



# Mechanical Circulatory Support in Children Undergoing Heart Surgery: An Analysis of the Society of Thoracic Surgeons Congenital Heart Surgery Database

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# Background

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- Mechanical circulatory support (MCS)
  - Utilized to support critically ill children undergoing congenital heart surgery
- Extracorporeal membrane oxygenation (ECMO)
  - Introduced in 1974
  - Most common – rapidly/simplely initiated
- Limitations of current MCS outcomes data:
  - Single center, narrow focus, small cohorts

# Purpose

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- Describe patterns of use, patient/operative characteristics, and outcomes associated with postoperative MCS across a large multicenter cohort of children undergoing congenital heart surgery



# Data Source



- **STS Congenital Heart Surgery Database**
  - Largest congenital heart surgery data registry worldwide
  - Contains data on >250,000 surgeries since 1998
  - Represents  $\approx 85\%$  of all US centers
  - Diverse center volume and geography
  - Clinician coded preoperative, operative, and outcomes data

# Study Population

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- 2000-2010
- Age <18 years
- Included centers with  $\geq 85\%$  complete data (n=80)
  - 96,596 patients
- Focus on postoperative MCS
  - Any type
  - Relative rarity of pre-operative MCS

# Data Collection

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- Patient characteristics

- Demographics & cardiac diagnosis
- Genetic abnormality
- Preoperative risk factors (cardiac, pulmonary, renal, neurologic, etc.)

- Operative characteristics

- STAT category, # prior operations, CPB time
- Utilization of post-op MCS

- Outcomes

- In-hospital mortality
- Post-op LOS

# Analysis

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- Pre-operative, operative, and outcomes data described in MCS and non-MCS cohorts
  - Overall
  - Common operations ( $n > 100$ )
  - STS “Benchmark” operations
- Center variation in MCS rates
  - Bayesian hierarchical models used to calculate hospital-level MCS rates, adjusting for any differences in patient characteristics and case mix across hospitals
  - Relationship of adjusted MCS rate and center volume also evaluated



# Results

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- 96,596 operations (80 centers)
- Overall MCS rate 2.8% (n=2750)
- Postoperative MCS rate = 2.4%

# Patient Characteristics

	Postoperative MCS (n=2287)	No MCS (n=94309)	p value
Median age (days)	13	195	<0.0001
Median weight (kg)	3.4	6.4	<0.0001
Non CV/genetic abnormality	29.6%	30.5%	0.3
STS Pre-op risk factor	57.3%	32.7%	<0.0001
Mech vent	36.6%	15.3%	<0.0001
Arrhythmia	4.6%	2.6%	<0.0001
Shock	7.4%	1.7%	<0.0001

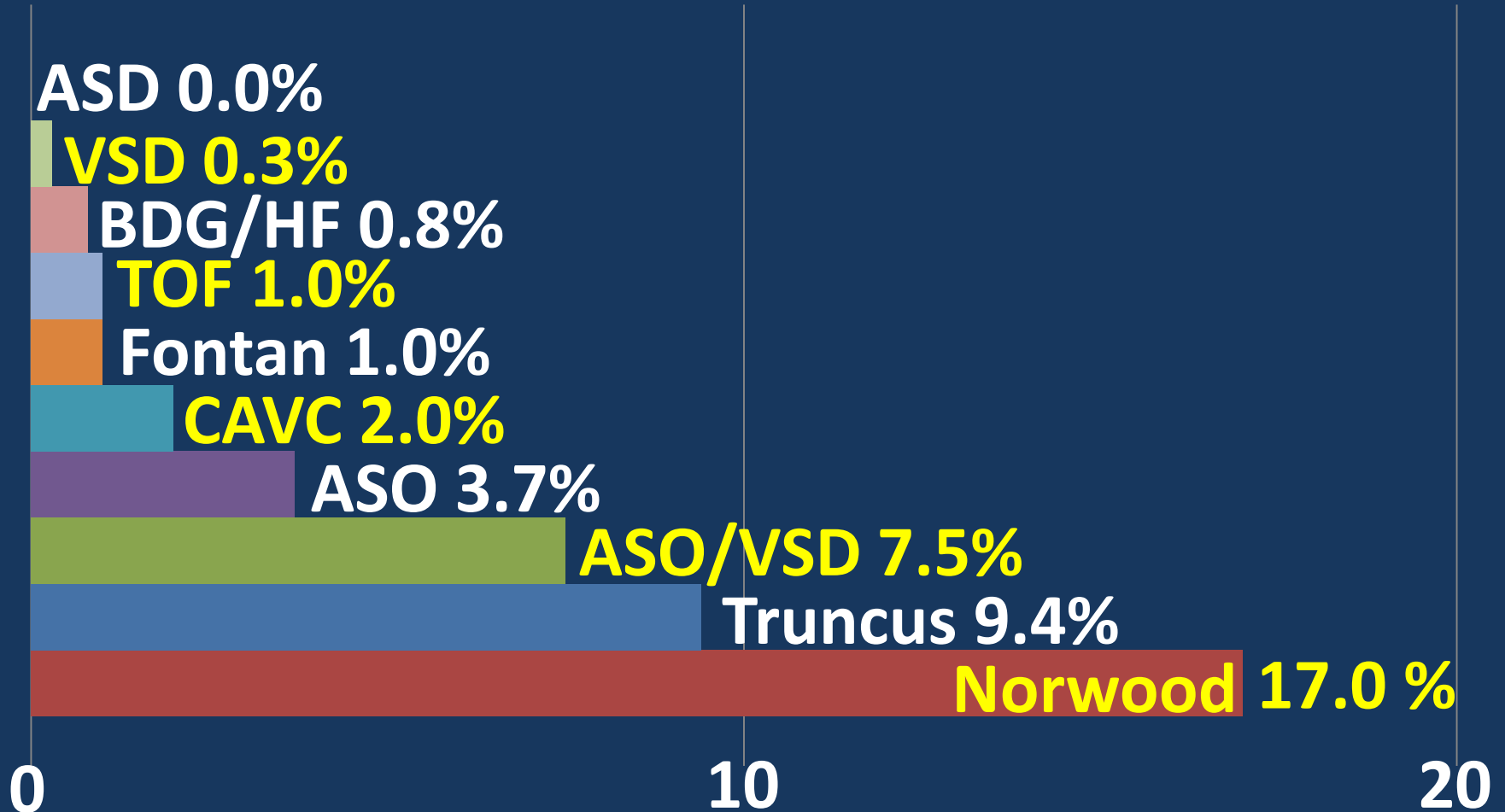
# Operative Characteristics & Outcomes

	Postoperative MCS (n=2287)	No MCS (n=94309)	p value
<b>Operative Data</b>			
STAT Category			
4-5 (vs. 1-3)	72.3%	23.4%	<0.0001
CPB time (min)	175	94	<0.0001
<b>Outcomes Data</b>			
In-hospital mortality	53.2%	2.9%	<0.0001
Length of stay (days)	28	6	<0.0001

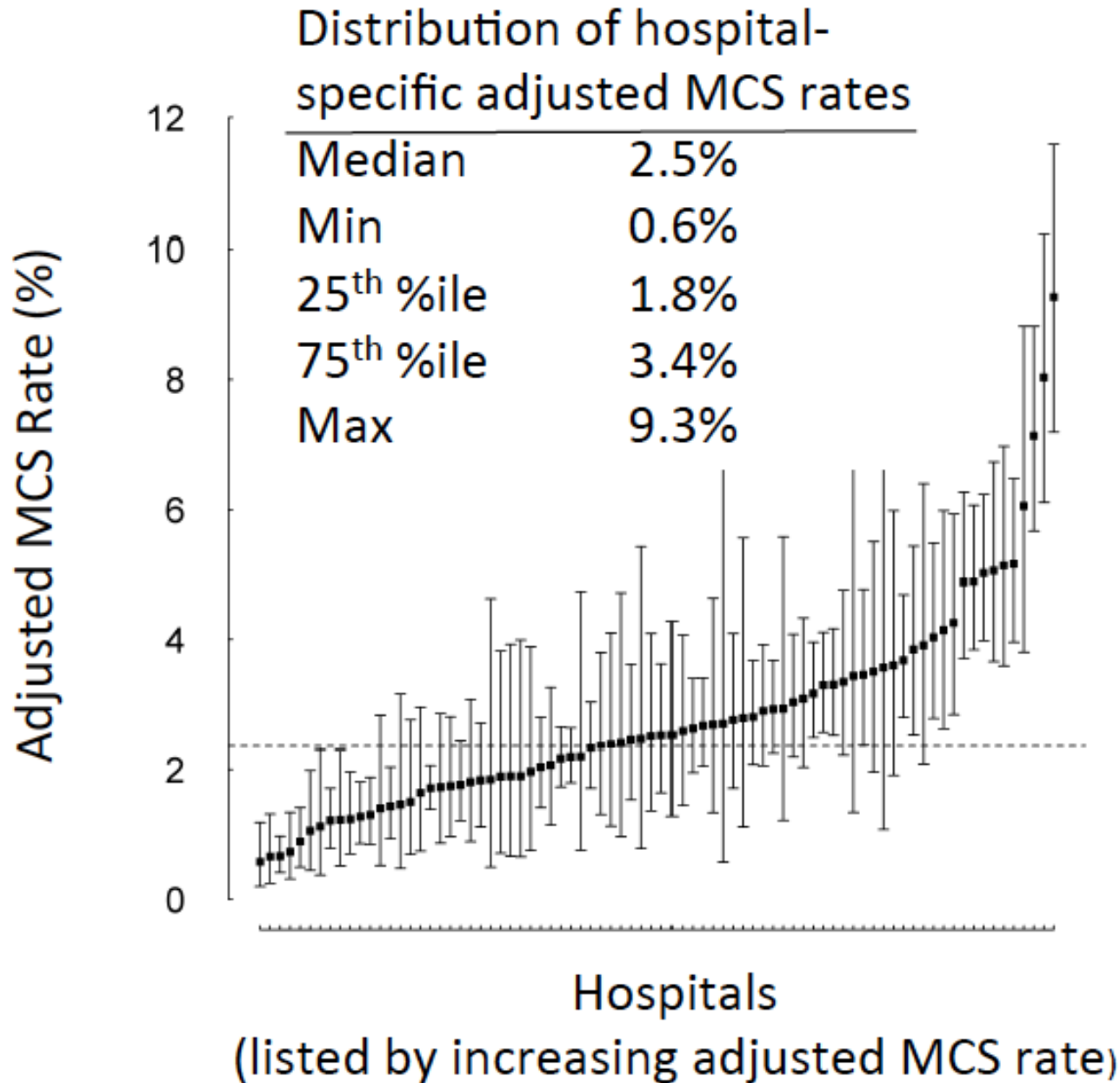
# Operations with Highest MCS Rate

Operation	MCS Rate (%)	Mortality with MCS (%)	Mortality without MCS (%)	p value
<b>Norwood</b>	<b>17</b>	<b>57</b>	<b>13</b>	<b>&lt;0.0001</b>
<b>ASO+VSD+arch</b>	<b>14</b>	<b>40</b>	<b>3</b>	<b>&lt;0.0001</b>
<b>DKS</b>	<b>13</b>	<b>40</b>	<b>10</b>	<b>&lt;0.0001</b>
<b>Truncus</b>	<b>9.4</b>	<b>71</b>	<b>5.5</b>	<b>&lt;0.0001</b>
<b>R-Konno</b>	<b>9.3</b>	<b>71</b>	<b>3.4</b>	<b>&lt;0.0001</b>
<b>Unifoc MAPCA</b>	<b>8.4</b>	<b>41</b>	<b>8</b>	<b>&lt;0.0001</b>
<b>TAPVC repair</b>	<b>8.2</b>	<b>59</b>	<b>7.4</b>	<b>&lt;0.0001</b>
<b>ASO+VSD</b>	<b>7.5</b>	<b>53</b>	<b>3.2</b>	<b>&lt;0.0001</b>
<b>ALCAPA repair</b>	<b>7.3</b>	<b>14</b>	<b>1</b>	<b>&lt;0.0001</b>

# MCS Rates-Benchmark Operations



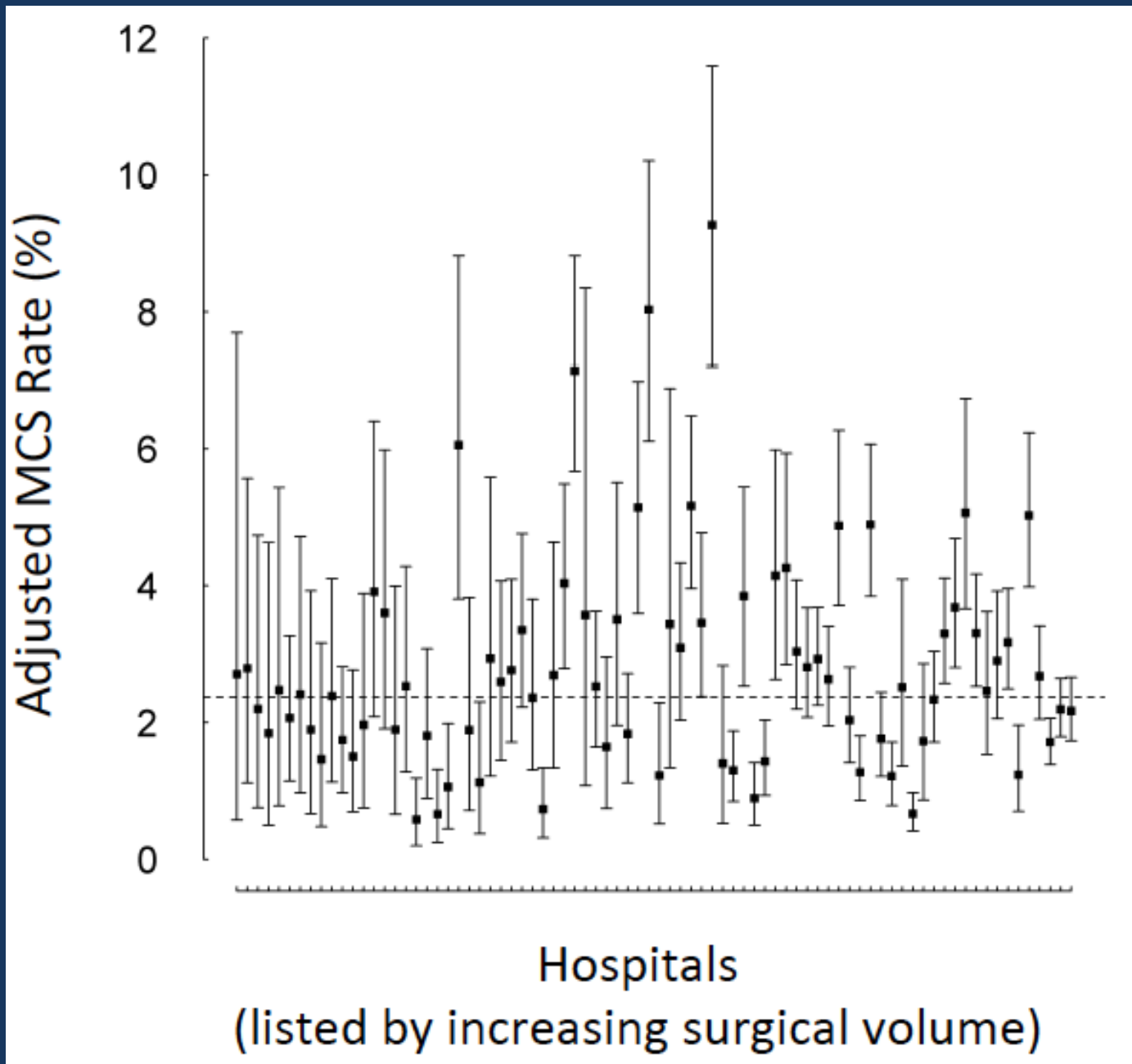
# Variation in Adjusted MCS rates Across Hospitals



# MCS Rate and Center Volume

<b>Volume group (Total cases/year)</b>	<b>MCS rate</b>
<b>&lt;150</b>	<b>2.33%</b>
<b>150-249</b>	<b>2.81%</b>
<b>250-349</b>	<b>2.25%</b>
<b>≥350</b>	<b>2.14%</b>

# MCS Rate and Center Volume





# Limitations

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- Not all centers participate in STS Congenital Heart Surgery Database or submit complete data
- Limited MCS information
  - Type (ECMO, ventricular assist device)
  - Indication, duration, complications
- No long term follow-up

# Conclusions

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- MCS associated with 53.2% in-hospital mortality
  - MCS-mortality >70% for certain operations
- Common in single ventricle palliation and complex biventricular repairs
  - Greatest MCS mortality risk in biventricular group
- MCS rate varies 15-fold across hospitals
- No clear overall relationship to center volume

# Future Directions

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- MCS is life-saving but wide variation in MCS use across hospitals and high mortality rates suggest room for improvement
- Future study aimed at better understanding and standardizing indication and management of MCS