# CHSS Paper: Standardizations and Implications for Regionalization of Care

RDB Jaquiss, MD
Assistant to Nicolas Madsen, MD and Jean Storey, MSN, RN, NEA-BC
Children's Health System of Texas
Dallas

# Disclosure

- I have no disclosure relevant to this presentation

# Objectives and Guardrails

- Vigorously defend surgical volume as *an* important factor in center designation.
- Vigorously defend regionalization as *one of several* methods of QI
- Suggest that we have a cognitive bias vis-à-vis the “bell curve”
- Lament unfortunate rhetorical techniques which employ straw-man arguments and statistical disingenuity
- Propose quality improvement initiatives built on the CHSS standards

All this while trying to….

- Not enlarge my enemies list or impugn motives

What would you do if I showed you a way produce a four-fold reduction  in your STS Mortality Rate?

## Evidence-Based Referral Results in Significantly Reduced Mortality Afte Congenital Heart Surgery

Steven W. Allen, MD*; Kimberlee Gauvreau, ScD‡; Barry T. Bloom, MD§; and Kathy J. Jenkins, MD, MPH

**ABSTRACT.** *Objective.* **Significant interinstitutional variation in mortality after congenital heart surgery has been demonstrated. Noting an association between reduced mortality and higher volume, a center with a small annual case volume began in August 1998 to selectively refer to high-volume surgical centers based on published or "apparent" low mortality rates for specific cardiac lesions. This study was undertaken to evaluate the effect of evidence-based referral in this practice.**

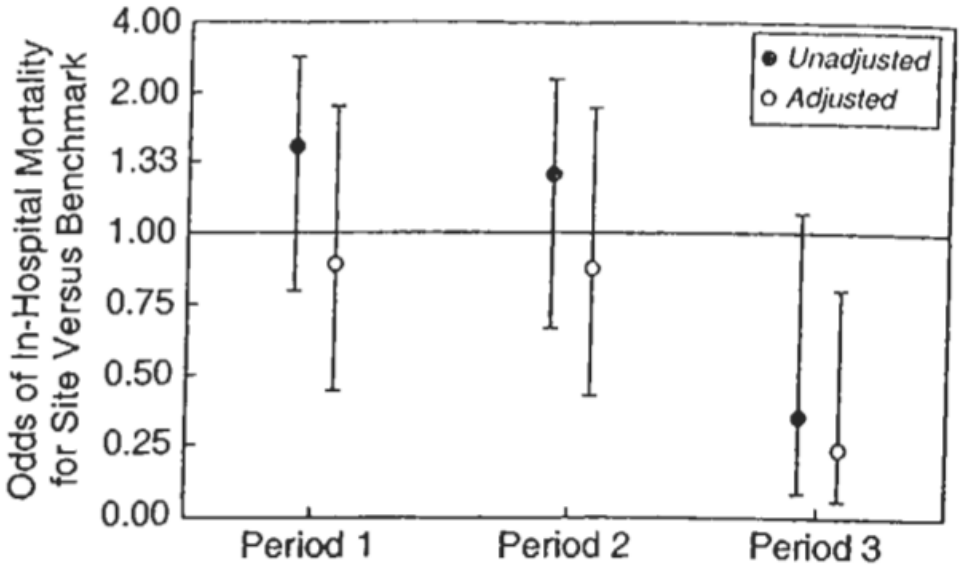
*Design, Setting, and Participants.* **A retrospective cohort comparison over a 10-year period for a small Midwestern pediatric cardiology practice. The institutional database was retrospectively reviewed for children (<18 years) undergoing surgery from August 1992 to July 2002. Data were divided into 3 time periods (August 1992 to July 1995, period 1; August 1995 to July 1998, period 2; and August 1998 to July 2002, period 3). Hospital discharge abstract data from 5 states (California, Illinois, Massachusetts, Pennsylvania, and Washington) in 1992, 1996, and 1998 provided contemporaneous benchmarks. Risk adjustment was performed us ment in Congenital Heart Surgery gory, age at surgery, prematurity, structural anomaly were entered i gistic regression model to compare adjusting for case-mix differences.**

*Results.* **A total of 514 congenita were identified from August 1992 t (98.6%) were assigned to a risk ca further. Unadjusted in-hospital mor in period 1, 5.9% in period 2, an Unadjusted mortality rates for ca data were 6.4% in 1992, 4.8% in 19 Risk adjusted mortality was comp mark data in periods 1 and 2, bu (odds ratio = 0.24) were demonstra**

*Conclusions.* **Evidence-based re volume pediatric cardiac center to tions resulted in a reduction in mor heart surgery.** *Pediatrics* **2003;112:2** *referral, congenital heart disease, ou*

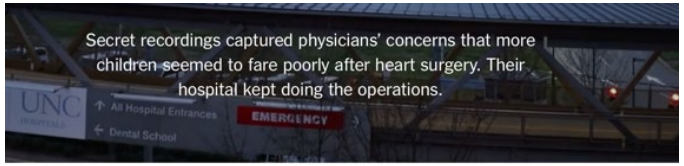
Surgical results for congenital heart diseas (CHD) have dramatically improved over th last 25 years.[1–3] Many low-complexity opera tions are approaching survival rates of 100%,[4,5] an in some institutions even the most complex lesion have low mortality.[6] Improvements in diagnosti techniques, anesthesia, perfusion, postoperative care and surgery have altered the natural history of thes conditions. However, there remains marked institu tional variability in the surgical outcome of patient with CHD.[5,6]

In response to the recently demonstrated relation ship between institutional volume and outcome fo CHD surgery,[1,4–6] a small Midwestern practice wit ~50 cases per year instituted a practice change ir August 1998. Cases were selectively referred to high volume (>300 cases/year) surgical centers based or published or "apparent" low mortality rates for spe cific cardiac lesions (evidence-based referral). After 4




Allen, Gavreau, Bloom, and Jenkins – PEDIATRICS 2003

# Wasn’t That From a Bygone Era?




Doctors Were Alarmed: ‘Would I Have My Children Have Surgery Here?’

BY ELLEN GABLER MAY 31, 2019

The Palm Beach Post
REAL NEWS STARTS HERE

**CNN puts St. Mary’s infant heart surgery deaths at 3x national average**

By Sonja Isger
Posted Jun 3, 2015 at 12:01 AM
Updated Jun 3, 2015 at 1:07 PM

WEST PALM BEACH — St. Mary's Medical Center, in response to a blistering CNN report, insisted Tuesday that the infant mortality rate in its pediatric open heart surgery unit is "consistent" with the national average and blasted the cable news station for trying to mislead the public through skewed arithmetic.

**Colorado News and Denver News: The Denver Post**

**Hospitals shield mortality rates**

By Allison Sherry
Denver Post Staff Writer

**March 2, 2001** - Hospital death rates, like those from Children's Hospital that became public this week, are usually seen only by doctors and hospital officials - not their patients.

But it wasn't always that way.

A legislative-appointed group, dubbed the Health Data Commission, used to scrutinize hospital expenses, mortality rates and prices for care. The fledgling group was disbanded in 1994 after bickering with hospital administrators about the subjectivity of its findings. In the end, the state legislature decided to cut its funding.

"The data is helpful internally, but it's less useful in a public document," said Peg O'Keefe, vice president of the Colorado Hospital Association. "People ask their physician what they recommend. There doesn't seem to be a great deal of inte

Screenshot

**After CNN investigation, a push to halt child heart surgery at some hospitals**

By Elizabeth Cohen, CNN Senior Medical Correspondent
9 minute read - Updated 11:27 AM EST, Wed January 13, 2016

From 2011 to 2015, nine babies died after heart surgery at St. Mary's Medical Center in Florida. This baby, Jashnide Desamours, went in organ failure after surgery there, but was transferred to another hospital and survived.

Menu SEATTLE WEEKLY
News & Comment Opinion Arts & Culture Eat Drink Toke Sports

**Tearing at Children’s Heart**

The controversy that has shaken Children's Hospital to its core

By Nina Shapiro
Monday, October 9, 2006 12:00am | NEWS & COMMENT

TEN-YEAR-OLD DARIUS SOLEIMAN didn't know that the operation he was scheduled to have would end his life. All he knew was that it was going to make him normal again, that it would, at last, relieve him of the congenital heart condition that left him unable to keep up with his schoolmates on the playground. He

ait.

the date on his calendar, June rew up a wish list for gifts after

CNN health Food Fitness Wellness Parenting Vital Signs

**Babies die; hospital halts heart surgeries**

By Elizabeth Cohen, Senior Medical Correspondent
Updated 10:50 AM ET, Sun August 4, 2013

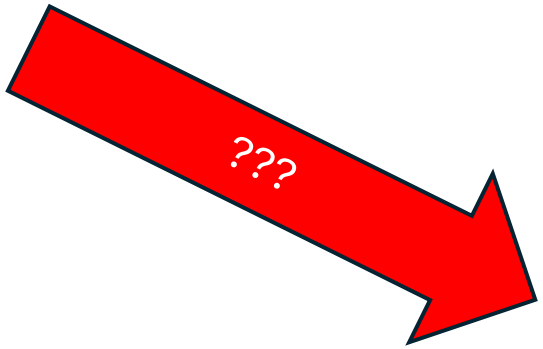

**Johns Hopkins promised to elevate All Children’s Heart Institute. Then patients started to die at an alarming rate.**

2001, 2006, 2013, 2015, 2016, 2019.....


I'm shocked – shocked! – to find
that gambling's going on in here.

# Magnitude of Local Crises?

- Open Door
  - Publicized – whistleblower etc.
- Closed Door
  - Internal and External Review

# A More Systematic Look in the Modern Era

Circulation

ORIGINAL RESEARCH ARTICLE

## National Variation in Congenital Heart Surgery Outcomes

Sara K. Pasquali, MD, MHS
Dylan Thibault, MS
Sean M. O'Brien, PhD
Jeffrey P. Jacobs, MD
J. William Gaynor, MD
Jennifer C. Romano, MD, MS
Michael Gaies, MD, MPH
Kevin D. Hill, MD, MS
Marshall L. Jacobs, MD
David M. Shahian, MD
Carl L. Backer, MD
John E. Mayer, MD

**BACKGROUND:** Optimal strategies to improve national congenital heart surgery outcomes and reduce variability across hospitals remain unclear. Many policy and quality improvement efforts have focused primarily on higher-risk patients and mortality alone. Improving our understanding of both morbidity and mortality and current variation across the spectrum of complexity would better inform future efforts.

**METHODS:** Hospitals participating in the Society of Thoracic Surgeons Congenital Heart Surgery Database (2014–2017) were included. Case mix–adjusted operative mortality, major complications, and postoperative length of stay were evaluated using Bayesian models. Hospital variation was quantified by the interdecile ratio (IDR, upper versus lower 10%) and 95% credible intervals (CrIs). Stratified analyses were performed by risk group (Society of Thoracic Surgeons–European Association for Cardiothoracic Surgery [STAT] category) and simulations evaluated the potential impact of reductions in variation.

**RESULTS:** A total of 102 hospitals (n=84 407) were included, representing ≈85% of US congenital heart programs. STAT category 1 to 3 (lower risk) operations comprised 74% of cases. All outcomes varied significantly across hospitals: adjusted mortality by 3-fold (upper versus lower decile 5.0% versus 1.6%, IDR 3.1 [95% CrI 2.5–3.7]), mean length of stay by 1.8-fold (19.2 versus 10.5 days, IDR 1.8 [95% CrI 1.8–1.9]), and major complications by >3-fold (23.5% versus 7.0%, IDR 3.4 [95% CrI 3.0–3.8]). The degree of variation was similar or greater for low- versus high-risk cases across outcomes, eg, ≈3-fold mortality variation across hospitals for STAT 1 to 3 (IDR 3.0 [95% CrI 2.1–4.2]) and STAT 4 or 5 (IDR 3.1 [95% CrI 2.4–3.9]) cases. High-volume hospitals had less variability across outcomes and risk categories. Simulations suggested potential reductions in deaths (n=282), major complications (n=1539), and length of stay (101 183 days) over the 4-year study period if all hospitals were to perform at the current median or better, with 37% to 60% of the improvement related to the STAT 1 to 3 (lower risk) group across outcomes.

**CONCLUSIONS:** We demonstrate significant hospital variation in morbidity and mortality after congenital heart surgery. Contrary to traditional thinking, a substantial portion of potential improvements that could be realized on a national scale were related to variability among lower-risk cases. These findings suggest modifications to our current approaches to optimize care and outcomes in this population are needed.

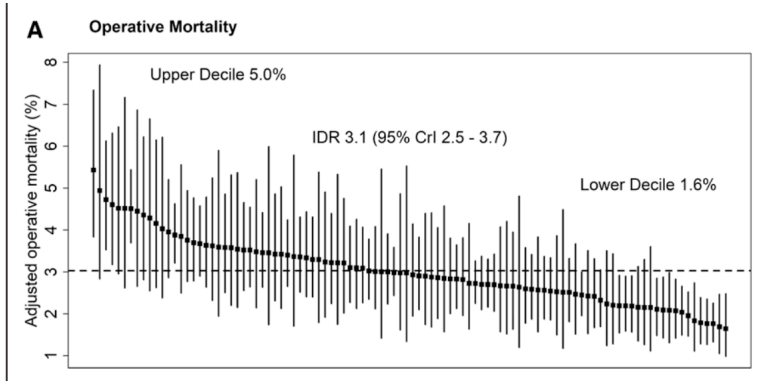
Key Words: congenital ■ outcome assessment, health care ■ quality of health care

Sources of Funding, see page 1359



https://www.ahajournals.org/journal/circ

| Outcome | Lower Quartile | Median | Upper Quartile | Inter-Quartile Ratio | Inter-Quartile Absolute Difference |
|---|---|---|---|---|---|
| **Operative mortality (%)** | | | | | |
| Overall | 1.9 (1.7 - 2.1) | 2.9 (2.7 - 3.1) | 4.4 (4.0 - 4.9) | 2.3 (2.0 - 2.6) | 2.5 (2.0 - 3.0) |
| Non-neonates | 1.1 (1.0 - 1.2) | 1.7 (1.6 - 1.9) | 2.7 (2.4 - 3.0) | 2.4 (2.0 - 2.9) | 1.5 (1.2 - 2.0) |
| Neonates | 5.2 (4.6 - 5.9) | 8.1 (7.4 - 8.9) | 13.0 (11.5 - 14.9) | 2.5 (2.0 - 3.1) | 7.7 (5.9 - 9.9) |
| STAT 1-3 | 0.8 (0.7 - 0.9) | 1.2 (1.1 - 1.3) | 1.8 (1.6 - 2.1) | 2.2 (1.7 - 2.9) | 1.0 (0.7 - 1.3) |
| STAT 4-5 | 5.2 (4.6 - 5.7) | 7.7 (7.1 - 8.3) | 11.6 (10.5 - 13.1) | 2.3 (1.9 - 2.7) | 6.5 (5.0 - 8.2) |




Simulations suggested potential ***reductions in deaths (n=282)***, major complications (n=1539), and length of stay (101 183 days) over the 4-year study period ***if all hospitals were to perform at the current median or better***, with 37% to 60% of the improvement related to the STAT 1 to 3 (lower risk) group across outcomes.

Pasquali et al 2020 Circulation

# A More Systematic Look in the Modern Era

Circulation

ORIGINAL RESEARCH ARTICLE

## National Variation in Congenital Heart Surgery Outcomes

Sara K. Pasquali, MD, MHS
Dylan Thibault, MS
Sean M. O'Brien, PhD
Jeffrey P. Jacobs, MD
J. William Gaynor, MD
Jennifer C. Romano, MD, MS
Michael Gaies, MD, MPH
Kevin D. Hill, MD, MS
Marshall L. Jacobs, MD
David M. Shahian, MD
Carl L. Backer, MD
John E. Mayer, MD

**BACKGROUND:** Optimal strategies to improve national congenital heart surgery outcomes and reduce variability across hospitals remain unclear. Many policy and quality improvement efforts have focused primarily on higher-risk patients and mortality alone. Improving our understanding of both morbidity and mortality and current variation across the spectrum of complexity would better inform future efforts.

**METHODS:** Hospitals participating in the Society of Thoracic Surgeons Congenital Heart Surgery Database (2014–2017) were included. Case mix–adjusted operative mortality, major complications, and postoperative length of stay were evaluated using Bayesian models. Hospital variation was quantified by the interdecile ratio (IDR, upper versus lower 10%) and 95% credible intervals (CrIs). Stratified analyses were performed by risk group (Society of Thoracic Surgeons–European Association for Cardiothoracic Surgery [STAT] category) and simulations evaluated the potential impact of reductions in variation.

**RESULTS:** A total of 102 hospitals (n=84 407) were included, representing ≈85% of US congenital heart programs. STAT category 1 to 3 (lower risk) operations comprised 74% of cases. All outcomes varied significantly across hospitals: adjusted mortality by 3-fold (upper versus lower decile 5.0% versus 1.6%, IDR 3.1 [95% CrI 2.5–3.7]), mean length of stay by 1.8-fold (19.2 versus 10.5 days, IDR 1.8 [95% CrI 1.8–1.9]), and major complications by >3-fold (23.5% versus 7.0%, IDR 3.4 [95% CrI 3.0–3.8]). The degree of variation was similar or greater for low- versus high-risk cases across outcomes, eg, ≈3-fold mortality variation across hospitals for STAT 1 to 3 (IDR 3.0 [95% CrI 2.1–4.2]) and STAT 4 or 5 (IDR 3.1 [95% CrI 2.4–3.9]) cases. High-volume hospitals had less variability across outcomes and risk categories. Simulations suggested potential reductions in deaths (n=282), major complications (n=1539), and length of stay (101 183 days) over the 4-year study period if all hospitals were to perform at the current median or better, with 37% to 60% of the improvement related to the STAT 1 to 3 (lower risk) group across outcomes.

**CONCLUSIONS:** We demonstrate significant hospital variation in morbidity and mortality after congenital heart surgery. Contrary to traditional thinking, a substantial portion of potential improvements that could be realized on a national scale were related to variability among lower-risk cases. These findings suggest modifications to our current approaches to optimize care and outcomes in this population are needed.

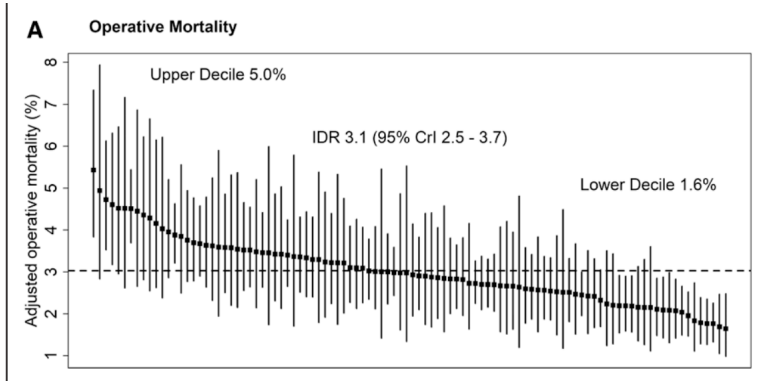
Key Words: congenital ■ outcome assessment, health care ■ quality of health care

Sources of Funding, see page 1359



https://www.ahajournals.org/journal/circ

| Outcome | Lower Quartile | Median | Upper Quartile | Inter-Quartile Ratio | Inter-Quartile Absolute Difference |
|---|---|---|---|---|---|
| **Operative mortality (%)** | | | | | |
| Overall | 1.9 (1.7 - 2.1) | 2.9 (2.7 - 3.1) | 4.4 (4.0 - 4 | 2.3 (2.0 - 2.6) | 2.5 .0 - 3.0) |
| Non-neonates | 1.1 (1.0 - 1.2) | 1.7 (1.6 - 1.9) | 2.7 (2.4 - 3 | 2.4 (2.0 - 2.9) | 1.5 .2 - 2.0) |
| Neonates | 5.2 (4.6 - 5.9) | 8.1 (7.4 - 8.9) | 13.0 (11.5 - 1 | 2.5 (2.0 - 3.1) | 7.7 .9 - 9.9) |
| STAT 1-3 | 0.8 (0.7 - 0.9) | 1.2 (1.1 - 1.3) | 1.8 (1.6 - 2. | 2.2 (1.7 - 2.9) | 1.0 0.7 - 1.3) |
| STAT 4-5 | 5.2 (4.6 - 5.7) | 7.7 (7.1 - 8.3) | 11.6 (10.5 - 13. | 2.3 (1.9 - 2.7) | 6.5 (5.0 - 8.2) |




Simulations suggested potential ***reductions in deaths (n=282***), major complications (n=1539), and length of stay (101 183 days) over the 4-year study period ***if all hospitals were to perform at the current median or better***, with 37% to 60% of the improvement related to the STAT 1 to 3 (lower risk) group across outcomes.

Pasquali et al 2020 Circulation

# Risk Factors

**TABLE 3 Results of Multivariable Logistic Regression Model With Inpatient Mortality as Outcome of Interest**

| Variable | Odds Ratio (95% CI) | *P* Value |
|---|---|---|
| Hospital volume | | |
| High-volume | 1 | (Reference) |
| Mid-volume | 1.13 (0.91-1.41) | .273 |
| Low-volume | 1.51 (1.19-1.90) | <.001 |
| Age | | |
| >1 y | 1 | (Reference) |
| Infant | 1.16 (0.86-1.56) | .325 |
| Neonate | 2.21 (1.61-3.07) | <.001 |
| Low birth weight (<2.5 kg) | 2.19 (1.52-3.10) | <.001 |
| Female sex | 1.11 (0.92-1.34) | .258 |
| White race | 0.69 (0.57-0.83) | <.001 |
| Genetic diagnosis | 1.83 (1.28-2.53) | <.001 |
| Heterotaxy | 1.81 (0.72-3.88) | .161 |
| Elective procedures | 0.29 (0.22-0.39) | <.001 |
| RACHS-2 category | 1.37 (1.26 - 1.5) | <.001 |
| Reoperation | 1.46 (1.04-2.01) | .023 |
| Preoperative length of stay, d | 1.01 (1-1.01) | <.001 |

# Modifiable Risk Factors

**TABLE 3 Results of Multivariable Logistic Regression Model With Inpatient Mortality as Outcome of Interest**

| Variable | Odds Ratio (95% CI) | *P* Value |
|---|---|---|
| Hospital volume | | |
| High-volume | 1 | (Reference) |
| Mid-volume | 1.13 (0.91-1.41) | .273 |
| Low-volume | 1.51 (1.19-1.90) | <.001 |


"Houston, we've had a problem.
... main B bus undervolt"

# Project Leadership

Joseph A Dearani, MD

Carl L. Backer, MD

James S. Tweddell, MD

Sara K. Pasquali, MD

CHSS

# Committee members

Carl L. Backer MD
David M. Overman MD
Joseph A. Dearani MD
James S. Tweddell MD
Jennifer C. Romano MD, MS
S. Ram Kumar, MD, PhD
Bradley S. Marino MD, MPP, MSCE, MBA
Emile A. Bacha MD
Robert D.B. Jaquiss MD
Ali N. Zaidi MD
Michelle Gurvitz MD
John M. Costello MD, MPH

Trudy A. Pierick MSN, ARNP, CPNP-PC
William J. Ravekes MD
James A. Reagor MD
James D. St. Louis MD
James Spaeth MD
William T. Mahle MD
Andrew Y. Shin MD
Keila N. Lopez MD, MPH
Tara Karamlou MD, MSc
Karl F. Welke MD, MS
Roosevelt Bryant MD
**S. Adil Husain MD**
Jonathan M. Chen MD

Aditya Kaza MD, MBA
Winfield J. Wells MD
Andrew C. Glatz MD, MSCE
Mitchell I. Cohen MD
Doff B. McElhinney MD
David A. Parra MD
Sara K. Pasquali MD MHS

# Working Groups

- Surgery
- Anesthesia
- Perfusion
- Critical Care
- Acute Care
- Imaging (echo/x-section)
- Catheterization
- Electrophysiology
- Heart Failure/Transplant/MCS
- Adult Congenital – Longitudinal Care
- Nursing and Advanced Practice
- Access; DEI

- First meeting March 2021

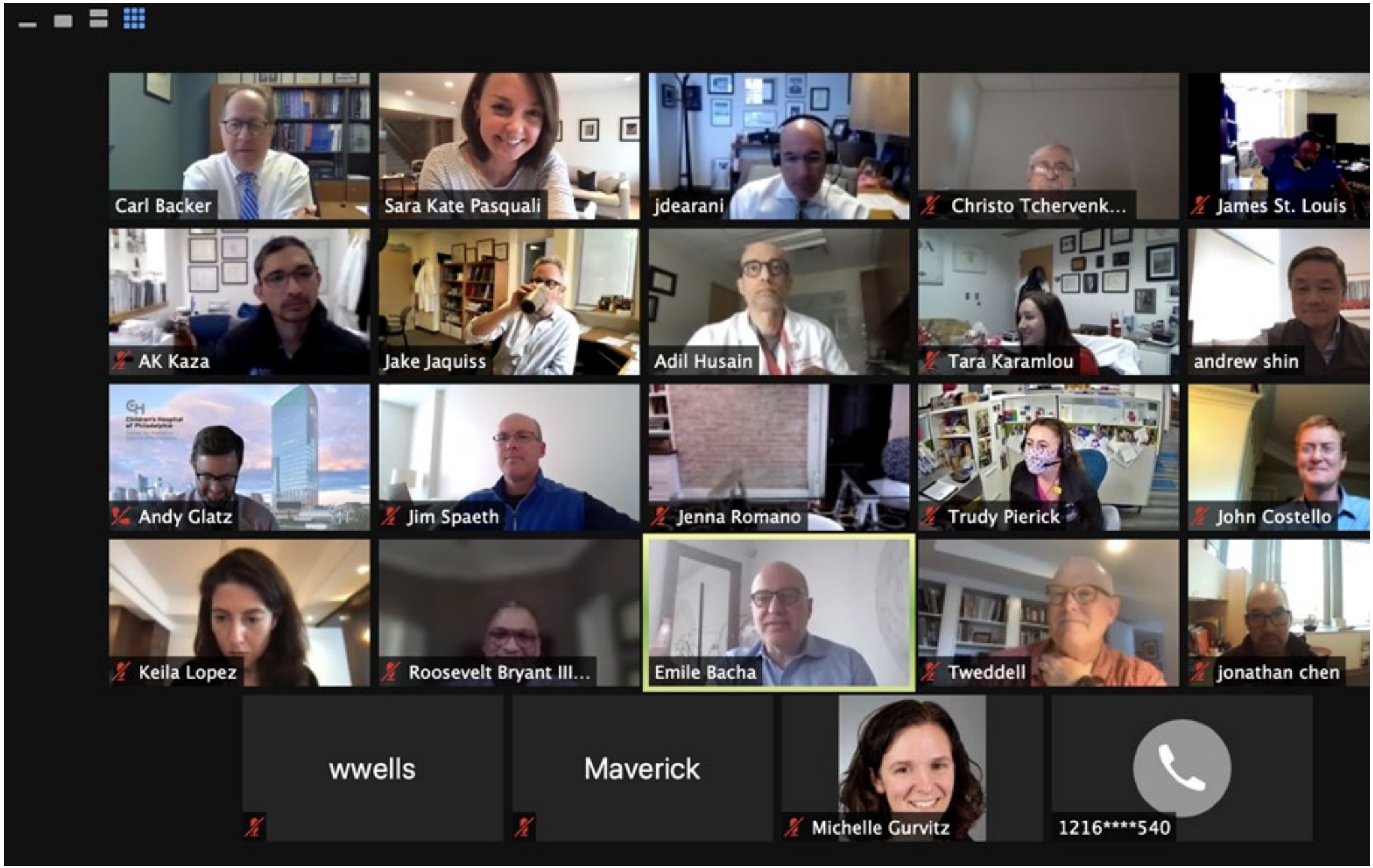
- Broad representation

- 30 members
- 13 societies
- Diverse representation across program size & geography
- Surgery, cardiology, anesthesia, nursing, perfusion, etc.

- 25 1-hour zoom meetings

**Participating Professional Societies**

Congenital Heart Surgeons' Society
Society of Thoracic Surgeons
American Association for Thoracic Surgery
American Heart Association
American College of Cardiology
**American Academy of Pediatrics**
Congenital Heart Public Health Consortium
Society of Pediatric Cardiovascular Nursing
Pediatric Cardiac Intensive Care Society
American Society of Extracorporeal Technology
Congenital Cardiac Anesthesia Society
Pediatric Heart Transplant Society
World Society for Pediatric and Congenital Heart Surgery

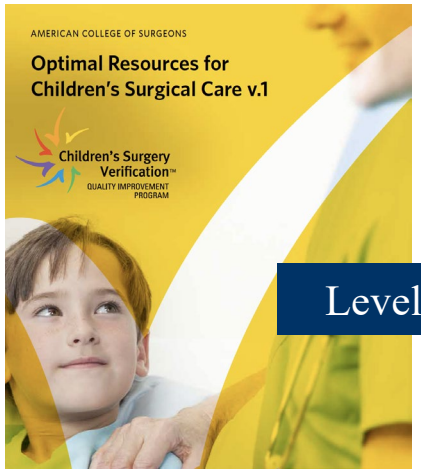

Carl Backer
Sara Kate Pasquali
jdearani
Christo Tchervenk...
James St. Louis
AK Kaza
Jake Jaquiss
Adil Husain
Tara Karamlou
andrew shin
Andy Glatz
Jim Spaeth
Jenna Romano
Trudy Pierick
John Costello
Keila Lopez
Roosevelt Bryant III...
Emile Bacha
Tweddell
jonathan chen
wwells
Maverick
Michelle Gurvitz
1216****540

## CHD Surgery: UK (2018)

# Congenital Heart Disease Standards & Specifications

- minimum of 4 surgeons
- surgeons operate together - complex cases
- Each surgeon >125 procedures/yr

ACS 2015, 2022




Levels I, II, III

Pediatric Heart Center 2002

PEDIATRICS
OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

**Guidelines for Pediatric Cardiovascular Centers**
Section on Cardiology and Cardiac Surgery
*Pediatrics* 2002;109:544-549
DOI: 10.1542/peds.109.3.544

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://www.pediatrics.org/cgi/content/full/109/3/544

## CHD Surgery: ECHSA/EACTS (2003)

- Optimal Structure of a Congenital Heart Surgery Department in Europe
  - Large units – Full spectrum
  - Smaller units – Standard care
- *Eur J Cardiothorac Surg* 2003;24:343-351

## NICU (2012)

PEDIATRICS
OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

**Levels of Neonatal Care**
COMMITTEE ON FETUS AND NEWBORN
*Pediatrics* 2012;130;587
DOI: 10.1542/peds.2012-1999 originally published online August 27, 2012;

Levels I, II, III, IV (4 Levels)

# Terms That Are Not Equivalent

Recommendations

I/We think you should...

Guidelines

I/We think you should...
because of this level of evidence

Standards

You must....

0003-4975/$36.00
https://doi.org/10.1016/j.athoracsur.2023.08.016



EXPERT CONSENSUS STATEMENT

# Recommendations for Centers Performing Pediatric Heart Surgery in the United States

Check for updates

Carl L. Backer, MD,[1] David M. Overman, MD,[2] Joseph A. Dearani, MD,[3] Jennifer C. Romano, MD, MS,[4] James S. Tweddell, MD,[1] S. Ram Kumar, MD, PhD,[5] Bradley S. Marino, MD, MPP, MSCE, MBA,[6] Emile A. Bacha, MD,[7] Robert D. B. Jaquiss, MD,[8] Ali N. Zaidi, MD,[9] Michelle Gurvitz, MD,[10] John M. Costello, MD, MPH,[11] Trudy A. Pierick, MSN, ARNP, CPNP-PC,[12] William J. Ravekes, MD,[13] James A. Reagor, MPS, CCP, FPP,[14] James D. St. Louis, MD,[15] James Spaeth, MD,[16] William T. Mahle, MD,[17] Andrew Y. Shin, MD,[18] Keila N. Lopez, MD, MPH,[19] Tara Karamlou, MD, MSc,[20] Karl F. Welke, MD, MS,[21] Roosevelt Bryant, MD,[22] S. Adil Husain, MD,[23] Jonathan M. Chen, MD,[24] Aditya Kaza, MD, MBA,[25] Winfield J. Wells, MD,[5] Andrew C. Glatz, MD, MSCE,[26] Mitchell I. Cohen, MD,[27] Doff B. McElhinney, MD,[18] David A. Parra, MD,[28] and Sara K. Pasquali, MD, MHS[29]

Care and outcomes for the more than 40,000 patients undergoing pediatric and congenital heart surgery in the United States annually are known to vary widely. While consensus recommendations have been published across numerous fields as one mechanism to promote a high level of care delivery across centers, it has been more than two decades since the last pediatric heart surgery recommendations were published in the United States. More recent guidance is lacking, and collaborative efforts involving the many disciplines engaged in caring for these children have not been undertaken to date. The present initiative brings together professional societies spanning numerous care domains and congenital cardiac surgeons, pediatric cardiologists, nursing, and other healthcare professionals from diverse programs around the country to develop consensus recommendations for United States centers. The focus of this initial work is on pediatric heart surgery, and it is recommended that future efforts focus in detail on the adult congenital population. We describe the background, rationale, and methodology related to this collaborative effort, and recommendations put forth for Essential Care Centers (essential services necessary for any program), and Comprehensive Care Centers (services to optimize comprehensive and high-complexity care), encompassing structure, process, and outcome metrics across 14 domains.

(Ann Thorac Surg 2023;116:871-907)



Endorsed By:

Congenital Heart Surgeons' Society
Society of Thoracic Surgeons
American Association for Thoracic Surgery
American Heart Association
American College of Cardiology
American Academy of Pediatrics
Congenital Heart Public Health Consortium
Society of Pediatric Cardiovascular Nursing
Pediatric Cardiac Intensive Care Society
American Society of Extracorporeal Technology
Congenital Cardiac Anesthesia Society
Pediatric Heart Transplant Society
World Society for Pediatric and Congenital Heart Surgery

0003-4975/$36.00
https://doi.org/10.1016/j.athoracsur.2023.08.016



EXPERT CONSENSUS STATEMENT

# Recommendations for Centers Performing Pediatric Heart Surgery in the United States

Check for updates

Carl L. Backer, MD,[1] David M. Overman, MD,[2] Joseph A. Dearani, MD,[3] Jennifer C. Romano, MD, MS,[4] James S. Tweddell, MD,[1] S. Ram Kumar, MD, PhD,[5] Bradley S. Marino, MD, MPP, MSCE, MBA,[6] Emile A. Bacha, MD,[7] Robert D. B. Jaquiss, MD,[8] Ali N. Zaidi, MD,[9] Michelle Gurvitz, MD,[10] John M. Costello, MD, MPH,[11] Trudy A. Pierick, MSN, ARNP, CPNP-PC,[12] William J. Ravekes, MD,[13] James A. Reagor, MPS, CCP, FPP,[14] James D. St. Louis, MD,[15] James Spaeth, MD,[16] William T. Mahle, MD,[17] Andrew Y. Shin, MD,[18] Keila N. Lopez, MD, MPH,[19] Tara Karamlou, MD, MSc,[20] Karl F. Welke, MD, MS,[21] Roosevelt Bryant, MD,[22] S. Adil Husain, MD,[23] Jonathan M. Chen, MD,[24] Aditya Kaza, MD, MBA,[25] Winfield J. Wells, MD,[5] Andrew C. Glatz, MD, MSCE,[26] Mitchell I. Cohen, MD,[27] Doff B. McElhinney, MD,[18] David A. Parra, MD,[28] and Sara K. Pasquali, MD, MHS[29]

Care and outcomes for the more than 40,000 patients undergoing pediatric and congenital heart surgery in the United States annually are known to vary widely. While consensus recommendations have been published across numerous fields as one mechanism to promote a high level of care delivery across centers, it has been more than two decades since the last pediatric heart surgery recommendations were published in the United States. More recent guidance is lacking, and collaborative efforts involving the many disciplines engaged in caring for these children have not been undertaken to date. The present initiative brings together professional societies spanning numerous care domains and congenital cardiac surgeons, pediatric cardiologists, nursing, and other healthcare professionals from diverse programs around the country to develop consensus recommendations for United States centers. The focus of this initial work is on pediatric heart surgery, and it is recommended that future efforts focus in detail on the adult congenital population. We describe the background, rationale, and methodology related to this collaborative effort, and recommendations put forth for Essential Care Centers (essential services necessary for any program), and Comprehensive Care Centers (services to optimize comprehensive and high-complexity care), encompassing structure, process, and outcome metrics across 14 domains.

(Ann Thorac Surg 2023;116:871-907)



Endorsed By:

Congenital Heart Surgeons' Society
Society of Thoracic Surgeons
American Association for Thoracic Surgery
American Heart Association
American College of Cardiology
American Academy of Pediatrics
Congenital Heart Public Health Consortium
Society of Pediatric Cardiovascular Nursing
Pediatric Cardiac Intensive Care Society
American Society of Extracorporeal Technology
Congenital Cardiac Anesthesia Society
Pediatric Heart Transplant Society
World Society for Pediatric and Congenital Heart Surgery

Number of times "regionalization" is used - 0
Number of times "standardization" is used – 4
-handoffs, training, care protocols

# Format of Recommendations

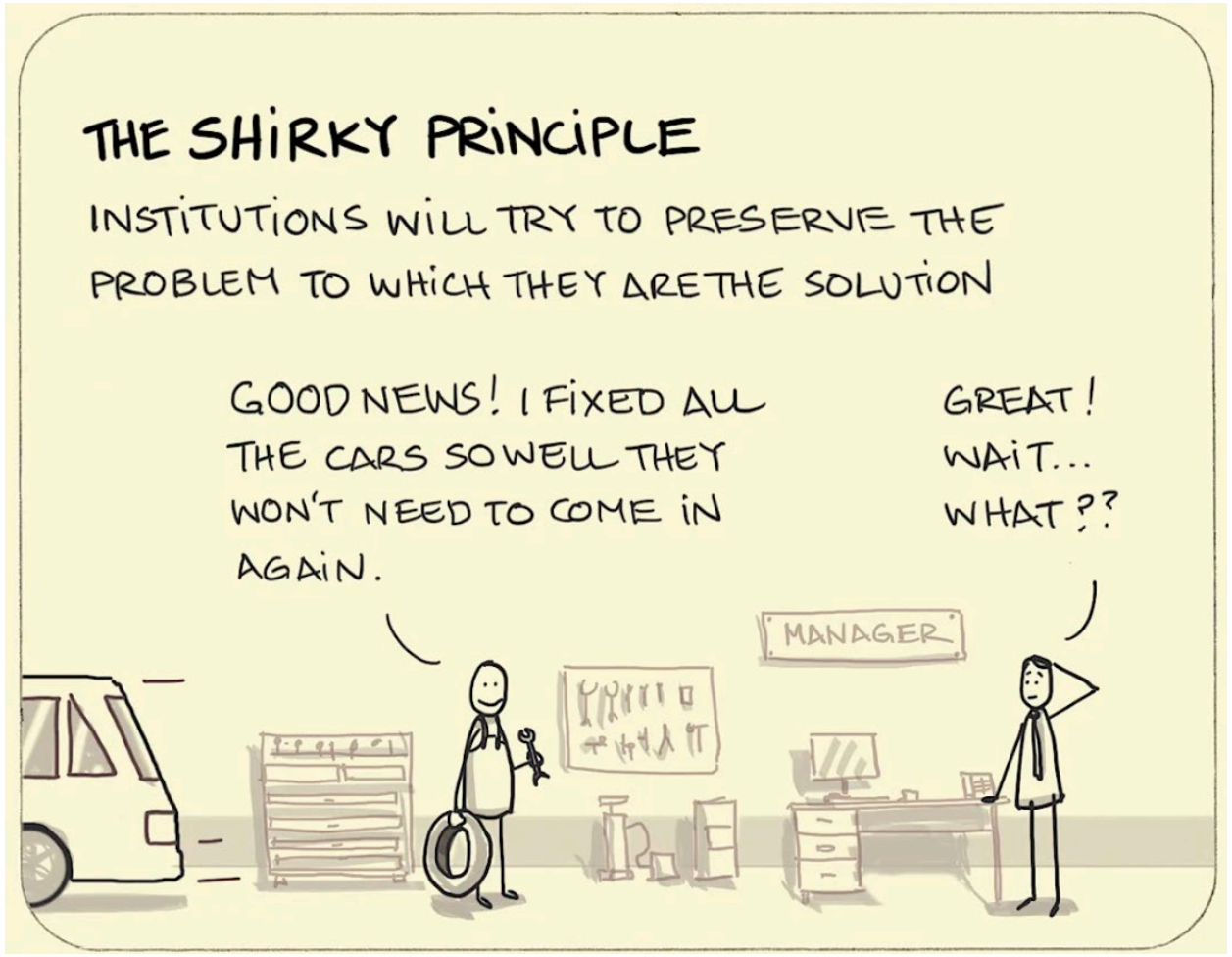
- Structure; Process; Outcomes
- Two Tiers
  - Volume & Complexity of Surgery
  - Scope of Service
  - Relationship-Affiliation
- Focus on Process-Variability Reduction
  - Failure to Rescue
  - Case Planning & Review
  - Organization/Structure Matter
  - Dependence on Systems *not* Individuals

# Selected Recommendations

| | Comprehensive | Essential |
|---|---|---|
| **Minimum Index Case Volume** | **200** | **75** |
| Complex Cases | Yes | In collaboration with CCC |
| Transplant / VAD | Yes | In collaboration with CCC |
| Number of Surgeons | >/= 3 | 2* |
| Coverage | 24/7/365 | 24/7/365 |
| Cardiac ORs | >/=2 | 1 |
| Prespecified Transfer/Collaboration | NA | Yes |
| Transparent Internal and External Outcome Reporting – STS Participation | Yes | Yes |
| **Dedicated CICU** | **Yes** | **No** |
| PC4 and PAC3 | Yes/Yes | Yes/Encouraged |
| Minimum Catheterization Volume | 150 | ? |

- Take a drink of water….interlude

# Numbers and Measurements….
# Lies, Damned Lies, and Statistics




Clay Shirky

Lawyers, statisticians, medical researchers……”more study is needed”

The New York Times

OPINION

# Why Can't Everyone Get A's?

Excellence is not a zero sum game.

June 15, 2019


Alvaro Dominguez



**By Alfie Kohn**
Mr. Kohn is the author of books on human behavior and education.

Statistician-supported and industrially-sponsored cognitive bias

The New York Times

OPINION

# Why Can't Everyone Get A's?

Excellence is not a zero sum game.

June 15, 2019

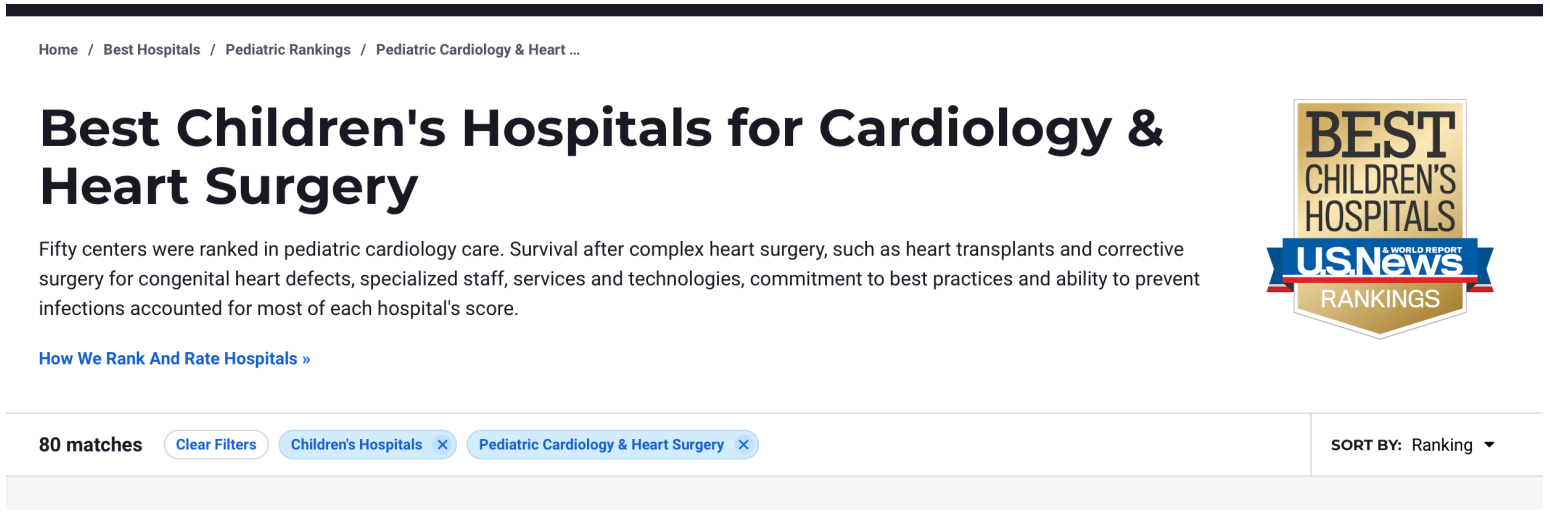

Alvaro Dominguez



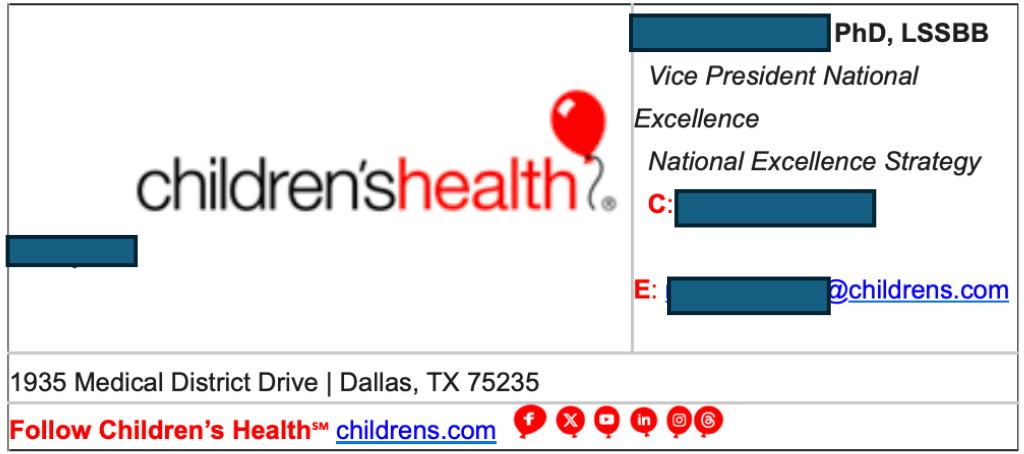
**By Alfie Kohn**
Mr. Kohn is the author of books on human behavior and education.


We can't all be here.....

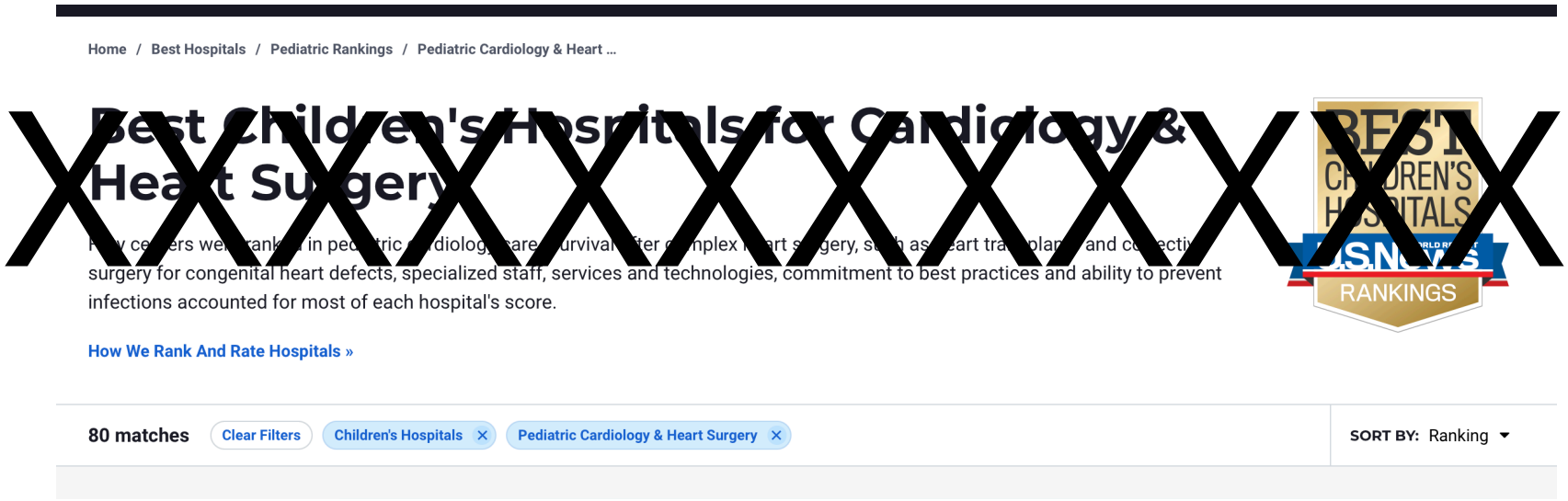
# Who Is Served By Rankings?




Hospital/Center employed “Departments of US News and World Report”



# Who Is Served By Rankings? – Not patients



The New York Times

OPINION

# Why Can't Everyone Get A's?

Excellence is not a zero sum game.

June 15, 2019

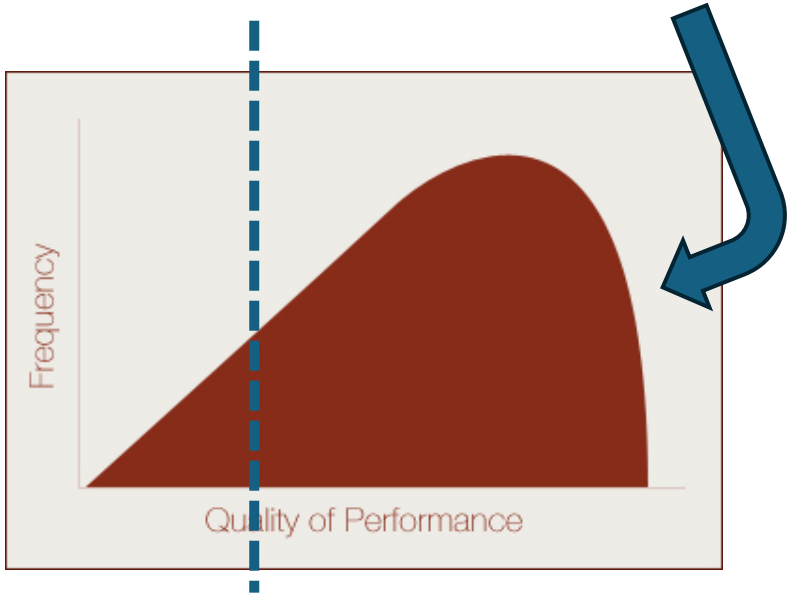

Alvaro Dominguez



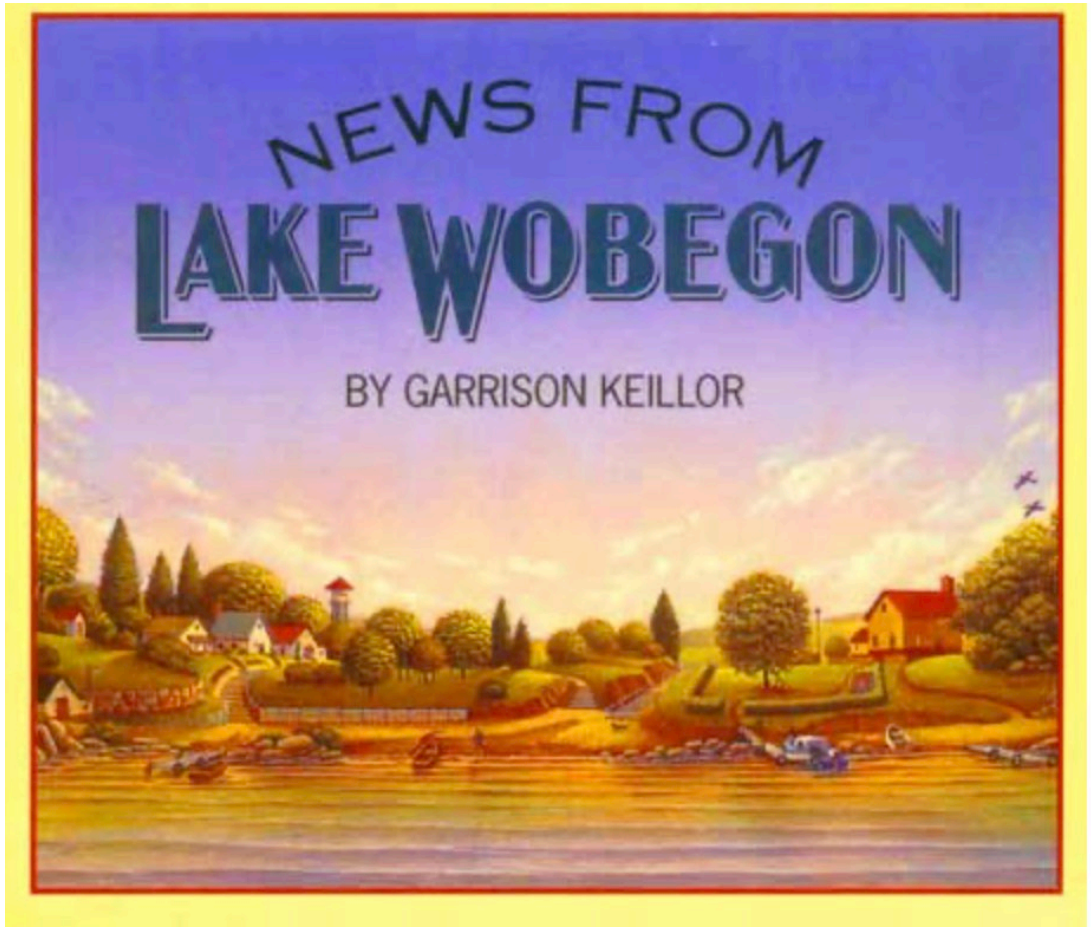
**By Alfie Kohn**
Mr. Kohn is the author of books on human behavior and education.


We can't all be here.....

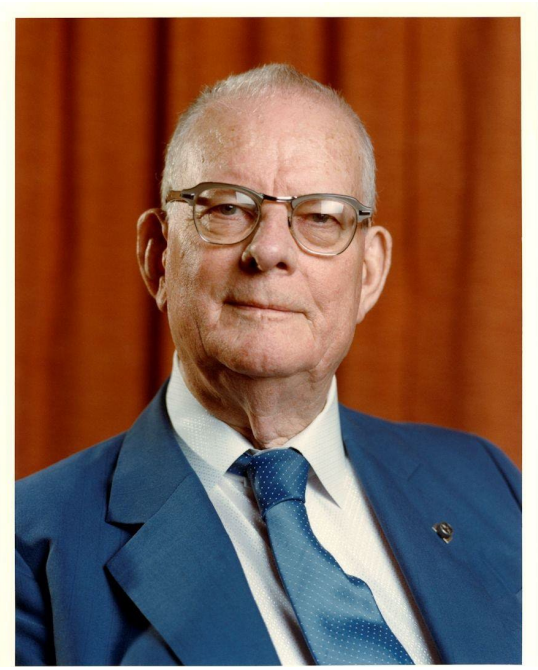
Can most of us be here?




Not Acceptable Acceptable




"Where the women are strong, the men are good- looking and all the children are above average."



“Patients and families made it clear that they did not want to travel to the best hospital. Rather they expected that we would provide excellent care, everywhere.”

Professor Martin Elliott

"It would be better if everyone worked together as a system, with the aim for everybody to win."

Dr. W. Edwards Deming

# Choosing a Center?

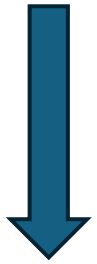

**Operative and Adjusted Operative Mortality (July 2019-June 2023)**

| Population: Neonates, Infants, Children & Adults | # / Eligible | Observed | Expected | O/E Ratio (95% CI) | Adj. Rate (95% CI) |
|---|---|---|---|---|---|
| Overall | 30 / 1390 | 2.16% | 2.63% | 0.82 (0.54, 1.09) | 2.18 (1.45, 2.9) |
| STAT Mortality Category 1 | 5 / 701 | 0.71% | 0.61% | 1.17 (0.38, 2.73) | 0.76 (0.25, 1.76) |
| STAT Mortality Category 2 | 2 / 289 | 0.69% | 1.94% | 0.36 (0.04, 1.28) | 0.69 (0.08, 2.48) |
| STAT Mortality Category 3 | 4 / 180 | 2.22% | 2.86% | 0.78 (0.21, 1.95) | 2.6 (0.71, 6.53) |
| STAT Mortality Category 4 | 7 / 149 | 4.7% | 7.56% | 0.62 (0.25, 1.25) | 4.86 (1.98, 9.77) |
| STAT Mortality Category 5 | 12 / 71 | 16.9% | 14.54% | 1.16 (0.62, 1.9) | 17.4 (9.31, 28.47) |

- 40% of deaths in STAT 5; 5% of cases
- 24% of death in entire STS; 4% of cases

| Observed | Expected | O/E Ratio (95% CI) | Adj. Rate (95% CI) |
|---|---|---|---|
| 2.16% | 2.63% | 0.82 (0.54, 1.09) | 2.18 (1.45, 2.9) |

# Measuring “Performance” in the STS Database

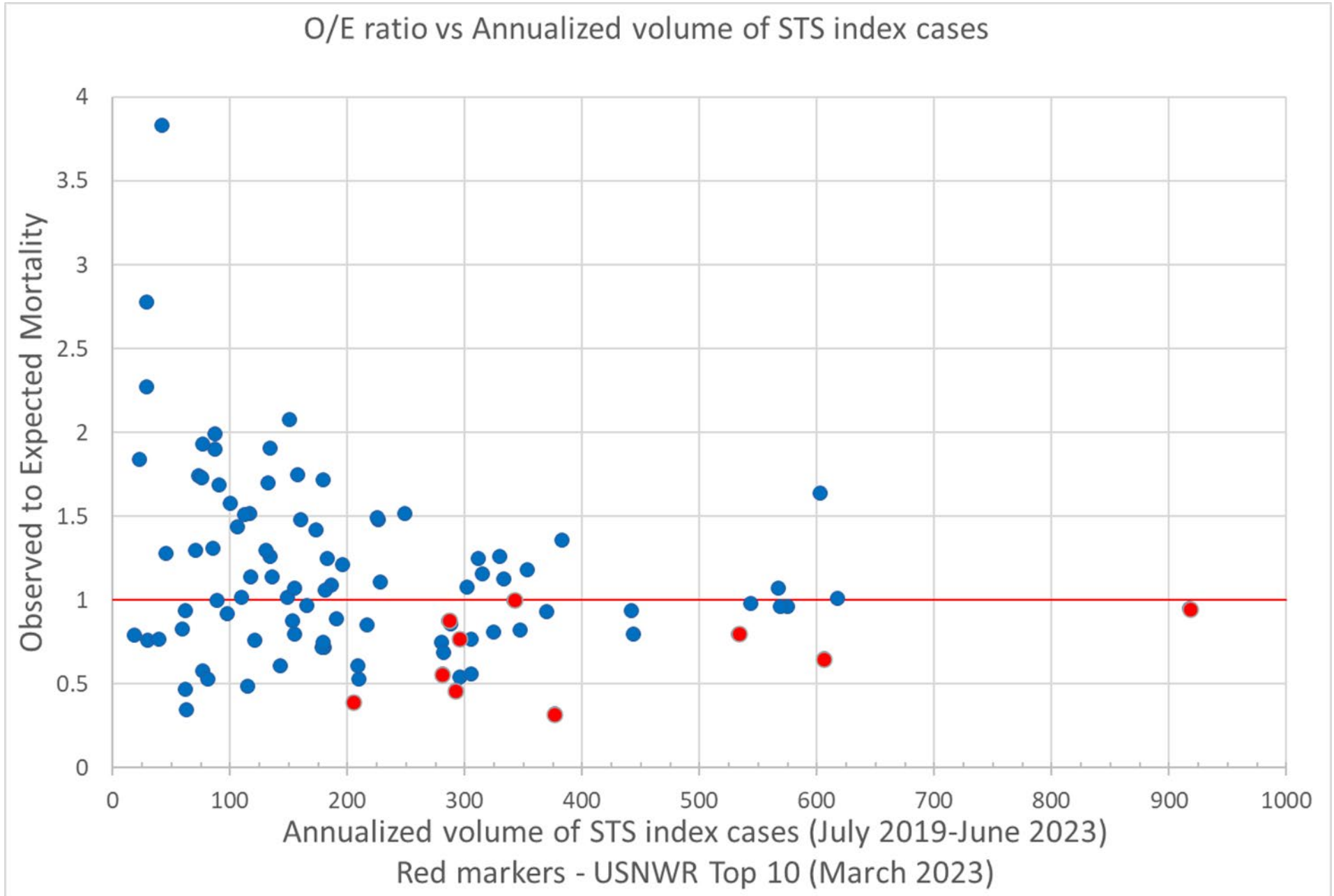


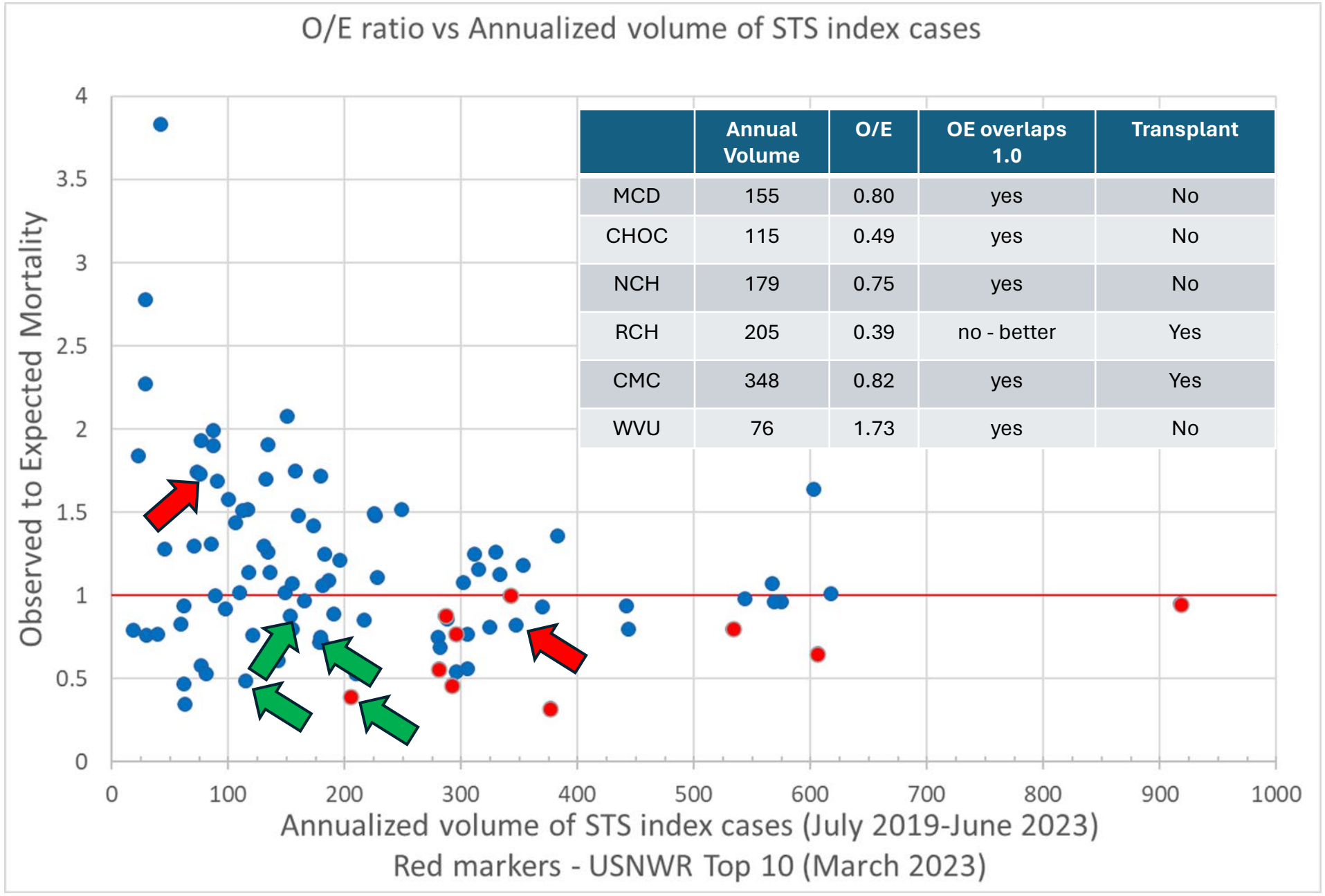
| Observed | Expected | O/E Ratio (95% CI) | Adj. Rate (95% CI) |
|---|---|---|---|
| 2.16% | 2.63% | 0.82 (0.54, 1.09) | 2.18 (1.45, 2.9) |

# The Confidence Interval – an Ally and an Enemy

- How sure are we that our point estimate is a true reflection?

- For small n measurements, the confidence interval is very wide
  - This gives cover (a place to hide)


O/E ratio vs Annualized volume of STS index cases
Observed to Expected Mortality
0
0.5
1
1.5
2
2.5
3
3.5
4
0
100
200
300
400
500
600
700
800
900
1000
Annualized volume of STS index cases (July 2019-June 2023)
Red markers - USNWR Top 10 (March 2023)




| | Annual Volume | O/E | OE overlaps 1.0 | Transplant |
|---|---|---|---|---|
| MCD | 155 | 0.80 | yes | No |
| CHOC | 115 | 0.49 | yes | No |
| NCH | 179 | 0.75 | yes | No |
| RCH | 205 | 0.39 | no - better | Yes |
| CMC | 348 | 0.82 | yes | Yes |
| WVU | 76 | 1.73 | yes | No |

# Observed to Expected Mortality by Size Category
# All Cases

| | **< 75 Cases** | **75-200 Cases** | **200-400 Cases** | **>400 Cases** |
|---|---|---|---|---|
| O:E Ratio > 1 | 8 | 29 | 10 | 2 |
| O:E Ratio =/<1 | 7 | 14 | 18 | 9 |

# Observed to Expected Mortality by Size Category
## **STAT 5 Cases**

| | **< 75 Cases** | **75-200 Cases** | **200-400 Cases** | **>400 Cases** |
|---|---|---|---|---|
| O:E Ratio > 1 | 5 | 25 | 10 | 4 |
| O:E Ratio =/<1 | 0 | 17 | 17 | 7 |

CONGENITAL HEART SURGERY:

*The Annals of Thoracic Surgery* CME Program is located online at http://www.annalsthoracicsurgery.org/cme/home. To take the CME activity related to this article, you must have either an STS member or an individual non-member subscription to the journal.

# Contemporary Relationship Between Hospital Volume and Outcomes in Congenital Heart Surgery



Karl F. Welke, MD, MS,[1] Tara Karamlou, MD, MSc,[2] Sean M. O'Brien, PhD,[3] Joseph A. Dearani, MD,[4] James S. Tweddell, MD,[5] S. Ram Kumar, MD, PhD,[6,7] Jennifer C. Romano, MD, MS,[8,9] Carl L. Backer, MD,[10,11] and Sara K. Pasquali, MD, MHS[12]

**ABSTRACT**

**BACKGROUND** Studies examining the volume-outcome relationship in congenital heart surgery (CHS) are more than a decade old. Since then, mortality has declined, and case-mix adjustment has evolved. We determined the current relationship between hospital CHS volume and outcomes.

**METHODS** Patients aged ≤18 years undergoing index operations in The Society of Thoracic Surgeons-Congenital Heart Surgery Database (2017-2020) were included. Associations between annual hospital volume and case-mix–adjusted operative mortality, major complications, failure to rescue (FTR), and postoperative length of stay (PLOS) were assessed using Bayesian hierarchical models, overall, by The Society of Thoracic Surgeons-European Association for Cardio-Thoracic Surgery (STAT) category, and for the Norwood procedure.

**RESULTS** Across 101 centers (76,714 index operations), median annual volume was 144 operations/y. Operative mortality was 2.7%. Lower-volume hospitals had higher mortality, with an apparent transition zone at ~190 operations/y (95% credible interval [CrI], 115-450 operations/y), below which a sustained uptick in the estimated odds of death occurred. Odds of death compared with a 450 operations/y reference were 50 operations/y (odds ratio [OR], 1.84; 95% CrI, 1.41-2.37), 100 operations/y (OR, 1.37; 95% CrI, 1.08-1.71), 200 operations/y (OR, 0.92; 95% CrI, 0.1-1.18), 300 operations/y (OR, 0.89; 95% CrI, 0.76-1.04). The volume-outcome effect was more apparent for STAT 4 to 5 than STAT 1 to 3 operations. In the overall cohort, PLOS and complications were similar across hospital volumes, whereas FTR rates were higher at lower-volume hospitals. Lower-volume hospitals had worse outcomes after the Norwood procedure, most notably mortality and FTR.

**CONCLUSIONS** Hospital volume is associated with mortality and FTR after CHS. The relationship is strongest for high-risk operations. These data can inform ongoing initiatives to improve CHS care.

(Ann Thorac Surg 2023;116:1233-40)

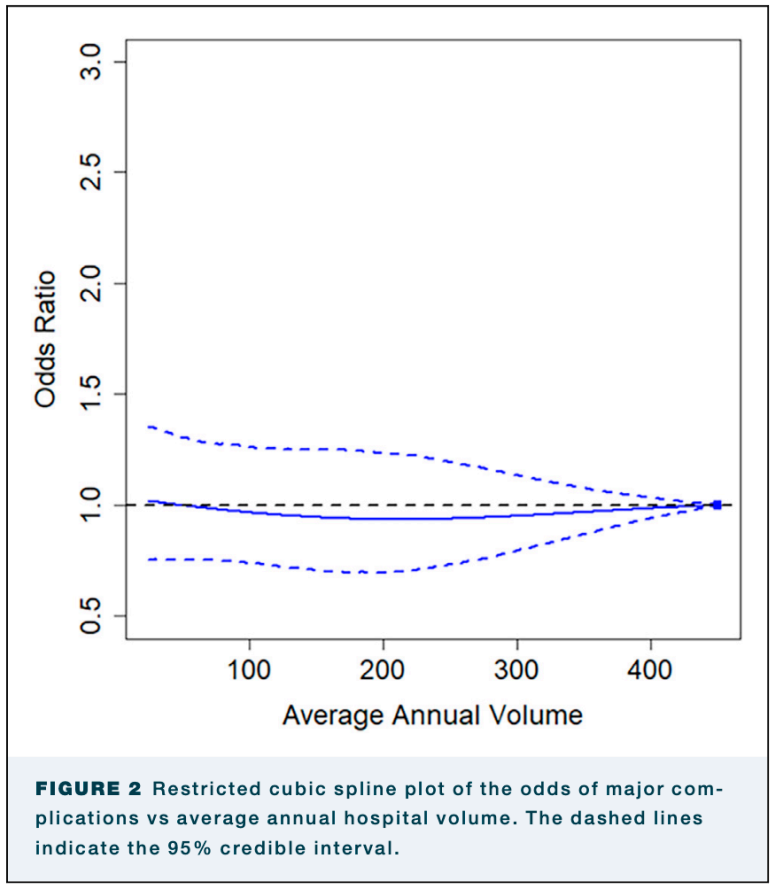



**FIGURE 2** Restricted cubic spline plot of the odds of major complications vs average annual hospital volume. The dashed lines indicate the 95% credible interval.

Complications

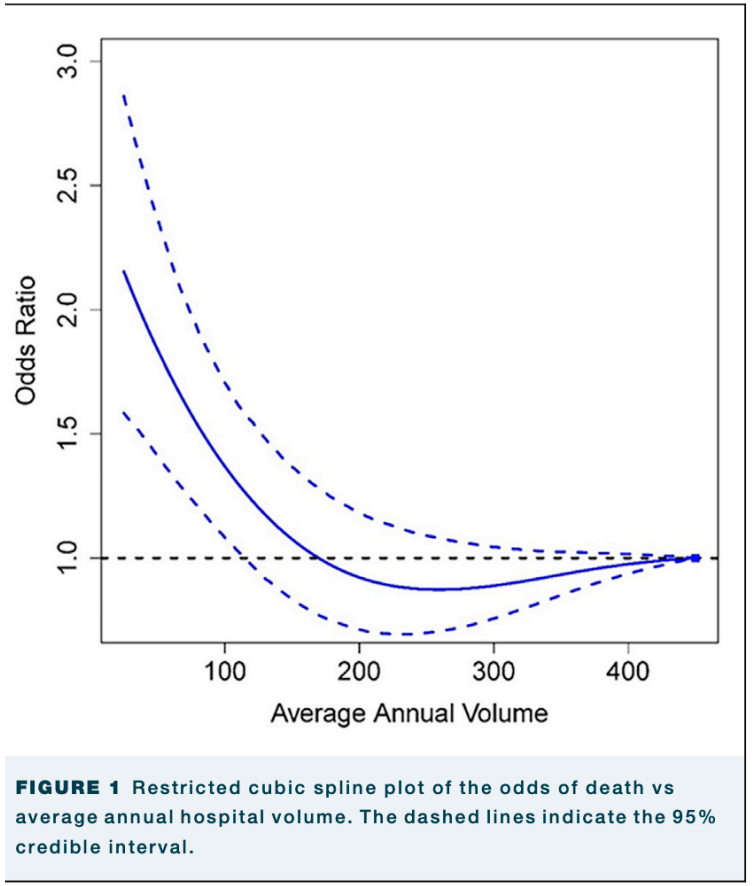



**FIGURE 1** Restricted cubic spline plot of the odds of death vs average annual hospital volume. The dashed lines indicate the 95% credible interval.

Mortality

# A Protest Appears…

# Specious Reasoning

- **Opinions Without Evidence**
- **Straw Man**
- **Selective Argument**
- **Flawed Premise**
- **Circular Logic**
- **Virtue Signalling**

# A Straw Man Meets Selective Argument

Congenital & Pediatric: Research

JAMES S. TWEDDELL MEMORIAL PAPER FOR CONGENITAL CARDIAC SURGERY

## Volume Alone Does Not Predict Quality Outcomes in Hospitals Performing Pediatric Cardiac Surgery

Dhaval Chauhan, MD,[1] J. Hunter Mehaffey, MD, MS,[1] J. W. Awori Hayanga, MD, MPH,[1] Jai P. Udassi, MD,[2] Vinay Badhwar, MD,[1] and Christopher E. Mascio, MD[1]

**ABSTRACT**

**BACKGROUND** Lower institutional volume has been associated with inferior pediatric cardiac surgery outcomes. This study explored the variation in mortality rates among low-, mid-, and high-volume hospitals performing pediatric cardiac surgery in the United States.

**METHODS** The Kids' Inpatient Database was explored for the years 2016 and 2019. Hospitals performing only off-bypass coarctation and ventricular septal defect repair were omitted. The hospitals were divided into 3 groups by their annual case volume. Multivariable logistic regression models were fit to obtain risk-adjusted in-hospital mortality rates.

**RESULTS** A total of 25,749 operations performed by 235 hospitals were included in the study. The risk-adjusted mortality rate for the entire sample was 1.9%. There were 140 hospitals in the low-volume group, 64 hospitals in the mid-volume group, and 31 in the high-volume group. All groups had low-mortality (mortality <1.9%) and high-mortality (mortality >1.9%) hospitals. Among low-volume hospitals, 53% were low-mortality (n = 74) and 47% were high-mortality (n = 66) hospitals. Among mid-volume hospitals, 58% were low-mortality (n = 37) and 42% were high-mortality (n = 27) hospitals. Among high-volume hospitals, 68% were low-mortality (n = 21) and 32% were high-mortality (n = 10) hospitals. There was no statistically significant difference in risk-adjusted in-hospital mortality when comparing low-, mid-, and high-volume centers for 7 Society of Thoracic Surgeons benchmark procedures.

**CONCLUSIONS** This national, real-world, risk-adjusted volume outcome analysis highlights that volume alone may not be the sole arbiter to predict quality of pediatric cardiac surgery outcomes. Using case volume alone as a surrogate for quality may unfairly asperse high-performing, low-volume programs.

(Ann Thorac Surg 2024;■:■-■)



"Volume Alone Does Not Predict Quality Outcomes…in …Pediatric Cardiac Surgery"

Congenital & Pediatric: Research

JAMES S. TWEDDELL MEMORIAL PAPER FOR CONGENITAL CARDIAC SURGERY

# Volume Alone Does Not Predict Quality Outcomes in Hospitals Performing Pediatric Cardiac Surgery

Dhaval Chauhan, MD,[1] J. Hunter Mehaffey, MD, MS,[1] J. W. Awori Hayanga, MD, MPH,[1] Jai P. Udassi, MD,[2] Vinay Badhwar, MD,[1] and Christopher E. Mascio, MD[1]

**ABSTRACT**

**BACKGROUND** Lower institutional volume has been associated with inferior pediatric cardiac surgery outcomes. This study explored the variation in mortality rates among low-, mid-, and high-volume hospitals performing pediatric cardiac surgery in the United States.

**METHODS** The Kids' Inpatient Database was explored for the years 2016 and 2019. Hospitals performing only off-bypass coarctation and ventricular septal defect repair were omitted. The hospitals were divided into 3 groups by their annual case volume. Multivariable logistic regression models were fit to obtain risk-adjusted in-hospital mortality rates.

**RESULTS** A total of 25,749 operations performed by 235 hospitals were included in the study. The risk-adjusted mortality rate for the entire sample was 1.9%. There were 140 hospitals in the low-volume group, 64 hospitals in the mid-volume group, and 31 in the high-volume group. All groups had low-mortality (mortality <1.9%) and high-mortality (mortality >1.9%) hospitals. Among low-volume hospitals, 53% were low-mortality (n = 74) and 47% were high-mortality (n = 66) hospitals. Among mid-volume hospitals, 58% were low-mortality (n = 37) and 42% were high-mortality (n = 27) hospitals. Among high-volume hospitals, 68% were low-mortality (n = 21) and 32% were high-mortality (n = 10) hospitals. There was no statistically significant difference in risk-adjusted in-hospital mortality when comparing low-, mid-, and high-volume centers for 7 Society of Thoracic Surgeons benchmark procedures.

**CONCLUSIONS** This national, real-world, risk-adjusted volume outcome analysis highlights that volume alone may not be the sole arbiter to predict quality of pediatric cardiac surgery outcomes. Using case volume alone as a surrogate for quality may unfairly asperse high-performing, low-volume programs.

(Ann Thorac Surg 2024;■:■-■)



We recommend the community to ***steer away from using specific numbers as a sole metric*** and give merit to a program on the basis of the presence of a comprehensive system of care.

Congenital & Pediatric: Research

JAMES S. TWEDDELL MEMORIAL PAPER FOR CONGENITAL CARDIAC SURGERY

# Volume Alone Does Not Predict Quality Outcomes in Hospitals Performing Pediatric Cardiac Surgery

Dhaval Chauhan, MD,[1] J. Hunter Mehaffey, MD, MS,[1] J. W. Awori Hayanga, MD, MPH,[1] Jai P. Udassi, MD,[2] Vinay Badhwar, MD,[1] and Christopher E. Mascio, MD[1]

**ABSTRACT**

**BACKGROUND** Lower institutional volume has been associated with inferior pediatric cardiac surgery outcomes. This study explored the variation in mortality rates among low-, mid-, and high-volume hospitals performing pediatric cardiac surgery in the United States.

**METHODS** The Kids' Inpatient Database was explored for the years 2016 and 2019. Hospitals performing only off-bypass coarctation and ventricular septal defect repair were omitted. The hospitals were divided into 3 groups by their annual case volume. Multivariable logistic regression models were fit to obtain risk-adjusted in-hospital mortality rates.

**RESULTS** A total of 25,749 operations performed by 235 hospitals were included in the study. The risk-adjusted mortality rate for the entire sample was 1.9%. There were 140 hospitals in the low-volume group, 64 hospitals in the mid-volume group, and 31 in the high-volume group. All groups had low-mortality (mortality <1.9%) and high-mortality (mortality >1.9%) hospitals. Among low-volume hospitals, 53% were low-mortality (n = 74) and 47% were high-mortality (n = 66) hospitals. Among mid-volume hospitals, 58% were low-mortality (n = 37) and 42% were high-mortality (n = 27) hospitals. Among high-volume hospitals, 68% were low-mortality (n = 21) and 32% were high-mortality (n = 10) hospitals. There was no statistically significant difference in risk-adjusted in-hospital mortality when comparing low-, mid-, and high-volume centers for 7 Society of Thoracic Surgeons benchmark procedures.

**CONCLUSIONS** This national, real-world, risk-adjusted volume outcome analysis highlights that volume alone may not be the sole arbiter to predict quality of pediatric cardiac surgery outcomes. Using case volume alone as a surrogate for quality may unfairly asperse high-performing, low-volume programs.

(Ann Thorac Surg 2024;■:■-■)



We recommend the community to ***steer away from using specific numbers as a sole metric*** and give merit to a program on the basis of the presence of a comprehensive system of care.

**TABLE 3 Results of Multivariable Logistic Regression Model With Inpatient Mortality as Outcome of Interest**

| Variable | Odds Ratio (95% CI) | *P* Value |
|---|---|---|
| Hospital volume | | |
| High-volume | 1 | (Reference) |
| Mid-volume | 1.13 (0.91-1.41) | .273 |
| Low-volume | 1.51 (1.19-1.90) | <.001 |

Congenital & Pediatric: Research

JAMES S. TWEDDELL MEMORIAL PAPER FOR CONGENITAL CARDIAC SURGERY

# Volume Alone Does Not Predict Quality Outcomes in Hospitals Performing Pediatric Cardiac Surgery

Dhaval Chauhan, MD,[1] J. Hunter Mehaffey, MD, MS,[1] J. W. Awori Hayanga, MD, MPH,[1] Jai P. Udassi, MD,[2] Vinay Badhwar, MD,[1] and Christopher E. Mascio, MD[1]

**ABSTRACT**

**BACKGROUND** Lower institutional volume has been associated with inferior pediatric cardiac surgery outcomes. This study explored the variation in mortality rates among low-, mid-, and high-volume hospitals performing pediatric cardiac surgery in the United States.

**METHODS** The Kids' Inpatient Database was explored for the years 2016 and 2019. Hospitals performing only off-bypass coarctation and ventricular septal defect repair were omitted. The hospitals were divided into 3 groups by their annual case volume. Multivariable logistic regression models were fit to obtain risk-adjusted in-hospital mortality rates.

**RESULTS** A total of 25,749 operations performed by 235 hospitals were included in the study. The risk-adjusted mortality rate for the entire sample was 1.9%. There were 140 hospitals in the low-volume group, 64 hospitals in the mid-volume group, and 31 in the high-volume group. All groups had low-mortality (mortality <1.9%) and high-mortality (mortality >1.9%) hospitals. Among low-volume hospitals, 53% were low-mortality (n = 74) and 47% were high-mortality (n = 66) hospitals. Among mid-volume hospitals, 58% were low-mortality (n = 37) and 42% were high-mortality (n = 27) hospitals. Among high-volume hospitals, 68% were low-mortality (n = 21) and 32% were high-mortality (n = 10) hospitals. There was no statistically significant difference in risk-adjusted in-hospital mortality when comparing low-, mid-, and high-volume centers for 7 Society of Thoracic Surgeons benchmark procedures.

**CONCLUSIONS** This national, real-world, risk-adjusted volume outcome analysis highlights that volume alone may not be the sole arbiter to predict quality of pediatric cardiac surgery outcomes. Using case volume alone as a surrogate for quality may unfairly asperse high-performing, low-volume programs.

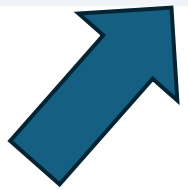
(Ann Thorac Surg 2024;■:■-■)



We recommend the community to ***steer away from using specific numbers as a sole metric*** and give merit to a program on the basis of the presence of a comprehensive system of care.

**TABLE 3 Results of Multivariable Logistic Regression Model With Inpatient Mortality as Outcome of Interest**

| Variable | Odds Ratio (95% CI) | *P* Value |
|---|---|---|
| Hospital volume | | |
| High-volume | 1 | (Reference) |
| Mid-volume | 1.13 (0.91-1.41) | .273 |
| Low-volume | 1.51 (1.19-1.90) | <.001 |



"BEWARE OF EXCEPTIONAL EXAMPLES USED TO MAKE A POINT ABOUT A WHOLE GROUP."

– HANS ROSLING

Hans Rosling, MD
1948-2017

- Volume isn’t everything (and no one said it was)
- Volume isn’t nothing

0003-4975/$36.00
https://doi.org/10.1016/j.athoracsur.2023.08.016



EXPERT CONSENSUS STATEMENT

# Recommendations for Centers Performing Pediatric Heart Surgery in the United States

Check for updates

Carl L. Backer, MD,[1] David M. Overman, MD,[2] Joseph A. Dearani, MD,[3] Jennifer C. Romano, MD, MS,[4] James S. Tweddell, MD,[1] S. Ram Kumar, MD, PhD,[5] Bradley S. Marino, MD, MPP, MSCE, MBA,[6] Emile A. Bacha, MD,[7] Robert D. B. Jaquiss, MD,[8] Ali N. Zaidi, MD,[9] Michelle Gurvitz, MD,[10] John M. Costello, MD, MPH,[11] Trudy A. Pierick, MSN, ARNP, CPNP-PC,[12] William J. Ravekes, MD,[13] James A. Reagor, MPS, CCP, FPP,[14] James D. St. Louis, MD,[15] James Spaeth, MD,[16] William T. Mahle, MD,[17] Andrew Y. Shin, MD,[18] Keila N. Lopez, MD, MPH,[19] Tara Karamlou, MD, MSc,[20] Karl F. Welke, MD, MS,[21] Roosevelt Bryant, MD,[22] S. Adil Husain, MD,[23] Jonathan M. Chen, MD,[24] Aditya Kaza, MD, MBA,[25] Winfield J. Wells, MD,[5] Andrew C. Glatz, MD, MSCE,[26] Mitchell I. Cohen, MD,[27] Doff B. McElhinney, MD,[18] David A. Parra, MD,[28] and Sara K. Pasquali, MD, MHS[29]

Care and outcomes for the more than 40,000 patients undergoing pediatric and congenital heart surgery in the United States annually are known to vary widely. While consensus recommendations have been published across numerous fields as one mechanism to promote a high level of care delivery across centers, it has been more than two decades since the last pediatric heart surgery recommendations were published in the United States. More recent guidance is lacking, and collaborative efforts involving the many disciplines engaged in caring for these children have not been undertaken to date. The present initiative brings together professional societies spanning numerous care domains and congenital cardiac surgeons, pediatric cardiologists, nursing, and other healthcare professionals from diverse programs around the country to develop consensus recommendations for United States centers. The focus of this initial work is on pediatric heart surgery, and it is recommended that future efforts focus in detail on the adult congenital population. We describe the background, rationale, and methodology related to this collaborative effort, and recommendations put forth for Essential Care Centers (essential services necessary for any program), and Comprehensive Care Centers (services to optimize comprehensive and high-complexity care), encompassing structure, process, and outcome metrics across 14 domains.

(Ann Thorac Surg 2023;116:871-907)



Endorsed By:

Congenital Heart Surgeons' Society
Society of Thoracic Surgeons
American Association for Thoracic Surgery
American Heart Association
American College of Cardiology
American Academy of Pediatrics
Congenital Heart Public Health Consortium
Society of Pediatric Cardiovascular Nursing
Pediatric Cardiac Intensive Care Society
American Society of Extracorporeal Technology
Congenital Cardiac Anesthesia Society
Pediatric Heart Transplant Society
World Society for Pediatric and Congenital Heart Surgery

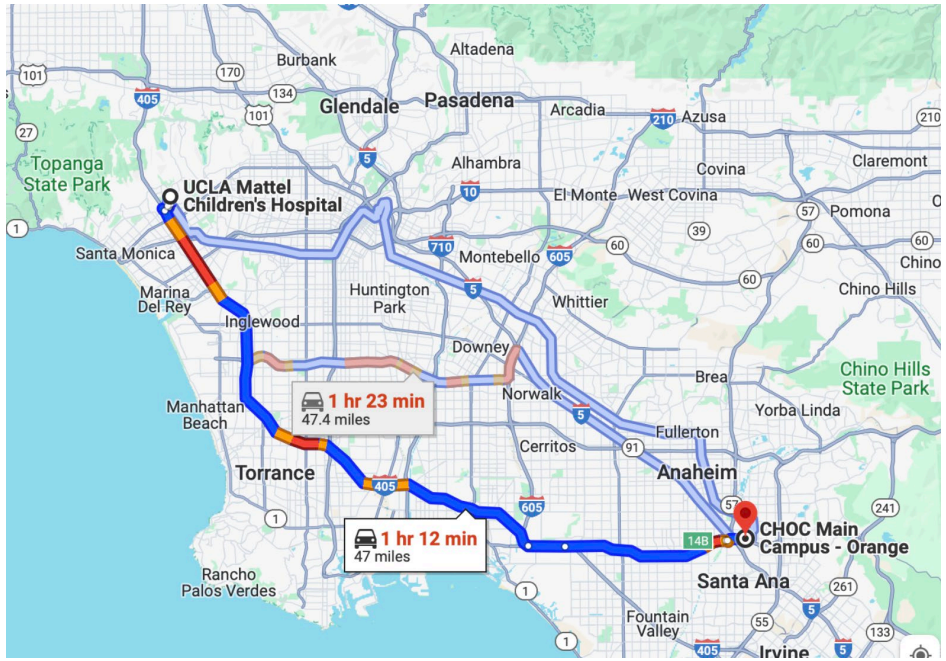
# Format of Recommendations

- Structure; Process; Outcomes
- Two Tiers
  - Volume & Complexity of Surgery
  - Scope of Service
  - Relationship-Affiliation
- Focus on Process-Variability Reduction
  - Failure to Rescue
  - Case Planning & Review
  - Organization/Structure Matter
  - Dependence on Systems *not* Individuals

# Some Things That Might Work…

- Affiliation
- (A Little) Regionalization
- Collaborative Learning (Cardiac Networks United etc.)
- Actual and Virtual Site Visits/Verification

# Affiliation




**Operative and Adjusted Operative Mortality (July 2019-June 2023)**

| Population: Neonates, Infants, Children & Adults | # / Eligible | Observed | Expected | O/E Ratio (95% CI) | Adj. Rate (95% CI) |
|---|---|---|---|---|---|
| Overall | 3 / 460 | 0.65% | 1.33% | 0.49 (0, 1) | 1.3 (0, 2.66) |
| STAT Mortality Category 1 | 0 / 271 | 0% | 0.47% | 0 (0, 2.88) | 0 (0, 1.86) |
| STAT Mortality Category 2 | 2 / 102 | 1.96% | 1.3% | 1.5 (0.18, 5.3) | 2.92 (0.36, 10.29) |
| STAT Mortality Category 3 | 0 / 34 | 0% | 1.94% | 0 (0, 5.3) | 0 (0, 17.74) |
| STAT Mortality Category 4 | 1 / 51 | 1.96% | 5.27% | 0.37 (0.01, 1.98) | 2.91 (0.07, 15.5) |
| STAT Mortality Category 5 | 0 / 2 | 0% | 8.69% | 0 (0, 9.69) | 0 (0, 100) |

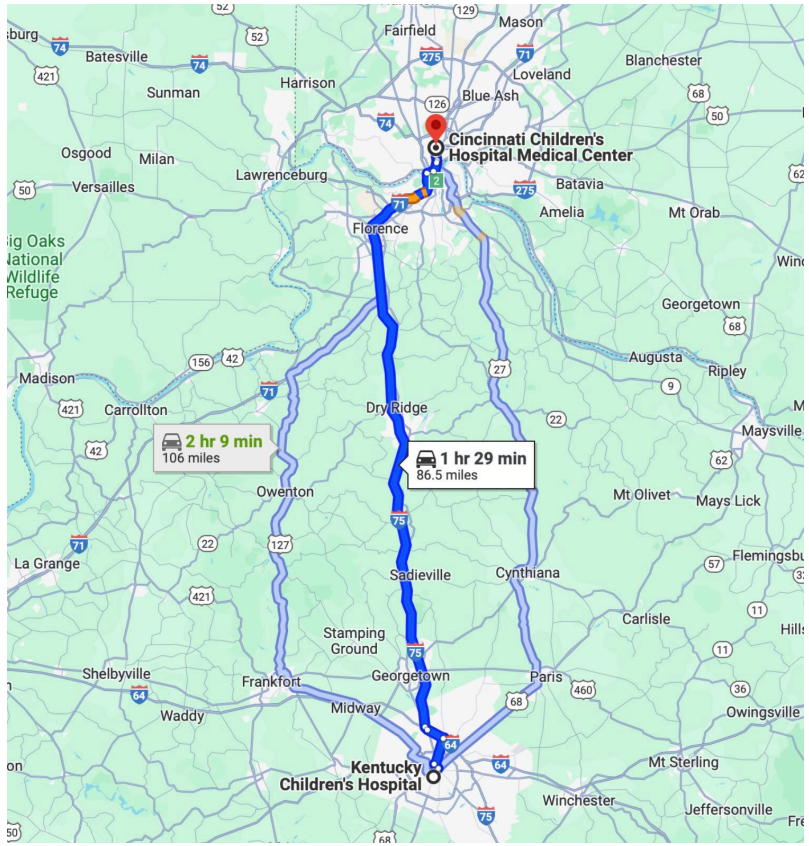
CHOC STAT 4 51/460 = 11% STAT 5 2/460 = 0.4%

**Operative and Adjusted Operative Mortality (July 2019-June 2023)**

| Population: Neonates, Infants, Children & Adults | # / Eligible | Observed | Expected | O/E Ratio (95% CI) | Adj. Rate (95% CI) |
|---|---|---|---|---|---|
| Overall | 26 / 1222 | 2.13% | 2.77% | 0.77 (0.52, 1.05) | 2.04 (1.37, 2.79) |
| STAT Mortality Category 1 | 5 / 536 | 0.93% | 0.7% | 1.33 (0.43, 3.08) | 0.86 (0.28, 1.99) |
| STAT Mortality Category 2 | 4 / 346 | 1.16% | 1.7% | 0.68 (0.19, 1.72) | 1.32 (0.36, 3.35) |
| STAT Mortality Category 3 | 4 / 119 | 3.36% | 3.16% | 1.06 (0.29, 2.65) | 3.56 (0.98, 8.87) |
| STAT Mortality Category 4 | 9 / 164 | 5.49% | 7.54% | 0.73 (0.34, 1.35) | 5.69 (2.64, 10.54) |
| STAT Mortality Category 5 | 4 / 57 | 7.02% | 14.16% | 0.5 (0.14, 1.2) | 7.42 (2.06, 17.98) |

UCLA. STAT 4 164/1222 = 13% STAT 5 57/1222 = 4.6%

# Affiliation




**Operative and Adjusted Operative Mortality (July 2019-June 2023)**

| Population: Neonates, Infants, Children & Adults | # / Eligible | Observed | Expected | O/E Ratio (95% CI) | Adj. Rate (95% CI) |
|---|---|---|---|---|---|
| Overall | 1 / 250 | 0.4% | 1.16% | 0.35 (0, 1.27) | 0.92 (0, 3.39) |
| STAT Mortality Category 1 | 0 / 174 | 0% | 0.56% | 0 (0, 3.76) | 0 (0, 2.43) |
| STAT Mortality Category 2 | 0 / 43 | 0% | 1.51% | 0 (0, 5.45) | 0 (0, 10.58) |
| STAT Mortality Category 3 | 1 / 17 | 5.88% | 2.97% | 1.98 (0.05, 9.66) | 6.63 (0.17, 32.31) |
| STAT Mortality Category 4 | 0 / 16 | 0% | 4.83% | 0 (0, 4.26) | 0 (0, 33.34) |
| STAT Mortality Category 5 | 0 / 0 | 0% | 0% | 0 (0, 0) | 0 (0, 0) |

UKCH STAT 4 16/250 = 6% STAT 5 0/250 = 0%

**Operative and Adjusted Operative Mortality (July 2019-June 2023)**

| Population: Neonates, Infants, Children & Adults | # / Eligible | Observed | Expected | O/E Ratio (95% CI) | Adj. Rate (95% CI) |
|---|---|---|---|---|---|
| Overall | 41 / 1368 | 3% | 3% | 1 (0.73, 1.28) | 2.65 (1.94, 3.41) |
| STAT Mortality Category 1 | 2 / 582 | 0.34% | 0.75% | 0.46 (0.06, 1.65) | 0.3 (0.04, 1.07) |
| STAT Mortality Category 2 | 8 / 343 | 2.33% | 1.87% | 1.24 (0.54, 2.42) | 2.42 (1.05, 4.71) |
| STAT Mortality Category 3 | 4 / 189 | 2.12% | 3.34% | 0.63 (0.17, 1.6) | 2.12 (0.58, 5.33) |
| STAT Mortality Category 4 | 17 / 174 | 9.77% | 8.12% | 1.2 (0.71, 1.87) | 9.41 (5.58, 14.63) |
| STAT Mortality Category 5 | 10 / 80 | 12.5% | 12.3% | 1.02 (0.5, 1.77) | 15.21 (7.5, 26.51) |

CCHMC STAT 4 174/1368 = 13% STAT 5 80/1368 = 6%

# Regionalization

# Regionalization Exists Already, Albeit Imperfectly

- Patients are referred for transplant to regional  centers, sometimes
- Patients are referred for certain rare diagnoses and procedures
  - TOF/MAPCA
  - Ebstein anomaly
  - Fetal intervention
- Cooperative arrangements
  - Cincinnati/UK; Columbia/Cornell; UCLA/CHOC; UCSF/Oakland; Duke/ECU; Mayo/Children's Minnesota
  - Not always successful – UTSW/Dell; others; 2 pediatric transplant programs in Houston; etc.
  - Too early to tell – Duke/UNC

# Reasons to Oppose Regionalization - Legitimate

- Potential for ”reduced access” (expense, time, insurance coverage, family support, coherent/continuous follow-up)?
- Logistical complexity (sharing of images/records/consultation)
- Capacity constraints at existing facilities
- Feasibility – financial, logistical, political, bureaucratic obstacles

# Reasons to Oppose Regionalization - Other

- Cardiac care is profitable – Tens/hundreds of millions of $/yr
- Cardiac care is important for education – UGME/GME
- Cardiac care provides halo effect – infrastructure
- Cardiac care is prestigious – medical school dean, CEO

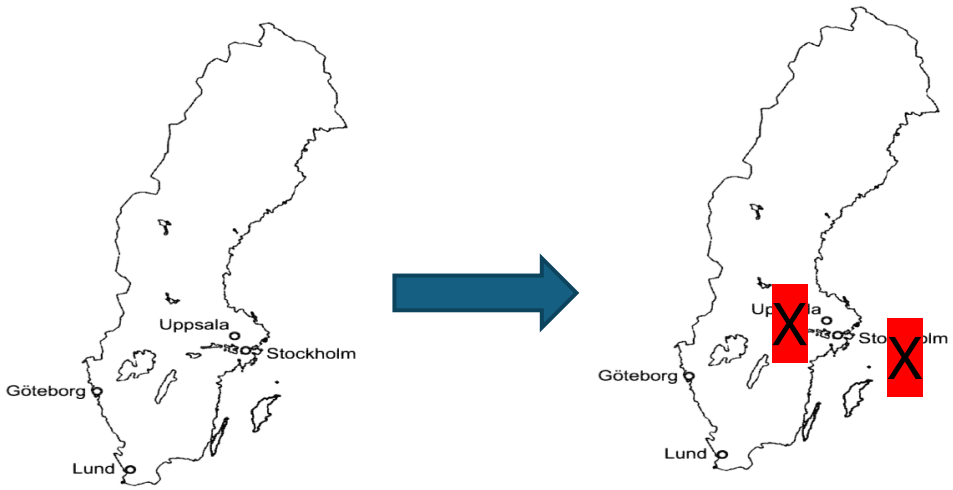
# Reasons to Support Regionalization

- **Improved outcomes = lives saved**
- **Faster improvement of care/better clinical research with larger n**
- Economic efficiency
- Better education for specialists

# Is Regionalization Effective and Feasible?

- Sweden – unequivocal yes
- Canada – unequivocal yes
- UK/Britain – maybe/likely

# Sweden – “Voluntary” Regionalization



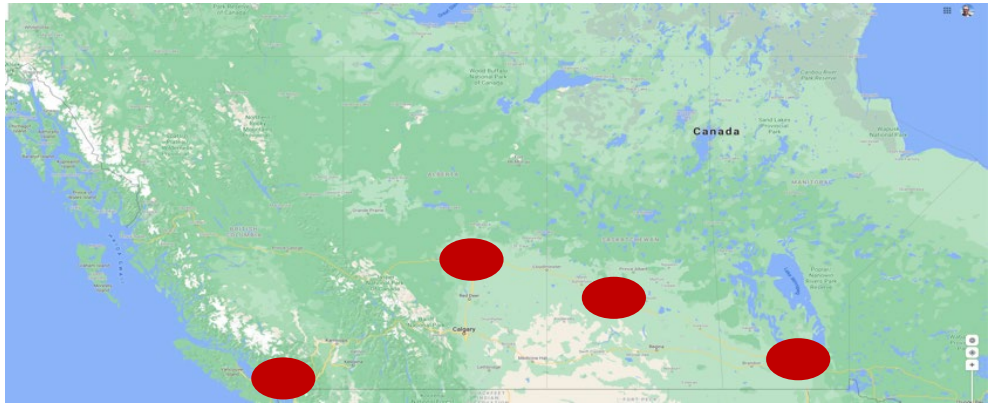

Jens Johansson Ramgren, MD

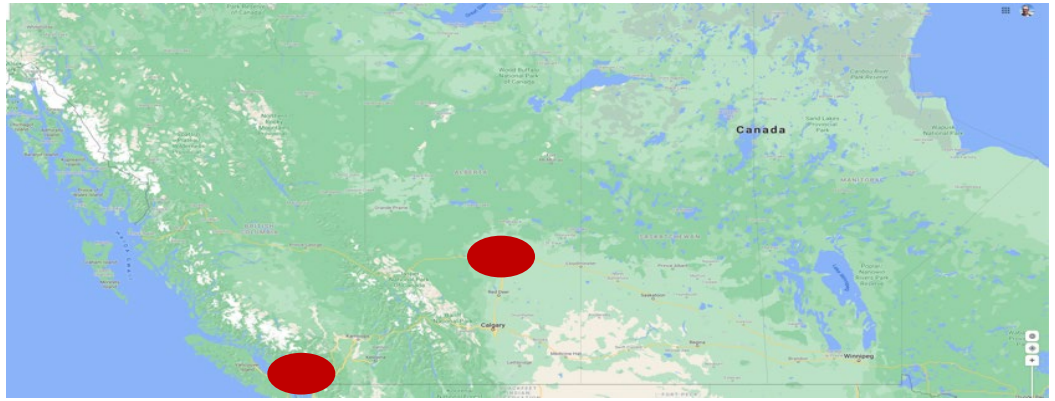
"My conviction is that centralization has been decisive for the good results we have been able to show.”

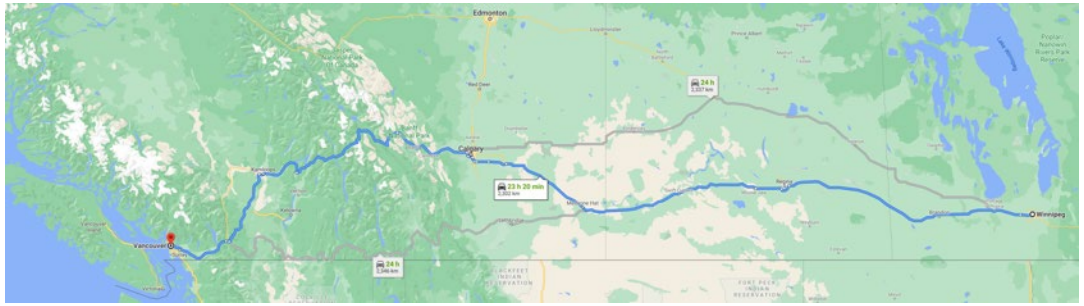
| | 1988-1991 | 1995-1997 | 2010-2019 |
|---|---|---|---|
| Op Mortality | 9.5% | 1.9% | 0.6% |

# Regionalization in Western Canada – Access

## Is “Access” A Virtue-Signalling Argument?



| | Population 2020 | Land area (km²) | Population density (per km²) |
|---|---|---|---|
| British Columbia | 5,120,184 | 922,503.01 | 5.0 |
| Alberta | 4,428,247 | 640,330.46 | 6.4 |
| Manitoba | 1,379,121 | 552,370.99 | 2.3 |
| Saskatchewan | 1,181,987 | 588,243.54 | 1.9 |

Vancouver ← 1450 miles → Winnipeg

| | |
|---|---|
| Automobile | 24 hours |
| Train | 2. 5 days |
| Flight | 3 hours |


| | Western Canadian Children's Heart Network |
|---|---|
| Total Population | 11,900,000 |
| Congenital Heart Surgical Centers | 2 |
| Congenital Heart Centers | 5 |
| Total Cases/yr | 620 |
| Cases/yr/center | 310 |
| Operative Mortality | 1.7% |

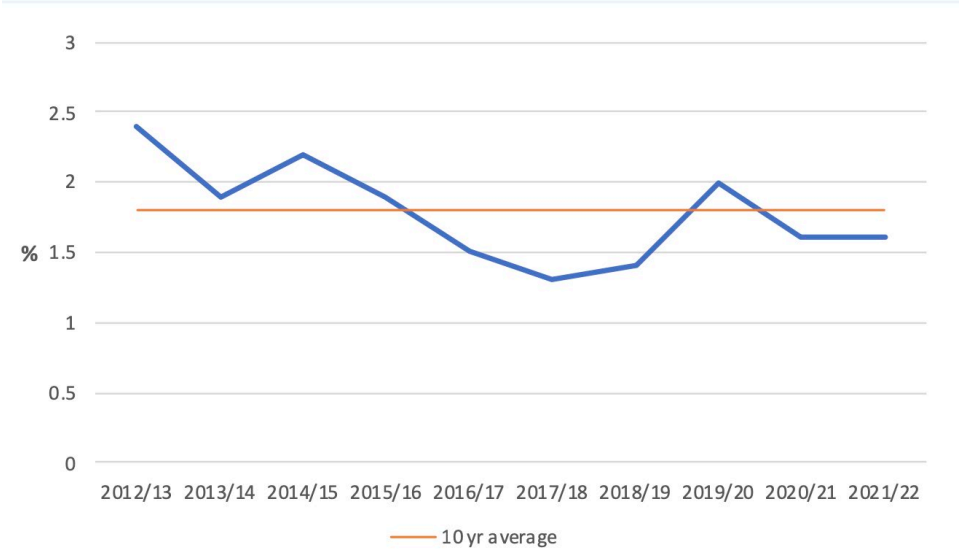
NHS England

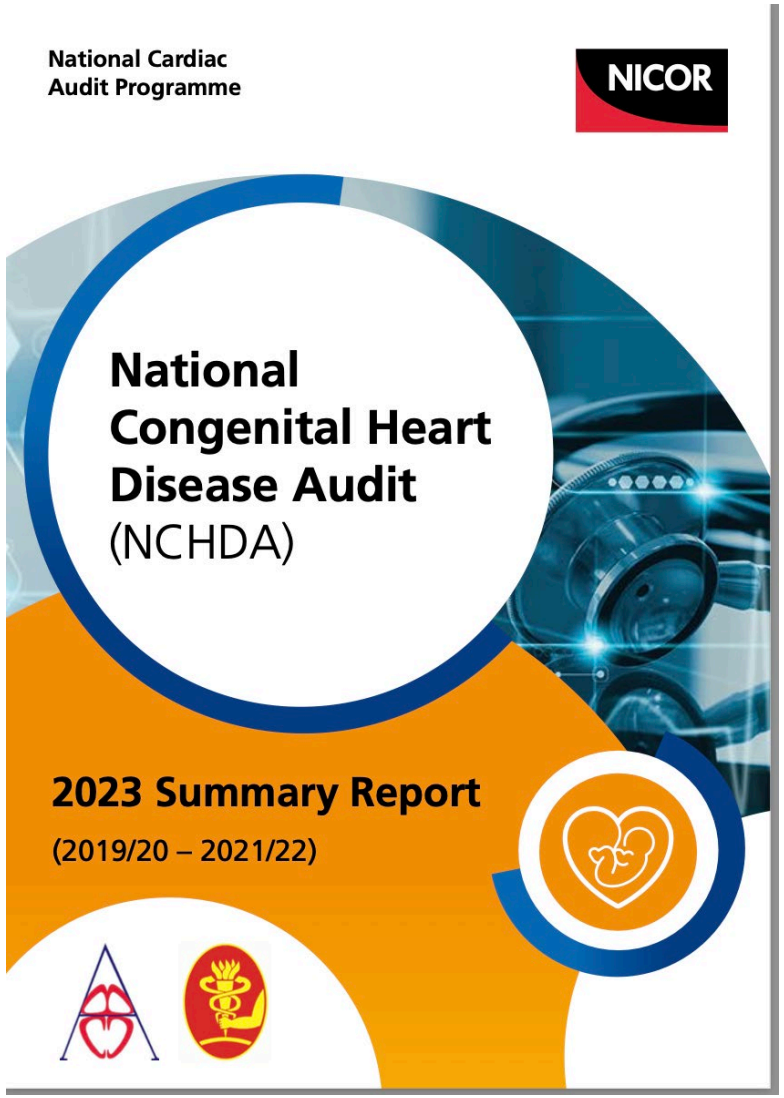
# UK- NHS Standards for Surgical Centres

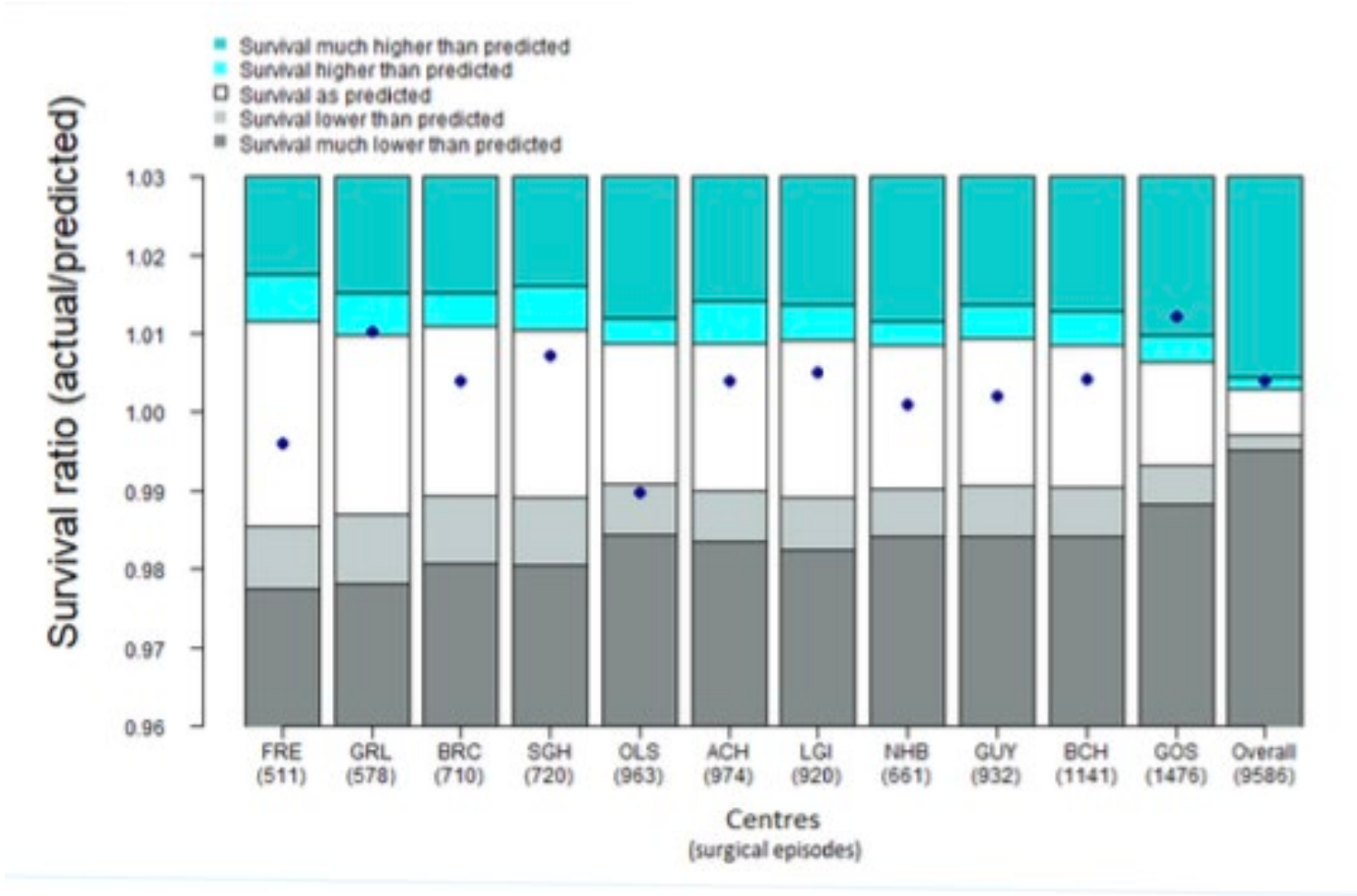
**Congenital Heart Disease: Draft Standards and Service Specifications for consultation**

- Must have minimum of 4 WTE surgeons
- Must provide 24/7 surgical care
- Surgeons operate together on complex cases.
- Each surgeon must perform > 125 operations/year

Reduction from 11 to 7 centres - ***blocked by lawsuits***

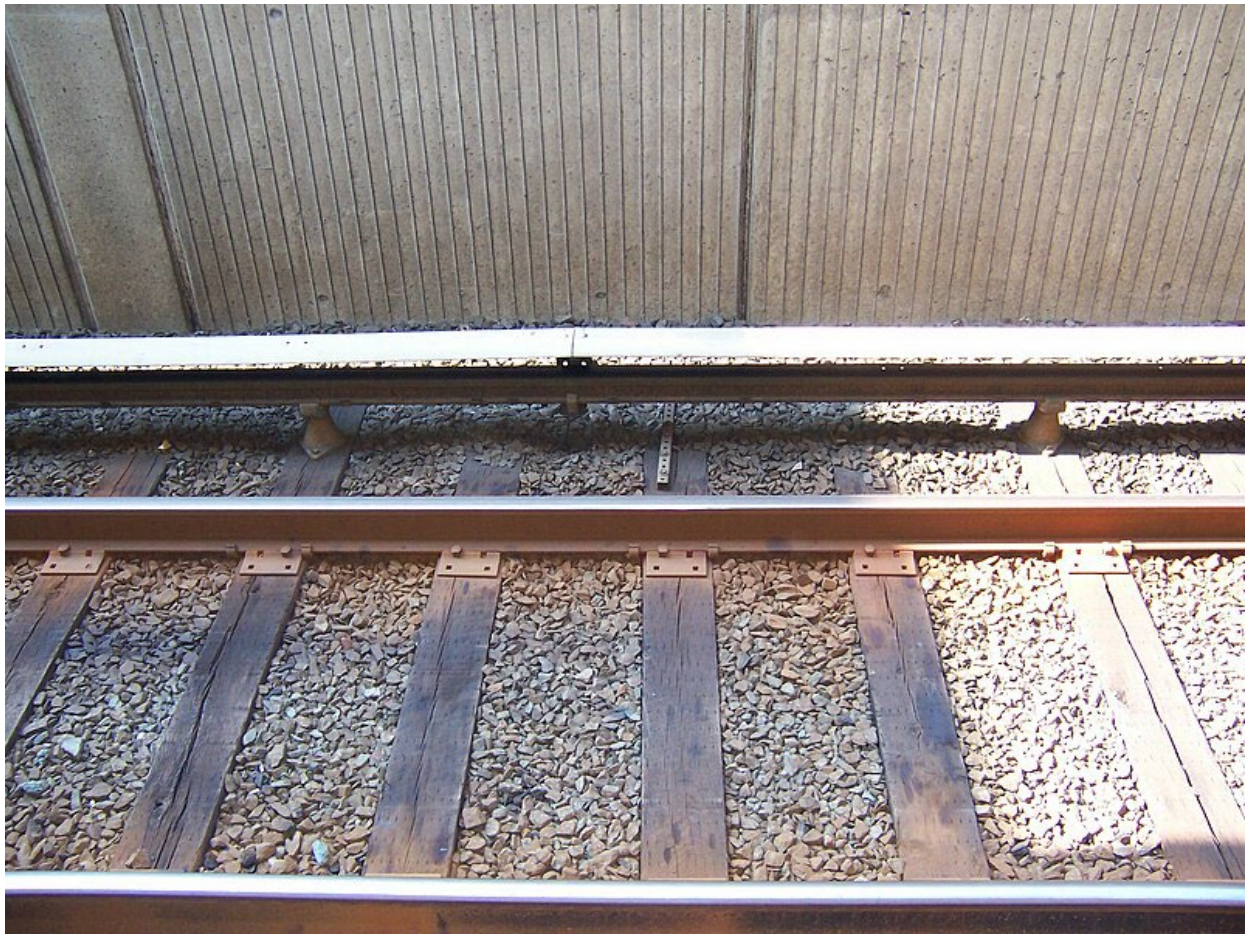




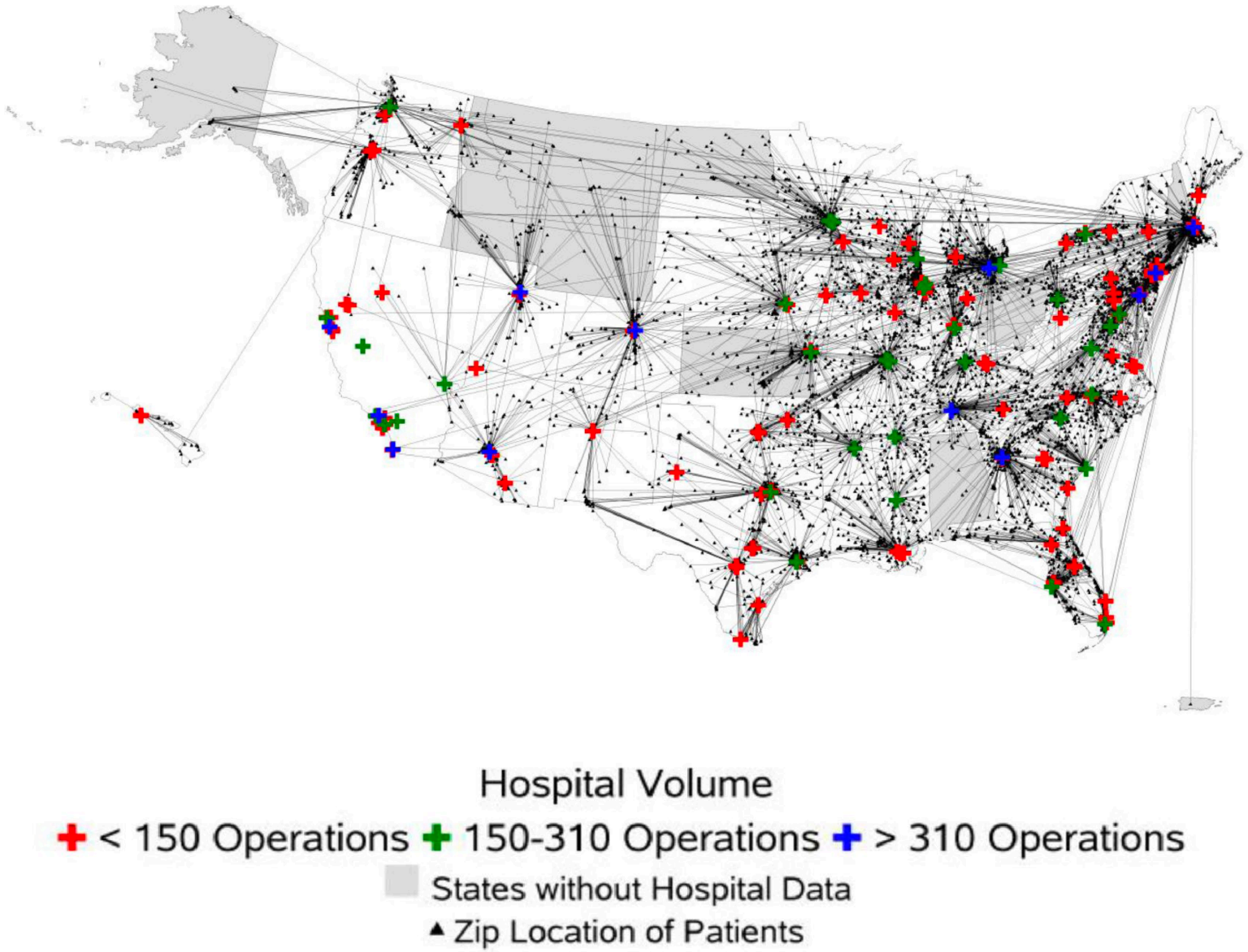




- ”Vastly superior to STS reports and transparent/publicly available” – speaker’s opinion
- ***<u>Note the number of programs which are “underperforming”…..</u>***

# Regionalization in the US?



# The Geography of US Congenital Heart Surgery



# An Ideal World -

CONGENITAL HEART

## Theoretical Model for Delivery of Congenital Heart Surgery in the United States

Karl F. Welke, MD, MS, Sara K. Pasquali, MD, MHS, Paul Lin, MS, Carl L. Backer, MD, David M. Overman, MD, Jennifer C. Romano, MD, MS, and Tara Karamlou, MD, MSc

Division of Congenital Cardiothoracic Surgery, Levine Children's Hospital/Atrium Health, Charlotte, North Carolina; Division of Pediatric Cardiology, Department of Pediatrics, University of Michigan C. S. Mott Children's Hospital, Ann Arbor, Michigan; Institute for Healthcare Policy and Innovation, University of Michigan Medical School, Ann Arbor, Michigan; Division of Cardiovascular-Thoracic Surgery, Ann and Robert H. Lurie Children's Hospital of Chicago, Northwestern University Feinberg School of Medicine, Chicago, Illinois; Division of Cardiovascular Surgery, The Children's Heart Clinic, Children's Hospitals and Clinics of Minnesota, Minneapolis, Minnesota; Department of Cardiac Surgery, University of Michigan C. S. Mott Children's Hospital, Ann Arbor, Michigan; and Division of Pediatric Cardiac Surgery and the Heart and Vascular Institute, The Cleveland Clinic, Cleveland, Ohio

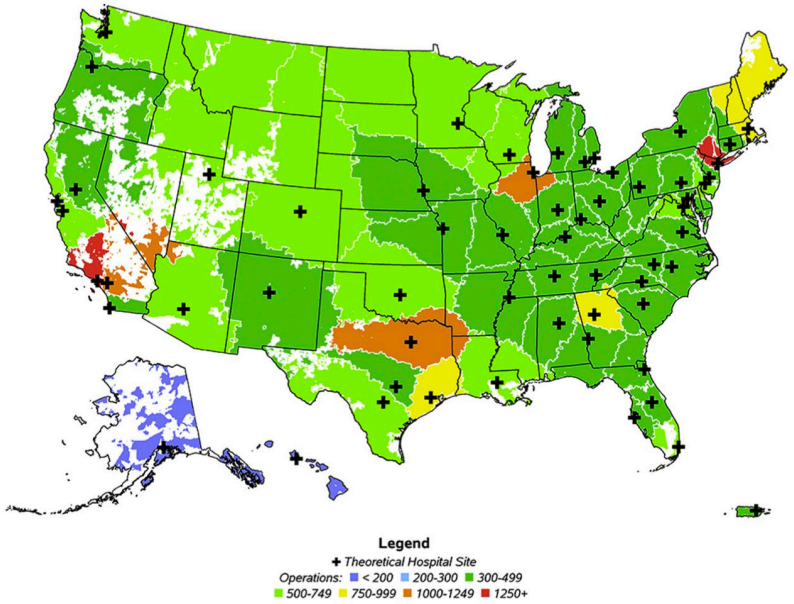
*Background.* Over 150 hospitals perform congenital heart surgery (CHS) in the United States. Many hospitals are close together, with a median patient travel distance of 38.5 miles. We began with a theoretical blank slate and used objective methodology guided by population density and volume thresholds to estimate the optimal number and locations of hospitals to provide CHS in the United States.

*Methods.* Guided by published data, we estimated the number of CHS operations in the United States in to be 32,500 per year. We distributed patients geographically based on population density. Metropolitan Statistical Areas (population centers and surrounding areas with close economic/social ties) were used as potential hospital locations. Patients were assigned to the closest hospital location such that all hospitals had a CHS volume of ≥300 operations.

*Results.* We estimated 57 hospitals could serve the contiguous United States. Median theoretical hospital volume after regionalization was 451 operations (interquartile range, 366-648). Median patient travel distance was 35.1 miles. Some patients (6396/31,895, 20%) traveled more than 100 miles.

*Conclusions.* Our model suggests the United States could be served by approximately 100 fewer CHS hospitals than currently exist. With hospitals optimally placed, patient travel burden would decrease. This model serves as a platform to improve care delivery by regionalization of CHS.

(Ann Thorac Surg 2021;111:1628-35)

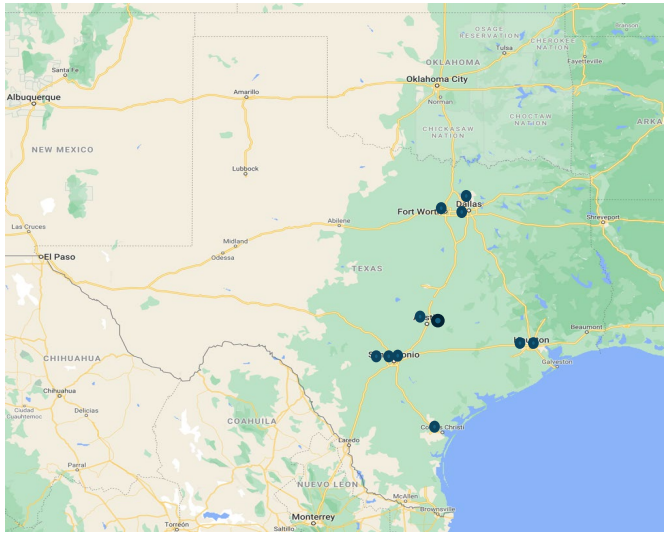




Simulation -all centers >300 cases/yr

- 116 lives saved
- **17% reduction in mortality**
- Increase mean travel distance of 31 miles

- WOULD CLOSE 80-100 CENTERS

# Republic of Texas



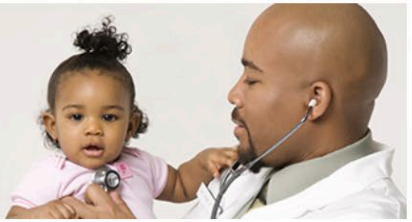

Texas Population 2024 – 30,964,000

Congenital Cardiac Surgery (n=~~10~~ 11; ~~8~~ 9 public report):

- Dallas-Ft. Worth - 3
- Austin – 1 **+ 1**
- Houston – 2
- San Antonio – 3
- Corpus Christi -1

Pediatric Transplant Programs – ~~2~~ 4

# PEDIATRIC CARDIAC TECHNICAL ADVISORY PANEL



Pediatric Cardiac Technical Advisory Panel
Annual Report
Calendar Year 2023

SUBMITTED BY THE AGENCY FOR HEALTH CARE ADMINISTRATION

December 2023

Better Health Care for All Floridians

"In 2016, the Florida Legislature enacted a new requirement to establish a pediatric cardiac technical advisory panel (PCTAP)..."

"Dr. McCormack asked about an update on site visits for panel members. Dr. Scholl stated he didn't believe AHCA would allow site visits ……. Dr. Blanchard noted that site visits are in statue and were added to proactively help improve programs. Dr. Scholl stated he would like AHCA's legal counsel to keep this under consideration as they investigate how to conduct site visits while staying within the Sunshine Law."


# A Congenital Heart Care “System”


# A Congenital Heart Care “System”

Designed (?) by “Florida Man”


| Center | 2015 -18 | 2019 - 22 | Transplant |
|---|---|---|---|
| A | 120 | 111 | |
| B | 119 | 84 | |
| C | 82 | 46 | Yes |
| D | 155 | 156 | Yes |
| E | 129 | 70 | Yes |
| F | | 77 | |
| G | 251 | 183 | |
| H | 160 | 161 | |
| I | 215 | 218 | Yes |
| J | 131 | 120 | |

Population – 22,975,931


| Center | 2015 -18 | 2019 - 22 | Transplant | Classification |
|---|---|---|---|---|
| A | 120 | 111 | | Essential |
| B | 119 | 84 | | Essential |
| C | 82 | 46 | Yes | ? + T |
| D | 155 | 156 | Yes | Essential +T |
| E | 129 | 70 | Yes | Essential? + T |
| F | | 77 | | ? |
| G | 251 | 183 | | Comprehensive-T? |
| H | 160 | 161 | | Essential |
| I | 215 | 218 | Yes | Comprehensive |
| J | 131 | 120 | | Essential |


| Center | 2015 -18 | 2019 - 22 | Transplant | Classification |
|---|---|---|---|---|
| | | | | |
| A | 120 | 111 | | Essential |
| B | 119 | 84 | | Essential |
| C | 82 | 46 | Yes | ? + T |
| D | 155 | 156 | Yes | Essential +T |
| E | 129 | 70 | Yes | Essential? + T |
| F | | 77 | | ? |
| G | 251 | 183 | | Comprehensive-T? |
| H | 160 | 161 | | Essential |
| I | 215 | 218 | Yes | Comprehensive |
| J | 131 | 120 | | Essential |

Comments

- During 2 eras, 30% of programs were near /below minimum vol.
  - ***All continued to do complex (STAT 5 cases)***
  - 3 “non-comprehensive” programs did transplants
- All essential or sub-threshold programs except 1 were ***within 25 miles*** of another program; the other was 73 miles away
- Two programs “affiliated” with out of state partners


# Affiliation/Alignment/Cooperative Model

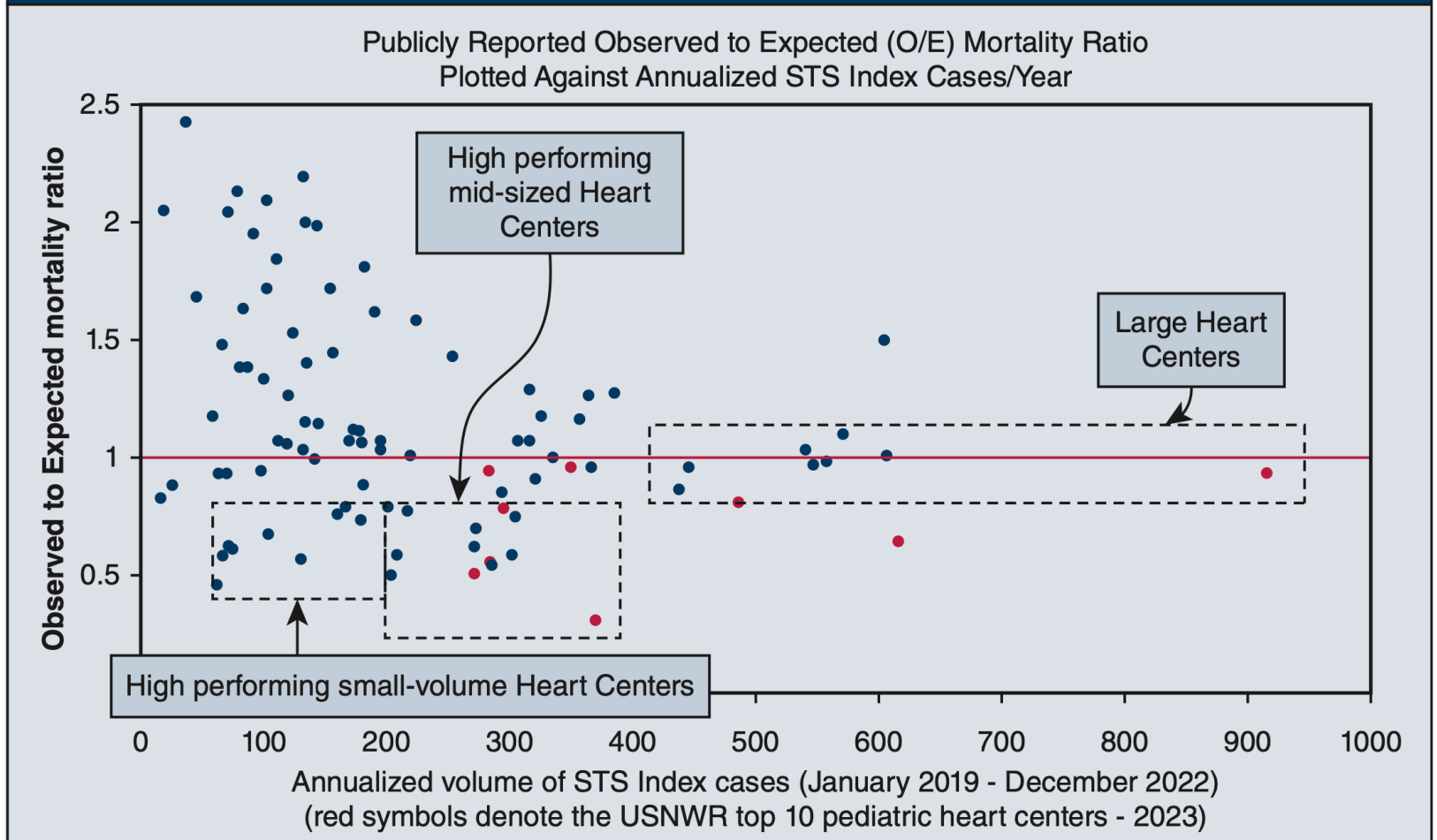
| Center | 2015 -18 | 2019 - 22 | Transplant | Classification |
|---|---|---|---|---|
| | | | | |
| A | 120 | 111 | | Essential |
| B | 119 | 84 | | Essential |
| F | | 77 | | ? |
| Group | 239 | 272 | | Comprehensive |
| | | | | |
| | | | | |
| C | 82 | 46 | Yes | ? + T |
| D | 155 | 156 | Yes | Essential +T |
| G | 251 | 183 | | Comprehensive-T? |
| Group | 488 | 385 | Yes* | Comprehensive |
| | | | | |
| E | 129 | 70 | Yes | Essential? + T |
| H | 160 | 161 | | Essential |
| Group | 289 | 231 | Yes | Comprehensive |
| | | | | |
| I | 215 | 218 | Yes | Comprehensive |
| J | 131 | 120 | | Essential |
| Group | 346 | 338 | Yes | Comprehensvie |


| Center | 2015 -18 | 2019 - 22 | Transplant | Classification |
|---|---|---|---|---|
| | | | | |
| A | ? | ? | | ? |
| B | ? | ? | | ? |
| F | | ? | | ? |
| Group | 239 | 272 | | Comprehensive |
| | | | | |
| | | | | |
| C | ? | ? | | ? |
| D | ? | ? | | ? |
| G | ? | ? | | ? |
| Group | 488 | 385 | Yes* | Comprehensive |
| | | | | |
| E | ? | ? | | ? |
| H | ? | ? | | ? |
| Group | 289 | 231 | Yes | Comprehensive |
| | | | | |
| I | ? | ? | | ? |
| J | ? | ? | | ? |
| Group | 346 | 338 | Yes | Comprehensvie |

# Next Steps

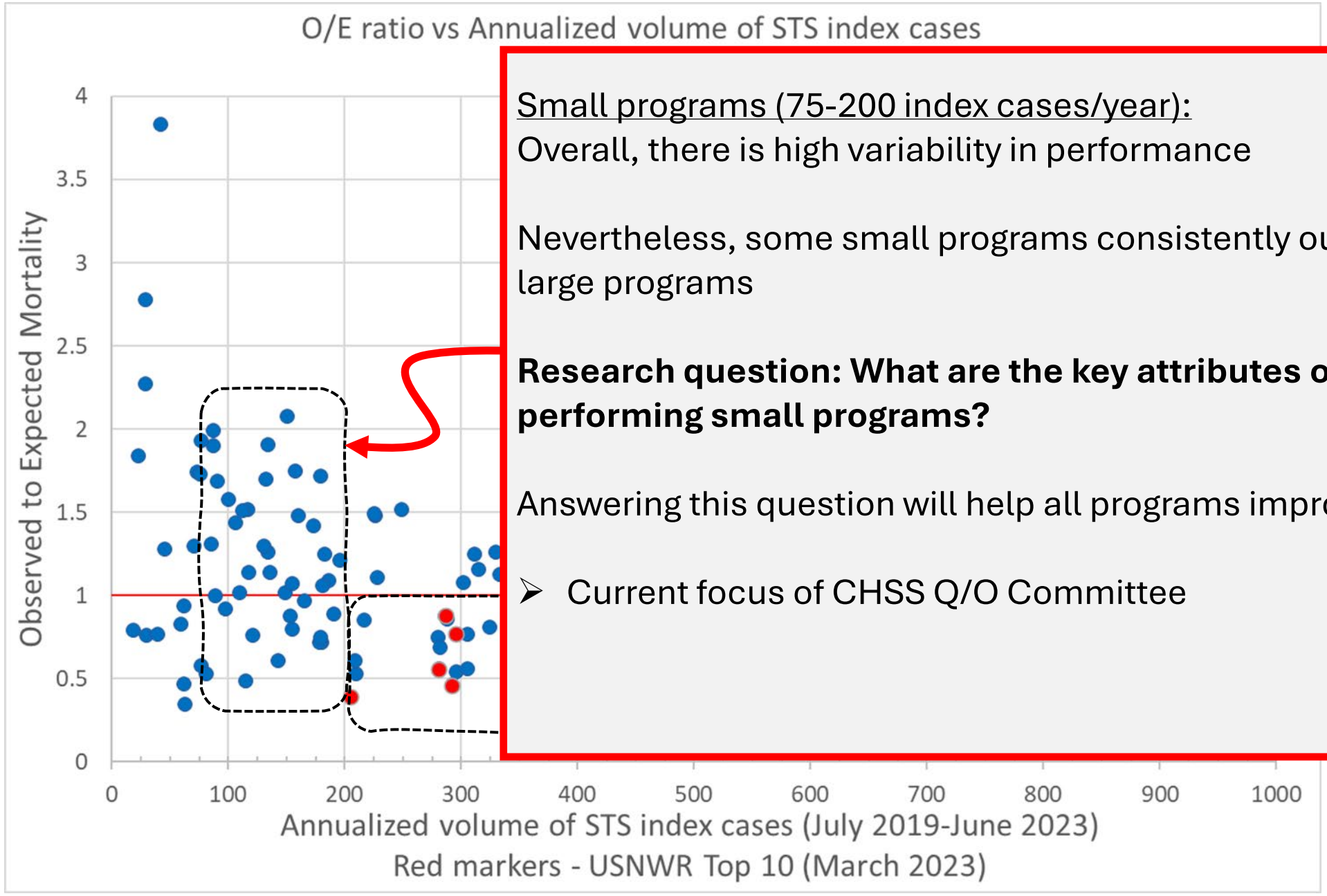
1. Convert Recommendations to Standards – to be verified by CHSS/PCICS/Cardiac Networks United/Etc.
   - Voluntary participation – Initial and Q3(?) years
   - Consultancy/Site Visit early if needed and requested by site
   - Issue Verification/"Seal of Approval"
2. For Essential Centers, Regionalization **WITHOUT** Closure
   - Urge transfer of most complex cases (STAT5, some STAT 4, transplants, VADs, etc.)
     ` -less than 10% of case volume
3. For "Too Small Centers", no verification offered or possible – alignment/closure urged
4. Vastly enhanced Real-Time public reporting – VLAD, granular/practical/simplified
5. Consign USNWR to the scrap heap of history.
6. CHSS Study – Seek success factors in high performing small centers…underway

## Building High Levels of Performance into Congenital Heart Centers




Greater volume is not the sole contributor to high performance.
Mission, Structure, Process and Culture should be optimized.

CHSS




Small programs (75-200 index cases/year):
Overall, there is high variability in performance

Nevertheless, some small programs consistently outperform large programs

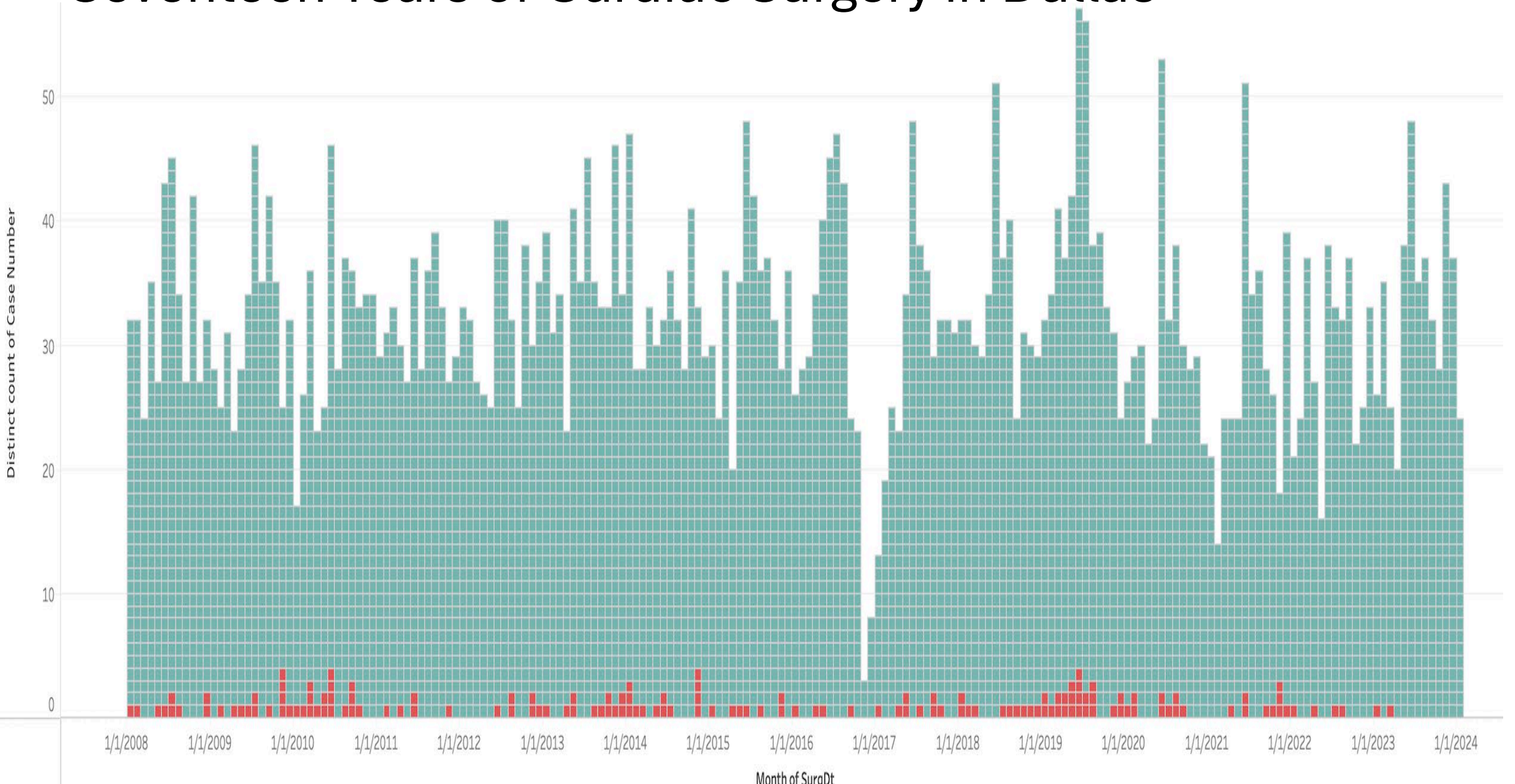
**Research question: What are the key attributes of the top performing small programs?**

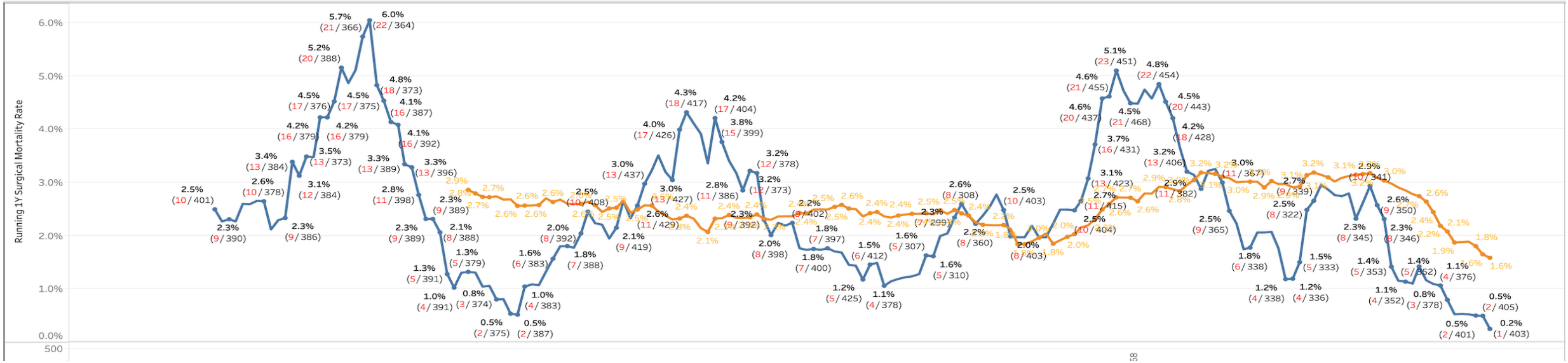
Answering this question will help all programs improve

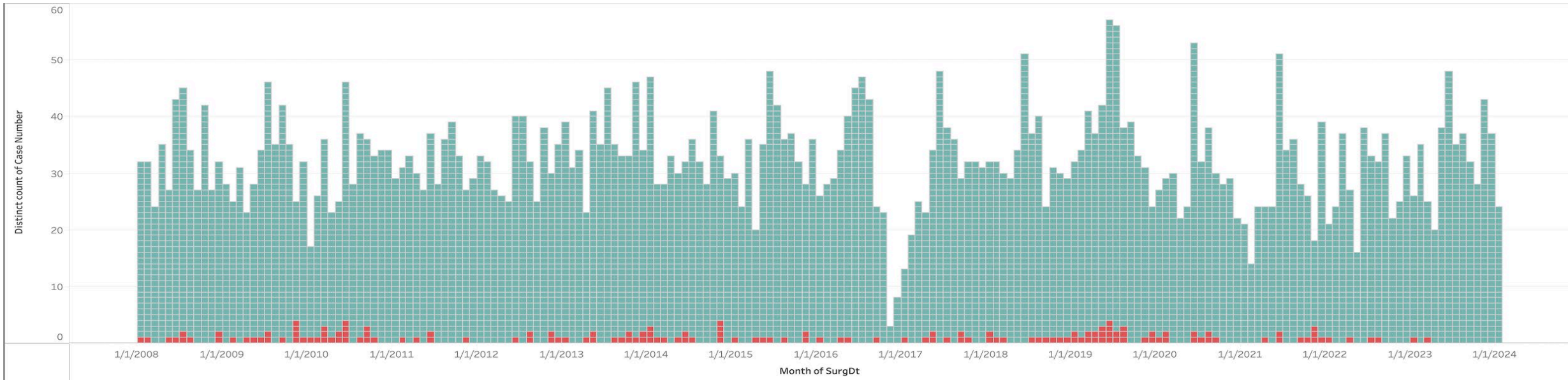
- Current focus of CHSS Q/O Committee

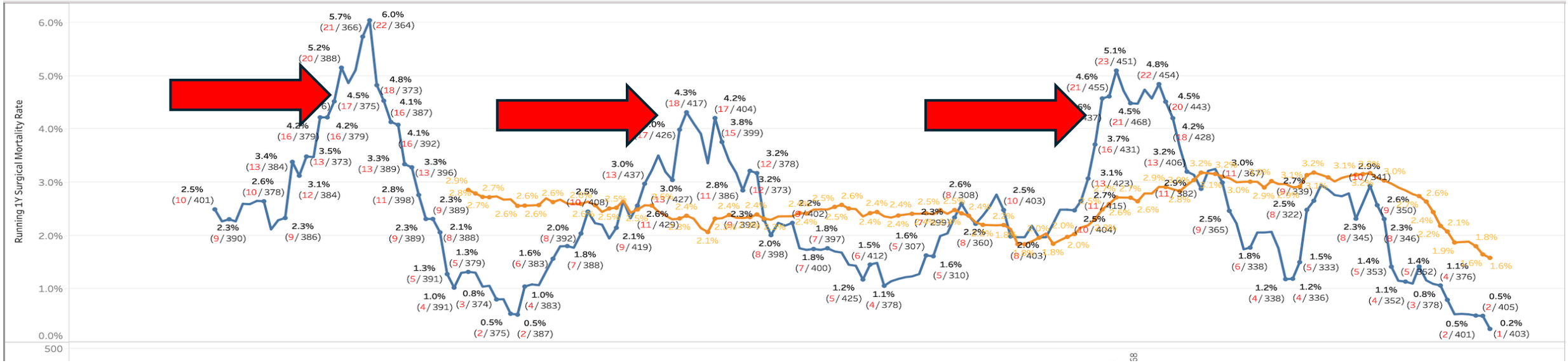
# Other Solutions Are Crucial

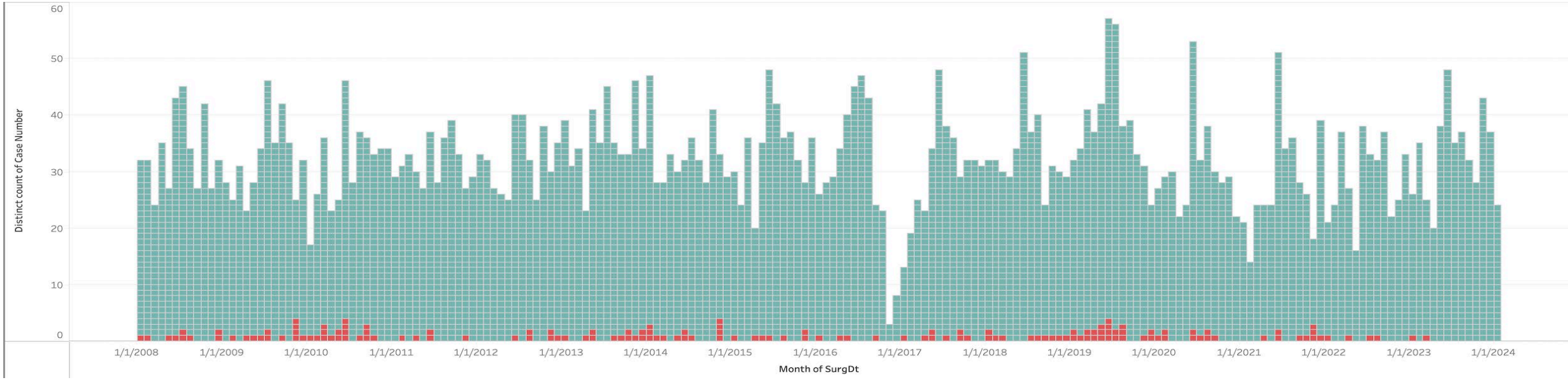
# Seventeen Years of Cardiac Surgery in Dallas

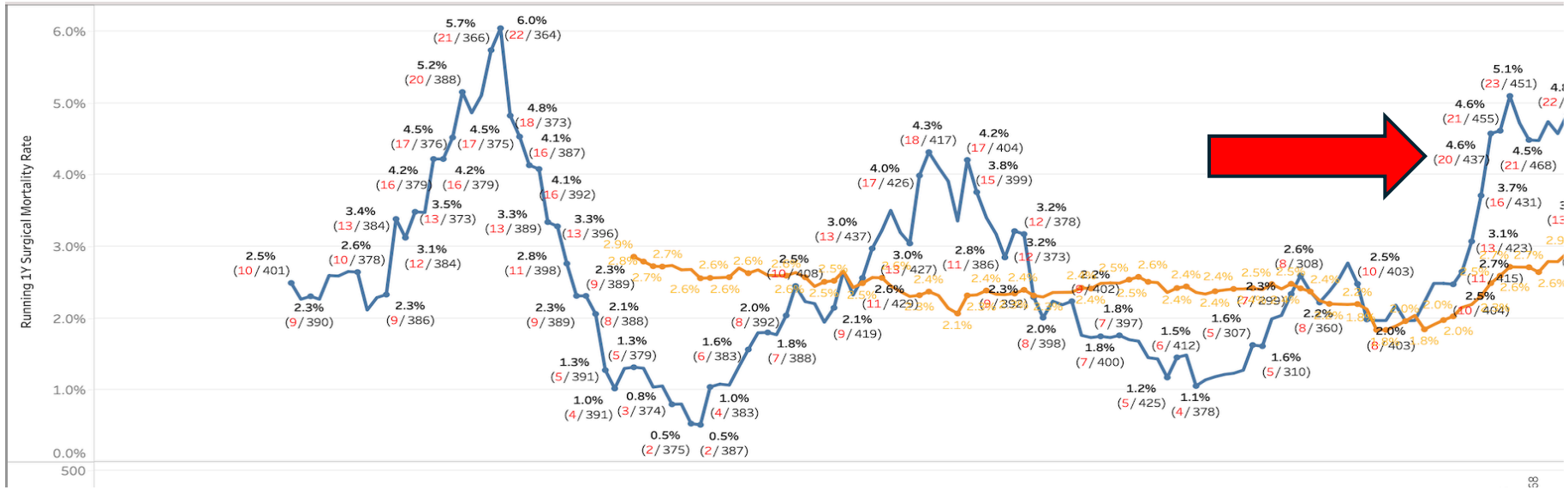


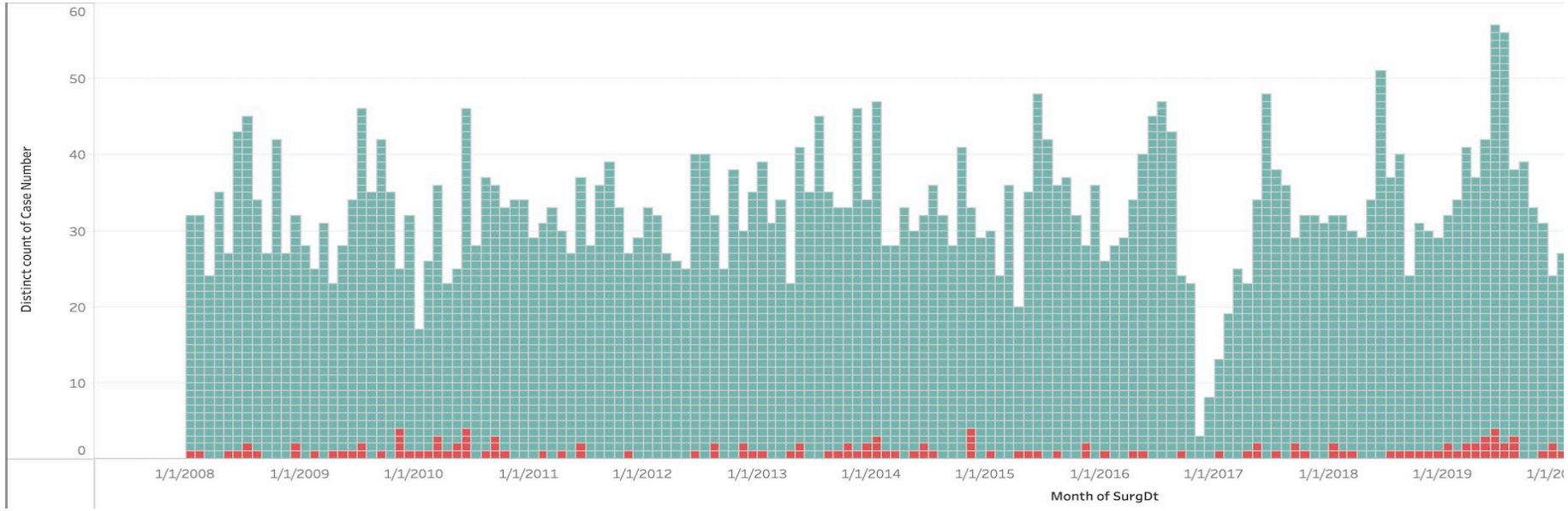

Running 1Y Surgical Mortality Rate
6.0%
5.0%
4.0%
3.0%
2.0%
1.0%
0.0%
500


Distinct count of Case Number
60
50
40
30
20
10
0
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
1/1/2016
1/1/2017
1/1/2018
1/1/2019
1/1/2020
1/1/2021
1/1/2022
1/1/2023
1/1/2024
Month of SurgDt

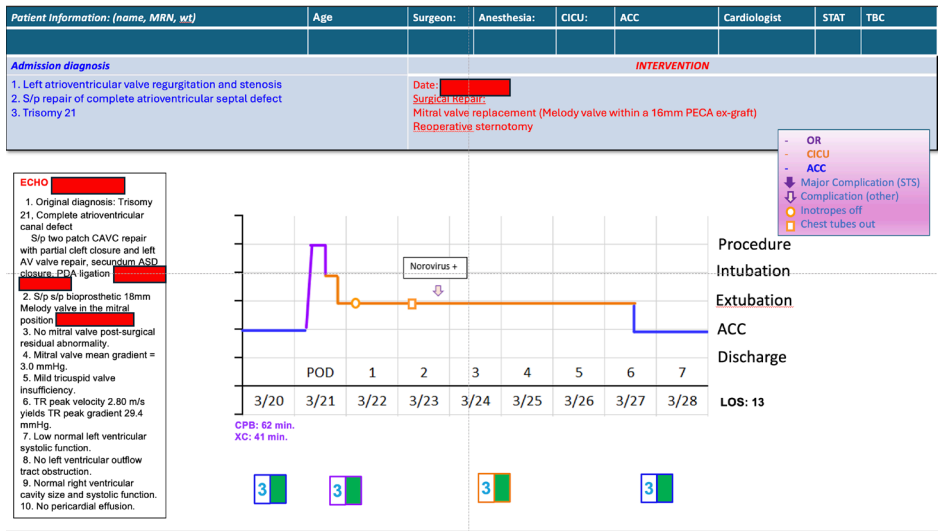

Running 1Y Surgical Mortality Rate
6.0%
5.0%
4.0%
3.0%
2.0%
1.0%
0.0%
500

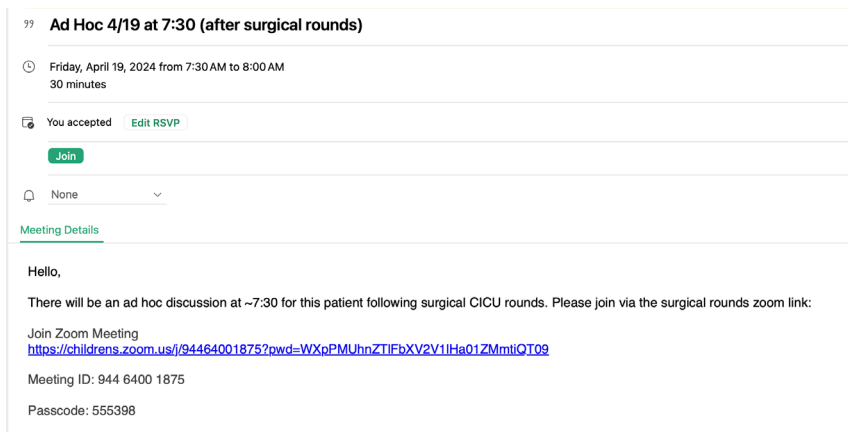

Distinct count of Case Number
60
50
40
30
20
10
0
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
1/1/2016
1/1/2017
1/1/2018
1/1/2019
1/1/2020
1/1/2021
1/1/2022
1/1/2023
1/1/2024
Month of SurgDt

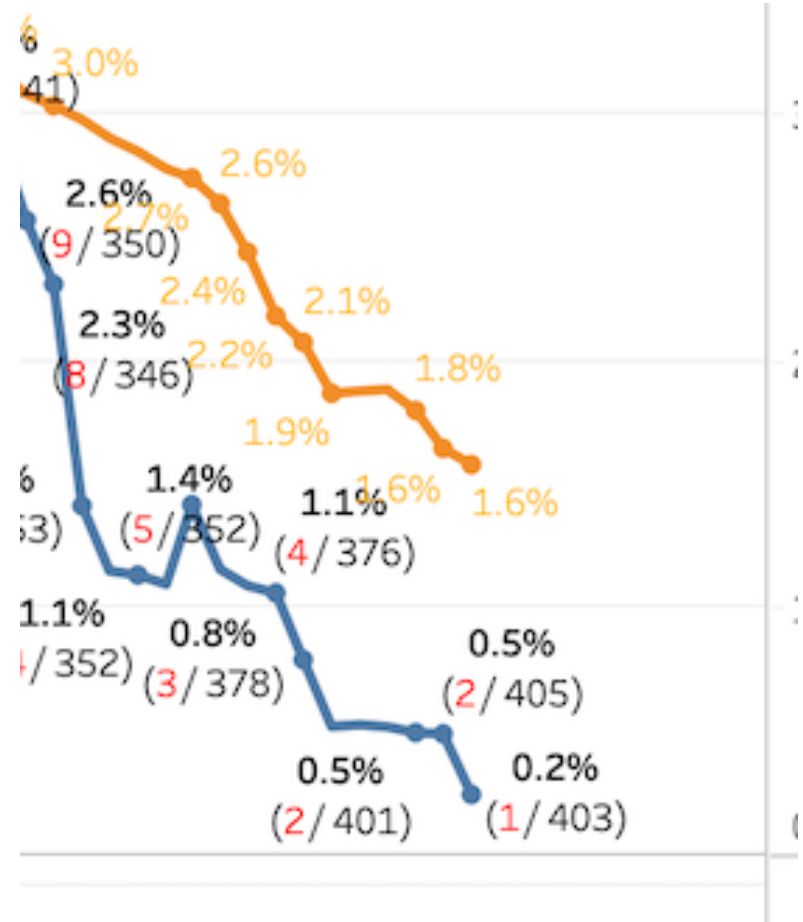

Running 1Y Surgical Mortality Rate
6.0%
5.0%
4.0%
3.0%
2.0%
1.0%
0.0%
500
2.5% (10 / 401)
2.3% (9 / 390)
2.6% (10 / 378)
3.4% (13 / 384)
4.2% (16 / 379)
4.5% (17 / 376)
5.2% (20 / 388)
5.7% (21 / 366)
2.3% (9 / 386)
3.1% (12 / 384)
3.5% (13 / 373)
4.2% (16 / 379)
4.5% (17 / 375)
6.0% (22 / 364)
2.8% (11 / 398)
3.3% (13 / 389)
4.8% (18 / 373)
2.3% (9 / 389)
4.1% (16 / 387)
2.1% (8 / 388)
3.3% (13 / 396)
1.3% (5 / 391)
4.1% (16 / 392)
1.0% (4 / 391)
1.3% (5 / 379)
0.8% (3 / 374)
0.5% (2 / 375)
0.5% (2 / 387)
1.6% (6 / 383)
1.0% (4 / 383)
2.0% (8 / 392)
1.8% (7 / 388)
2.5% (10 / 408)
3.0% (13 / 437)
2.1% (9 / 419)
4.0% (17 / 426)
2.6% (11 / 429)
3.0% (13 / 427)
4.3% (18 / 417)
2.8% (11 / 386)
4.2% (17 / 404)
2.3% (9 / 392)
3.8% (15 / 399)
3.2% (12 / 378)
2.0% (8 / 398)
3.2% (12 / 373)
2.2% (9 / 402)
1.8% (7 / 397)
1.8% (7 / 400)
1.2% (5 / 425)
1.5% (6 / 412)
1.1% (4 / 378)
1.6% (5 / 307)
2.3% (7 / 299)
1.6% (5 / 310)
2.6% (8 / 308)
2.2% (8 / 360)
2.5% (10 / 403)
2.0% (8 / 403)
2.5% (10 / 404)
2.7% (11 / 415)
3.1% (13 / 423)
3.7% (16 / 431)
4.5% (21 / 468)
4.6% (20 / 437)
4.6% (21 / 455)
5.1% (23 / 451)


Distinct count of Case Number
60
50
40
30
20
10
0
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
1/1/2016
1/1/2017
1/1/2018
1/1/2019
Month of SurgDt

# Same Surgeons, Same ICU, Same Volume



“You can always count on the Americans to do the right thing, ……..”

“You can always count on the Americans to do the right thing, after they have exhausted all the other possibilities.”

There is much more to do……

# References


- Backer J Thorac Cardiovasc Surg 2023;166:1782-820
- Pasquali Circulation. 2020;142:1351–1360
- Welke Ann Thorac Surg 2023;116:1233-40
- Welke Ann Thorac Surg 2021;111:1628-35
- Allen Pediatrics 2003;112(1): 24-28
- Caldarone J Thorac Cardiovasc Surg 2024; 167(4):1435-1443
- Chauhun Ann Thorac Surg 2024 https://doi.org/10.1016/j.athoracsur.2024.01.006
- Barnhart Semin Pediatr Surg. 2023 Apr;32(2):151276.
- https://www.nicor.org.uk/national-cardiac-audit-programme/congenital-audit-nchda. – accessed 5 1 2024

# Impact of Diffusion of Programs on Education

- Young surgeons leaving training are, in general, very poorly prepared to function independently
- Established surgeons, in general, do a lousy job of mentoring junior partners – too little experience early on; partners become fodder; exeptions exist but are rare
- EON call is terrible, and only exceeded by EN call