SWADDLE (Sedation, Weaning, Analgesia, Delirium, Development, Loving Support, Early Mobility) in the CICU at CHP – Phase 1

Shannon A. Solt DO [1]; Michelle Kane, MSN, RN, CCRN[2]; Josh Heynes[3]; Jesse Klug[3]; Kevin Ordons, PharmD, BCCCP[4]; Chris Horvat, MD, MHA, MSIT [1]; Rod Ghassemzadeh, MD [1];

(1) Department of Critical Care Medicine, University of Pittsburgh

(2) Heart Institute, Children's Hospital of Pittsburgh

(3) ICU Service Center, Children's Hospital of Pittsburgh

(4) Department of Pharmacy, Children's Hospital of Pittsburgh

Background

- Variable practice around use of analgesia, sedation and delirium medications in our Cardiac Intensive Care Unit (CICU) at the Children's Hospital of Pittsburgh (CHP).
- Optimizing assessment and treatment of pain, sedation and delirium is vital to achieving high-value care, maintaining patient safety and comfort, and reducing complications.

Objectives

- **Overall Outcome/Global Aim**: Implement comprehensive pain, sedation, and delirium guidelines in our unit that align with current evidence and best practice, as well as integrating interventions to help with guideline implementation
- **SMART Aim:** Decrease opioid/benzodiazepine (benzo) utilization and increase the use of validated pain/sedation scoring tools by 15% in our benchmark post-operative cardiac patients over the course of 1 year from the time of implementation.

Methods

- A multidisciplinary team was identified to create evidence-based management pathways for analgesia, sedation, and delirium.
- Using a simplified Failure Mode and Effects Analysis (sFMEA), our team developed the key driver diagram (Figure 1).
- Quality interventions will be further developed using Plan-Do-Study-Act (PDSA) cycle quality improvement (QI) methodology.
- Measured compliance with pain and State Behavioral Scale (SBS) scores and opioid/benzo utilization (in morphine and lorazepam milligram equivalents/kg (MME/LZPM)) pre- and post-interventions
- Demographic data and clinical variables were collected using our locally available data (PC4/STS) and the electronic medical record (EMR).
- ***Inclusion Criteria:***
  - Benchmark Procedure Post Operative Patients admitted to the CICU
- ***Exclusion Criteria:***
  - None

Authors have no relevant disclosures.

Results

Figure 1. Key Driver Diagram

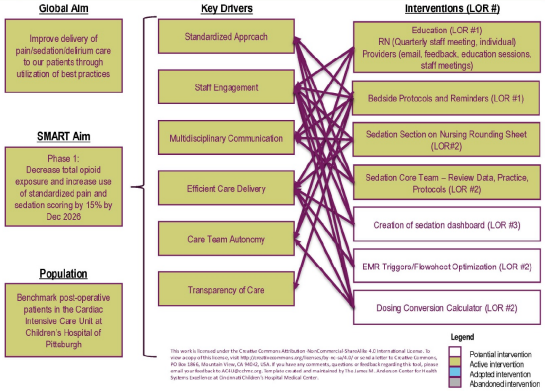

Figure 2. Scale Compliance

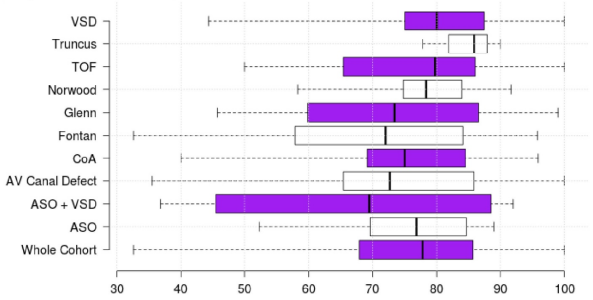

Figure 3. MME Eq Total Dose (mgEq/kg/96hrs)

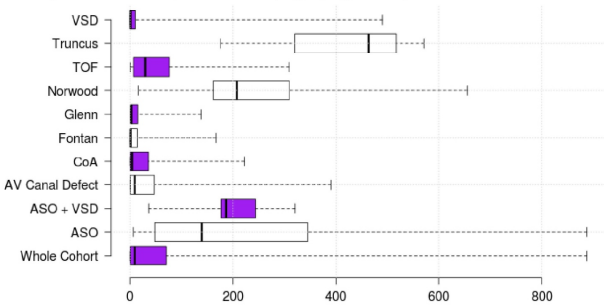

Figure 4. LZPM Eq Total Dose (mgEq/kg/96hrs)

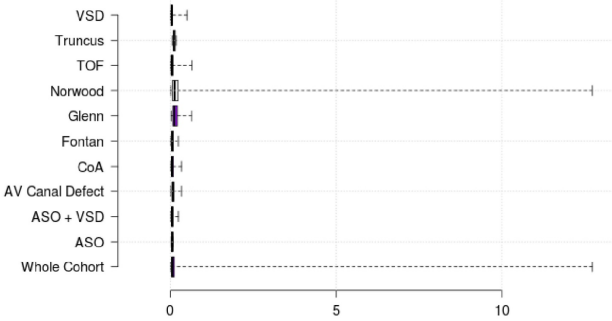

Table 1. Demographics

	Whole Cohort	ASO	ASO + VSD	AV Canal Defect	CoA	Fontan	Glenn	Norwood	TOF	Truncus	VSD
Total (n)	223	10 (4.5%)	6 (2.7%)	27 (12.1%)	23 (10.3%)	27 (12.1%)	20 (9%)	22 (9.9%)	24 (10.8%)	3 (1.3%)	61 (27.4%)
Male (%)	132 (59.2%)	9 (90%)	3 (50%)	12 (44.4%)	5 (21.7%)	18 (66.7%)	10 (50%)	14 (63.6%)	17 (70.8%)	2 (66.7%)	33 (54.1%)
Syndrome (%)	87 (39%)	2 (20%)	1 (16.7%)	23 (85.2%)	14 (60.9%)	8 (29.6%)	7 (35%)	6 (27.3%)	11 (45.8%)	1 (33.3%)	23 (37.7%)
Open Chest (%)	45 (20.2%)	8 (80%)	4 (66.7%)	1 (3.7%)	0 (0%)	1 (3.7%)	1 (5%)	21 (95.5%)	6 (25%)	3 (100%)	0 (0%)
Post-Op ECMO (%)	9 (4%)	0 (0%)	2 (33.3%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	5 (22.7%)	1 (4.2%)	0 (0%)	1 (1.6%)
Extubated in OR (%)	147 (65.9%)	0 (0%)	0 (0%)	20 (74.1%)	14 (60.9%)	26 (96.3%)	17 (85%)	0 (0%)	15 (62.5%)	0 (0%)	55 (90.2%)
# Pt Rec Benzo (%)	135 (60.54%)	6 (60%)	6 (100%)	11 (40.74%)	10 (43.48%)	19 (70.37%)	17 (85%)	17 (77.27%)	17 (70.83%)	2 (66.67%)	30 (49.18%)

Table 2. Patient Characteristics

	Whole Cohort	ASO	ASO + VSD	AV Canal Defect	CoA	Fontan	Glenn	Norwood	TOF	Truncus	VSD
Weight (kg) at Op	5.7 (3.8-9)	3.4 (3.2-3.8)	3.6 (3.4-4.5)	5.3 (4.6-5.7)	3.4 (2.8-6.8)	13.9 (12.5-16.4)	6.2 (5.6-7.3)	3.3 (3-3.5)	5.9 (4.8-7.1)	3.2 (3.1-3.4)	7.1 (5.2-11)
Age (days) at Op	143 (54-360)	6.5 (4.3-7.8)	6.5 (5-76.5)	151 (120.5-176)	50 (9-155)	1058 (849-1432)	187.5 (147-227.8)	6.5 (5-9)	142 (65-168.3)	7 (6.5-13)	201 (120-783)
Post-Op CICU LOS (days)	3 (1.8-7.9)	6.9 (5.9-10.6)	7.4 (4.4-10.5)	3 (2.1-4.6)	3 (1.9-5.1)	3.2 (1.5-6)	3.5 (2.1-6.3)	22.9 (17.5-30.4)	3.1 (1.2-9.3)	12.1 (10.6-12.6)	1.8 (1-2.2)
Post-Op Hosp LOS (days)	8 (4-19.5)	18 (12.3-29)	14.5 (12.3-20.5)	7 (5-12)	7 (4.5-10)	9 (6.5-18)	9 (7-16.3)	85.5 (43-116.5)	7 (5-16)	26 (19.5-40)	3 (3-5)
Cum Hours of Mech Vent (hrs)	110.7 (29.1-261.4)	111.7 (93.9-402.8)	115.1 (76.6-161.5)	24.4 (22.1-69.2)	48.4 (24.9-69.8)	67.2 (36.9-97.5)	25 (19.3-123.9)	264.4 (188.5-524.1)	63.9 (50.9-202.1)	120.3 (109.5-232.7)	26.9 (20-209.6)

Table 3. Median Clinical Endpoints

	Whole Cohort	ASO	ASO + VSD	AV Canal Defect	CoA	Fontan	Glenn	Norwood	TOF	Truncus	VSD
LZPM Totals (mg/kg/96 hrs)	0.06 (0.03-0.12)	0.06 (0.03-0.07)	0.05 (0.03-0.08)	0.07 (0.05-0.11)	0.05 (0.03-0.09)	0.06 (0.03-0.09)	0.12 (0.07-0.21)	0.13 (0.06-0.23)	0.04 (0.02-0.08)	0.11 (0.03-0.15)	0.04 (0.02-0.05)
MME Totals (mg/kg/96 hrs)	9.3 (0.6-70.4)	139.2 (48.3-345)	186.5 (177-244.1)	9.3 (0.5-47.3)	3.8 (0.5-35.7)	1 (0.5-14.3)	2.4 (1-15.2)	207.3 (162.1-309)	29.7 (6.7-76.6)	464.1 (319.7-517.6)	0.9 (0.3-10.6)
Scale Complete Opioids (%)	80 (70.5-87.2)	78.5 (70.4-85.1)	72.3 (46.8-88.1)	9.3 (70.2-84.5)	78.6 (70.4-86.8)	75 (67.4-86.6)	75.8 (66.5-86)	84.5 (78-87.2)	83.3 (68.8-88.9)	85.9 (83.5-90.3)	81.2 (75-87.5)
Scale Complete Benzo (%)	65.4 (33.3-94.7)	53.1 (31.3-75.5)	45.9 (23-77.1)	49.3 (6.3-87.5)	42.5 (18.8-87.5)	45.6 (16-93.8)	69.9 (54.7-100)	63.2 (48.3-72.7)	75 (49.5-100)	63.8 (61.3-66.3)	92.9 (50-100)
Scale Complete All (%)	77.8 (67.9-85.7)	76.9 (69.6-84.7)	69.5 (45.5-88.5)	72.7 (65.4-85.9)	75 (69.2-84.6)	72 (57.9-84.2)	73.4 (59.9-86.6)	78.4 (74.8-84)	79.8 (65.4-86.1)	85.9 (81.9-88)	80 (75-87.5)

Conclusions

- Utilizing multi-disciplinary collaboration and QI methodology can allow for implementation of comprehensive, evidence-based management pathways for sedation, analgesia, and delirium tailored to the CICU environment.
- Integrating local data from quality collaborative databases (PC4/STS) and the EMR can help provide real-time feedback
- Emphasize validated assessment tools, analgesia-first strategies, sedation targets, and multimodal approaches to reduce opioid/benzo exposure.
- **Implementing these protocols are expected to improve** pain control, reduce excessive sedation, decrease delirium incidence and enhance patient outcomes.
- **Future phases**
  - Collect post-intervention data to integrate into PDSA cycles
  - Development of SWADDLE dashboard

References

- Achuff BJ, Lemming K, Causey JC, et al. Opioid Weaning Protocol Using Morphine Compared With Nonprotocolized Methadone Associated With Decreased Dose and Duration of Opioid After Norwood Procedure. Pediatric Critical Care Medicine. 2022;23(5):361-370. doi:10.1097/PCC.0000000000002885. PMID: 34982761.
- Acharya M, Dunning J. Does the Use of Non-Steroidal Anti-Inflammatory Drugs After Cardiac Surgery Increase the Rks of Renal Failure? Interactive Cardiovascular and Thoracic Surgery. 2010;11(4):461-7. doi:10.1510/icvts.2010.238053. PMID: 20639308.
- Aneja R, Heard AM, Fletcher JE, Heard CM. Sedation Monitoring of Children by the Bispectral Index in the Pediatric Intensive Care Unit. Pediatric Critical Care Medicine. 2003;4(1):60-64. doi:10.1097/00130478-200301000-00012. PMID: 12606545.
- Crain N, Slonim A, Pollack MM. Assessing Sedation in the Pediatric Intensive Care Unit by Using BIS and the COMFORT Scale. Pediatric Critical Care Medicine. 2002;3(1):11-14. doi:10.1097/00130478-200201000-00003. PMID: 12793915
- Curley MAQ, Harris SK, Fraser KA, Johnson RA, Arnold JH. State Behavioral Scale: A Sedation Assessment Instrument for Infants and Young Children Supported on Mechanical Ventilation. Pediatr Crit Care Med. 2006;7(1):107-114. doi:10.1097/01.PCC.0000200015.49063.38. PMID: 16444603.
- Fraumeni MS, Gorman DT, Linn DD, Young SN, Milano TA. Systematic Review and Meta-Analysis of the Correlation Between Bispectral Index (BIS) and Clinical Sedation Scales: Toward Defining the Role of BIS in Critically Ill Patients. Pharmacotherapy. 2022;42(8):667-676. doi:10.1002/phar.2712. PMID: 35707963
- Incecik M, Caltabarone CA, Frndova H, et al. Safety and Efficacy of Ketocolac in Children After Cardiac Surgery. Intensive Care Medicine. 2009;35(9):1584-1592. doi:10.1007/s00134-009-1541-1. PMID: 19562323
- Michel F, Hofbeck M, Gerbig I, Ickova V, Heimberg E, Jost W, Schlensak C, Kumpf M, Blumenstock G, Neunhoffer F. Nurse-Driven Analgesia and Sedation in Pediatric Patients With Univentricular Hearts Requiring Extracorporeal Life Support After First-Stage Palliation Surgery: A Pilot Study. Paediatr Anaesth. 2017;27(12):1261-1270. doi:10.1111/pan.13274. PMID: 29063727
- Nair VG, DiNardo JA. Sedation and Analgesia in Pediatric Cardiac Critical Care. Pediatric Critical Care Medicine. 2016;17(8 Suppl 1):S225-S231. doi:10.1097/PCC.0000000000000756. PMID: 27490904.
- Smith HAB, Besunder JB, Betters KA, et al. 2022 Society of Critical Care Medicine Clinical Practice Guidelines on Prevention and Management of Pain, Agitation, Neuromuscular Blockade, and Delirium in Critically Ill Pediatric Patients With Consideration of the ICU Environment and Early Mobility. Pediatric Critical Care Medicine : A Journal of the Society of Critical Care Medicine and the World Federation of Pediatric Intensive and Critical Care Societies. 2022;23(2):e74-e110. doi:10.1097/PCC.0000000000002873.
- Smith-Parrish M, Vargas Chaves DF, Taylor K, Achuff BJ, Lasa JJ, Hopper A, Ramamoorthy C. Analgesia, Sedation, and Anesthesia for Neonates With Cardiac Disease. Pediatrics. 2022;150(Suppl 2):e2022056415K. doi:10.1542/peds.2022-056415K. PMID: 36317978.