CARDIOLOGY 2023

THE SUCCESSFUL AND DRAMATIC REDUCTION IN INTERSTAGE MORTALITY

How Did We Do This?

Sunday, February 26, 2023

Children's Hospital of Philadelphia Cardiac Center

Monique M. Gardner, MD

Assistant Professor, Anesthesiology & Critical Care and Pediatrics

Attending Physician, Cardiac Critical Care &

Infant Single Ventricle Monitoring & Management Program

Perelman School of Medicine University of Pennsylvania

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…And What Comes Next?

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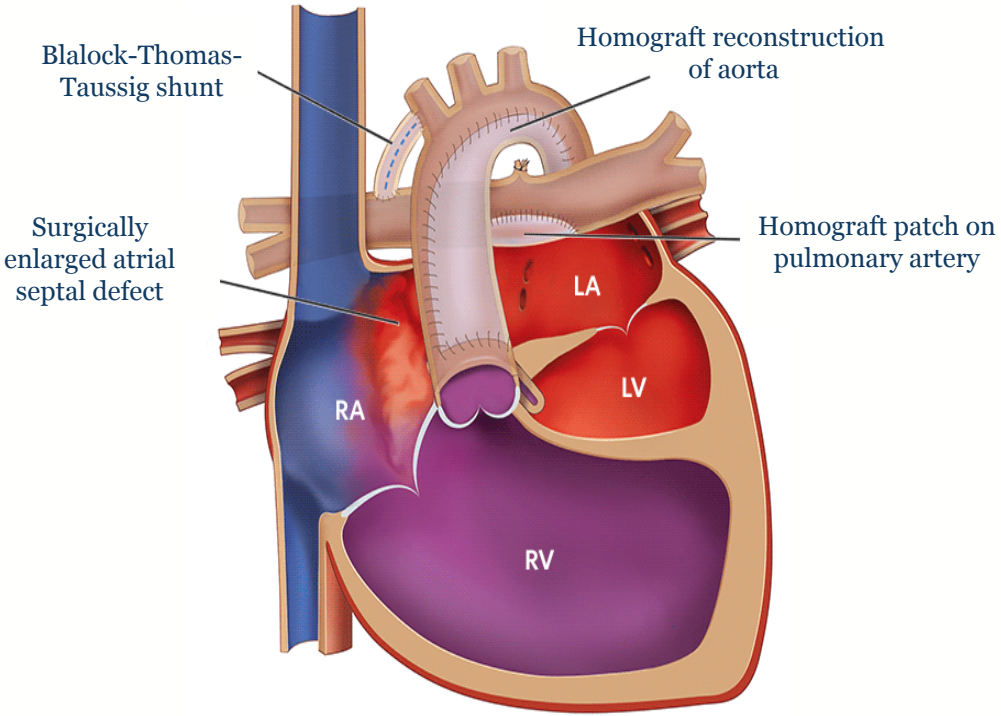
OVERVIEW

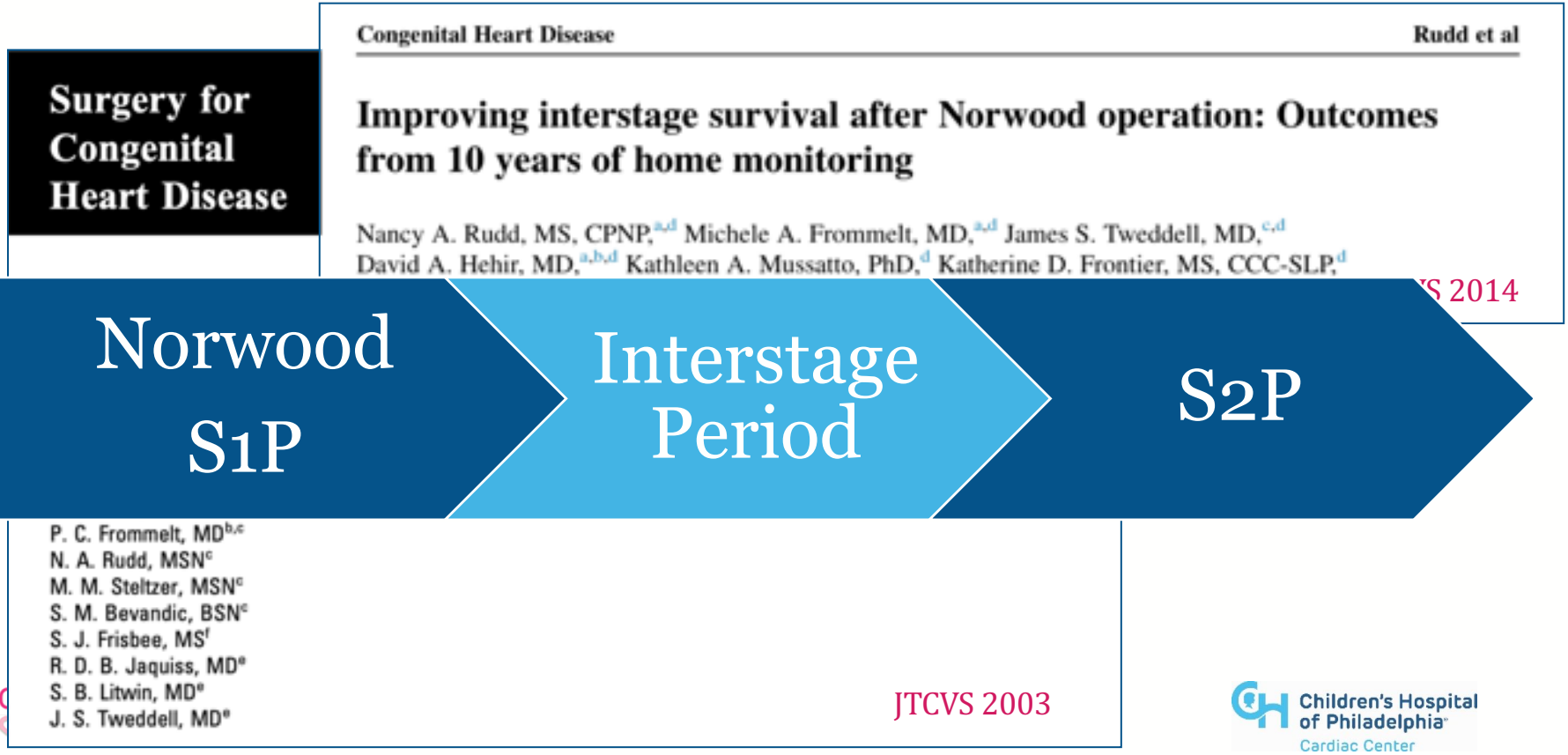
- Review of interstage period & mortality
- Background on home monitoring
- Future directions

INTERSTAGE PHYSIOLOGY



Stage 1 (Norwood) operation

THE INTRODUCTION OF HOME MONITORING



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WHAT DOES HOME MONITORING ENTAIL?

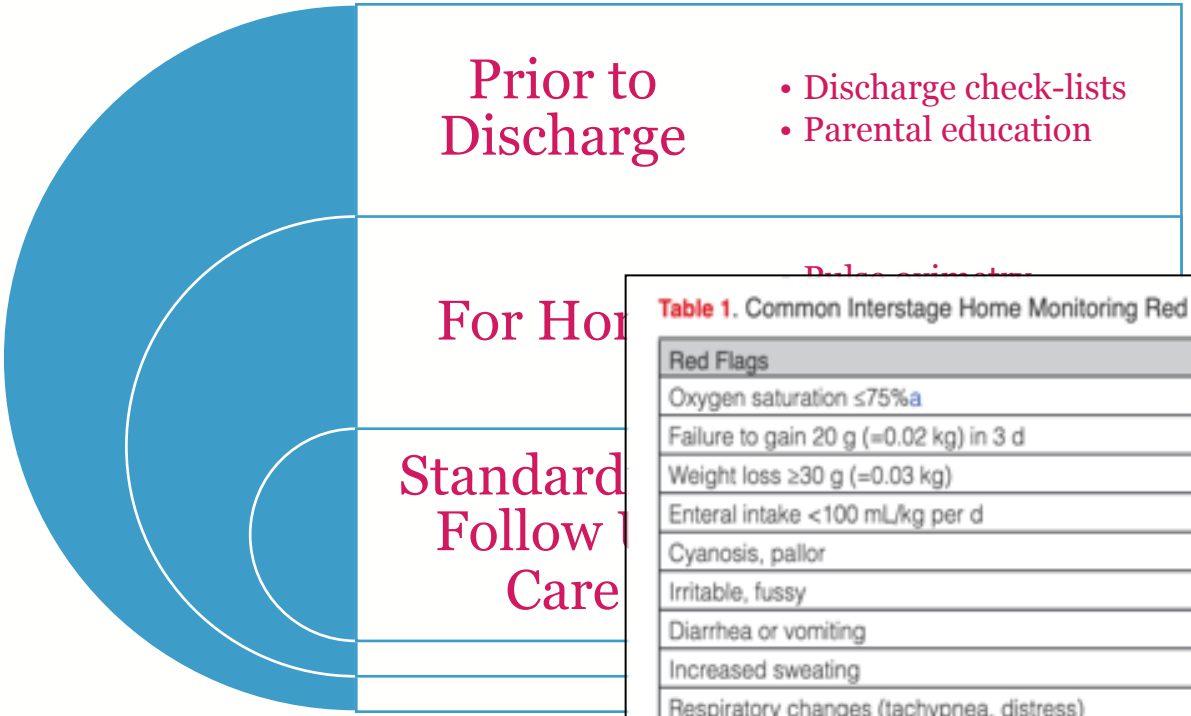

Table 1. Common Interstage Home Monitoring Red Flags[4, 10, 14, 15] (Table view)

Red Flags
Oxygen saturation ≤75%[a]
Failure to gain 20 g (=0.02 kg) in 3 d
Weight loss ≥30 g (=0.03 kg)
Enteral intake <100 mL/kg per d
Cyanosis, pallor
Irritable, fussy
Diarrhea or vomiting
Increased sweating
Respiratory changes (tachypnea, distress)
Temp >100.4°F

[a] Unanticipated increase in oxygen saturation from baseline (eg ≥90% in infant with Norwood physiology) should be considered a red flag.

Rudd, et al. "Interstage Home Monitoring for Infants With Single Ventricle Heart Disease: Education and Management: A Scientific Statement From the American Heart Association." *Journal of the American Heart Association* 9.16 (2020): e014548.

THE IMPACT OF HMPS: REDUCED MORTALITY

Table 1. Studies reporting interstage mortality and impact of HMP

First author and study	Period	Population (n)	Results/Comments
Mahle 2000 (CHOP)	1984–1999	840	Interstage death = 13.9% (no HMP)
Ghanayem 2003 (CHW)	1996–2001	87	Pre-HMP = 15.8%; HMP = 0%
Fenton 2003 (PITT)	1991–2000	146	Interstage death = 14% (no HMP)
Hehir 2009 (CHOP)	1998–2005	368	
Furck 2010 (Kiel)	1996–2007	157	Pre-HMP = 15.8%; HM
Hansen 2011 (Kiel)	1996–2009	187	Pre-HMP = 12.4%
Debrolet 2011 (Miami)	2006–2010	59	Control = 6%;
Petit 2011 (TCH)	2007–2010	230	Pre-HMP = 1
Husain 2012 (NCH)	2006–2011	51	Non-HMP
Ghanayem 2012 (SVR)	2005–2008	42	

CHOP, Children's Hospital of Philadelphia; CHW, Children's Hospital of Wisconsin; H
Holstein, Kiel, Germany; Miami, Miami Children's Hospital and Arnold Palmer Childre
Ohio; PITT, Children's Hospital of Pittsburgh; SVR, Single Ventricle Reconstruction Trial;

Hehir DA, Ghanayem NS. Single-ventricle infant home monitoring programs: outc

Pre-HMP = 13%, HMP = 5.4%

Journal of the American Heart Association
Volume 8, Issue 10, 21 May 2019
https://doi.org/10.1161/JAHA.118.010783

Association of a Home Monitori
and Stage 2 Outcomes

Monique M. Gardner, MD[*,1]; Laura Mercer-Rosa, MD
Michael P. DiLorenzo, MD, MSCE[4]; Katherine E. Bates,
Shobha S. Natarajan, MD[2]; Anita Szwast, MD[2]; Stephanie
Mascio, MD[7]; Desiree Fleck, PhD, CRNP[6]; Deborah L. Torowi
MD[2]; Jonathan J. Rome, MD[2]; Chitra Ravishankar, MD[2]

No interstage mortality in HLHS from 2016 to 2022

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National Pediatric Cardiology
Quality Improvement Collaborative

Cumulative interstage mortality has decreased from 9.5% to 5.1%

0%?

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SHIFTING GEARS: NOT JUST SURVIVE, THRIVE

Texas Children's Hospital®

Improved interstage weight gain, allowing early stage 2 at an equivalent weight

Children's Hospital of Philadelphia℠

Despite being younger at stage 2, HMP cohort had higher WAZ

Children's Wisconsin

Interstage infants enrolled in an HMP experienced normal growth velocity

Aggregate growth failure reduced from **18.6% to 13.3%**

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Hehir *et al.* 2012 Pediatric Cardiology

McCrary *et al.* 2013 Cardiology in the Young

Gardner *et al.* 2019 JAHA

Petit *et al.* 2011 JTCVS

Anderson *et al.* 2012 Journal of Pediatrics

THE DOWNSIDES OF HOME MONITORING?

MORE EMERGENCY ROOM VISITS

MORE REINTERVENTIONS

MORE READMISSIONS

YOUNGER AGE AT S2P

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Edelson et al, 2018 Journal of American College of Cardiology
Hanke et al, 2016 Seminars in Thoracic and Cardiovascular Surgery
Gardner et al, 2019 Journal of American Heart Association

Buelow et al, 2018 Congenital Heart Disease
Meza et al, 2018 Annals of Thoracic Surgery

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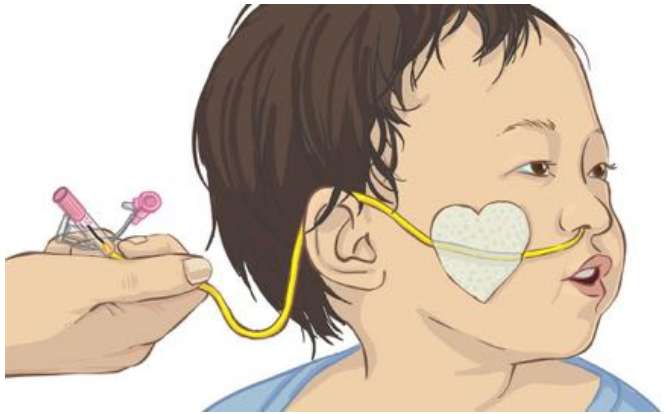
MORE DOWNSTREAM EFFECTS

Congenital Heart Disease

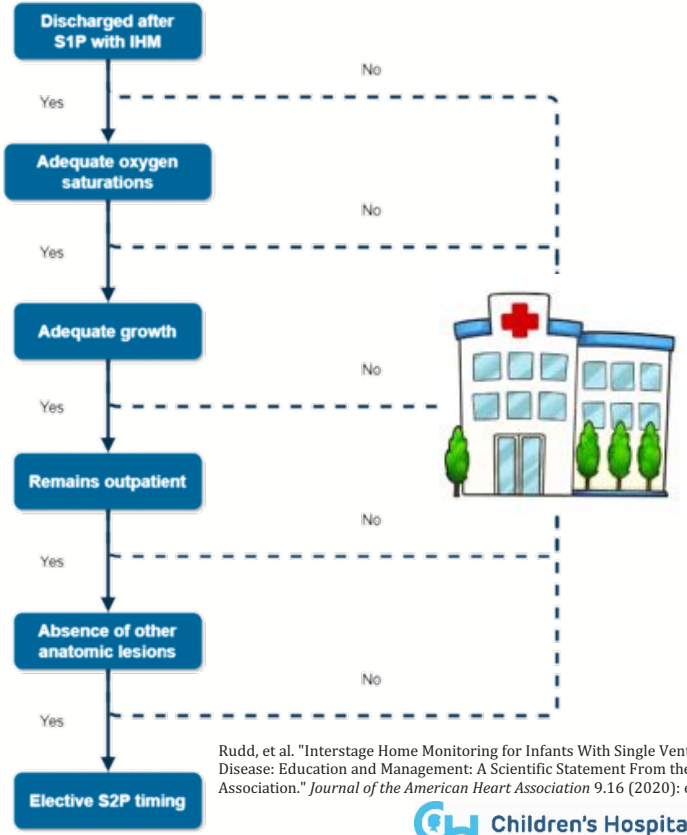
ORIGINAL ARTICLE

Caregiver Anxiety Due to Interstage Feeding Concerns

Jamie Stewart RN, Robert Dempster PhD, Robin Allen RN, Holly Miller-Tate RN, Gabrielle Dickson RN, Samantha Fichtner RN, Alex J. Principe MBA, Rachel Fonseca BS, Lisa Nicholson PhD, Clifford L. Cua MD



Sick Kids Health. Nasogastric (NG) Tube: How to insert your child's NG tube.



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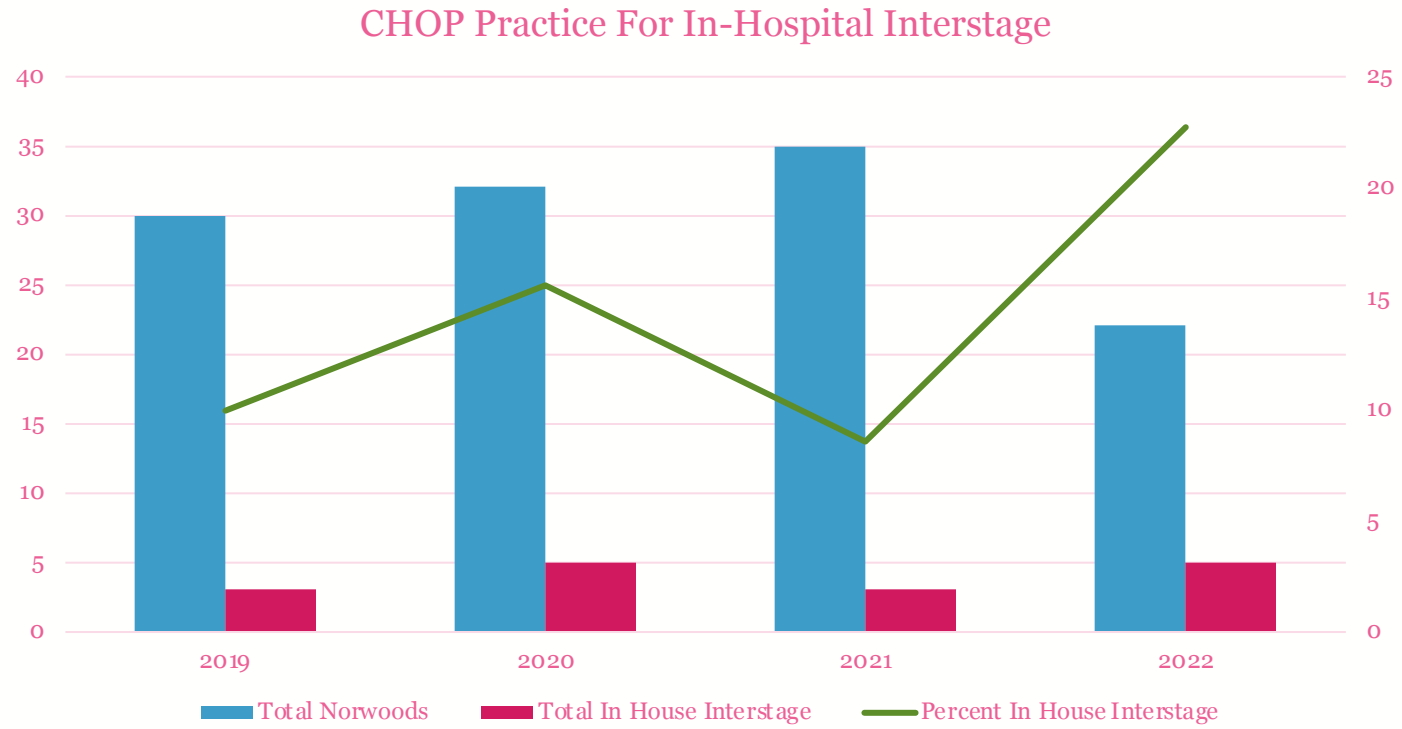
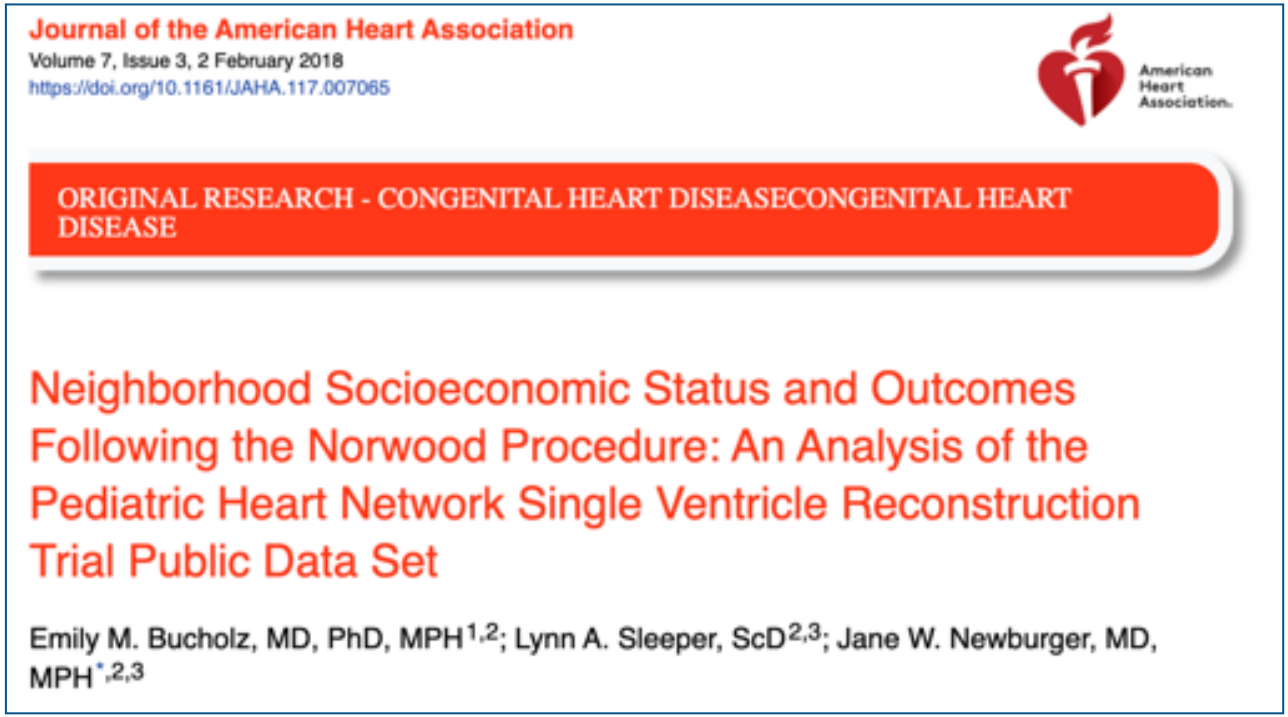
IDENTIFYING OUTLIERS



FUTURE DIRECTIONS FOR HOME MONITORING

- Deliver More Equitable Care
- Advance Care Through Telemedicine
- Personalized Care
- Interstage Care 2.0?

DELIVERING MORE EQUITABLE CARE



Journal of the American Heart Association
Volume 7, Issue 3, 2 February 2018
https://doi.org/10.1161/JAHA.117.007065

American Heart Association.

ORIGINAL RESEARCH - CONGENITAL HEART DISEASECONGENITAL HEART DISEASE

Neighborhood Socioeconomic Status and Outcomes Following the Norwood Procedure: An Analysis of the Pediatric Heart Network Single Ventricle Reconstruction Trial Public Data Set

Emily M. Bucholz, MD, PhD, MPH[1,2]; Lynn A. Sleeper, ScD[2,3]; Jane W. Newburger, MD, MPH[*,2,3]

DELIVERING MORE EQUITABLE CARE

Rachel Shustak, MD MSCE

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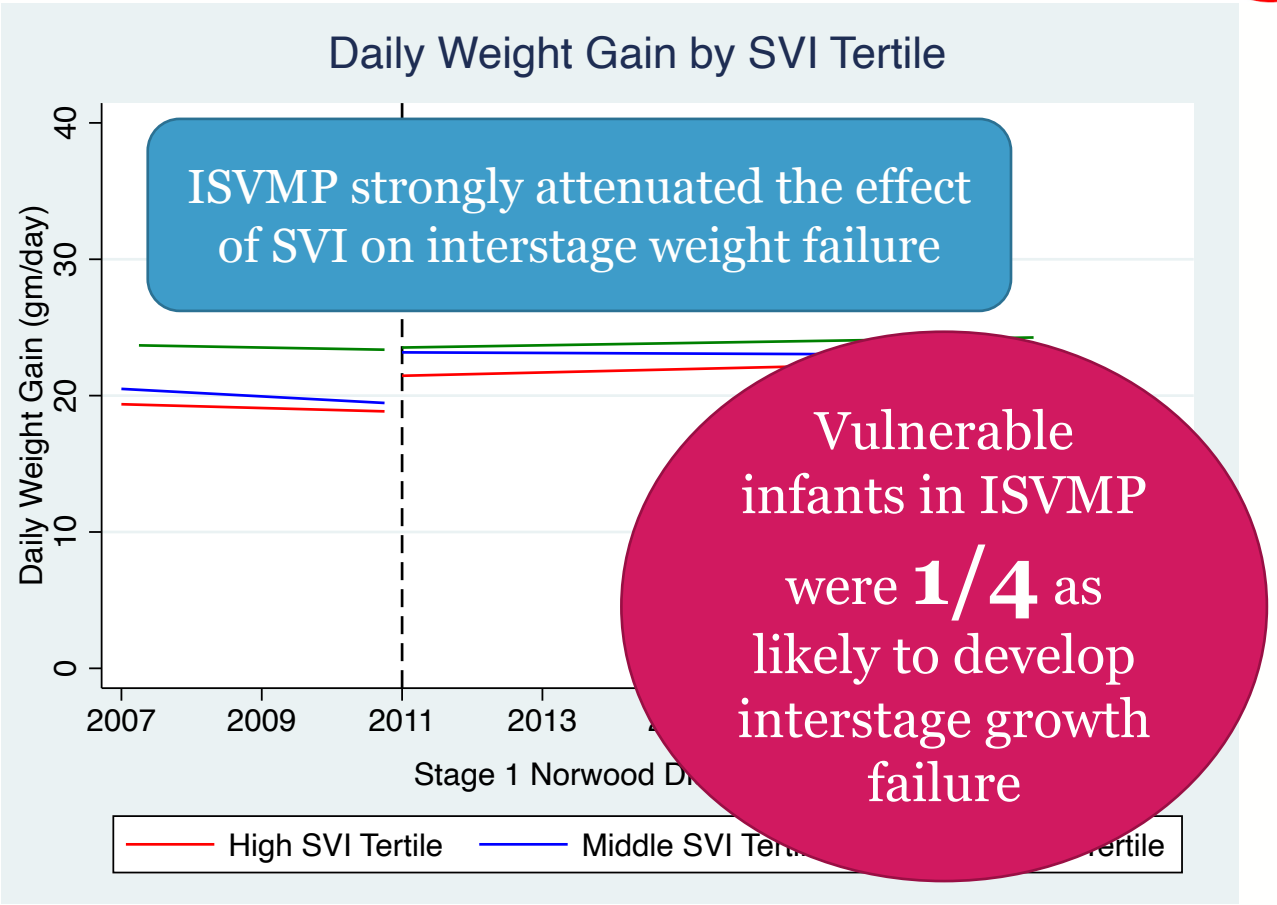
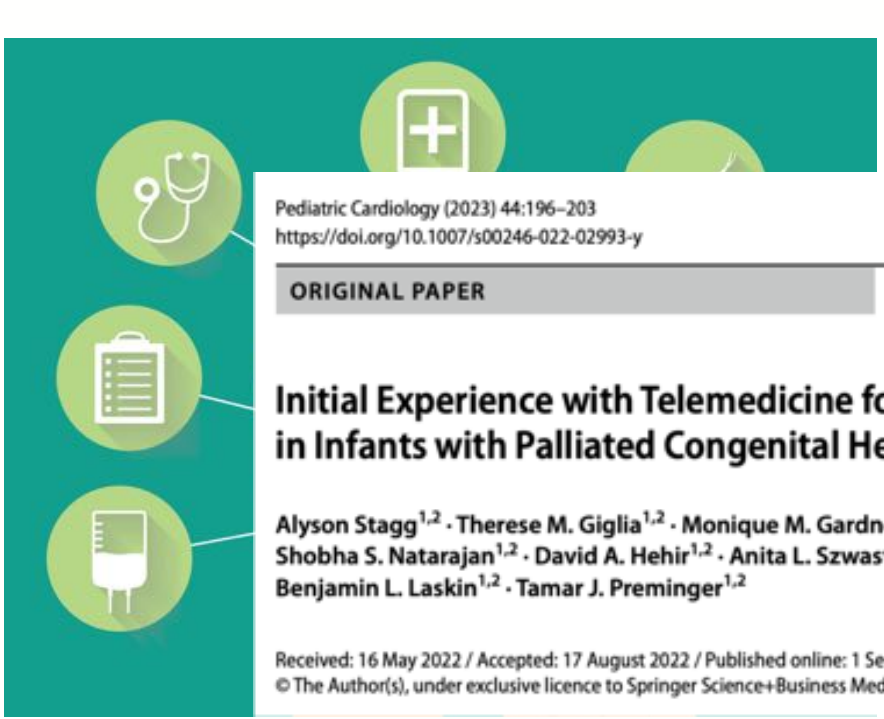


LEVERAGING TECHNOLOGY



Pediatric Cardiology (2023) 44:196–203
https://doi.org/10.1007/s00246-022-02993-y

ORIGINAL PAPER

Initial Experience with Telemedicine for Interstage Monitoring in Infants with Palliated Congenital Heart Disease

Alyson Stagg[1,2] · Therese M. Giglia[1,2] · Monique M. Gardner[1,2] · Bonnie F. Offit[1] · Kate M. Fuller[1] · Shobha S. Natarajan[1,2] · David A. Hehir[1,2] · Anita L. Szwast[1,2] · Jonathan J. Rome[1,2] · Chitra Ravishankar[1,2] · Benjamin L. Laskin[1,2] · Tamar J. Preminger[1,2]

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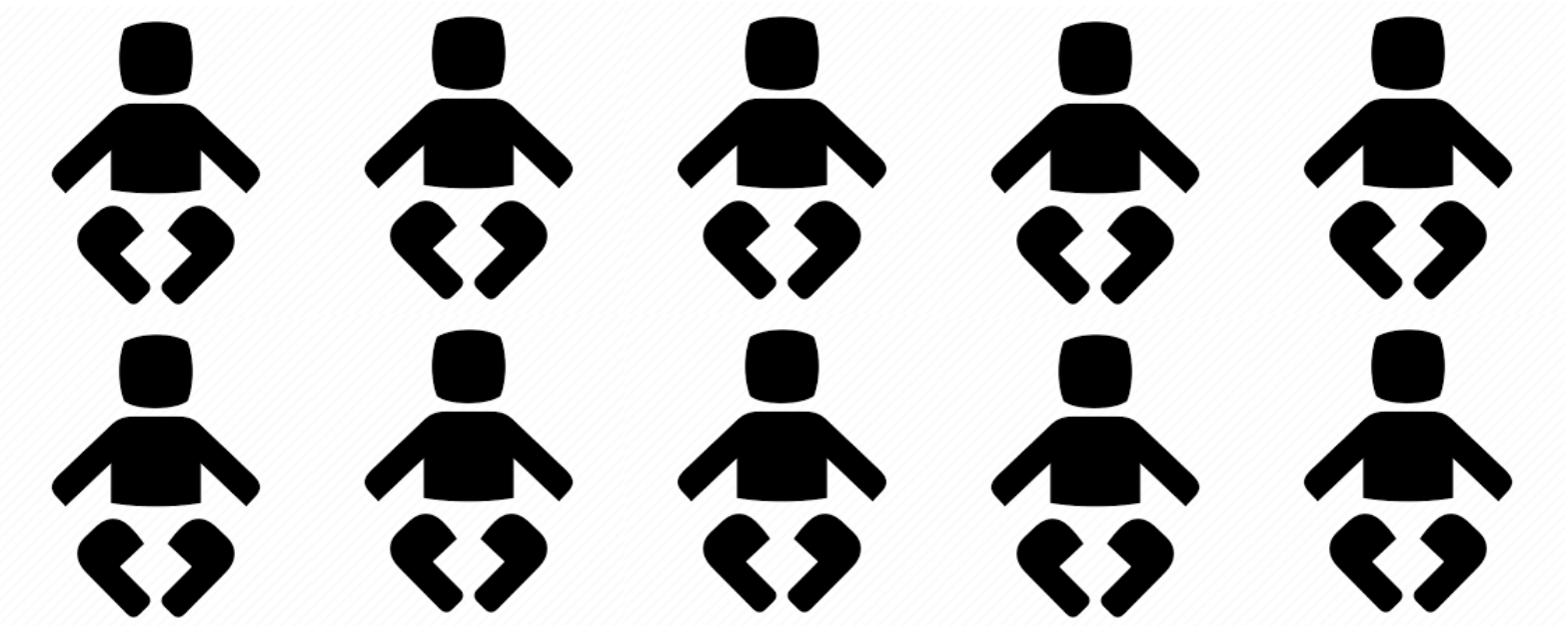
PERSONALIZED HMP: NOVEL BIOMARKERS OF RISK



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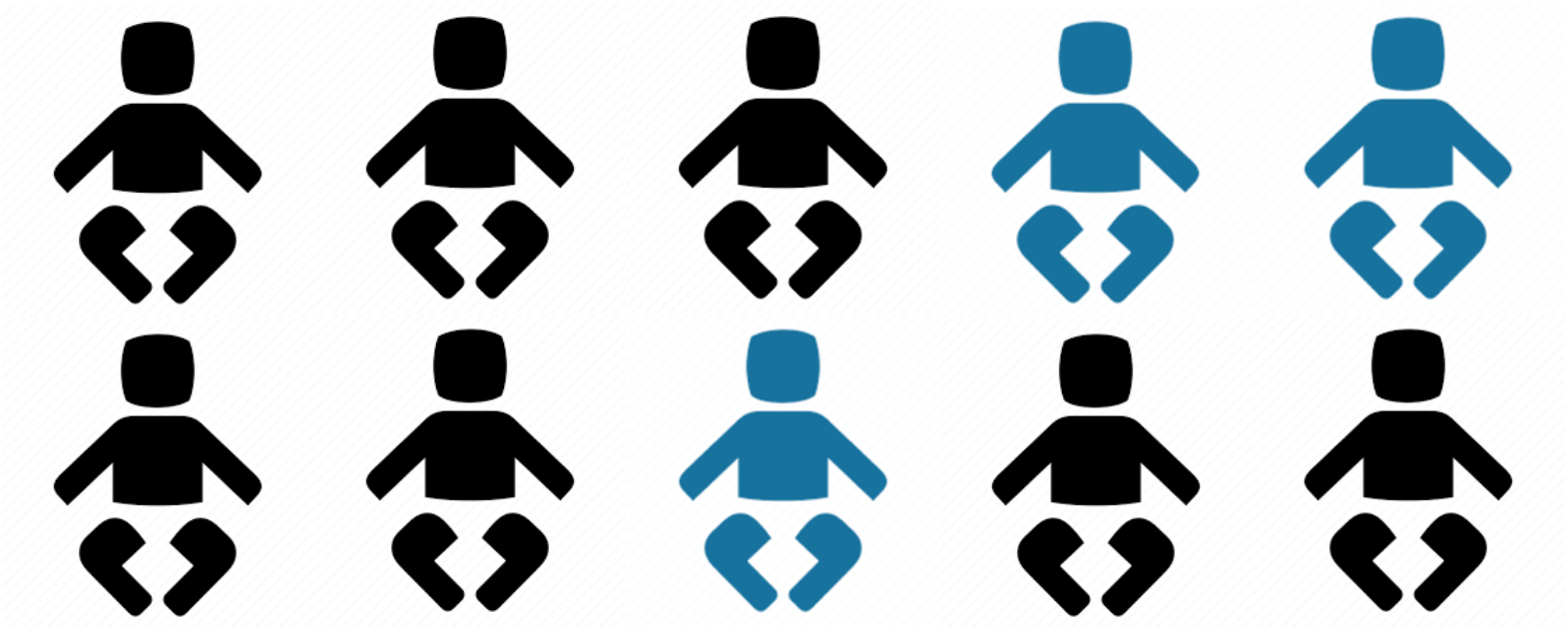

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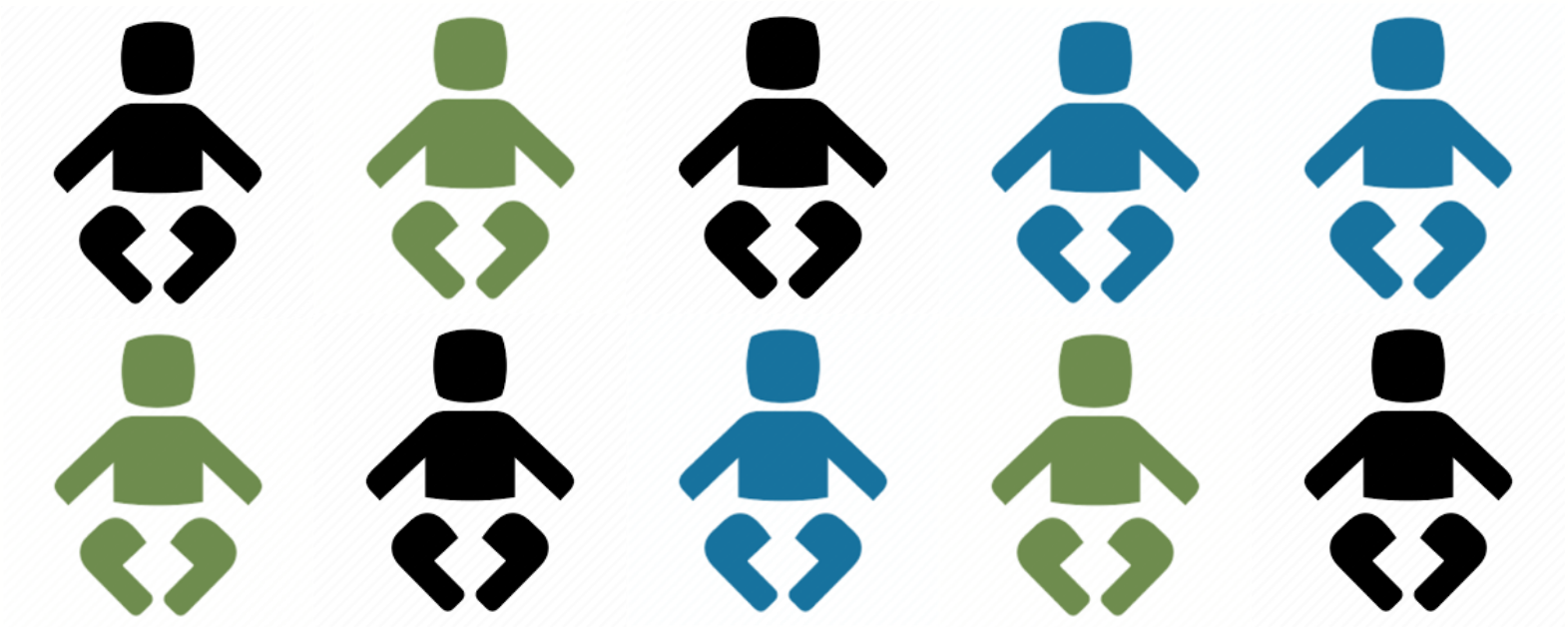

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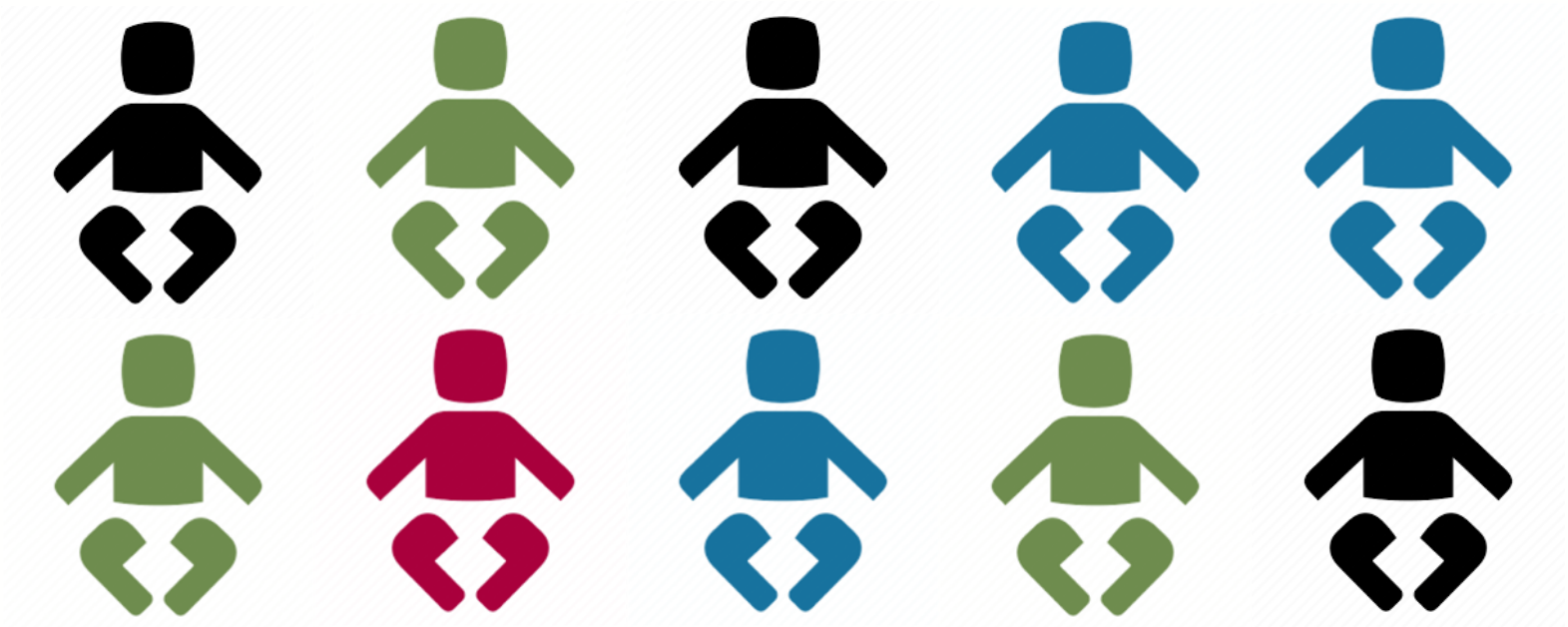


THE [SECOND] INTERSTAGE PERIOD?

Interstage attrition between bidi
palliation in children with hypop

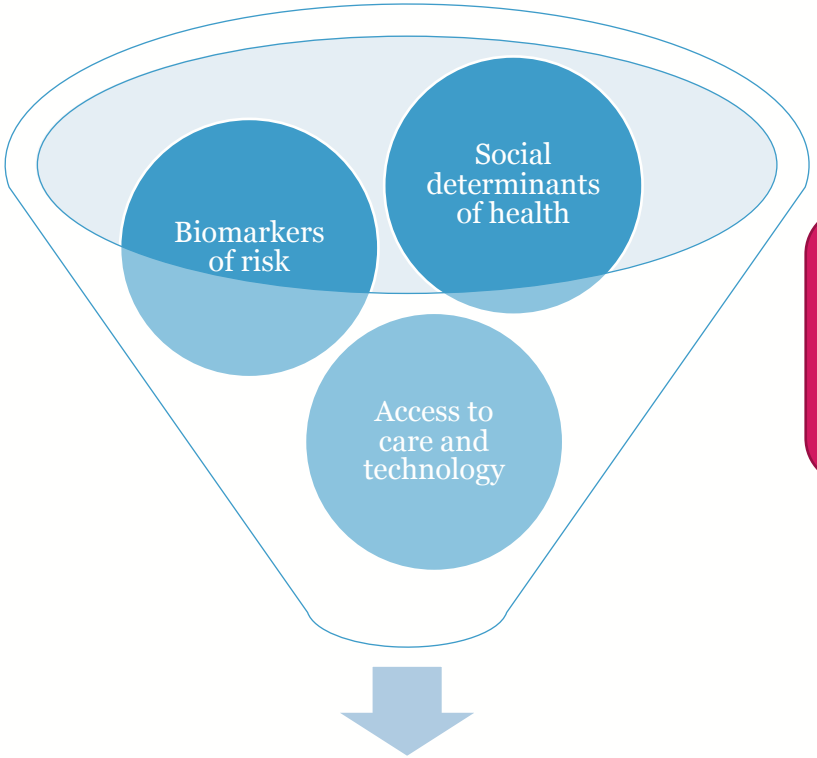
"Interstage attrition bet
Fontan procedures occ
pop

ELSEVIER
The Journal of Thoracic and Cardiovascular Surgery
Available online 22 October 2020
In Press, Journal Pre-proof

Attrition Between the Superior Cavo-Pulmonary Connection and the Fontan Procedure in Hypoplastic Left Heart Syndrome

Could home monitoring make a difference?

"In this study spanning more than 3 decades, ***8.3% of children with HLHS failed to undergo Fontan after SCPC.*** *Attrition rate has not decreased over 30 years.*



Uniform, standardized care?

Should we tailor our monitoring to the patient?

SO, HOME MONITORING: HOW DID WE DO THIS AND WHAT COMES NEXT?

Alyson Stagg, CRNP

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