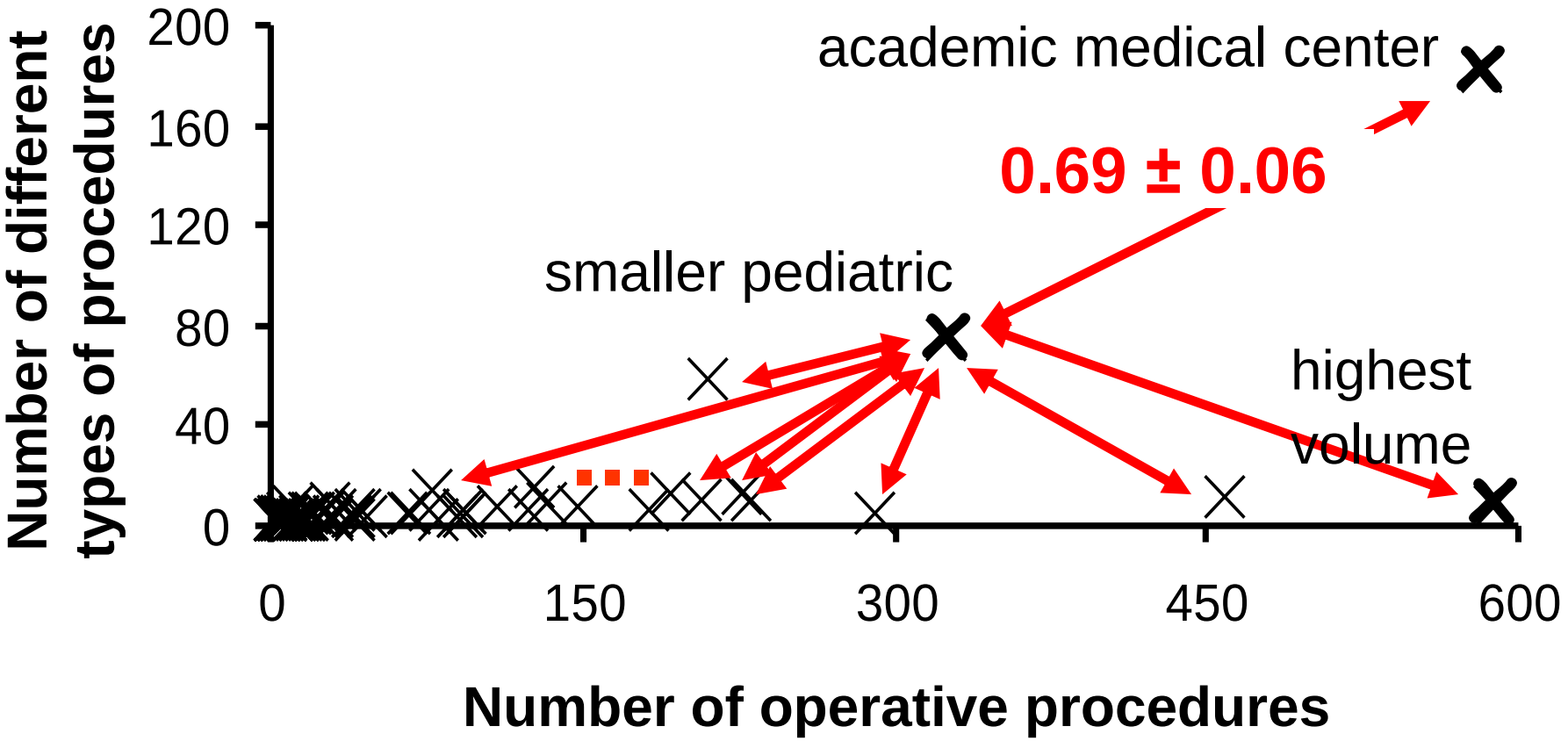
Low Value of Similarity Index



Higher Value of Similarity Index



Similarity


Number of different types of procedures
200
160
120
80
40
0
0
150
300
450
600
Number of operative procedures
academic medical center
0.69 ± 0.06
smaller pediatric
highest volume

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 ± 0.06
  - Smaller pediatric hospital and other hospitals combined 0.74 ± 0.04
  - Difference -0.06 ± 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 ± 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 ± 0.03)

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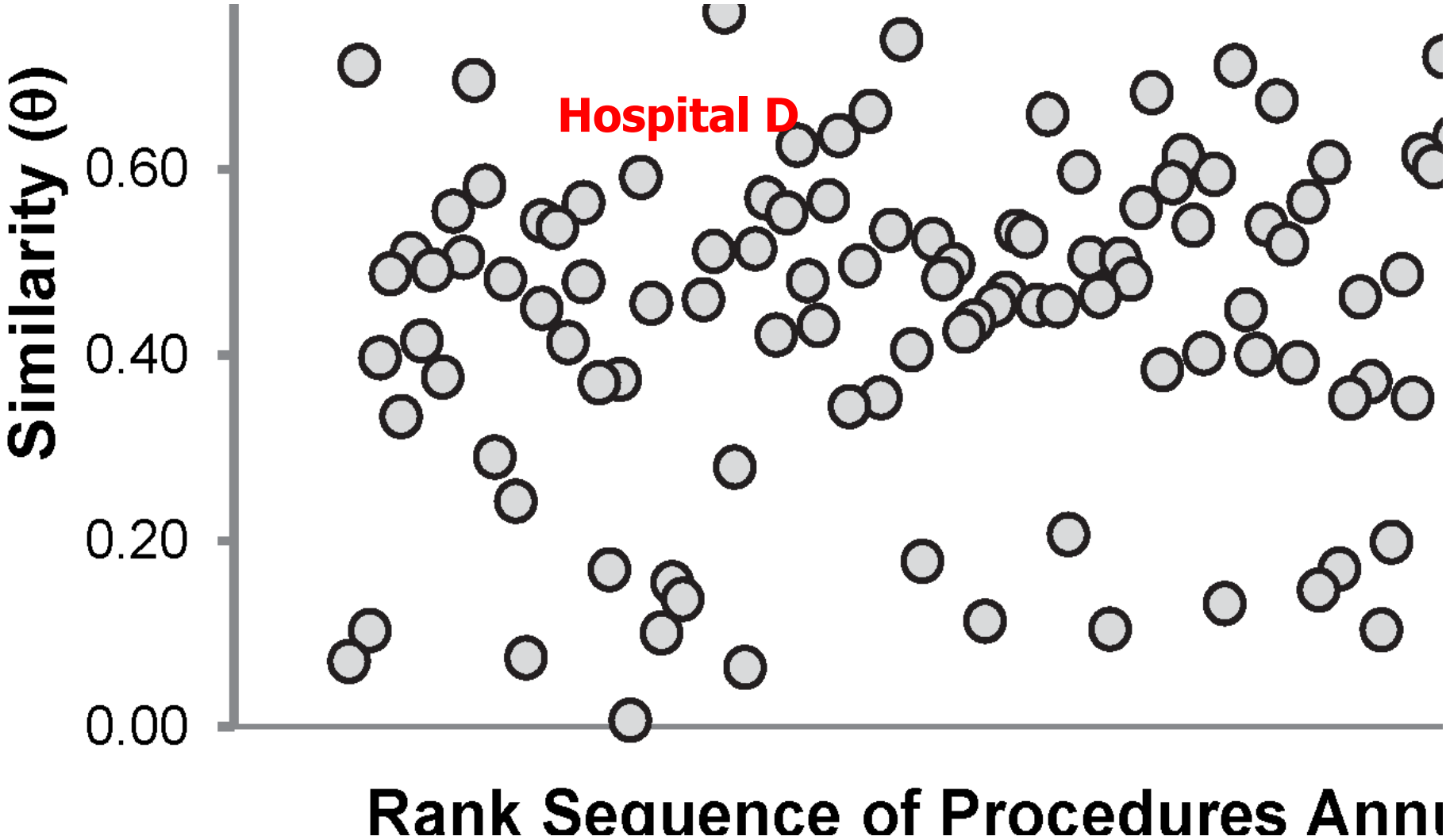

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➢ Moral: Principal competition literally next door

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 × many (≅ 10 million) rows

HOSPITAL		PROCEDURE
219	,	“4501”
219	,	“8152”
219	,	“2001”
•		•
•		•
•		•
712	,	“8051”
712	,	“0780”
•		•
•		•
•		•
219	,	“562”

More Examples About Similarity Index Because So Practical

- Data: 2 columns × many (≅ 10 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 × many (≅ 10 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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    - ➢ Inpatient procedures, and when outpatient procedures are available, generally only from hospital outpatient departments

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  - Inpatient procedures, and when outpatient procedures are available, generally only from hospital outpatient departments
  - ➢ If code appears 50 times in 10 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?

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

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

Physiologically Complex Procedures

- Anesthesiologists' payment 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

- Most procedures are not physiologically complex at all types of hospitals:
  - Ontario
    - 16% of procedures and 15% of discharges among the 4 pediatric hospitals
    - 2% of procedures and 3% of discharges among the other hospitals performing surgery among children ≤ 18 years

O'Leary J et al. Can J Anesth 2018

Physiologically Complex Procedures

- Most procedures are not physiologically complex at all types of hospitals:
  - Iowa
    - 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

Dexter F et al. Anesthesiology 2003

Physiologically Complex Procedures

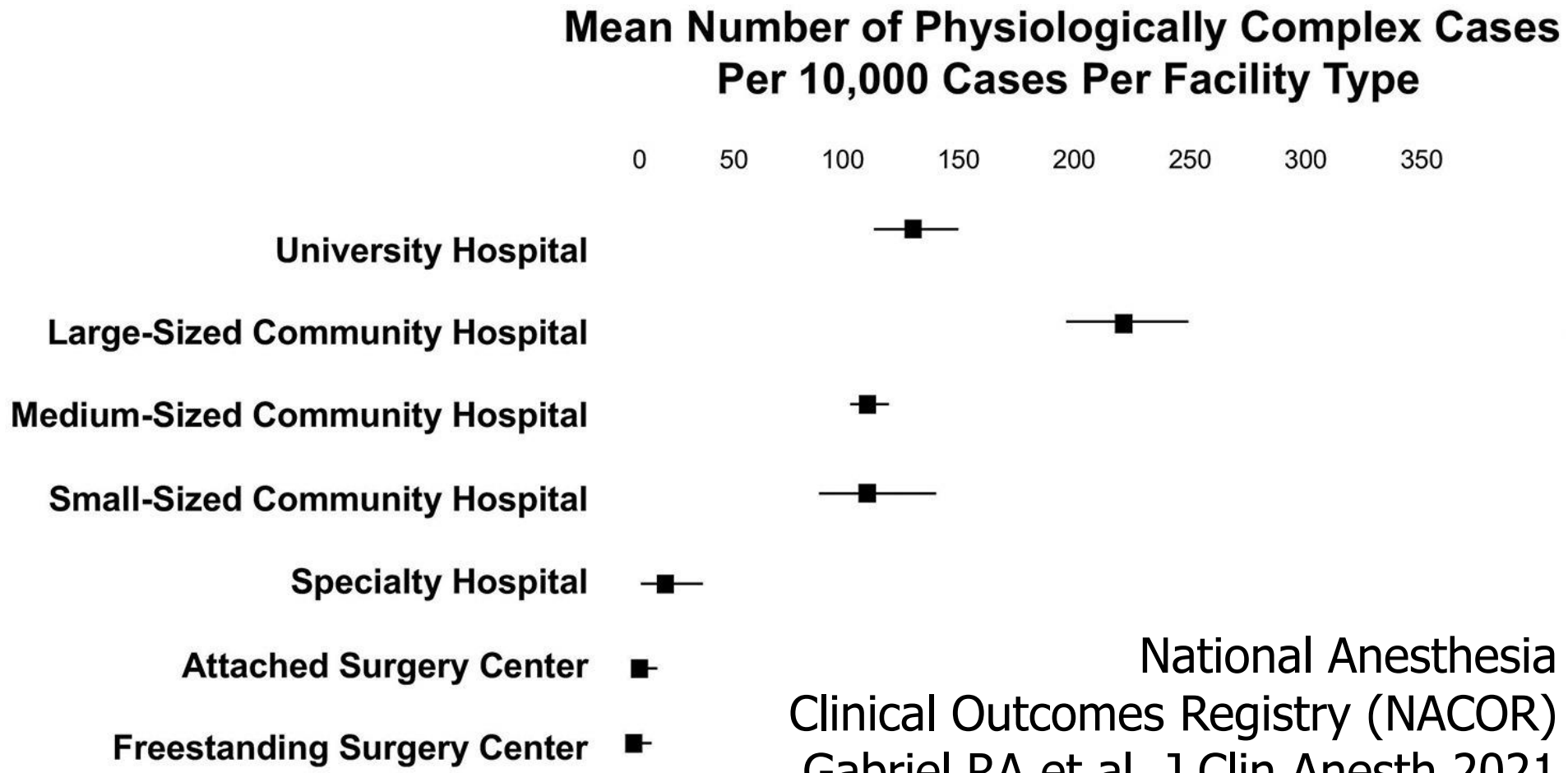
- Pediatric hospitals perform most of the physiologically complex surgery
  - In Ontario, among 158 hospitals, the 4 pediatric hospitals perform 78%
  - In Iowa, among 117 hospitals, the large academic medical center performs 64%

O'Leary J et al. Can J Anesth 2018

Dexter F et al. Anesthesiology 2003

Physiologically Complex Procedures

- Adults and children, but further shows validity



National Anesthesia Clinical Outcomes Registry (NACOR)
Gabriel RA et al. J Clin Anesth 2021

Physiologically Complex Procedures

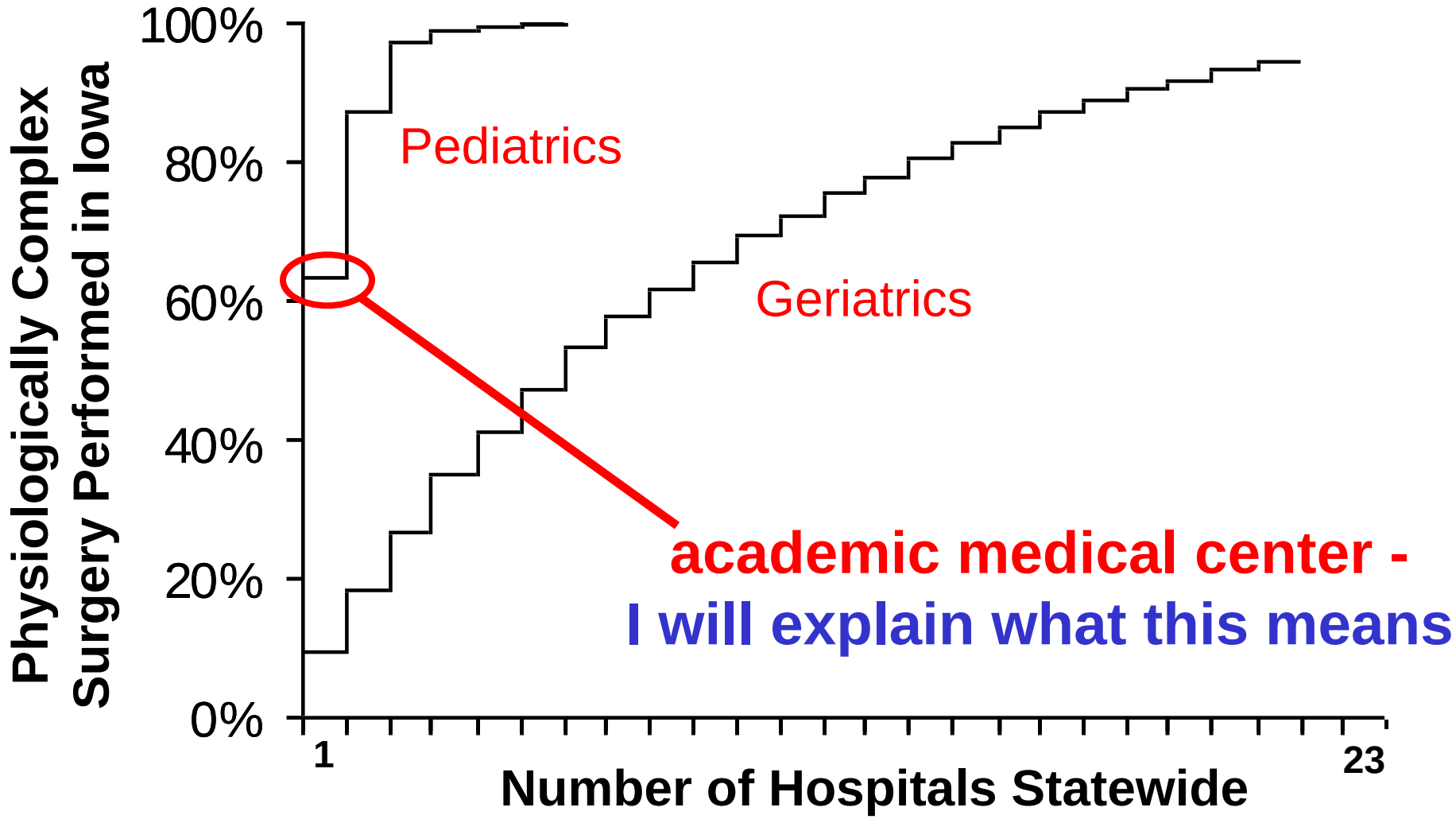
- Insurers cannot exclude hospital from preferred provider network (organization)
- Donors and benefactors can appreciate unique expertise

Physiologically Complex Procedures

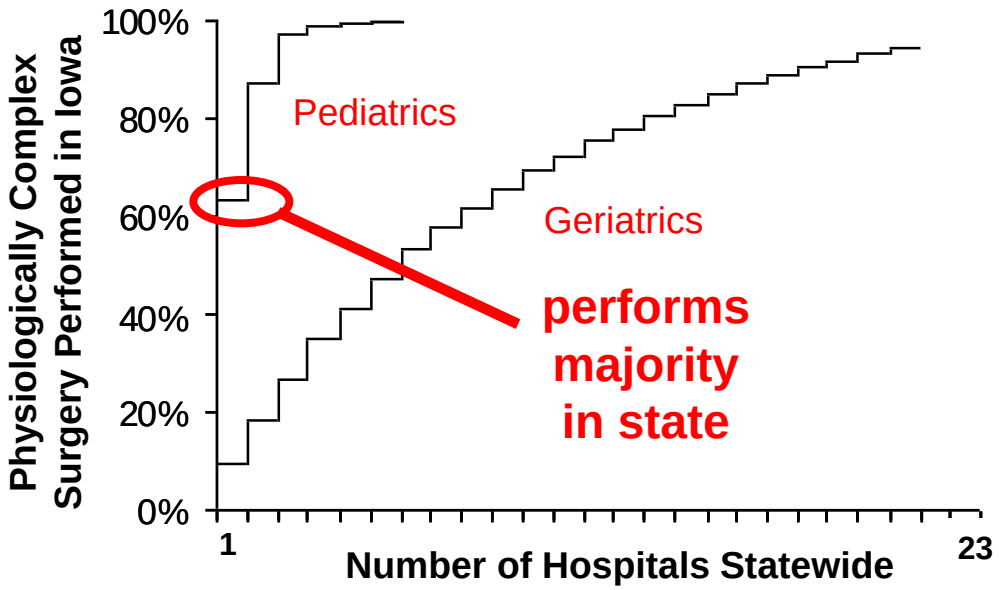
Will illustrate graphically the dominance of the academic medical center in performing 64% of physiologically complex procedures in the state in infants and young children

Wachtel RE, Dexter F. Anesthesiology 2004

Physiologically Complex Procedures

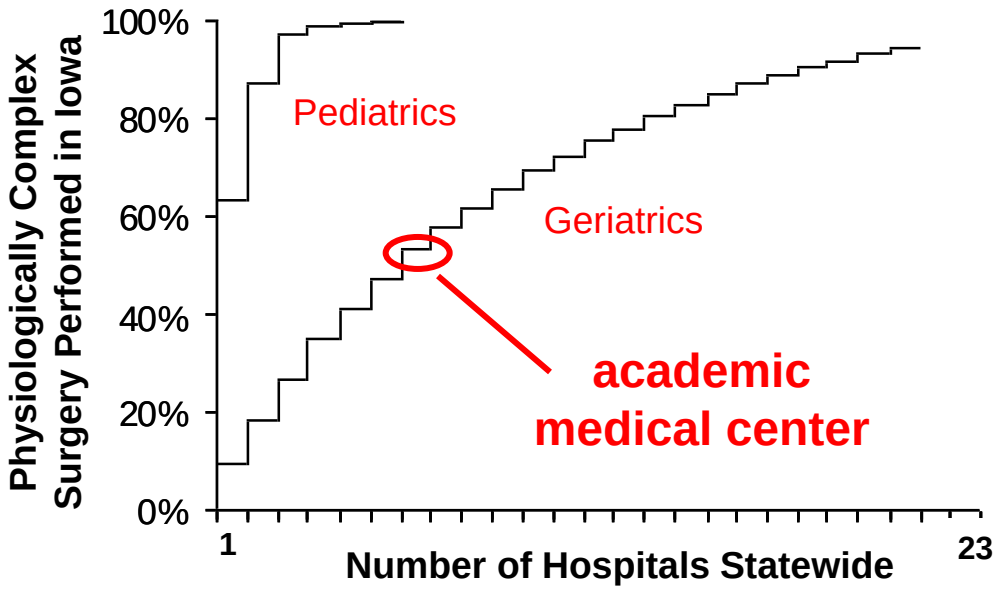


Physiologically Complex Procedures



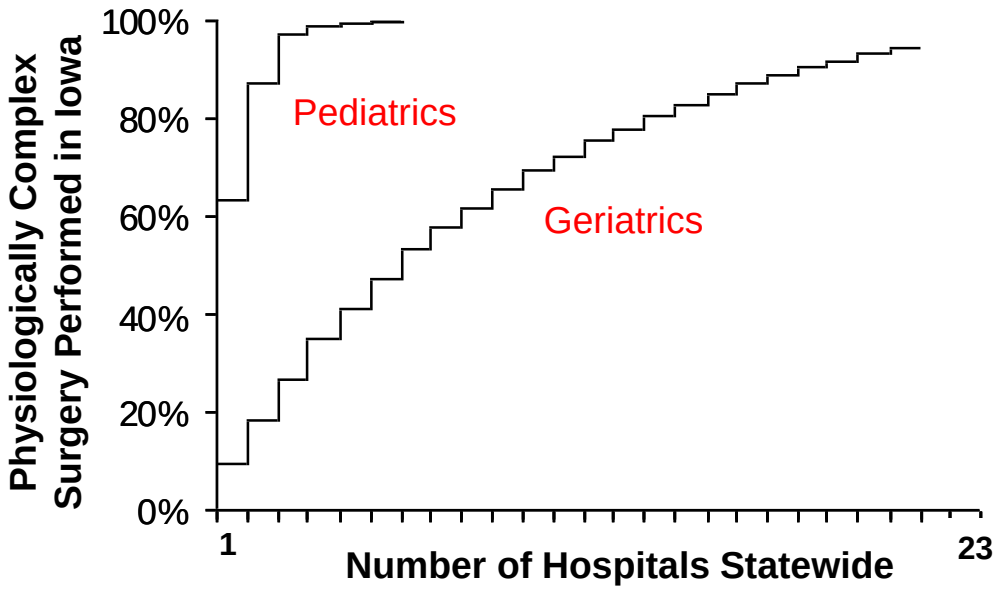
- cumulative distribution plots
- sort hospitals in decreasing order of percentage performed
- contribution of each hospital is shown as step
- graph represents cumulative percentage as each successive hospital is added to total

No Similar Dominance for Geriatrics



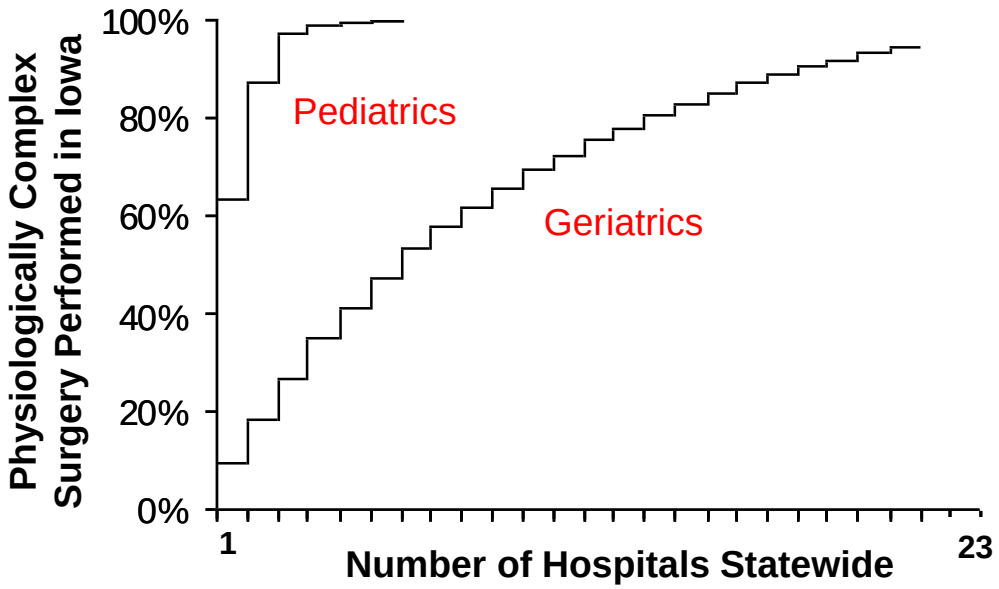
- for pediatrics (0-2 yr), one hospital performed 64% of complex procedures in state
- geriatrics (≥ 80 yr) shown for comparison
  - no single hospital dominated
  - serves as control group to show pediatric results not artifact
  - makes pediatric results seem even more impressive

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

$$0.48 = (0.64)^2 + (0.24)^2 + (0.10)^2 + (0.02)^2$$

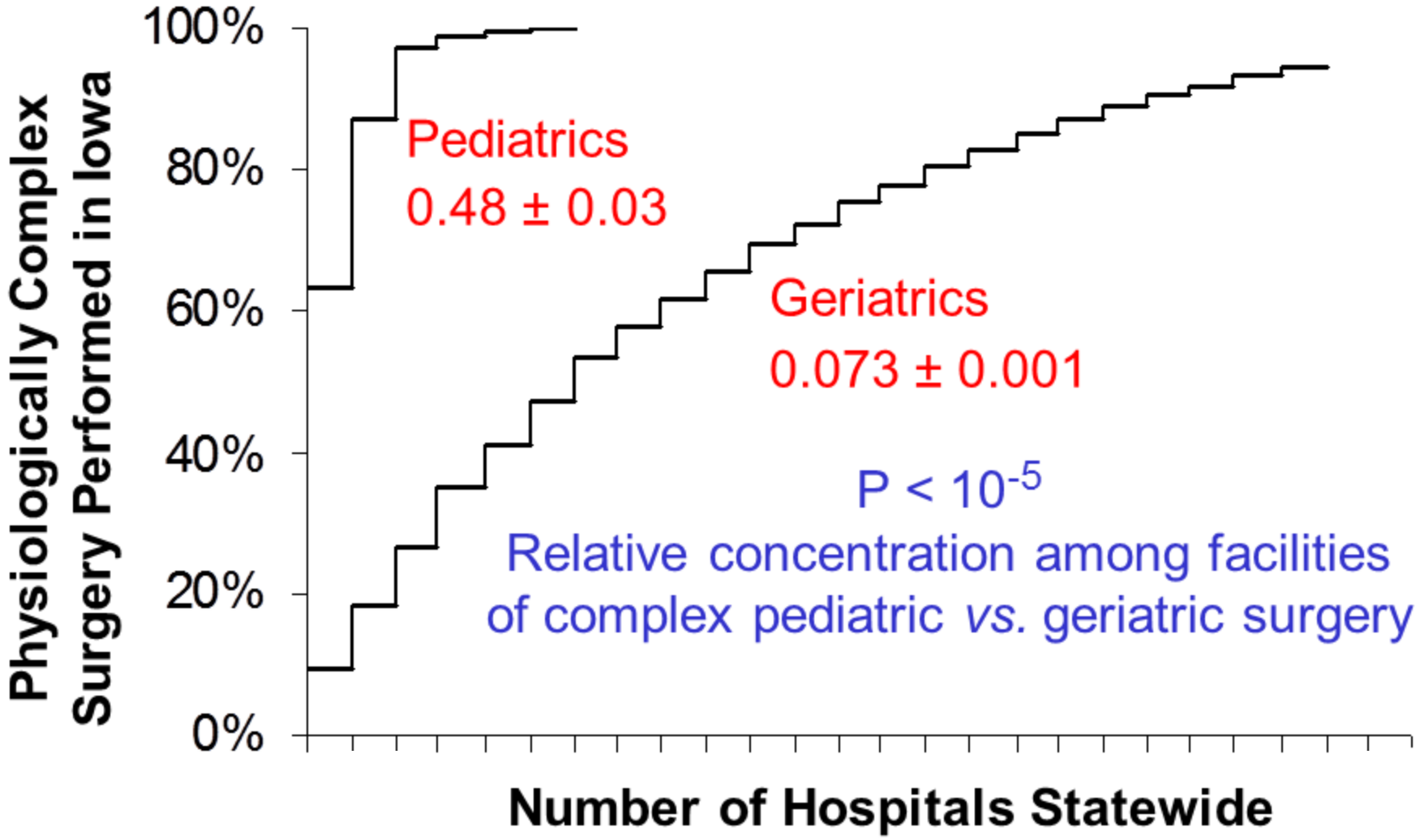
Applying Herfindahl-Hirschman Index

- Physiologically complex pediatric surgery statewide: 0.48 ± 0.03
- Physiologically complex geriatric surgery statewide: 0.073 ± 0.001

Taplin RH. Abacus 2003

Wachtel RE, Dexter F. Anesthesiology 2004

Applying Herfindahl-Hirschman Index



Geriatrics

- Previously examined pediatric surgery at academic medical center
  - Nearly all physiologically complex procedures in infants and toddlers are rare procedures
- How do we distinguish ourselves with regard to geriatrics?
  - Hypothesize large teaching hospital differs from other hospitals not in physiologically complex procedures per se but rare ones

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

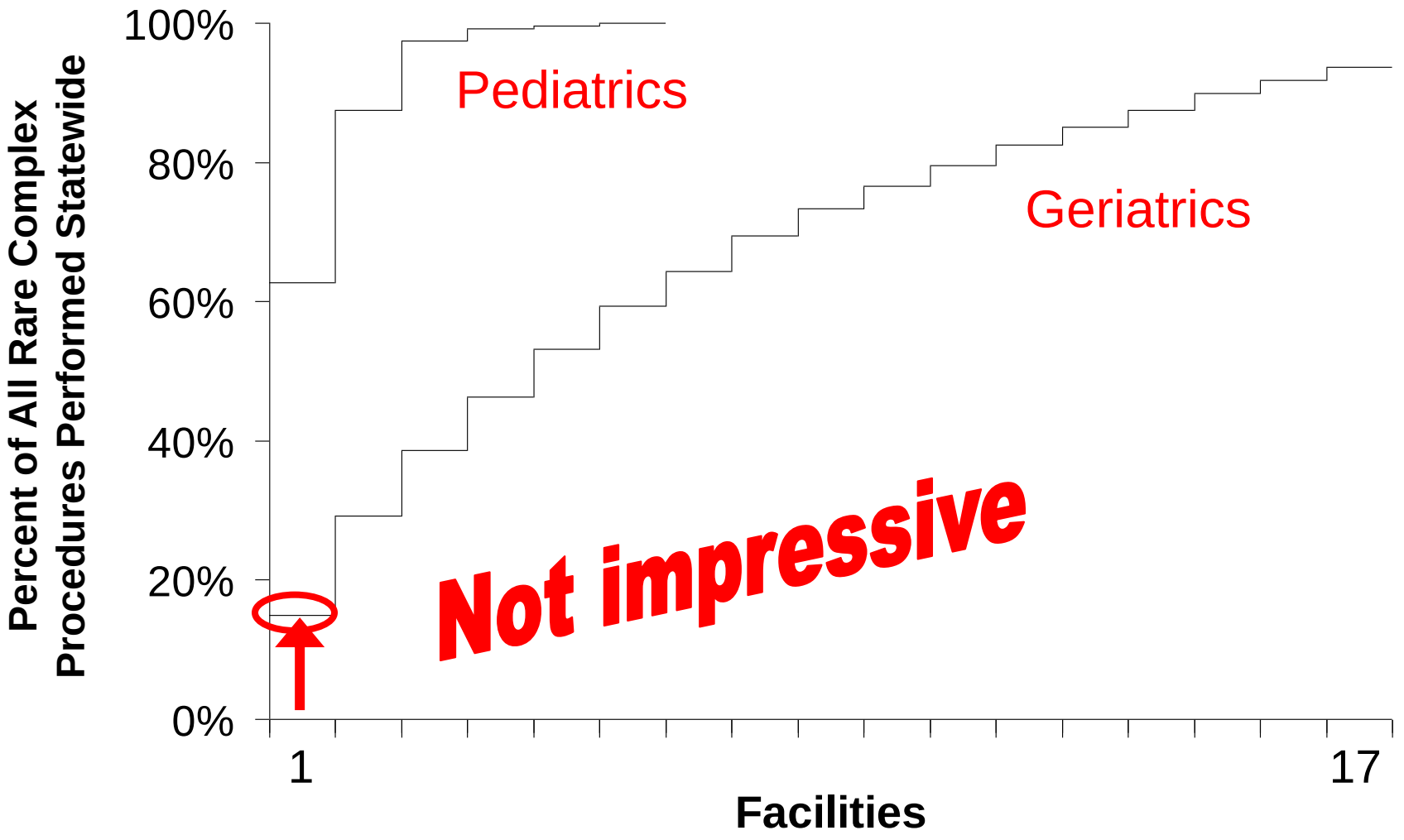
- Performed, on average, less than once per workday statewide
  - < 250 times per year is intuitive
  - Applicable to any region
    - City
    - Part of state (e.g., Central NY)
    - State
  - In Iowa, < 0.06% of all procedures, both operative and non-operative

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



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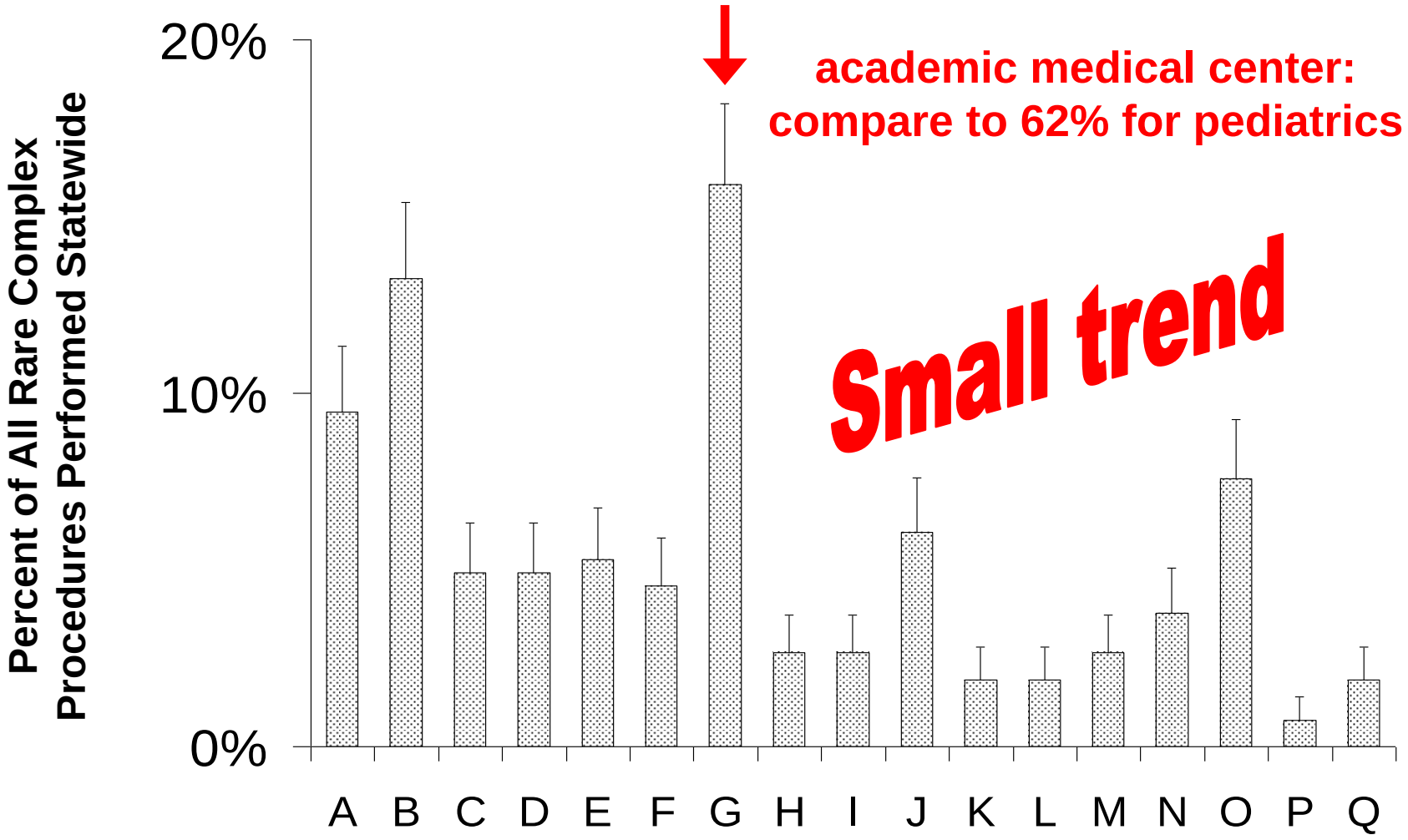
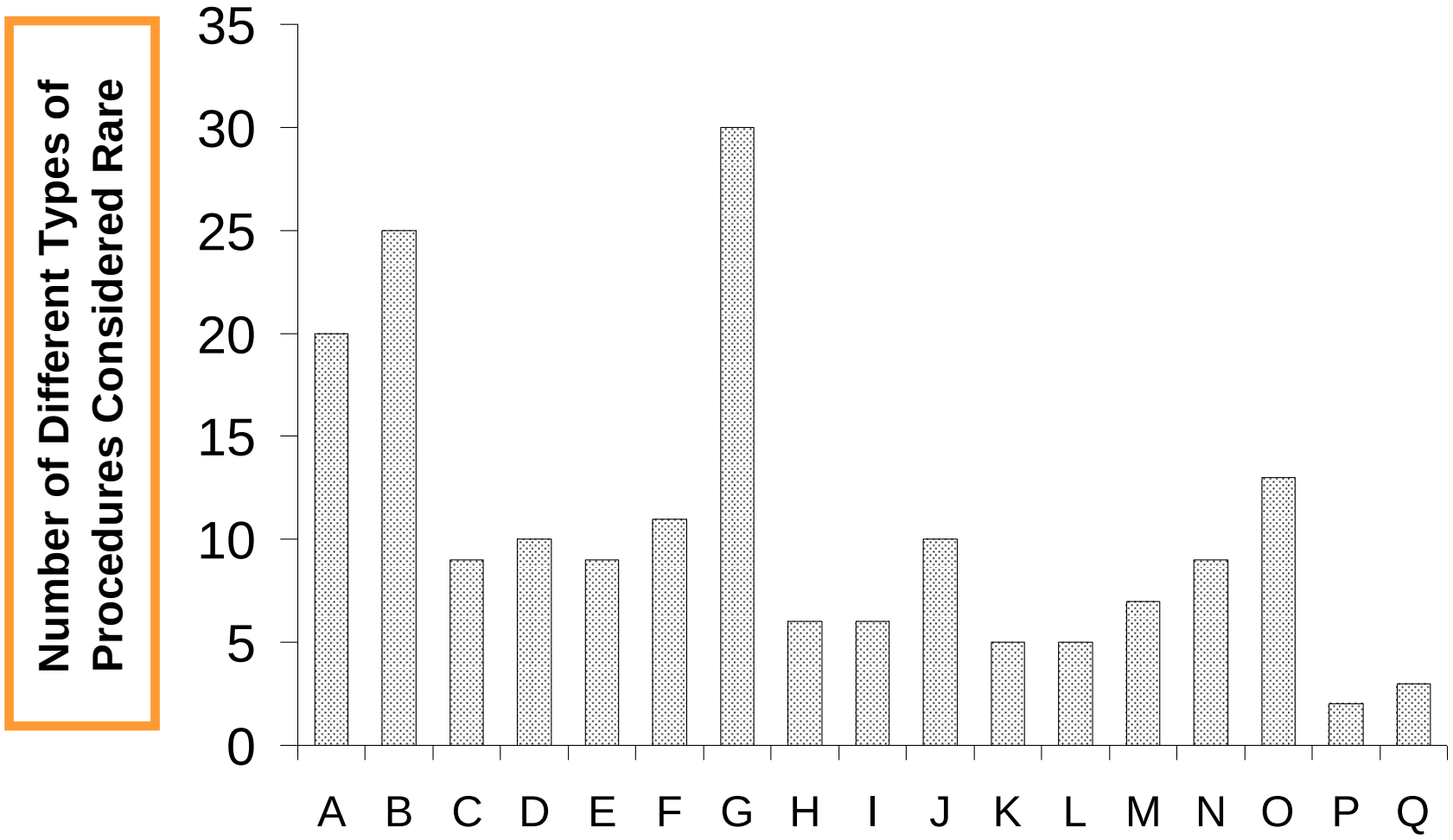
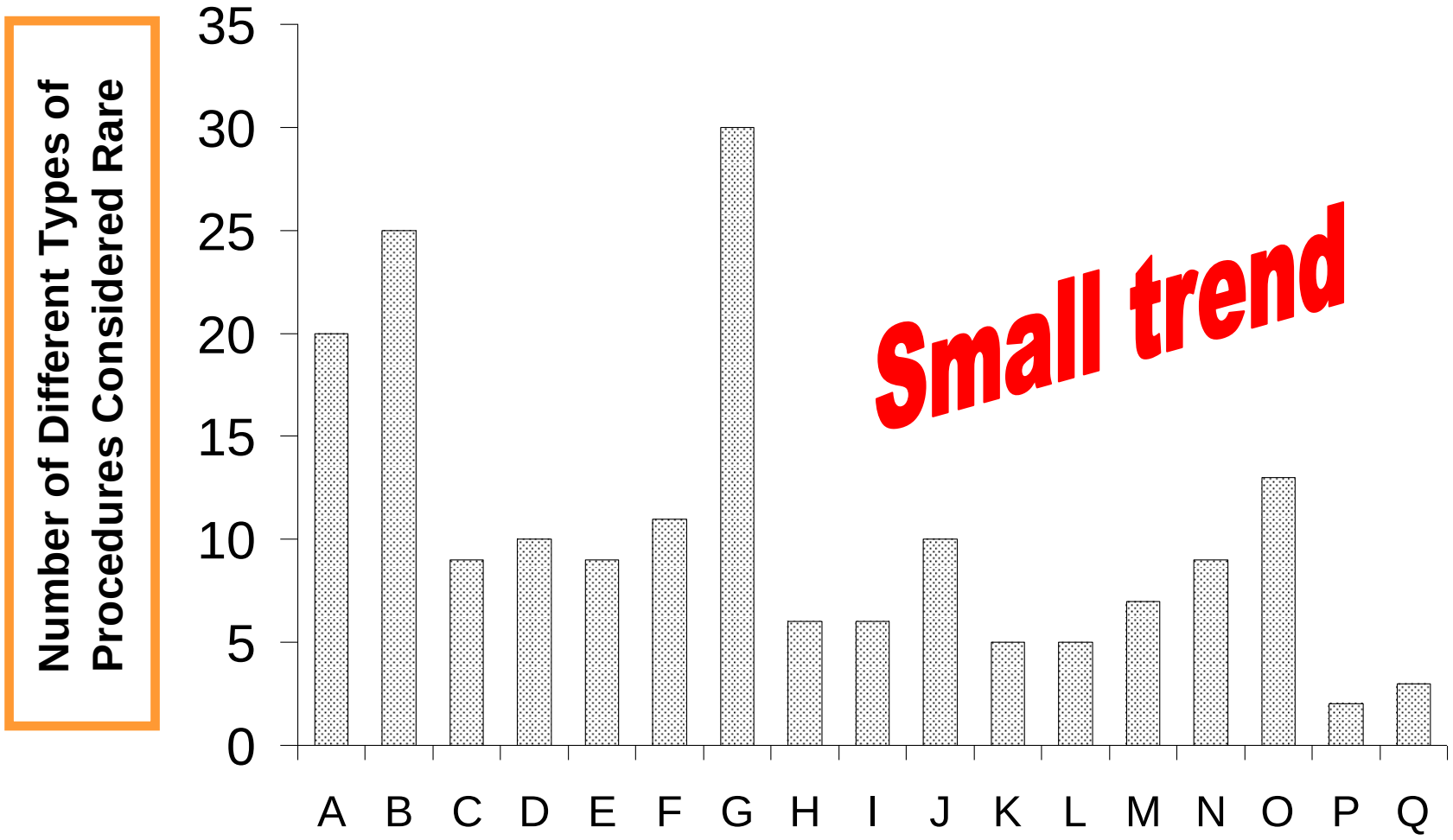


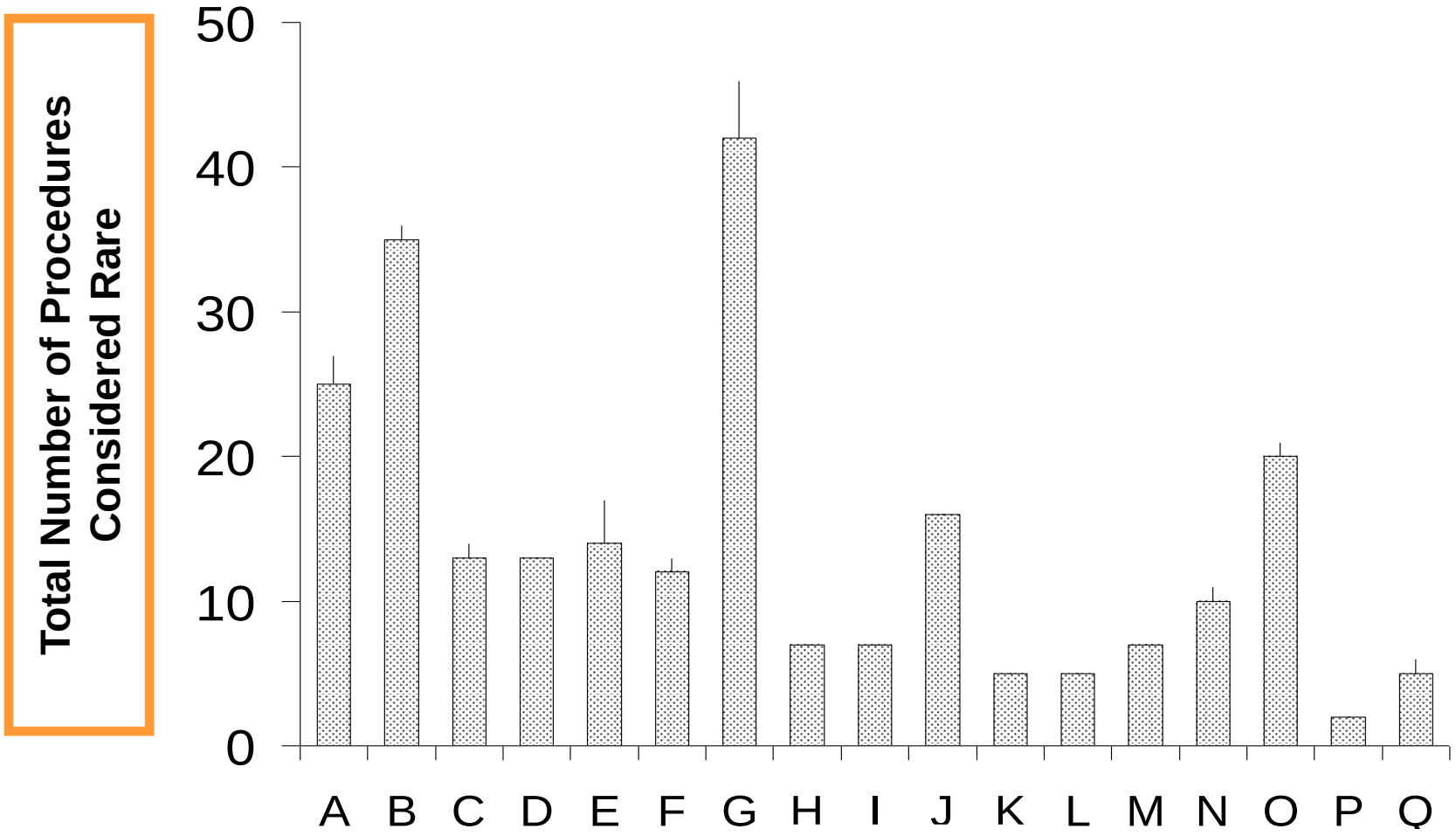
Rare Procedures in Geriatric Patients



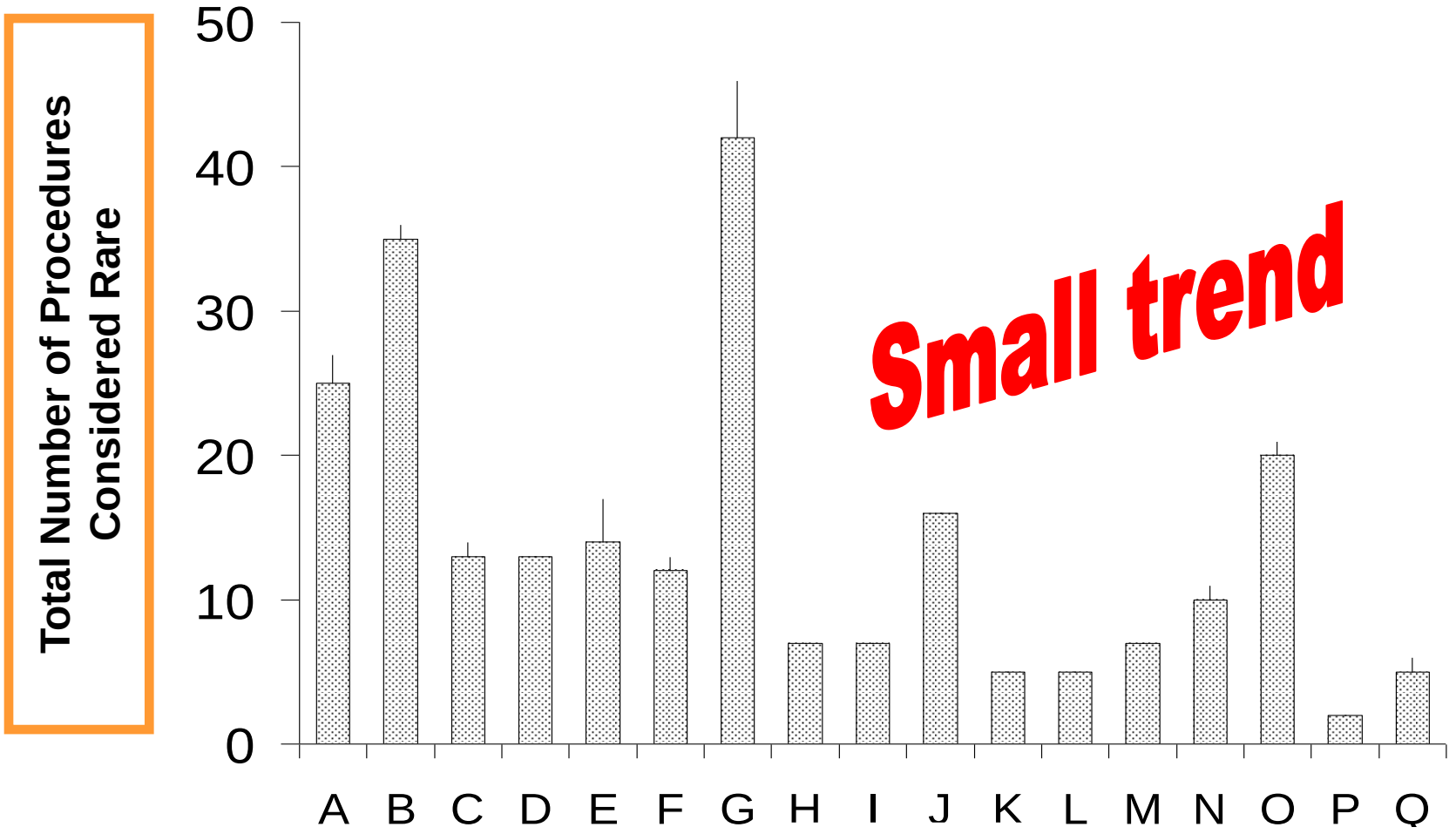
Rare Procedures in Geriatric Patients



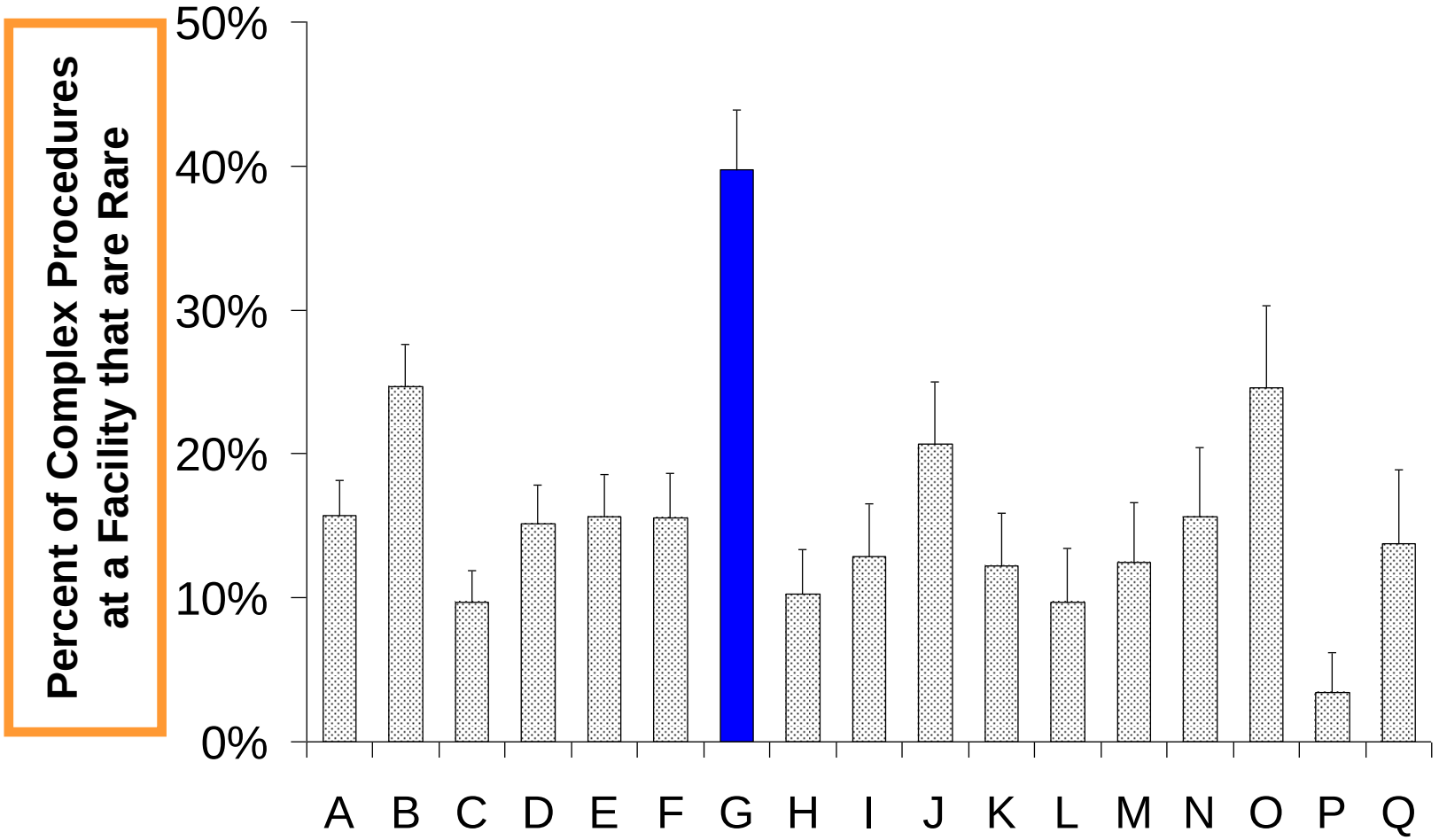
Rare Procedures in Geriatric Patients



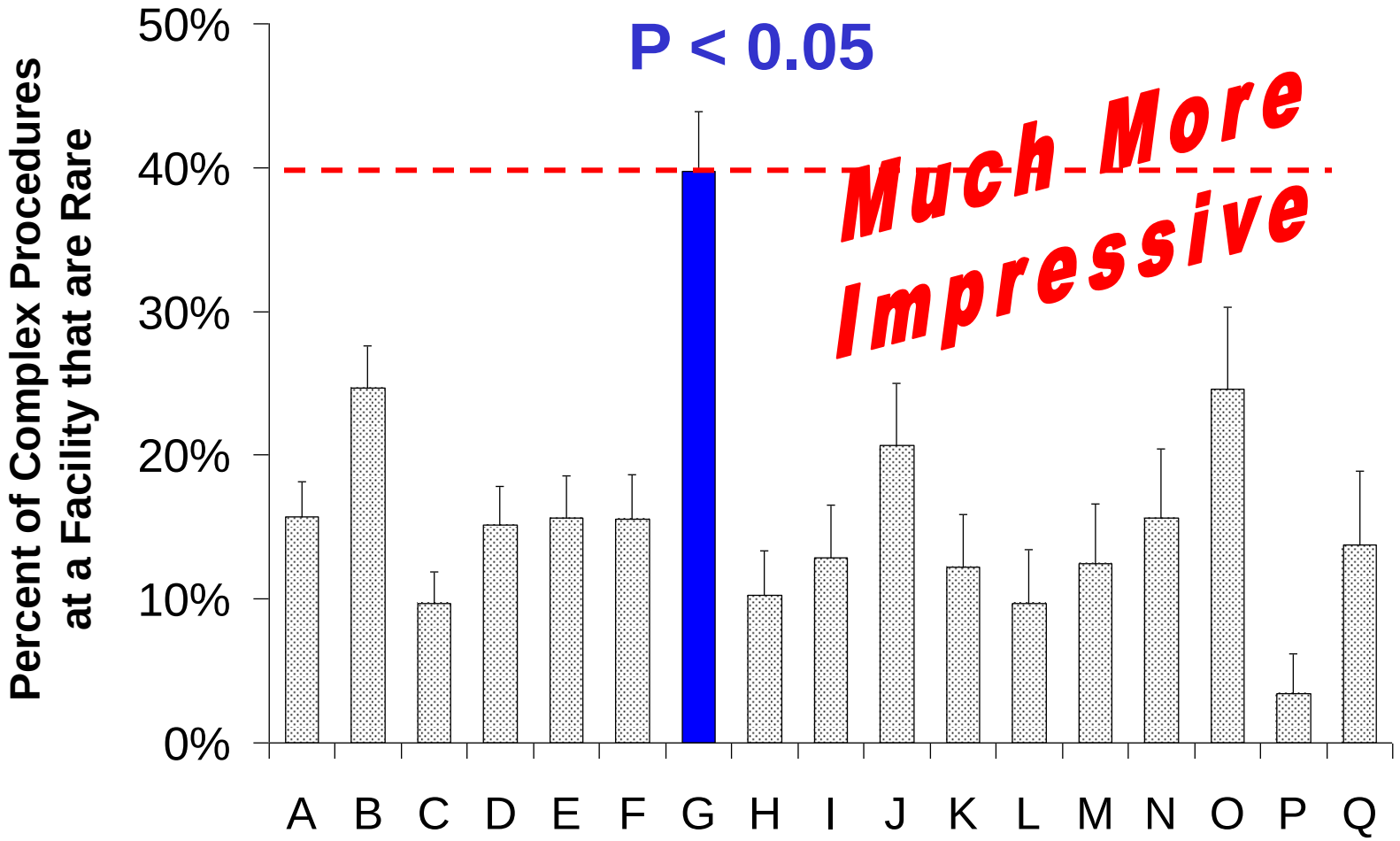
Rare Procedures in Geriatric Patients



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."

Koch HF, Hothorn LA. J Statist Plan Infer 1999

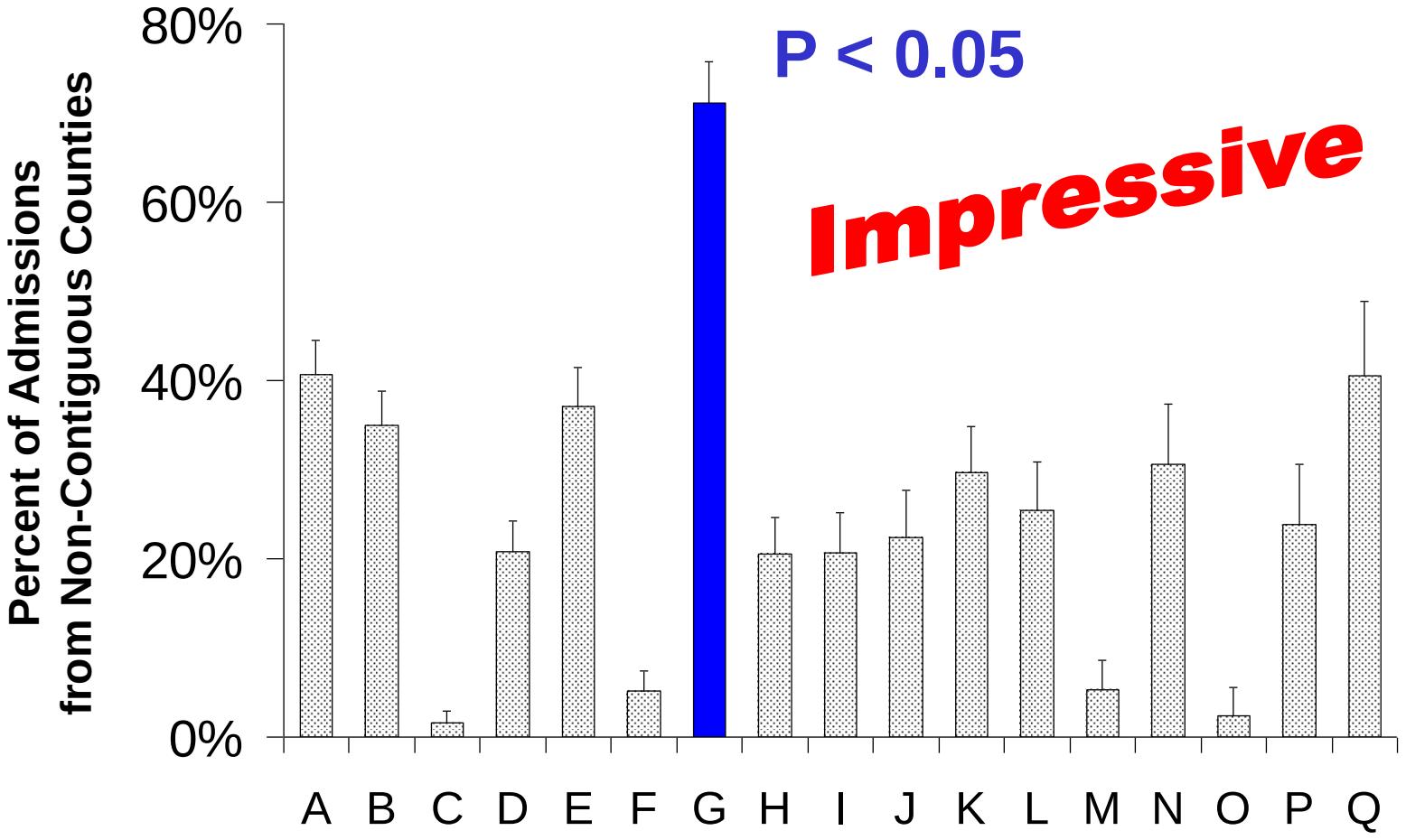
Rare Procedure: "Kaylee's Story"

Comparing Hospitals

- Volume
- Diversity of procedures
- Number and types of physiologically complex procedures
- 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

Prior Surgical Experience Not Influencing Where Care

- Studied every patient having outpatient surgery in State of Iowa during 3 months
- When next surgery, outpatient or inpatient, performed at any hospital in the State?
- Median time to next surgical case > 2 years
  - When weighted by intraoperative surgical relative value units, 65.9% of patients had no other surgery within 2 years

Dexter F et al. Anesth Analg 2018

Patient Perceptions of the Services Provided

- At the academic medical center (Hospital G), 4/5th 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)

Dexter F et al. Anesth Analg 2009

Patient Perceptions of the Services Provided

- "Assume … surgeon … you met in clinic did not have time available to do your surgery within the next 4 workdays, but his/her colleague would have had time to do your surgery within the next 4 workdays … Discuss with a member of the surgical team (e.g., the scheduler) … surgery with … the equally qualified surgeon … within the next 4 workdays?"

Logvinov II et al. Anesth Analg 2018

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  - 59% of lung cancer and gallbladder surgery patients want to share in such a discussion

Review – Summarize the Facts of the Talk

What is the Competition? Heterogeneity Among our Sites?

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
  - 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
  - Comprehensive bibliography of peer reviewed articles in operating room and anesthesia group management