



Roller vs. Centrifugal ECMO

THE CHOP EXPERIENCE

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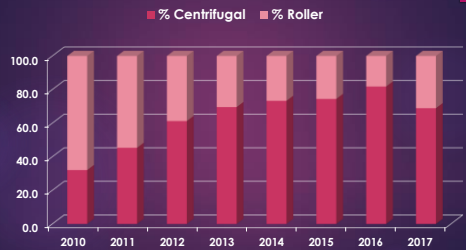


INTRODUCTION

▶ August 2013

- ▶ All ECMO circuits at CHOP were converted to centrifugal pump technology

NATIONAL TREND*



*Based on ELSO Registry data for all patients < 18 years old.

INTRODUCTION

- ▶ **March 2014**
 - ▶ NICU ECMO circuits converted back to roller pumps
- ▶ **December 2015**
 - ▶ Cardiac ECMO circuits converted back to roller pumps
 - ▶ Concern for poorer patient outcomes
 - ▶ Concern for increased mechanical complications



QUESTION

Are there appreciable differences between cardiac ECMO patients supported with a centrifugal pump versus a roller pump?

DATA COLLECTION PLAN

- ▶ Stop the use of the centrifugal ECMO circuit
 - ▶ Exclusion: Non-cardiac patients
- ▶ Compare patient outcomes
 - ▶ Equal amount of centrifugal pump runs and roller pump runs
 - ▶ Caveats:
 - ▶ Patients who had a pump-type change during their run
 - ▶ Patients who had multiple runs

VARIABLES (47)

PATIENT DEMOGRAPHICS

Age • Weight • Height
Gender • Diagnosis • Surgery
Genetic Syndrome
Extracardiac Anomalies

ECMO VARIABLES

Duration • CPR? • Pump Type
• Cannula Size • Cannula Location
Component Change-outs • Platelets
SCUF or Dialysis?

DAILY VALUES

Platelet Count • Hgb • Plasma Hgb
ACT • pTT • Anti Xa
Heparin Dose
Pump RPMs • Weight-based flow
Pre- and Post-oxygenator pressures

OUTCOMES/COMPLICATIONS

Bleeding • Arrhythmias • Infection
Cardiac • Pulmonary • Neurologic
Renal
Length of Stay

DATA SUMMARY

ROLLER

- n = 85 runs
- 81 patients
- 647 days

CENTRIFUGAL

- n = 85 runs
- 82 patients
- 497 days

STATISTICAL ANALYSIS

- ▶ STATA v10 (Stata Corp., College Station, TX)
- ▶ Wilcoxon Rank Sum test or Pearson chi-square
- ▶ Statistical significance established at a two-tailed p-value < 0.05

RESULTS: DEMOGRAPHICS

	ROLLER (n=85)		CENTRIFUGAL (n=85)		p
	Count	Percent	Count	Percent	
Male	50	60%	48	59%	0.9
Neonate	33	39%	33	40%	0.9
Post-op ECMO	61	72%	70	82%	0.1
Known Syndrome	28	33%	29	35%	0.78
Chromosomal Anomaly	32	38%	31	38%	0.97
	Median	Range	Median	Range	p
Age at operation (days)	93	(1-6972)	73.5	(0-10905)	0.71
Weight at operation (kg)	4.55	(1.7-110)	4.4	(1.8-100)	0.69

RESULTS: CANNULATION

	ROLLER (n=85)		CENTRIFUGAL (n=85)		p
	Count	Percent	Count	Percent	
Arterial					0.35
Chest	19	22%	25	30%	
Neck	63	74%	57	69%	
Femoral	3	3.5%	1	1%	
Venous					0.36
Chest	21	25%	25	29%	
Neck	62	73%	59	69%	
Femoral	2	2%	0	0%	

RESULTS: DAILY VALUES

	ROLLER (n=646)		CENTRIFUGAL (n=497)		p
	Mean	SD	Mean	SD	
Max Flow (ml/kg/min)	117	40	116	41	0.77
Min Flow (ml/kg/min)	95	42	88	40	0.005
Max Pre-Oxy Pressure	194	54	205	60	0.0013
Min Pre-Oxy Pressure	152	48	171	60	<0.0001
Max Post-Oxy Pressure	177	51	191	57	<0.0001
Min Post-Oxy Pressure	137	44	157	56	<0.0001

RESULTS: DAILY VALUES

	ROLLER (n=649)		CENTRIFUGAL (n=494)		p
	Mean	SD	Mean	SD	
Max Hemoglobin	12.6	2.0	12.9	1.8	0.035
Min Hemoglobin	11.5	1.8	11.6	1.9	0.5

Results of a Single-Center Study

High Hemoglobin Is an Independent Risk Factor for the Development of Hemolysis During Pediatric Extracorporeal Life Support

Christopher L. Jenks, MD^{1,2}, Agathe Zia, MD^{1,2}, Ramgopal Venkataratnam, PhD^{1,2}, and Lakshmi Ramani, MD^{1,2*}

1) The Children's Hospital of Philadelphia, 2) The University of Pennsylvania, 3) The University of Pennsylvania School of Nursing, 4) The University of Pennsylvania School of Medicine, 5) The University of Pennsylvania School of Public Health, 6) The University of Pennsylvania School of Engineering and Applied Science

RESULTS: CHANGE-OUTS

	ROLLER (n=85)		CENTRIFUGAL (n=85)		p
	Count	Percent	Count	Percent	
Any Component Change	20	24%	28	33%	0.23
Oxygenator Change	10	12%	18	21%	0.15
Circuit Change	10	12%	5	6%	0.28
Bladder Change	6	7%	2	2%	0.28

Table 2
Complications of ECMO

	Roller	Centrifugal	p Value
Circuit problems	461 (86)	861 (108)*	<0.001
Airlocks	351 (66)	391 (111)*	<0.001
Other problems	823 (123)	624 (252)*	<0.001
Circuit Malfunction (airlocks)	324 (76)	234 (72)*	<0.001
Other Malfunction	275 (12)	294 (44)*	<0.001
Other thrombotic	687 (121)	1431 (191)*	<0.001
Oxygenator Malfunction	440 (71)	912 (122)*	<0.001

Centrifugal pumps and hemolysis in pediatric extracorporeal membrane oxygenation (ECMO) circuits: An analysis of Extracorporeal Life Support Organization (ELSO) registry data. O'Brien C, Matherly C, Schen C, Chering L. *Perfusion*. 2017; 32(10):1074-1078. Epub 2017 Aug 16.

RESULTS: ECMO DATA

	ROLLER (n=85)		CENTRIFUGAL (n=85)		p
	Count	Percent	Count	Percent	
Survived ECMO	59	69%	48	56%	0.11
Dialysis or SCUF	9	11%	6	7%	0.59
Platelets Given	74	87%	75	88%	1
	Median	Range	Median	Range	p
ECMO Duration (hrs)	112	(1-694)	94	(3-538)	0.12
Amount of Platelets	423	(35-12193)	370	(38-4773)	0.59

RESULTS: MORBIDITIES

- ▶ We found no statistical differences in any morbidities between the roller or centrifugal groups.

OUTCOMES/COMPLICATIONS

Bleeding • Arrhythmias • Infection
Cardiac • Pulmonary • Neurologic
Renal Complications

BUT WHAT ABOUT HEMOLYSIS?

- ▶ Not enough routine measurements to perform adequate analysis
- ▶ Plasma-free Hemoglobin test not available for early roller pump cases
- ▶ Tests performed after evidence or suspicion of hemolysis

NEONATAL SUBANALYSIS

- ▶ Roller: 39% neonates
- ▶ Centrifugal: 40% neonates
- ▶ No significant differences in any of the measured variables

CONCLUSIONS

- ▶ We identified no differences in outcomes between roller and centrifugal pump cases
 - ▶ Sub analysis of patients <10kg also showed no significant differences
- ▶ Continue utilizing roller pump for cardiac ECMO patients
- ▶ Centrifugal pumps continue to be utilized in the PICU and during ECMO transports

THANK YOU

