COVID 19 AND PEDIATRIC CARDIAC ANESTHESIA PROGRAMS

Moderators:
Viviane G. Nasr, MD
Mona Momeni, MD

Session I: Changes in Institutional Practice during the COVID-19 Pandemic: Triage, COVID-19 testing, PPE and TEE use.

Session II: Risk of Blood Shortage during the COVID-19 Pandemic. Blood Conservation and Transfusion Protocol.

Session III: Panel discussion with representation from different regions in North America.

COVID-19 Disease Pandemic
Case Selection / Triage

Luis M. Zabala, MD
Professor of Anesthesiology
Director Pediatric Cardiac Anesthesia
Department of Anesthesia and Pain Management
UT Southwestern, Children's Health
Dallas, TX

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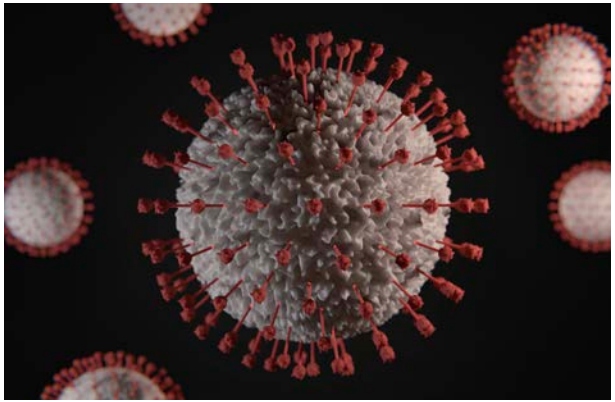
Children's Medical Center

COVID 19 AND PEDIATRIC CARDIAC ANESTHESIA PROGRAMS

Outline

- Context
- Lessons Learned from other Countries
- Healthcare Response
- Children's Health Dallas Experience

Context – PPE



World Health Organization

Shortage of personal protective equipment endangering health workers worldwide

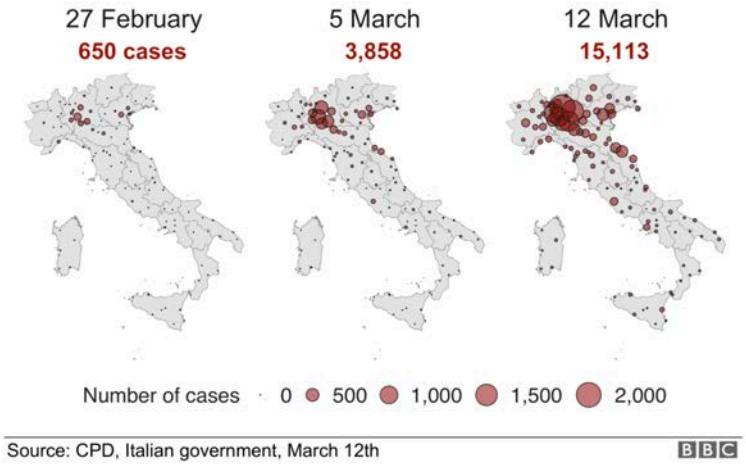
3 March 2020 | News release | Geneva

WHO calls on industry and governments to increase manufacturing by 40 per cent to meet rising global demand

https://www.northernvirginiamag.com/culture/news/2020/03/12/who-declares-global-pandemic-local-venues-cancel-mass-gatherings/
https://www.who.int

Lessons Learned

Change in number of reported cases in Italy, by province



Infrastructure and Personnel

INTENSIVE CARE: Medical staff in protective suits treat coronavirus patients in an intensive care unit at the Cremona hospital in northern Italy.
Image Credit: REUTERS/REUTERS


NURSE TAKES A BRIEF RESPITE: A nurse rests during a night shift at a hospital in Cremona, Italy.
Image Credit: REUTERS

https://www.bbc.com/news/uk-51858987
https://gulfnews.com/photos/news/photos-italys-hospitals-struggle-through-coronavirus-outbreak-1.1584276575459?slide=7

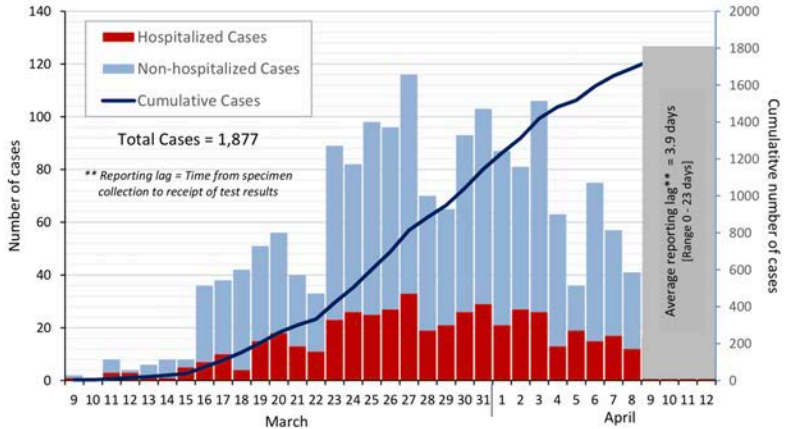
US Response – March 2020

Guidance/ Recommendations	Goals
Social distancing	Decrease rate of infection
CDC	Preserve PPE
CMS and DHHS	Protect the safety of health care professionals
American College of Surgeons	Allocate scarce resources for the care of COVID patients

Community Needs
Dallas County Data / 8 Hospitals

Figure 1. Daily and Cumulative COVID-19 Cases by Date of Test collection, Dallas County: March 10 – April 12, 2020*

**The data in this summary reflect cumulative data received as of 8:00 pm, April 13, 2020. All data are preliminary and subject to change as cases represented are being actively investigated, and may be updated between press releases. Includes only cases in Dallas County residents.*



https://www.dallascounty.org/covid-19/
https://www.wfaa.com/article/news/health/coronavirus/

Resources Available

- **Total beds**: 2,868
- **Beds occupied**: 1,542
- **Total ICU beds**: 361
- **ICU beds occupied**: 204
- **Total ventilators**: 342
- **Ventilators in use**: 139

Recent Numbers COVID 19
Total Cases 1877
Admitted to ICU 173

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COVID-19 Guidelines for Triage of Pediatric Patients Congenital Heart Disease

- "Elective Cases" Delay results in minimal patient risk (> 2 Months).
  - No anticipated short-term or long-term negative impact as a result of delaying a procedure or surgery.

- Medically managed arrythmias for EPS.
- Slowly progressive AS scheduled for Ross operation
- Valvular regurgitation managed medically

- "Urgent or Medically Indicated Cases" Delays of days to weeks may be detrimental.
  - Deterioration or disease progression if the procedure is significantly delayed.

- Obstructive lesions stabilized with PGE
- AVC on maximal therapy / FTT/ repeat hospitalization
- Most neonatal CHD

- "Emergency Cases" Delay is life threatening.

- Obstructed veins, shunt thrombosis, HLHS intact atrial septum, ECMO or VAD,
- Transplant

COVID-19: Crisis Management in Congenital Heart Surgery

		Emergent (24-48 hours of diagnosis when adequate resources)	**Urgent** (within 1-2 weeks when adequate resources)	**High priority elective** (>2 weeks when adequate resources)
Neonate		*note: timing for categories will depend on resources available, institutional protocols, and other pending cases*		
Shunts, Mixing Lesions				
	TAPVC/cor triatriatum	obstructed	increasing gradient	
	TGA		<1 week if IVS	2-4 weeks if VSD
	Truncus Arteriosus			if stable
	Tetralogy of Fallot	severe hypoxemia/hypercyanotic spells	symptomatic	
Regurgitant Lesions				
	Ebstein Anomaly		refractory medical management	
Obstructive Lesions				
	Coarctation	shock unable to stabilize on PGE	if able to stabilize on PGE	
	Critical Aortic Stenosis	shock unable to stabilize on PGE	if able to stabilize on PGE	
PGE-dependent pulmonary blood flow				
	PA/IVS		if PDA stent not available	
PGE-dependent systemic blood flow				
	HLHS	intact, restrictive atrial sepum if BAS not available	case and surgeon dependent	case and surgeon dependent
Other				
	Shunt	shunt thrombosis	shunt stenosis	
	Arrhythmias	symptomatic congenital heart block unable to medically manage/externally pace		
	ALCAPA	once medically stabilized		

- https://wspchs.org/component/edocman/covid-19-crisis-management-in-congenital-heart-surgery

Children's Health Dallas

- COVID–19 Surgical Review Committee
  - Surgeon, Anesthesia, Cardiology, CV Anesthesia Coordinator, Catheterization, EP, Imaging.
  - Surgical NP, OR Manager and Heart Center Administration
- Meetings
  - March 12th - Review the list through April 22nd
  - March 24th – Review the list through May 10th
- Cancelled > 70 elective surgery/ catheterization/ EP
  - Volume down 20% March / 50% April (projected)

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- Medically Indicated Procedures (Inpatients)
  - PICC Lines
  - Direct laryngoscopy bronchoscopy
  - Bronchoscopy / BAL
  - MRI brain (pre-surgery / diagnostic)
  - Bedside chest closures
  - CT Angio

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Summary

- Time to prepare and anticipate is critical
- Understanding your community needs and resources is critical
- There is no single agreed upon surgical triage list for patients with CHD
- Triage will depend on clinical status, individual resources, capacity and personnel
- COVID-19 Surgical Triage Committee recommended

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Testing for SARS-CoV-2
&
Personal Protective Equipment (PPE)

Dr. Mark Twite MA MB BChir FRCP
Professor of Anesthesiology
Director of Congenital Cardiac Anesthesia
Children's Hospital Colorado &
University of Colorado Anschutz Medical Campus

Mark.Twite@CUAnschutz.edu

University of Colorado
Anschutz Medical Campus

Nomenclature

SARS-CoV-2	Severe Acute Respiratory Syndrome Coronavirus 2
COVID-19	Coronavirus Disease 2019 (declared a pandemic on March 11th 2020 by the WHO)

COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University (JHU)

Total Confirmed
2,273,382

Confirmed Cases by Country/Region/Sovereignty

- 706,830 US
- 191,726 Spain
- 172,434 Italy
- 149,132 France
- 141,968 Germany
- 115,299 United Kingdom
- 83,786 China
- 80,868 Iran
- 78,546 Turkey
- 37,183 Belgium
- 36,793 Russia
- 34,221 Brazil
- 32,857 Canada
- 31,766 Netherlands
- 27,404 Switzerland
- 19,685 Portugal

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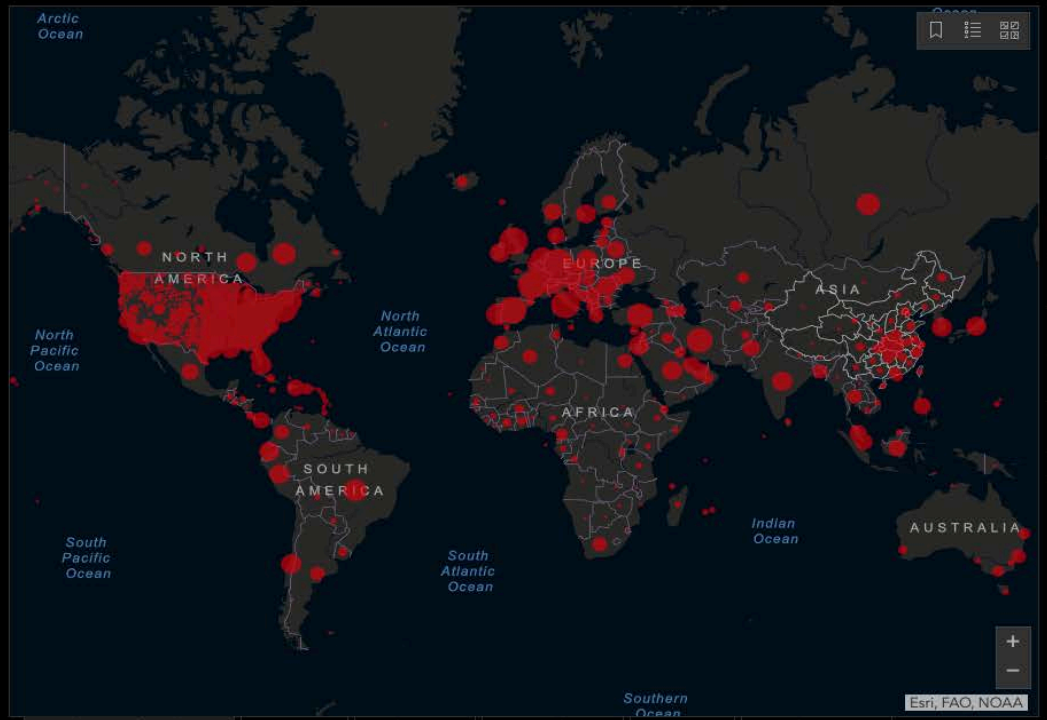
Last Updated at (M/D/YYYY)
4/18/2020, 7:38:24 AM



Cumulative Confirmed Cases | Active Cases | Incidence Rate | Case-Fatality Ratio | Testing Rate | Hospitalization Rate

185 countries/regions

Lancet Inf Dis Article: Here. Mobile Version: Here.
Lead by JHU CSSE. Automation Support: Esri Living Atlas team and JHU APL. Contact US. FAQ.

Data sources: WHO, CDC, ECDC, NHC, DXY, 1point3acres, Worldometers.info, BNO, the COVID Tracking Project (testing and hospitalizations), state and national government health departments, and local media

Total Deaths
156,064

- 22,745 deaths Italy
- 20,043 deaths Spain
- 18,681 deaths France
- 15,464 deaths United Kingdom
- 13,202 deaths New York City **New York** US
- 5,453 deaths Belgium
- 5,031 deaths Iran
- 4,512 deaths

Deaths | Recovered

Total Tested in the US
3,574,392

- 573,223 tested **New York** US
- 251,614 tested **California** US
- 239,982 tested **Florida** US
- 169,536 tested **Texas** US
- 157,449 tested **New Jersey** US
- 148,744 tested **Massachusetts** US
- 147,373 tested **Pennsylvania** US
- 131,987 tested Louisiana US

US Tested

Confirmed | Logarithmic | Daily Cases

COVID-19 United States Cases by County Johns Hopkins University

State: Please select a state | County: Please select a county

Total Confirmed
694,296

Total Deaths
31,456

Total Recovered
58,545

Top 50 Confirmed Cases by County

37,447 confirmed
Queens

22,499 confirmed
Kings

20,539 confirmed
Nassau

17,014 confirmed
Bronx

15,035 confirmed
Suffolk

12,476 confirmed
Westchester

11,391 confirmed
Cook

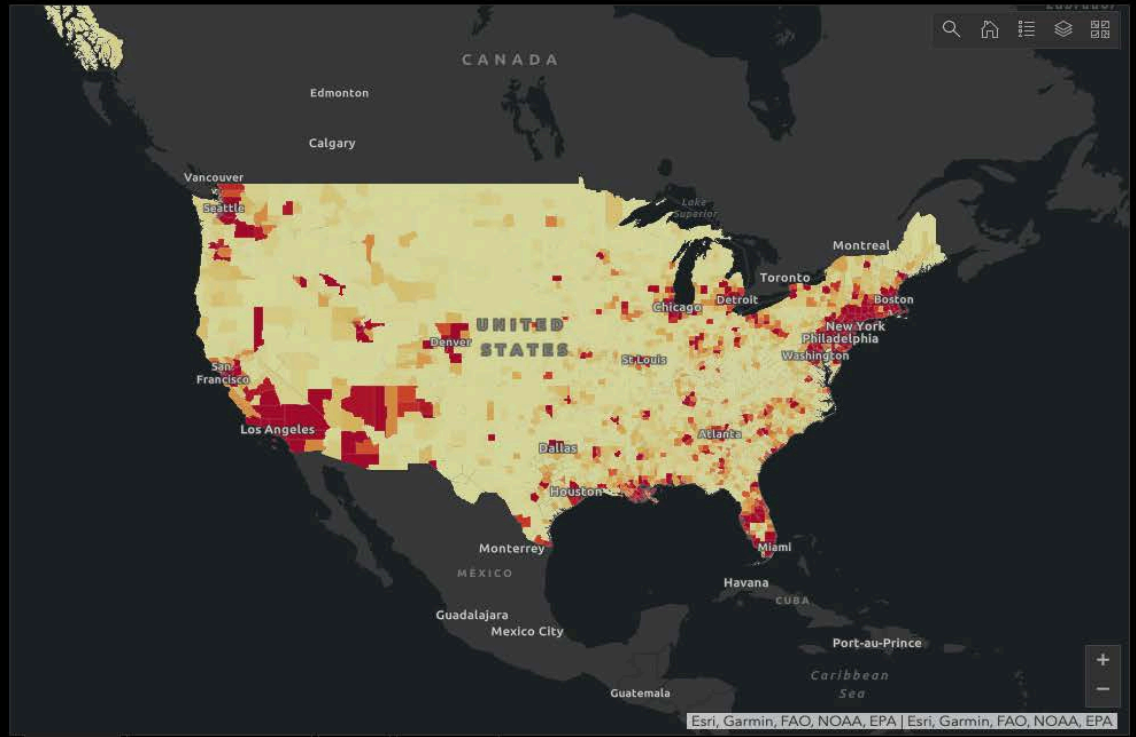
10,952 confirmed
New York

10,233 confirmed
Wayne

9,863 confirmed
Bergen

9,400 confirmed
Los Angeles

8,472 confirmed
Essex



Confirmed | Confirmed by Population | Deaths | Fatality Rate

Top 20 Counties by Number of Deaths

2,402 deaths
Queens

2,293 deaths
Kings

1,802 deaths
Bronx

1,109 deaths
Nassau

1,044 deaths
Wayne

1,004 deaths
New York

760 deaths
Cook

714 deaths
Bergen

Confirmed | Deaths

Last Updated on:
2020-04-17

Map Data Sources (for the section under the U.S. Map)
Data is updated daily after 8 p.m. Eastern.
Map Visualization: Centers for Civic Impact. Automation Support: Esri Living Atlas team, JHU APL, and JHU Sheridan Libraries. Contact Us. FAQ.
Data sources: Coronavirus COVID-19 Global Cases by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University; the Red Cross; the Census American

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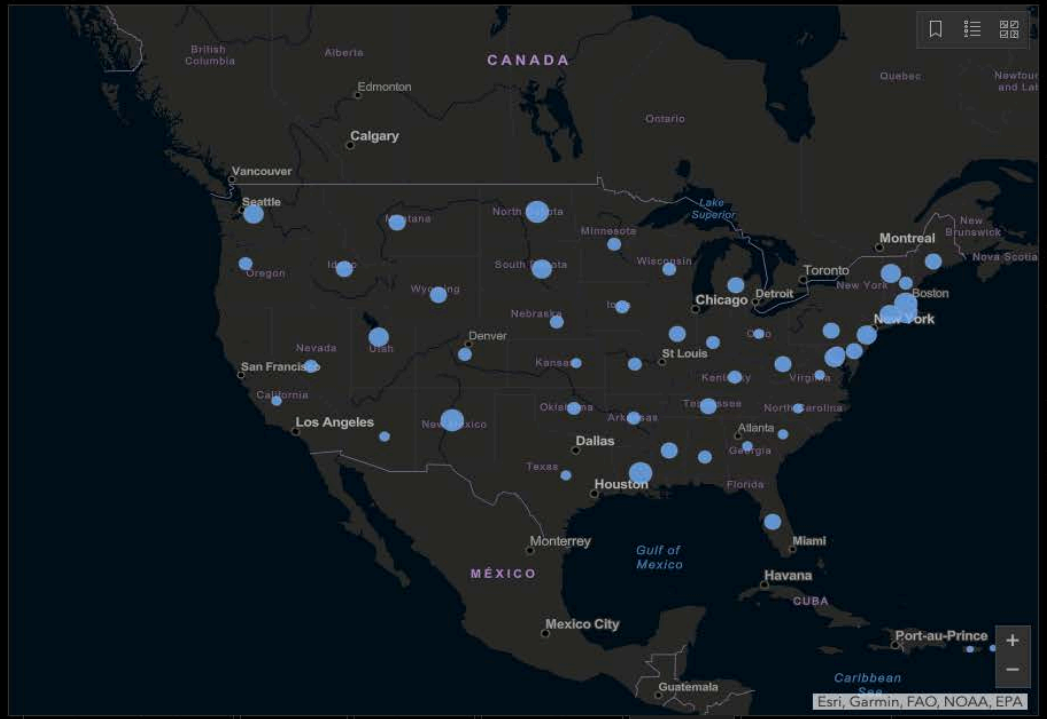

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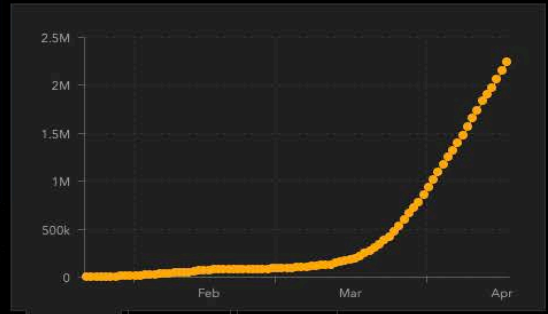
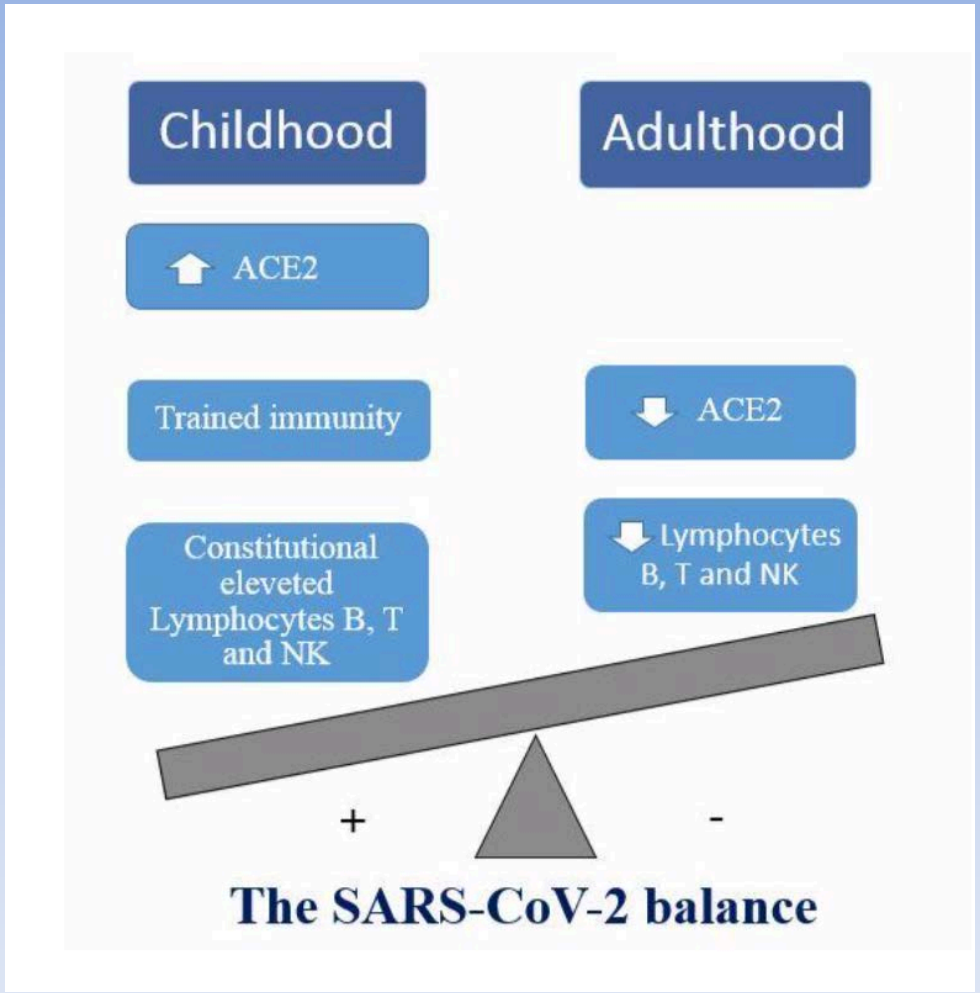


Confirmed | Logarithmic | Daily Cases

ACE 2 protein expressed in lungs and is the binding site of the SARS-CoV-2 S protein which downregulates it. Low ACE2 can cause chronic heart failure & lung injury.

Frequent viral infections and vaccinations in children induce an active innate immune system which is protective against different pathogens

Children infected with SARS-CoV-2 often have normal lymphocyte counts. Possibly due to the everlasting immune system activation in childhood. Less activation of cytokine storm.



ARDS
Heart failure
Cytokine storm
Hypercoagulable

Will children reveal their secret? The coronavirus dilemma *Eu Resp J 2020 In press*

World Health Organization

Test, Test, Test……..

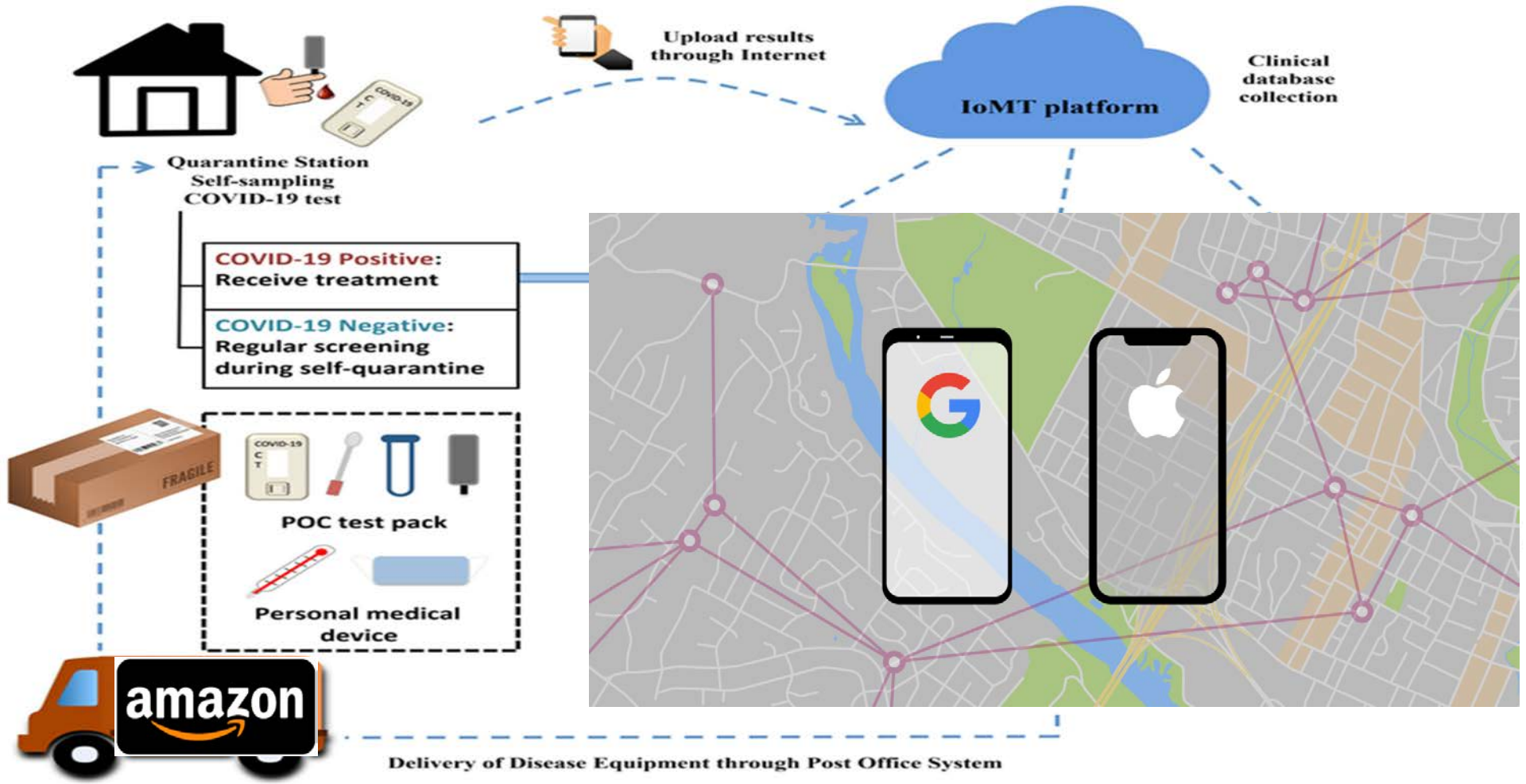
Global strategy to control the COVID-19 pandemic is to **SLOW DOWN TRANSMISSION** and **REDUCE MORTALITY** associated with the disease

COVID-19 Strategy Update WHO April 14th, 2020

Why test?

- Mitigation strategies
- Diagnosis to guide clinical care of the patient and appropriate PPE for healthcare workers
- Guide public policy to re-open operating rooms, businesses, schools etc.
- Verify future vaccines work

"Very aggressive contact tracing required for US to return to normal"
Robert Redfield, CDC Director. April 10th 2020



Yang, T.; Gentile, M.; Shen, C.-F.; Cheng, C.-M. Combining Point-of-Care Diagnostics and Internet of Medical Things (IoMT) to Combat the COVID-19 Pandemic. Diagnostics 2020, 10, 224.

nature biotechnology

NEWS · 23 MARCH 2020

· UPDATE 17 APRIL 2020 , UPDATE 14 APRIL 2020 , UPDATE 07 APRIL 2020 , UPDATE 06 APRIL 2020 , UPDATE 01 APRIL 2020

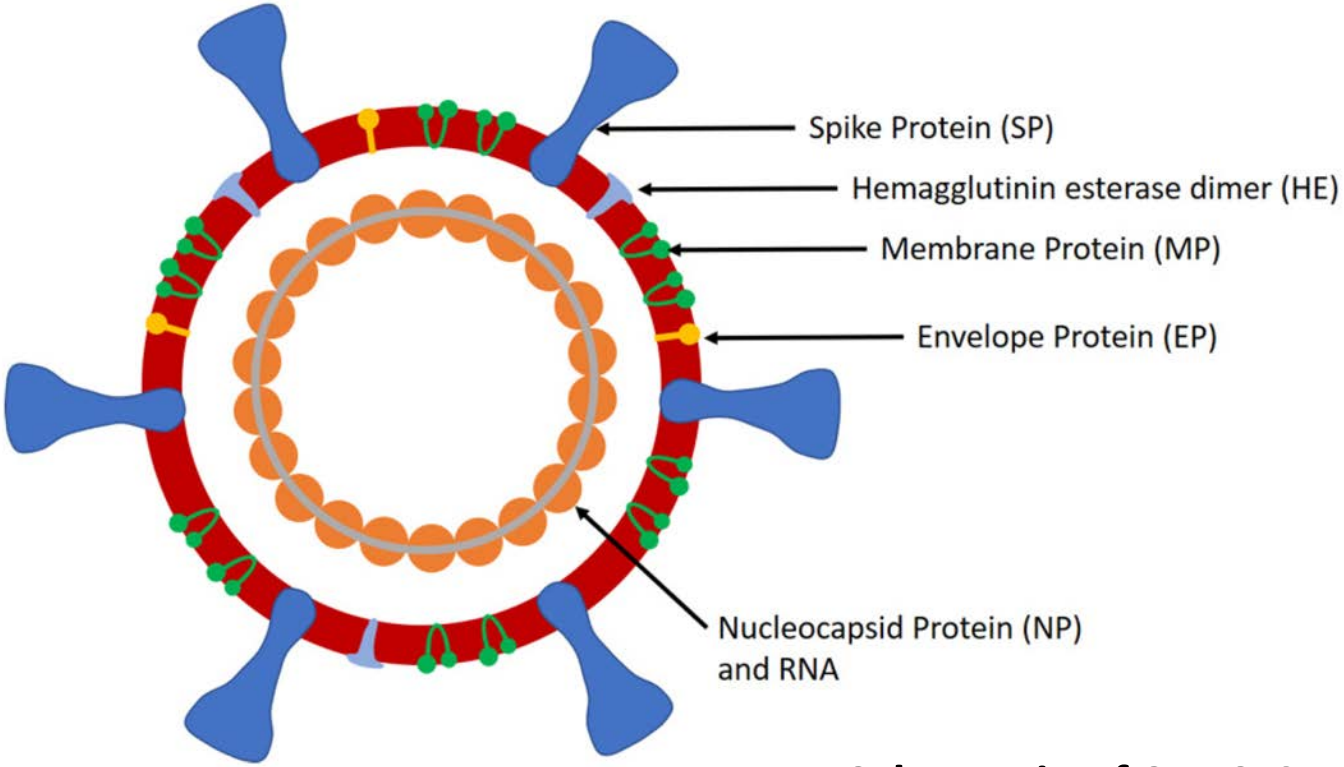
Fast, portable tests come online to curb coronavirus pandemic

Testing kits delivered by courier and digital tools combine to battle the COVID-19 outbreak.

Cormac Sheridan

7 Viral RNA Tests in Commercial Development
13 Antibody Tests in Commercial Development

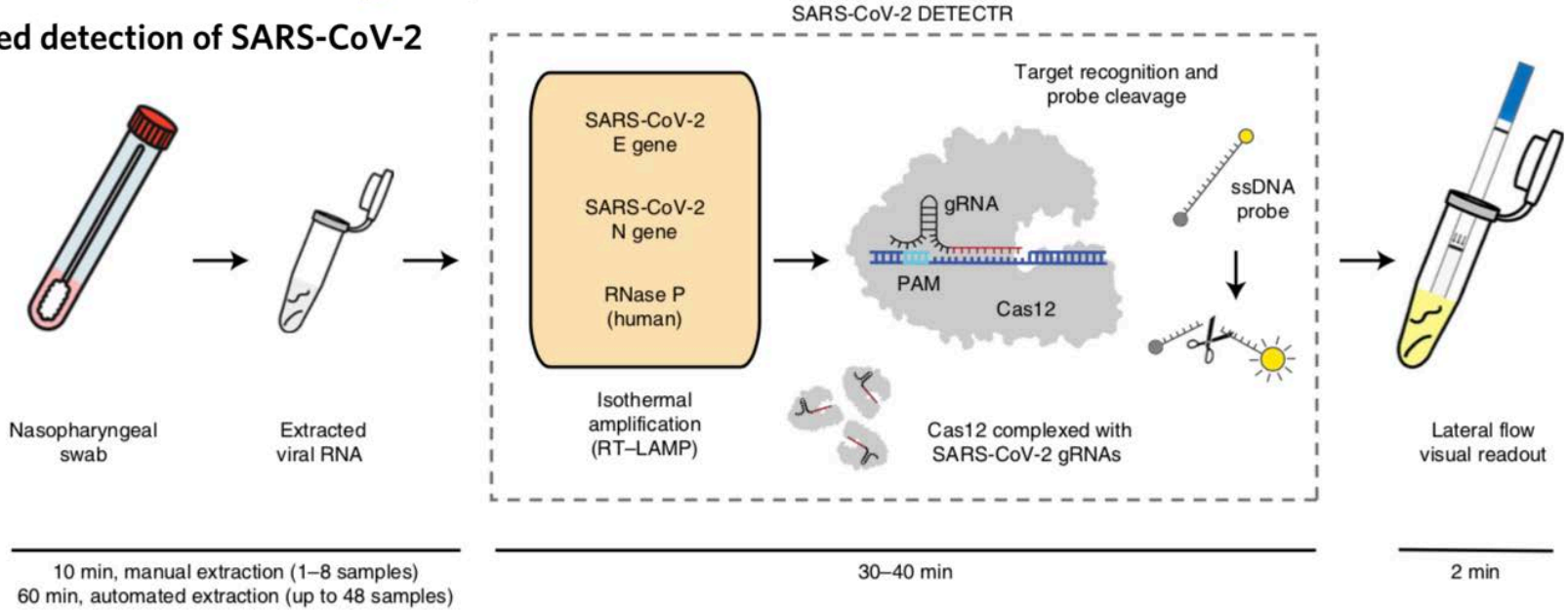
	Viral RNA	Antibody detection
Test technology	Real time RT-PCR CRISPR	

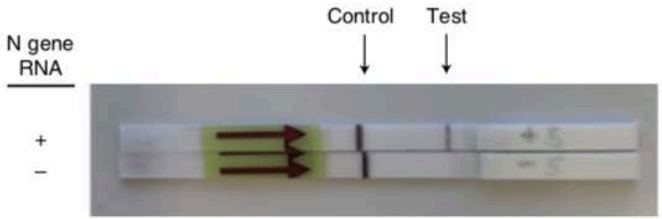


Schematic of SARS-CoV-2

nature biotechnology
LETTERS
https://doi.org/10.1038/s41587-020-0513-4
Check for updates

CRISPR–Cas12-based detection of SARS-CoV-2





N gene	E gene	RNase P	Result
+	+	+/–	SARS-CoV-2 positive
+	–	+/–	Presumptive positive
–	+	+/–	Presumptive positive
–	–	+	SARS-CoV-2 negative
–	–	–	QC failure

	Viral RNA	Antibody detection
Test technology	Real time RT-PCR CRISPR	
Validation	FDA EUA Clinical studies lacking	

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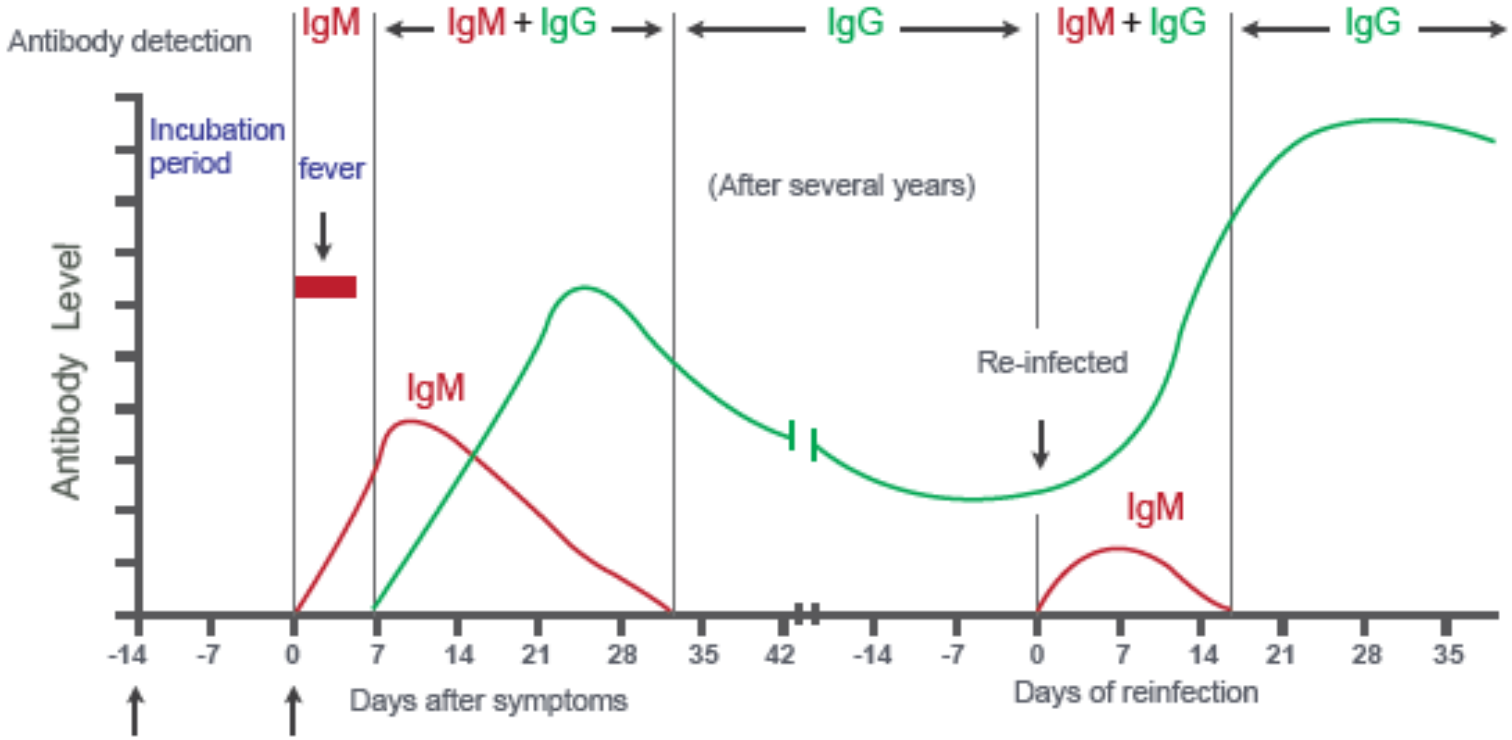
Time to result	20 mins to 48 hrs	
Equipment	Certified labs, special equipment Developing POC office kits	



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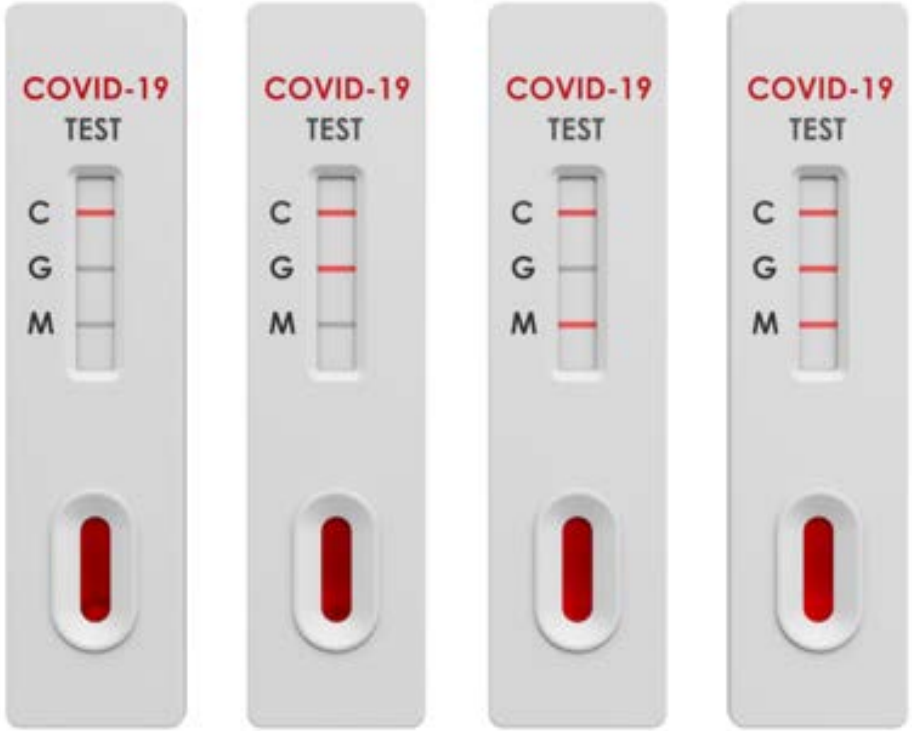

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Sample collection (& sample quality)	NP and OP swabs (availability issues) Nasal wash BAL if pneumonia, critically ill	Few drops of blood
Time of Collection (& variable virus load)	Anytime – symptomatic or asymptomatic	
Time to result	20 mins to 48 hrs	
Equipment	Certified labs, special equipment Developing POC office kits	

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Sample collection (& sample quality)	NP and OP swabs (availability issues) Nasal wash BAL if pneumonia, critically ill	Few drops of blood
Time of Collection (& variable virus load)	Anytime – symptomatic or asymptomatic	7 – 14 days after exposure
Time to result	20 mins to 48 hrs	
Equipment	Certified labs, special equipment Developing POC office kits	

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Time to result	20 mins to 48 hrs	15 mins
Equipment	Certified labs, special equipment Developing POC office kits	Home kits

Who is CHC (viral RNA) testing?

- Every patient admitted to the hospital
- Every patient 24hr before anesthesia
    - Asymptomatic positives?
    - ‘False’ negatives?
- High risk outpatients (oncology, heart transplants)
- Health care workers with symptoms
- Parents?

Children's Hospital Colorado

US Aircraft Carrier Theodore Roosevelt

Tested 4,800 crew

- 600 SARS-CoV-2 Positive
  - 60% no symptoms

“With regard to COVID-19, we’re learning that stealth in the form of asymptomatic transmission is this adversary’s secret power”

Rear Admiral Bruce Gillingham, surgeon general of the US Navy

Preferably negative pressure room
Separate anesthesia workstation

High risk AGS: bronchoscopy, TEE, endoscopy, dental		High-Risk Aerosol Generating Surgery & Emergent Procedures*	All Other Procedures	
		All patients	COVID-19 positive / PUI or unknown	COVID-19 negative
Intubation / Extubation and Room Clearance Wait Times	**Intubation / Extubation** **Videolaryngoscopy**	**Full duration of case**: **ALL** team members in PAPR or fit-tested respirator Extubation: Minimize coughing	**Intubation/extubation only**: **TWO** providers in PAPR or fit-tested respirator Extubation: Minimize coughing	
	Room Clearance Waiting Time (After Intubation / Extubation)	None	15 min	
	Surgery	Continue PAPR or fit-tested respirator	Continue standard surgical attire following intubation and room clearance time	

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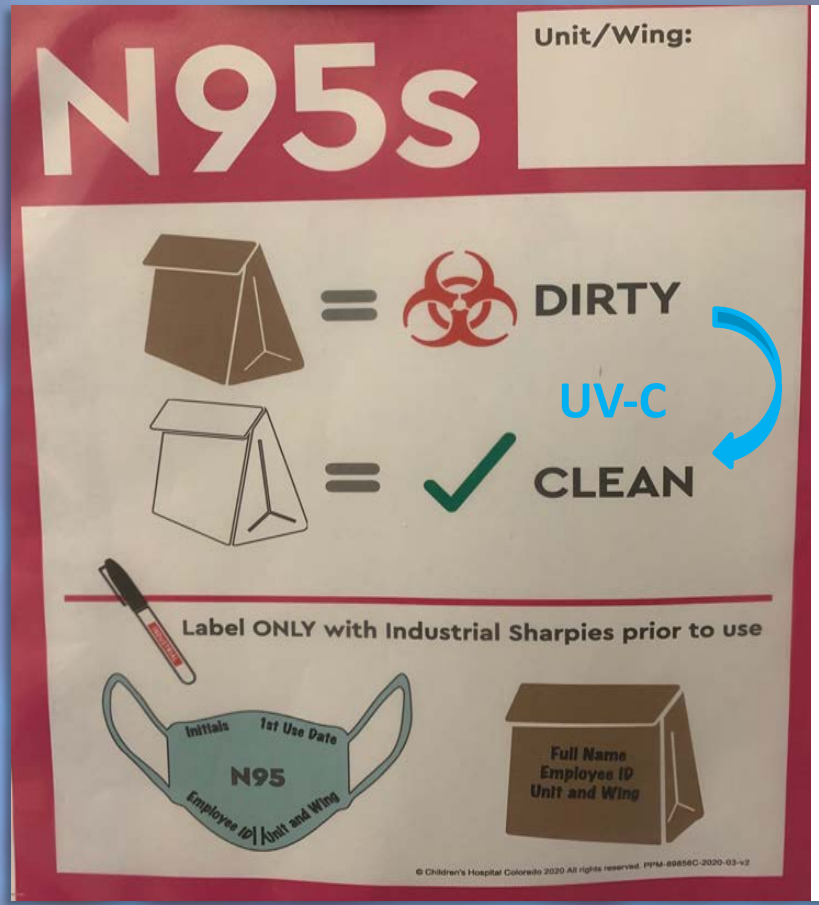

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Selected References

1. Patel R, Babady E, Theel ES, et al. Report from the American Society for Microbiology COVID-19 International Summit, 23 March 2020: Value of Diagnostic Testing for SARS-CoV-2/COVID-19. mBio. 2020;11(2):e00722-20. Published 2020 Mar 26. doi:10.1128/mBio.00722-20
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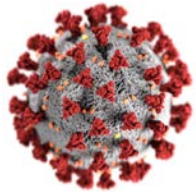


CORONAVIRUS DISEASE AND ECHOCARDIOGRAPHY

Wanda C. Miller-Hance, M.D., FAAP, FACC, FASE
President, Congenital Cardiac Anesthesia Society
Professor of Anesthesiology and Pediatrics
Department of Anesthesiology, Perioperative and Pain Medicine
Department of Pediatrics, Section of Cardiology
Baylor College of Medicine
Texas Children's Hospital
Houston, TX

COVID 19 AND PEDIATRIC CARDIAC ANESTHESIA PROGRAMS

LEARNING OBJECTIVES

- Highlight impact of COVID-19 pandemic in echo services
- Review recent ASE recommendations
- Address consideration regarding TEE
- Outline suggested approach to patients requiring TEE

No Disclosures

COVID-19 – BACKGROUND

From, UT Southwestern Med Ctr

- caused by SARS-CoV-2
- transmission: droplet, fomites, aerosol
- infection in asymptomatic and pre-asymptomatic individuals
- virus detected in upper/lower resp tract, blood, stool
- lung injury, other organs, potential cardiovascular involvement

PUBLIC HEALTH

Heart Damage in COVID-19 Patients Puzzles Doctors

Up to one in five hospitalized patients have signs of heart injury. Cardiologists are trying to learn whether the virus attacks the organ

Scientific American, April 6, 2020

KHN Illustration; Getty Images

AMERICAN COLLEGE of CARDIOLOGY

ACC CLINICAL BULLETIN
COVID-19 Clinical Guidance
For the CV Care Team

COVID-19 Clinical Guidance For the Cardiovascular Care Team

Coronaviruses and the cardiovascular system: acute and long-term implications

FREE

Tian-Yuan Xiong, Simon Redwood, Bernard Prendergast ✉, Mao Chen ✉

European Heart Journal, ehaa231, https://doi.org/10.1093/eurheartj/ehaa231
Published: 18 March 2020

Potential Effects of Coronaviruses on the Cardiovascular System

A Review

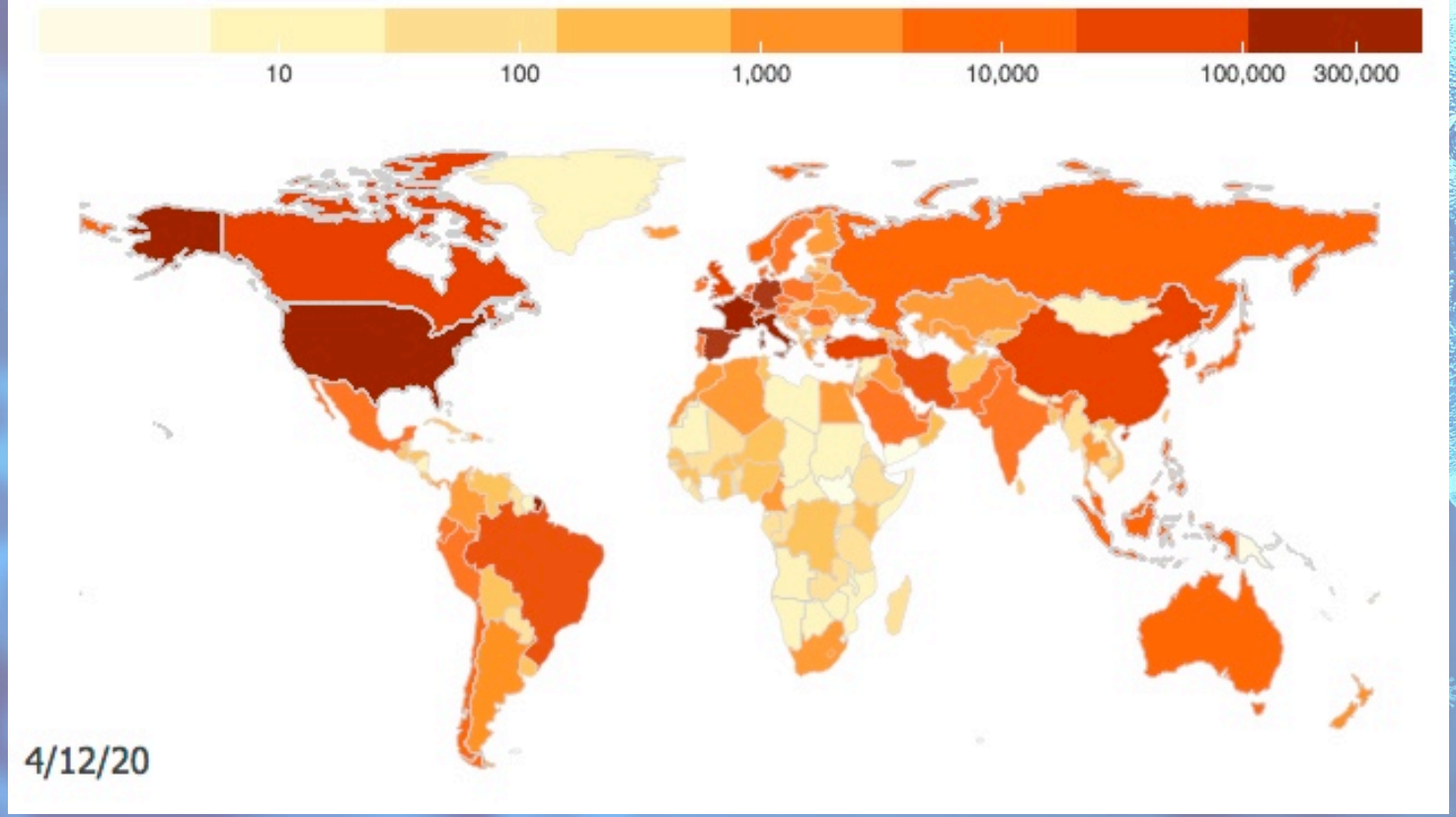
Mohammad Madjid, MD, MS[1]; Payam Safavi-Naeini, MD[2]; Scott D. Solomon, MD[3]; et al

» Author Affiliations | Article Information

JAMA Cardiol. Published online March 27, 2020. doi:10.1001/jamacardio.2020.1286

COVID 19 AND PEDIATRIC CARDIAC ANESTHESIA PROGRAMS

CORONAVIRUS DS 2019 PANDEMIC



From John Hopkins Coronavirus Resource Center

ASE Statement on Protection of Patients and Echocardiography Service Providers During the 2019 Novel Coronavirus Outbreak

Endorsed by the American College of Cardiology

COVID 19 AND PEDIATRIC CARDIAC ANESTHESIA PROGRAMS

ASE Statement on Protection of Patients and Echocardiography Service Providers During the 2019 Novel Coronavirus Outbreak

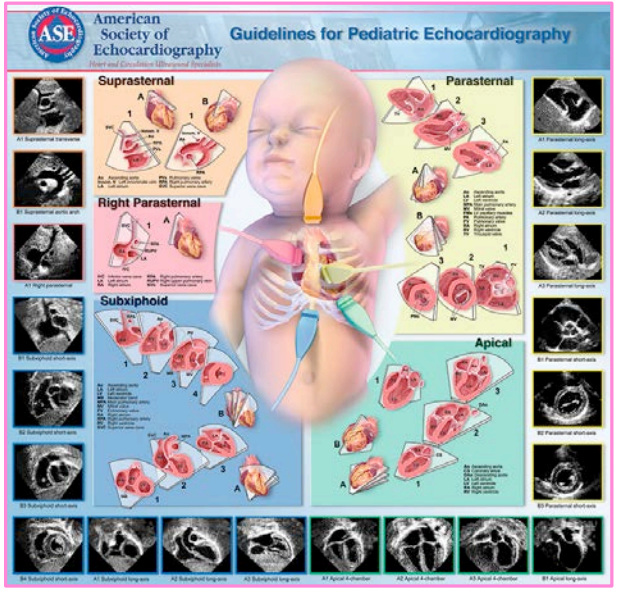
Specific Considerations for the Protection of Patients and Echocardiography Service Providers When Performing Perioperative or Periprocedural Transesophageal Echocardiography During the 2019 Novel Coronavirus Outbreak: Council on Perioperative Echocardiography Supplement to the Statement of the American Society of Echocardiography

Endorsed by the Society of Cardiovascular Anesthesiologists

COVID 19 AND PEDIATRIC CARDIAC ANESTHESIA PROGRAMS


Suggested Algorithm for Determining Indication and Level of Protection of Patients and Echocardiography Service Providers During the 2019 Novel Coronavirus Outbreak
Is an echo indicated at this time?
Yes
No
STOP
Defer/ Reschedule
What is the COVID-19 status?
Negative
Standard Precautions
Consider droplet precautions for TEE
Positive/ Suspected
Special Considerations
TTE/ Stress
1. Echo Lab
2. Ward
3. Cath/EP Lab
4. ED
Droplet Precautions
1. ICU
2. Operating Room
3. Invasive/Non-invasive Ventilation
Airborne Precautions
All TEE
Airborne Precautions
Protocols
Protection
• POCUS
• Focused Imaging
Limit Staff Participation
• Essential Personnel only
• Limit Exposure
• >60
• Chronically ill
• Immunocompromised
• Pregnant
ASE
Sound Saves Lives
© Copyright American Society of Echocardiography. March 2020

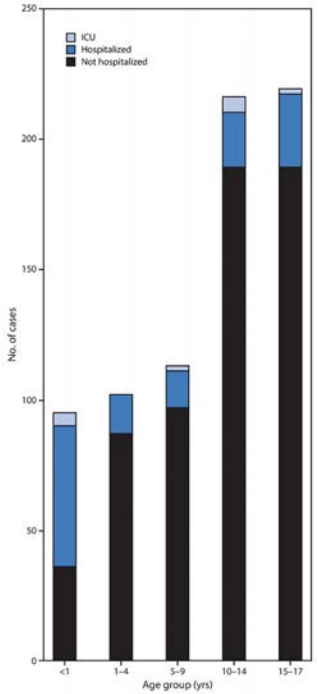
PEDIATRIC ECHOCARDIOGRAPHY



- primary imaging modality of CV system
- essential in dx, mgmt and surveillance
- various modalities
- outcome benefits

COVID-19 IN CHILDREN

- contribute to viral transmission
- minority of cases
- fewer symptoms, mild disease
- low fatality rate



COVID-19 in Children-USA, Feb 12–Apr 2, 2020
From MMWR Morb Mortal Wkly Rep 2020;69

COVID-19, CHILDREN AND ECHO

- SARS-CoV-2 infection more likely asymptomatic
- accompanied by parents/caregivers for exam
- uncooperative
- secretions
- limited ability to wear a mask
- unable to maintain social distancing

Specific Considerations for Pediatric, Fetal, and Congenital Heart Disease Patients and Echocardiography Service Providers During the 2019 Novel Coronavirus Outbreak: Council on Pediatric and Congenital Heart Disease Supplement to the Statement of the American Society of Echocardiography

COVID 19 AND PEDIATRIC CARDIAC ANESTHESIA PROGRAMS

TRANSESOPHAGEAL ECHOCARDIOGRAPHY

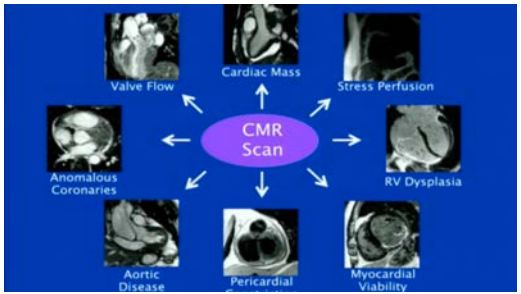
- ***Provides significant benefits***
  - diagnostic, perioperative, and cardiac catheterizations
- ***Heightened risk of SARS-CoV-2 spread***
  - droplet transmission and viral aerosolization
  - cross-contamination

COVID-19 AND TEE

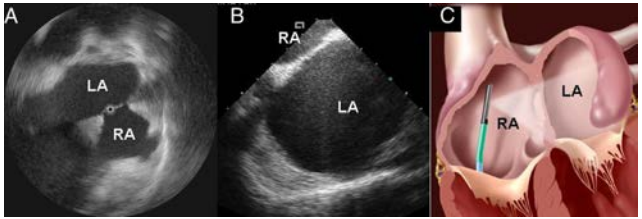
- ***Defer/Reschedule non essential studies/unlikely to impact care***
  - evaluate risk-benefit of all studies
  - case by case assessment
  - defer/reschedule/cancel elective cases
  - proceed with urgent/emergency cases

COVID-19 AND TEE

- Defer/Reschedule non essential studies/unlikely to impact care
- ***Consider alternate options***
  - imaging modalities: TTE, contrast echo, CT, CMR, ICE, epicardial
  - others: invasive hemodyn data, direct surgical observation



From Broadcast Med

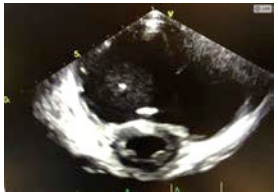


Kim et al., JACC 53:2117-28, 2009

TEE VERSUS EPICARDIAL IMAGING

Epicardial Echo

- interrupts surgery
- risks:
  - ✓ infection
  - ✓ hemodyn changes
  - ✓ arrhythmias
- limited windows
- need expertise



TEE

- standard intraop imaging
- continuous assessment
- esophageal and gastric windows

COVID-19 AND TEE

- Defer/Reschedule non essential studies/unlikely to impact care
- Consider options
- ***Pre-procedure SARS-CoV-2 testing if possible***
  - **assume patient positive unless avail test**

COVID-19 AND TEE

- Defer/Reschedule non essential studies/unlikely to impact care
- Consider options
- Pre-procedure SARS-CoV-2 testing if possible
- ***Precautions***
  - limit personnel exposure
  - PPE recommendations (balance risk vs. resources)
  - prevent environment/equipment/reading room transmission

SUGGESTED APPROACH FOR TEE IN COVID-19

BEFORE PROCEDURE

- Don PPE for airborne precaution measures (gown, face shield or goggles, airborne protection mask)
- Double glove
- Consider covering the ultrasound system (knobs, screen) with a plastic barrier, including transducer ports

DURING PROCEDURE

- Consider using video laryngoscope or direct laryngoscopy to limit contact with patient's secretions
- Limit examination time by performing a focused exam
- Remove outer gloves and wipe inner gloves with approved viricidal wipes or solution whenever other patient activities are undertaken
- Avoid unnecessary contamination of touchable surfaces of the ultrasound system (knobs, screen)

AFTER PROCEDURE

- Remove TEE probe from patient, disinfect probe and place in closed container and/or biohazard bag
- Wipe outer gloves, gown, and sleeves with approved viricidal wipes or solution
- Wipe down equipment and probe container
- Remove outer glove.
- Remove equipment and probe container to induction room/anteroom
- Wipe equipment and probe container with approved viricidal wipes
- Doff PPE
- Transport probe in closed container to the cleaning room for immediate cleaning

From ASE TEE Coronavirus Statement 2020

TEE EQUIPMENT

Handling and cleaning critical

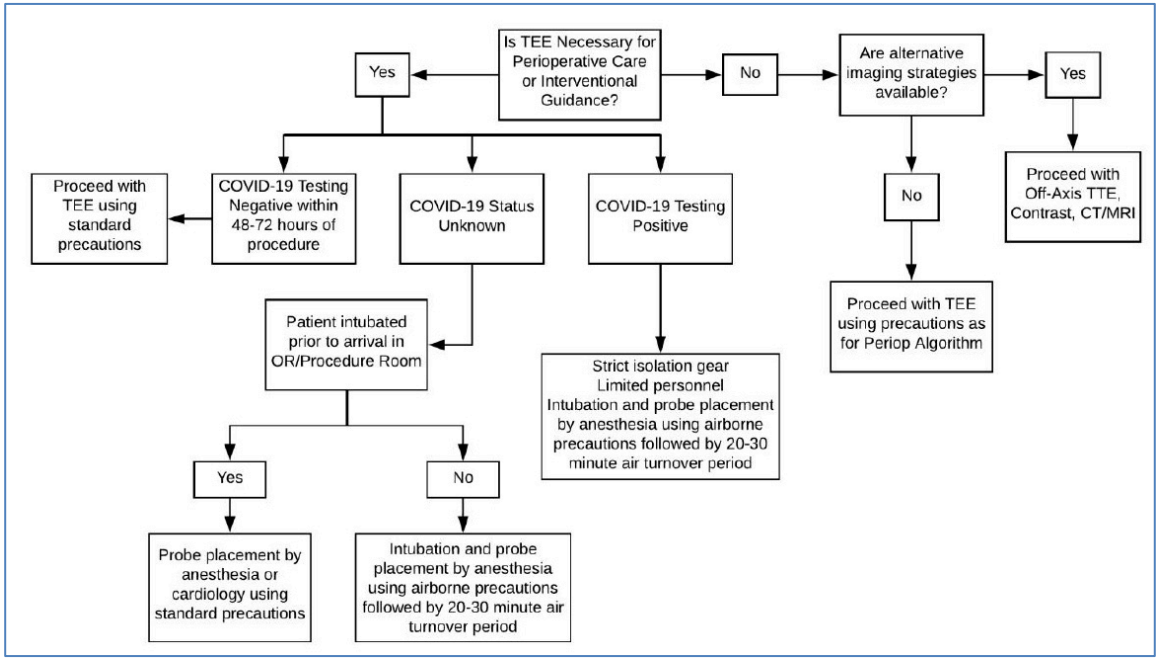
- guided by institutional protocol, ID experts, manufacturers
- consider protective barriers
- two-people model
- reduce non essential equipment from system

From ASE TEE Coronavirus Statement 2020

COVID-19 AND TEE

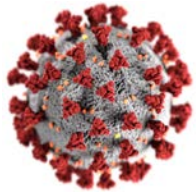
- Defer/Reschedule non essential studies/unlikely to impact care
- Consider options
- Pre-procedure SARS-CoV-2 testing if possible
- Precautions
- ***Collaborative protocols with involved disciplines***

COVID-19 AND TEE



From ASE Pedi, Fetal & CHD Coronavirus Statement 2020

SUMMARY



- ✓ Consider indications
- ✓ COVID-19 testing
- ✓ Regard TEE as aerosol generating procedure
- ✓ Precautions to minimize risk
- ✓ Develop standard approach

Blood Conservation for Pediatric Cardiac Surgery During COVID-19

Nina A. Guzzetta, MD
Emory University School of Medicine
Children's Healthcare of Atlanta

No Financial Disclosures

Blood Conservation is Not New

Patient Blood Management for Neonates and Children Undergoing Cardiac Surgery: 2019 NATA Guidelines

David Faraoni, Jens Meier, Helen V. New, Philippe J. Van der Linden, Beverley J. Hunt
J Cardiothorac Vasc Anesth 2019;33:3249-3263

- **Preoperative Anemia and Optimization of Hemoglobin**
- **Preoperative Coagulation Assessment and Risk Stratification**
- **Anti-fibrinolytic Therapies**
- **Cardiopulmonary Bypass and Priming**
- **Cell Salvage and Normovolemic Hemodilution**
- **Anticoagulation and Monitoring**
- **Intraoperative Monitoring of Hemostasis**
- **Postoperative RBC Transfusion and Thresholds**
- **Fibrinogen Supplementation**
- **Other Products: rFVIIa, PCCs, Desmopressin**

Recommendations

- **31 bullet-pointed recommendations:**
  - **No Grade 1A**
  - **Grade 1B = 7: Strong with moderate quality evidence**
  - **Grade 1C = 13: Strong with low quality evidence**
  - **Grade 2C = 11: Weak with low quality evidence**

Level C evidence: observational studies, unsystematic clinical experience, or randomized controlled trials with serious flaw; any estimate of effect is uncertain

Blood Conservation Strategy has to Work at Your Institution

Blood Conservation Strategies

- **Preoperative Interventions:**
  - **Treatment of preoperative anemia**
  - **Diagnosis and treatment of acquired or congenital bleeding disorders**

Blood Conservation Strategies

- **Intraoperative Interventions:**
  - **Autologous blood collection and re-infusion**
  - **Intraoperative cell savage**
  - **Miniaturized CPB circuits**
  - **Composition of CPB prime**
  - **Hemoconcentration techniques**
  - **Anti-fibrinolytic therapies**
  - **Topical hemostatic agents**
  - **Individualized transfusion algorithms**
  - **Procoagulant agents**

Feasibility of autologous intraoperative blood collection and re-transfusion in small children with complex congenital heart defects undergoing cardiopulmonary bypass

A Kaiser, K Miller, G Tian, RH Moore, NA Guzzetta
Paediatr Anaesth 2018;28:795

- **Children weighing <10kg who underwent CPB (n=18)**
- **52 ml (+ 8 ml CPD) autologous blood off the study patients**
- **1:1 matched design on preop Hct, surgical procedure and weight**

Results

	Study (n = 18)	Control (n = 18)	Odds Ratio or Mean Diff (95% CI)	p-value
Pre-CPB inotropic support[#] N (%)	7 (39)	6 (33)	1.2 (0.2, 7.5)	0.83
RBCs transfused on CPB (ml/kg)	21 (11, 32)	19 (8, 30)	2 (-11, 15)	0.76
Total volume transfused[*] (ml/kg)	47 (23, 71)	70 (49, 92)	-23 (-50, 4)	0.09
Total donor exposures[*] (n)	2.6 (1.2, 4.1)	6.5 (5.5, 7.5)	-4 (-5.7, -2.1)	0.0002
24 hour CTO (ml/kg)	25 (19, 31)	26 (18, 35)	-1 (-11, 9)	0.82
Duration mechanical ventilation (hours)[†]	26 (11, 62)	59 (28, 124)	N/A	0.009
ICU length of stay (days)[†]	3 (2, 5)	8 (5, 14)	N/A	0.005
ECMO, N (%)	0 (0)	0 (0)	N/A	N/A
In-hospital mortality, N (%)	0 (0)	0 (0)	N/A	N/A

Kaiser et al. *Paediatr Anaesth 2018;28:795*

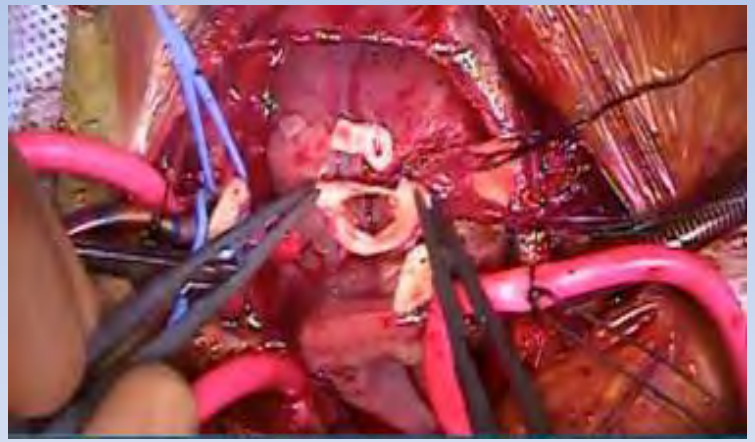
Transfusion Algorithms

- Standard coagulation tests
- Point-of-care viscoelastic tests
  - ROTEM
  - TEG

Blood Conservation Strategies

- **Postoperative Interventions:**
  - **Limit blood sampling/minimize blood wastage**
  - **Postoperative cell saver**
  - **Restrictive transfusion practices**

Surgical Hemostasis



Abnormal coagulation parameters are associated with poor prognosis in patients with novel coronavirus pneumonia

N Tang, D Li, X Wong, Z Sun
J Thromb Haemost 2020

- **At admission, non-survivors had significantly higher D-dimer and FDP levels, and longer PT compared to survivors**
- **By late hospitalization, non-survivors had significantly lower fibrinogen and AT levels compared to survivors**
- **Conclusion: conventional coagulation parameters during the course of infection are associated with prognosis**
- **? Low grade DIC ?**

Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China

C Huang, Y Wang, X Li, et al.
Lancet 2020;395:497

- **Plasma concentrations of pro-inflammatory markers are high in both ICU and non-ICU COVID-19+ patients**
- **Comparison between ICU and non-ICU patients showed that plasma concentrations of IL2, IL7, IL10 and TNFα were higher in ICU patients than non-ICU patients**
- **? Inflammatory state ⟶ pro-thrombotic state ?**

Cyanotic Heart Disease

- Generates high shear stress
- Increases platelet activation
- Predisposes to the intravascular deposition of platelet and fibrin thrombi
- Low-grade consumptive coagulopathy confirmed by elevated levels of D-dimers

COVID-19

Cyanotic Heart Disease


Welcome
to
Children's®
Healthcare of Atlanta

Risk of Blood Shortage during the COVID-19 Pandemic: Blood Conservation and Transfusion Protocol

The Canadian Experience

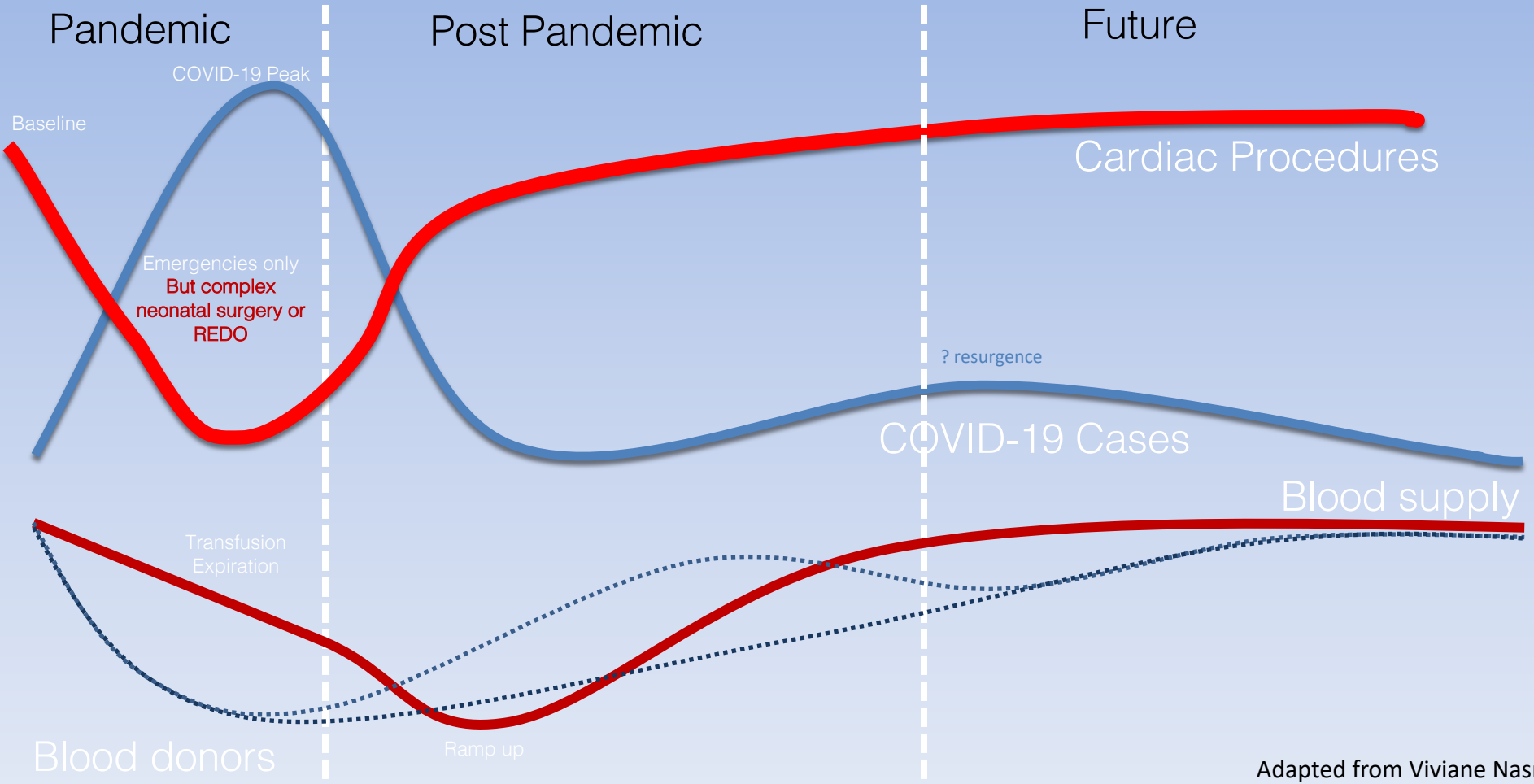
David Faraoni, MD, PhD, FAHA
Toronto, Canada

@dfaraoni @PedsCardiacAnes

COVID 19 AND PEDIATRIC CARDIAC ANESTHESIA PROGRAMS

NO CONFLICT OF INTEREST

Considerations during the pandemic, post-pandemic and the future



Adapted from Viviane Nasr

National Plan for Management of Shortages of Labile Blood Components

Green Phase Advisory	Definition: CBS inventory levels are low with respect to a specific blood component Action: 1. Determine local inventory and report back to CBS as advised on the NEMBC notification
Amber Phase	Definition: CBS inventory levels are insufficient to continue with routine transfusion practices. Action: 1. Adjust inventory levels of affected components to pre-determined Amber Phase levels. 2. Request inventory from CBS based on Amber Phase levels. 3. Defer/cancel elective[1] surgery/procedures that require the affected component. 4. Follow transfusion guidelines for Amber Phase (see page 2). a. All requests that do not fulfill pre-determined acceptance criteria require referral to Medical Director or designate prior to issuing. Record the requests/outcomes.
Red Phase	Definition: CBS inventory levels are insufficient to ensure non-elective transfusion practices. Action: 1. Adjust inventory levels of affected components to pre-determined Red Phase levels 2. Request inventory from CBS based on Red Phase levels. 3. Defer/cancel all surgery/procedures that require the affected component except for emergency[1] procedures. 4. If possible, defer stem cell transplantation, chemotherapy treatments or other treatments requiring affected blood component. 5. Follow transfusion guidelines for Red Phase (see page 2). a. All requests that do not fulfill pre-determined acceptance criteria require referral to Medical Director or designate prior to issuing. Record the requests/outcomes. 6. If instructed by NEMBC, refer to the Emergency Framework for Rationing/Triaging of blood during a Red Phase: https://nacblood.ca/resources/shortages-plan/emergency-framework-final.pdf
Recovery Phase	Definition: CBS inventory levels have begun to increase and expected to be maintained. Action: 1. Slowly adjust inventory levels and reinstitute procedures and transfusions on the basis of urgency. Review previous documentation of requests/outcomes to help determine order of resumption. 2. Slowly or partially replace emergency stocks to sites that had inventory redistributed.

National Inventory Advisory

Date and time of issue	2020-04-16 0600 (EST)
Inventory Availability Phase	**GREEN PHASE ADVISORY**
Product(s)	**Platelets and Plasma Protein Products**
Description	**This is a notice of continuation of the Green Phase Advisory, declared March 17, 2020, for platelets and plasma protein products.** The advisory does not apply to red blood cells, frozen plasma and cryoprecipitate. The advisory affecting these components was lifted last week as a result of improved inventory levels due to both a reduced hospital demand and the recent donor response augmenting the supply. The impacts of COVID-19 and the uncertainties related to this pandemic continue to affect blood supply planning at Canadian Blood Services. Inventory of all blood components and products are currently at Green Phase levels. However, Canadian Blood Services forecasting predicts the potential for shortages with particular risk to the platelet and plasma protein product supply, given the ongoing pandemic situation. **Due to the dynamic and evolving nature of this situation, the advisory status for all products may be escalated quickly if demand outpaces supply.**

Canadian Blood Services
BLOOD PLASMA STEM CELLS ORGANS & TISSUES

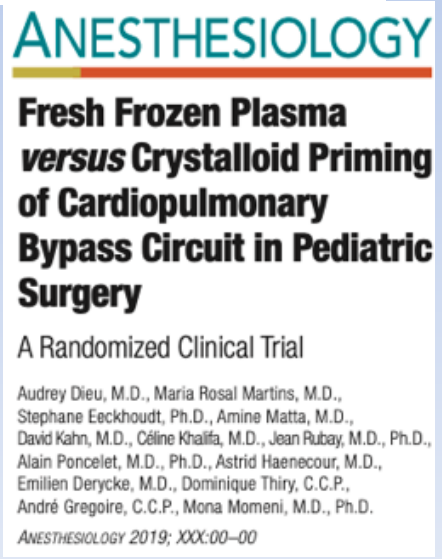
Blood Components & Storage

- Red Blood Cells
  - 42 days
  - Treatment of Anemia/Cell Salvage
  - Irradiate >28 days/Wash
- Platelets
  - 7 days
  - No alternative (DDAVP?, PCC?)
  - Extend expiry date to 9-11 days?
- Frozen Plasma
  - 12 months
  - 4F-PCC
- Cryoprecipitate
  - 12 months
  - Fibrinogen Concentrate

ORBCoN
Ontario Regional Blood Coordinating Network

Desmopressin does not decrease bleeding after **cardiac** operation in young children.
Reynolds LM, Nicolson SC, Jobes DR, Steven JM, Norwood WI, McGonigle ME, Manno CS.
J Thorac Cardiovasc Surg. 1993 Dec;106(6):954-8.
PMID: 8246577
Similar articles

The effect of **desmopressin** acetate (DDAVP) on postoperative blood loss after **cardiac** operations in children.
Seear MD, Wadsworth LD, Rogers PC, Sheps S, Ashmore PG.
J Thorac Cardiovasc Surg. 1989 Aug;98(2):217-9.
PMID: 2666759
Similar articles


ANESTHESIOLOGY

Fresh Frozen Plasma *versus* Crystalloid Priming of Cardiopulmonary Bypass Circuit in Pediatric Surgery

A Randomized Clinical Trial

Audrey Dieu, M.D., Maria Rosal Martins, M.D., Stephane Eeckhoudt, Ph.D., Amine Matta, M.D., David Kahn, M.D., Céline Khalifa, M.D., Jean Rubay, M.D., Ph.D., Alain Poncelet, M.D., Ph.D., Astrid Haenecour, M.D., Emilien Derycke, M.D., Dominique Thiry, C.C.P., André Gregoire, C.C.P., Mona Momeni, M.D., Ph.D.

ANESTHESIOLOGY 2019; XXX:00–00

Canadian Blood Services
BLOOD PLASMA STEM CELLS ORGANS & TISSUES

The FIBRES Randomized Clinical Trial

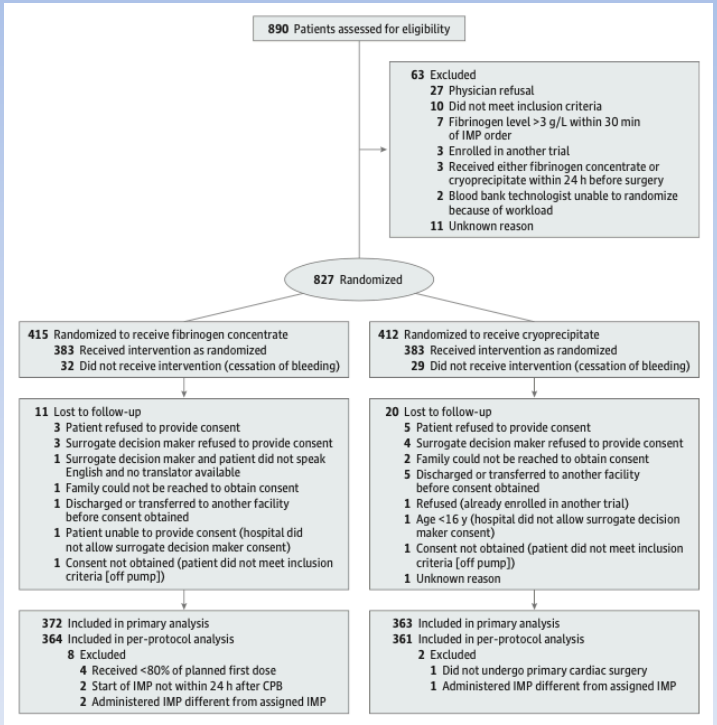


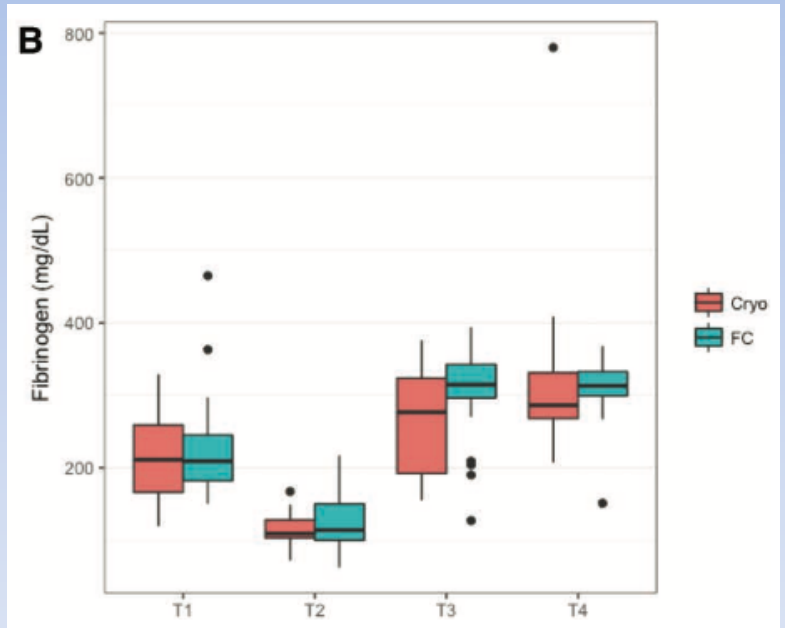
Table 3. Primary and Secondary Outcomes: Allogeneic Blood Component Transfusions

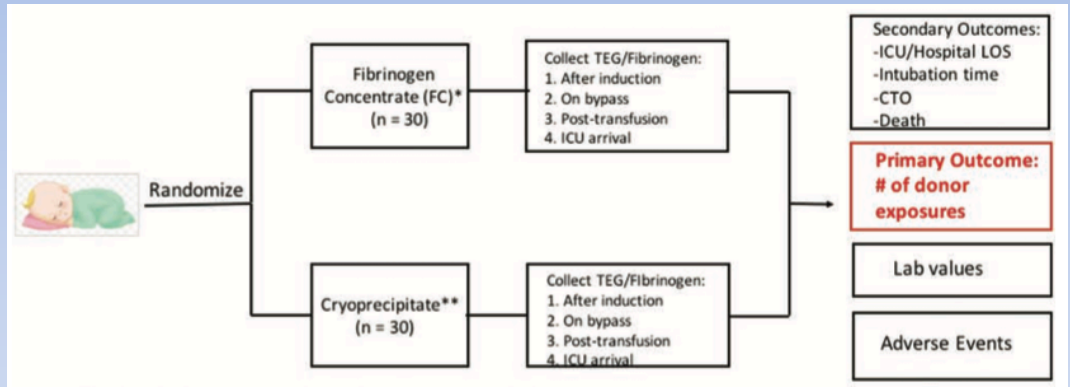
Population	Fibrinogen Concentrate No.	Fibrinogen Concentrate Median (IQR)	Fibrinogen Concentrate LS Mean (95% CI)	Cryoprecipitate No.	Cryoprecipitate Median (IQR)	Cryoprecipitate LS Mean (95% CI)	Mean Difference (95% CI)	Unadjusted Ratio of LS Means (1-Sided 97.5% CI)	Noninferiority *P* Value
Primary Outcome: Cumulative Allogeneic Blood Components Transfused Within 24 h After Cardiopulmonary Bypass[a]									
Primary analysis set	372	12.0 (5.5 to 22.0)	16.3 (14.9 to 17.8)	363	14.0 (7.0 to 23.0)	17.0 (15.6 to 18.6)	−0.73 (−3.10 to 1.64)	Unadjusted 0.96 (−∞ to 1.09)	<.001
								Adjusted 0.91 (−∞ to 1.03)[c]	<.001
Per-protocol set[b]	364	12.0 (6.0 to 22.0)	16.4 (15.0 to 18.0)	361	14.0 (7.0 to 22.0)	16.9 (15.5 to 18.5)	−0.50 (−2.90 to 1.89)	Unadjusted 0.97 (−∞ to 1.10)	<.001
								Adjusted 0.92 (−∞ to 1.05)[c]	<.001

Outcome	No. (%) Fibrinogen Concentrate (n = 372)	No. (%) Cryoprecipitate (n = 363)
Any adverse event	248 (66.7)	264 (72.7)
No. of events	623	673
Any serious adverse event	117 (31.5)	126 (34.7)
No. of events	224	264
Thromboembolic adverse events[a]	26 (7.0)	35 (9.6)

Callum J et al. JAMA 2019 Published online October 21, 2019.

(Adult) Cryoprecipitate vs. Fibrinogen Concentrate





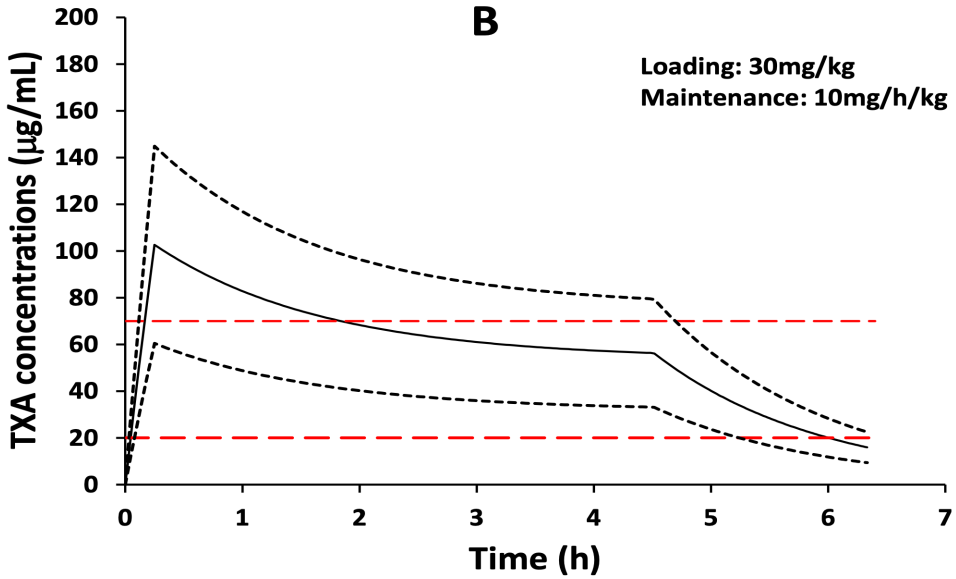
Efficacy *Plasma* **<< Cryo ≈ FC**

Safety *Plasma* **<< Cryo < FC**

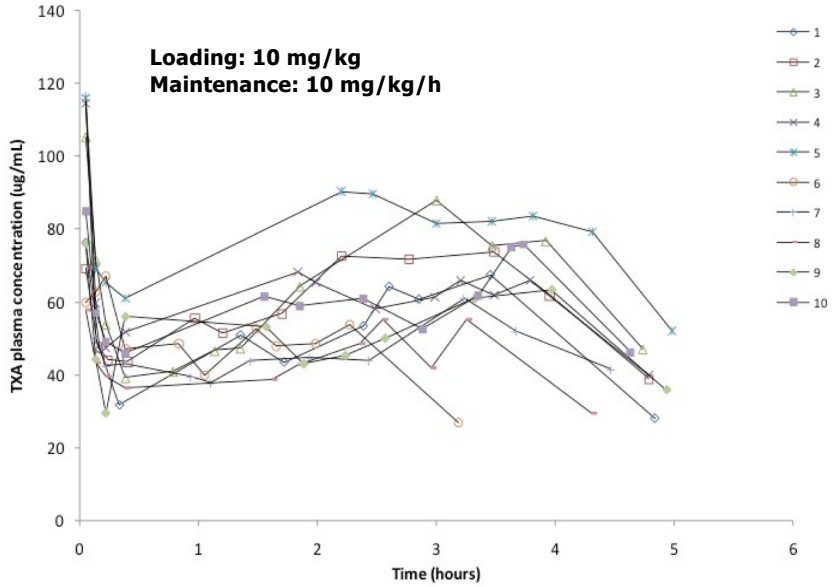
Downey L et al. Anesth Analg 2020; 130(3):740-751

Tranexamic Acid

< 12 mo



≥ 12 mo



Goobie SM & Faraoni D. Curr Opin Anaesthesiol 2019; 32(3):343-352

Bleeding Management in Neonates & High-Risk Infants

Pre-Bypass

- ❑ Preop. Coag, CBC, and AT
- ❑ Baseline ACT: … sec
- ❑ TXA:
  - ❑ 30 mg/kg (≤ 1 yr.)
  - ❑ 10 mg/kg (> 1 yr.)
- ❑ Bleeding Risk Stratification:
  - ❑ High
  - ❑ Moderate
  - ❑ Low
- ❑ Heparin after sternotomy
- ❑ Heparin dose of 400 IU/kg

Bypass

- ❑ Prime:
  - ❑ Initial dose of RBC: …. mL/kg
  - ❑ Initial dose of FFP: …. mL/kg
- ❑ TXA: 10 mg/100 mL of prime
- ❑ CPB:
  - ❑ Total dose of RBC: …. mL/kg
  - ❑ Total dose of FFP: …. mL/kg
- ❑ Coag & CBC rewarming.
- ❑ MUF time: … min (MAX 12 min)
- ❑ Bleeding coming off:
  - ❑ > 50 mL/min
  - ❑ < 30 mL/min

Bleeding & Transfusion

- ❑ PLT
  - ❑ < 150 10^9/L or
  - ❑ Bleeding > 50 mL/min
  - ❑ **Order: PLT 10-15 mL/kg**
- ❑ Fibrinogen
  - ❑ < 1.0 g/L or
  - ❑ Bleeding > 50 mL/min
  - ❑ **Order: FC 50-100 mg/kg**
- ❑ Plasma
  - ❑ Left from CPB: … mL
  - ❑ Bleeding > 50 mL/min
  - ❑ **Prepare: Plasma 10-20 mL/kg**
- ❑ Surgical field inspection
- ❑ Tisseel
- ❑ Cell-Saver Ready
- ❑ Bleeding coming off: ... mL/min

Post-Bypass

- ❑ Protamine dose: … mg
- ❑ Bleeding > 50 mL/min
  - ❑ Platelets transfused: … mL
  - ❑ Pump blood max 2 syringes (CS)
  - ❑ Plasma: … mL
  - ❑ ACT Post-protamine: Hep?
- ❑ 30-min bleeding assessment:
  - ❑ High
  - ❑ Moderate
  - ❑ Low
- ❑ If high/moderate
  - ❑ Residual heparin?
  - ❑ EXTEM A10 < 40 mm &
  - ❑ FIBTEM A10 < 7 mm
    - ❑ **FC 50-100 mg/kg**
  - ❑ EXTEM A10 < 40 mm &
  - ❑ FIBTEM A10 ≥ 7 mm
    - ❑ **PLT: 10 ml/kg**
  - ❑ EXTEM CT > 110 sec
    - ❑ **PCC 50 IU/kg**
- ❑ +30-min bleeding assessment:
  - ❑ High
  - ❑ Moderate
  - ❑ Low

Guidelines

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SOCIETY FOR THE ADVANCEMENT OF BLOOD MANAGEMENT

The Essential Role of Patient Blood Management in a Pandemic: A Call for Action

Aryeh Shander, MD,[1] Susan Marie Goobie, MD,[2] Matthew A Warner, MD,[3] Matti Aapro, MD,[4] Elvira Bisbe, MD, PhD,[5] Angel A Perez-Calatayud, MD,[6] Jeannie Callum, MD,[7] Melissa M Cushing, MD,[8] Wayne B Dyer, PhD,[9] Jochen Erhard, MD,[10] David Faraoni, MD, PhD,[11] Shannon Farmer,[12] Tatyana Fedorova, PhD,[13] Steven M Frank, MD,[14] Bernd

Take Home Message

- There is a risk of blood shortage
  - Daily communication with blood services
  - Monitor blood supplies
- Blood conservation protocol
- Pediatric vs. Adult
- Ramp up

Question?
david.faraoni@sickkids.ca
@dfaraoni