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Article type : Original Article

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# Variation in Care Practices Across Pediatric Acute Care Cardiology Units: Results of the Pediatric Acute Care Cardiology Collaborative (PAC[3]) Hospital Survey

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This is the author manuscript accepted for publication and has undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the Version of Record. Please cite this article as doi: 10.1111/chd.12739

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Background: The Pediatric Acute Care Cardiology Collaborative (PAC[3]) was established in 2014 to improve the quality, value, and experience of hospital-based cardiac acute care outside of the intensive care unit. An initial PAC[3] project was a comprehensive survey to understand unit structure, practices, and resource utilization across the collaborative. This

report aims to describe the previously unknown degree of practice variation across member institutions.

Methods: A 126-stem question survey was developed with a total of 412 possible response fields across 9 domains including demographics, staffing, available resources and therapies, and standard care practices. Five supplemental questions addressed surgical case volume and number of cardiac acute care unit admissions. Responses were recorded and stored in Research Electronic Data Capture (REDCap).

Results: Surveys were completed by 31 out of 34 centers (91%) with minimal incomplete fields. A majority (61%) of centers have a single dedicated cardiac acute care unit, which is contiguous or adjacent to the intensive care unit in 48%. A nurse staffing ratio of 3:1 is most common (71%) and most (84%) centers employed a resource nurse. Centralized wireless rhythm monitoring is used in 84% of centers with 54% staffed continuously. There was significant variation in the use of non-invasive respiratory support, vasoactive infusions, and ventricular assist devices across the collaborative. Approximately half of the surveyed centers had lesion-specific post-operative pathways and approximately two-thirds had protocols for single-ventricle patients.

Conclusions: The PAC$^3$ hospital survey is the most comprehensive description of systems and care practices unique to cardiac acute care units to date. There exists considerable heterogeneity among unit composition and variation in care practices. These variations may allow for identification of best practices and improved quality of care for patients.

Key Words: pediatric cardiology, inpatient cardiology, cardiovascular care unit, quality improvement



**Introduction**

Due in part to advances in medical care and improved surgical outcomes for congenital heart

disease (CHD) patients, the complexity and diversity of patients frequently encountered on cardiac acute care (inpatient non-intensive care unit (ICU) cardiology) services has increased.[1] Simultaneously, there is increasing demand for cost reduction and efficient utilization of health care resources. Hospital systems have responded with attention to quality improvement (QI) science and standardization initiatives. However, these efforts are often performed in isolation, resulting in widespread variation in models of CHD acute care. The variation amongst noncritical pediatric cardiac acute care units (CACUs) was previously described by Mott et al, who proposed creation of "uniform nomenclature to define the critical care elements needed for inpatient cardiology care".[2]

The Pediatric Acute Care Cardiology Collaborative (PAC$^3$) was established in 2014 to assess and understand clinical care practices and systems structure in the cardiac acute care domain. Specifically, the mission of PAC$^3$ is to improve the quality, value, and experience of cardiac acute care.[3] The principle of collaboration is fundamental to the efforts of PAC$^3$ in order to develop shared capacity for QI advancement and improved patient outcomes.

The PAC$^3$ hospital survey was designed to identify variations in practice across the disciplines important to cardiac acute care. These disciplines were surveyed under the following themes: unit composition, staffing, resources and therapies, standards of care, transitions in care, and discharge practice. The goal of this report is to present the key areas of commonality and heterogeneity identified in pursuit of safe, efficient, and high quality cardiac acute care.

**Methods**

A panel of PAC$^3$ members with geographic and content expertise diversity was formed to identify areas of potential clinical practice variation within pediatric CACUs and to develop a survey to reflect these domains of variation. The panel created a survey of questions to identify institution-based clinical practice variation. The recommended

variables were pilot tested by 3 centers and approved by the PAC[3] Executive Committee and Scientific Review Committee.

The survey consisted of nine sections with a total of 126 stem questions. The sections were as follows: introduction (4 questions), hospital/patient demographics (32 questions), staffing (18 questions), resources/therapies (17 questions), standard care practices (18 questions), transitions in care (14 questions), discharge practices (18 questions), QI initiatives (4 questions), and conclusion (1 question). Multiple questions had branching logic following positive responses, leading to a total of 412 possible response fields. For the standard care practices section, we defined (1) a protocol as a written accessible document or a process driven by shared order sets and (2) a procedure as a standard practice used 95% of the time without a written policy.

The survey data were collected and managed using Research Electronic Data Capture (REDCap) tools hosted at Cincinnati Children's Hospital Medical Center. REDCap is a secure, web-based application designed to support data capture for research studies.[4] Centers were instructed to complete only one survey per center; it was anticipated that the expertise of more than one person would be required to complete all data fields. The survey required 45-60 minutes for completion. For any missing data or data that did not fit the branching logic, the PAC[3] project coordinator contacted the respondent to clarify or answer the question.

After preliminary review and analysis, it was determined that additional descriptive patient and surgical volume variables were necessary. These 5 additional questions were approved at a May 2017 PAC[3] meeting and sent to each member. The local surgical volume data was crossed referenced with the local Society of Thoracic Surgery data to organize PAC[3] member institutions into 5 groups based on case volume: < 250, 251-325, 326-500, and >500 surgical cases per year. In order to assess correlation of program surgical volume with unit size, data were analyzed for normality. Group differences were evaluated for with ANOVA testing. A p-value <0.05 was considered significant. All analyses were performed using Statistical Analysis Software, version 9.4 (SAS Inc, Cary, North Carolina).

The study was approved by the Institutional Review Board at Cincinnati Children's Hospital Medical Center.



**Results**

Surveys were returned by 91% of the 34 member centers and completed primarily by cardiologists (84%), of which 69% served as the unit's Medical Director. Verification of all initial missing responses to the primary survey resulted in excellent final completion rates with <1% missing responses. Due to branching logic of many root questions, sites answered a total of between 200 – 300 unique questions. Sites had relatively more difficulty obtaining answers to the 5 additional surgical volume questions, with 33 remaining missing fields.

*Unit Structure*

The cardiac acute care teams of the responding centers function within a variety of environments. The majority (61%) of centers have a single, dedicated CACU, while 35% had a mixed-specialty unit. The size of the CACU varied; the most common size was 21-30 beds (45%). Table 1 shows the distribution of unit size by bed number as a function of surgical volume. Surgical volumes differed between unit bed number categories ($p=0.0047$). When differences were compared between individual institutions, the surgical volume performed in the unit with > 40 beds was statistically different from the remaining institutions, but no other differences existed. Nearly all (90%) centers in this cohort receive intra-institution transfers from a dedicated pediatric cardiac ICU. Half of the CACUs are contiguous with or on the same floor as the ICU. One center has a more novel approach and admits all cardiac patients to an "acuity-adaptable" unit where patients stay in the same room throughout the hospitalization rather than in a separate cardiac ICU and CACU. Centralized wireless rhythm monitoring is utilized in 84% of centers with 54% staffed continuously, usually by a nurse or technician trained in rhythm detection. In addition to the CACU beds, 55% of centers have a dedicated procedure space with sedation capabilities within or adjacent to the CACU, and some (32%) have

an area designated for staffed sedation recovery. Despite many centers having these areas designated for procedures and sedation recovery, only 29% centers report administering procedural sedation in the CACU. Three centers have a dedicated observation unit for overnight (<24 hour) stays following cardiac catheterization and other minor cardiac procedures.

Regarding the structure of daily bedside rounds, 80% centers reported that the assigned bedside nurse for that shift was present during rounds for >75% of patients. Approximately half (53%) of CACUs practice nurse-led rounds to some extent, with the bedside nurse leading the update on the status of the patient. Inclusion of family members during patient management discussions is as follows: 94% units conduct family-centered rounds and 71% have family presence on rounds more than 50% of the time.

*Admission Practices*

Many patients with CHD, especially those with high-risk lesions, are admitted to a CACU regardless of the chief complaint. These high-risk patients include those with unrepaired cyanotic lesions (100%), shunt dependent patients (95%), single-ventricle patients following stage 1 palliation (95%) and stage 2 palliation (91%), and any with "significant" residual lesions (95%). Conversely, only 10% of institutions with selective admission practices admit patients with repaired congenital defects without residual disease to a CACU when the hospitalization is for a non-cardiac indication. While all centers except two (6%) accept non-cardiac patients to the unit, these patients accounted for a minority of the unit census. Typically (68% of respondents), non-cardiac patients are admitted to the CACU only after other acute care units reach capacity, and are cared for by a different service team.

*Special Populations*

Single-ventricle patients following stage 1 palliation (interstage patients) tend to be the subject of specific practice policies in many centers. Two centers do not discharge these patients under any circumstances prior to their second stage surgery. Conversely, 13% have no standard policy regarding this cohort. At the remaining institutions, 16% only

admit these patients after an interventional procedure, 28% admit after any invasive procedure (e.g. hemodynamic catheterization), and most (56%) admit interstage patients after any outpatient sedation. The decision whether to admit interstage patients to the cardiac ICU versus CACU was not specifically addressed by this survey. At most institutions (84%), interstage patients are not routinely admitted the night prior to stage 2 palliation.

Orthotopic heart transplant patients are cared for at 90% of centers. Among these institutions, 54% admit to the general cardiology service while 46% admit to an independent transplant service. Smaller units are more likely to have orthotopic heart transplant patients admitted to a general cardiology service. There is substantial variation among institutions regarding admission practices for patients with pulmonary hypertension (PH). Most centers admit PH patients to the general cardiology service with or without a PH consult (42% and 19%, respectively). Some centers admit PH patients to an independent PH service (19%). A minority (6%) admits to the pulmonology service. Twenty-five institutions admit adults with congenital heart disease (ACHD) with 48% having some restriction regarding age or co-morbidities and 36% admitting without any restrictions. Four centers admit ACHD patients to a dedicated adult unit. When the patient is admitted to the CACU, 81% admit to the pediatric cardiology or pediatric cardiothoracic surgery service. Less frequently (24%), the adult patient is admitted to an adult congenital cardiology service. No center reported that ACHD patients are admitted to an adult internal medicine service.

*Staffing: Nursing*

Most (71%) centers reported using a 3:1 nursing ratio. The presence of a resource nurse was reported at 84% sites. The importance of nurses being skilled in caring for CHD patients was reflected by the fact that a majority (84%) of units have <25% of nurses re-assigned from another unit. In addition, CACU nursing is recognized as its own skill set; notably, 52% of sites have < 25% of staff nurses cross-trained in the cardiac ICU. Across the collaborative, 81% centers have achieved Magnet status from the American Nurses' Credentialing Center.

*Staffing: Physician*

Service assignment and provider coverage have more variability than nurse staffing. Cardiac medical and cardiac surgical patients are assigned to different services at 35% of centers. In addition, heart failure patients are assigned to a separate service at 65% of centers. The pool for attending weekday coverage of the general pediatric cardiology service ranges from 2 – 24 cardiologists, with an average of 10 cardiologists. All centers have 1 – 2 pediatric cardiologists (average 1.3 cardiologists) on service at any time during weekdays. Most centers (74%) have the cardiology attending on service rotate weekly. In addition to the general pediatric cardiology service attending, it is common to have other division faculty on-service simultaneously to cover the subspecialty services: heart transplant (65%), pre- and post-catheterization laboratory 68%), electrophysiology (65%), and pulmonary hypertension (39%).

Nearly all centers (90%) have a cardiology fellow on the cardiac acute care team, but the fellow often has other responsibilities: weekday consults (58%), night and weekend consults (94%), and performing after-hours echocardiograms (61%). Nearly all centers (94%) employ advanced practice providers (nurse practitioners and physician assistants) who cover ≤50% of patients in 8 centers, between 50-75% of patients in 7 centers, and >75% of patients in 13 centers. Pediatric residents are involved with the management of CACU patients in most centers (84%). Pediatric interns are on the care team at 15 centers with upper level resident oversight in 12 of the 15. In addition, resident physicians are involved in overnight care of CACU patients in 71% of centers.

*Acuity and Resources*

A wide variety of practices associated with different levels of patient acuity and resource utilization were found at the different centers. Table 2 illustrates the spectrum of acuity levels of care among CACUs. Figure 1 provides similar data with regard to resource utilization.

Methods to identify patients as being high-risk and how units respond to potentially high-risk events were evaluated. An objective warning score or other system by which nurses chart indicators of clinical deterioration is used by 77% of CACUs. Additionally, 71% centers reported having a mechanism to identify patients who are at risk for clinical deterioration. Approximately half have a designated cardiac rapid response team defined as a team of health care providers, including a cardiology physician, which respond to hospitalized patients. The remaining centers have a general rapid response team to evaluate patients exhibiting early signs of clinical deterioration.

*Standard Care Practices*

A variety of care protocols and pathways are used within the cohort. Approximately half the centers have lesion-specific surgical pathway protocol(s) or guidelines for post-operative patients, but only 42% reported using these pathways regularly (Figure 2). There was variation in surgical pathway use: 22% use a written protocol, 33% had a standard practice procedure, and 45% reported no surgical pathways. Practice protocols pertaining specifically to the single ventricle population were assessed and showed notable variation (Figure 3). A policy regarding inpatient care of high-risk infants (interstage patients/shunt-dependent patients) was reported by 68% centers. The nursing ratio is customized in 19% of centers for these patients and 52% of centers require continuous heart rhythm monitoring for these patients at all times.

*Transitions in Care*

Communication of information between care teams impacts the ongoing care of these patients; however, the methods to achieve accurate and efficient transfer of information are not uniform. Most centers (68%) have a written policy or standard practice regarding cardiac ICU to CACU transfer of care. There is no typical location where provider hand-off occurs. Sign-out occurs at the cardiac ICU bedside in 35%, face-to-face in the ICU but not at the bedside in 26%, or by a phone call in 23%. The majority (84%) of centers reported that nursing hand-off occurs separately from provider hand-off, most commonly by phone. When nursing handoff occurs face-to-face, it is equally distributed between bedsides (23% in cardiac ICU and 26% in CACU). Most centers with a standard handoff

practice have a consistent team present at sign-out: cardiac ICU and CACU bedside nurses and attending physicians, as well as frontline providers from each unit, more than 80% of the time. A respiratory therapist, pharmacist, or nutritionist are less likely to be present.

All centers have practices that allow discharge of patients with CHD with at least some assisted enteral nutrition, including via nasogastric tube (97%) or gastrostomy tube (100%). Post-pyloric feedings are employed much less frequently (39%). Half of the centers allowed patients to be discharged while receiving parenteral nutrition. Other practices surveyed included whether certain procedures could be performed on the day of discharge: chest tube removal in 42% and temporary pacing wire removal in 55%.

As families are prepared for discharge, a parental overnight stay for teaching and documentation of care skills is required at 94% of centers for at least some patients. Most centers (81%) have a pharmacist review discharge medications with patients and families prior to discharge. The CACU team communicates discharge plans to the referring cardiologist by a number of methods: E-mail or fax (87%), phone call (84%), paper records given to the family (26%), mail (16%), and/or teleconference (3%).

*Quality Improvement*

Two-thirds of centers have a QI officer assigned to the cardiology division and 73% have dedicated staff members collect and analyze data related to QI initiatives. Most sites (90%) hold regularly scheduled meetings to discuss local QI initiatives specific to pediatric cardiology. The most common topic for QI work is discharge processes (87%). Additional QI projects include: transfer hand-offs from cardiac ICU to CACU (71%), feeding protocols (71%), surgical pathways (55%), cardiac ICU readmissions (48%), and hospital readmissions (45%).

**Discussion**

PAC[3] aims to enhance safety, outcomes, and quality of pediatric cardiac acute care. As an initial project, the collaborative sought to describe the current structure and function of CACUs at member institutions. Utilizing a comprehensive survey with branching logic covering several domains, these results highlight the similarity and heterogeneity of practice patterns. In the longer term, the aim will be to couple the data from this survey, and similar surveys to follow biennially, with outcomes data generated by the PAC[3] Data Registry launched in 2018 to foster measurable opportunities for improvement.

The concept of enhanced quality of care for patients outside of the ICU is a relatively new focus in clinical practice. In 2009, The Joint Commission's National Patient Safety Goals included the improved identification and response to clinical deterioration of hospital-ward patients.[5] In 2016, a brief survey of North American pediatric cardiology programs was the first to describe the structure of inpatient, acute care services in non-critical cardiac care units.[2] This study by Mott, et al. included 72 responding centers that answered a 25-item questionnaire. The general areas of focus were the institutional setting, programmatic definitions, provider staffing, resource utilization primarily described by care pathways and protocols, and hospital discharge transition practices. Our current study elaborates on these CACU learnings using a significantly more detailed questionnaire. For example, in addition to describing whether a select group of cardiologists attended on the CACU, and which service the patient was assigned to, our survey attempted to understand how many cardiologists from a variety of different sub-specialties were on service simultaneously along with detailing the role of the unit attending. This information is particularly important since the pediatric CACU is now increasingly recognized as a unique unit with specific needs and skillsets.

Our survey also included a more detailed assessment of nursing staffing models, resource utilization, and therapies describing acuity of care. We found significant variation in these areas, but not necessarily in a similar pattern across domains. Institutions develop practice patterns that fit their needs and are permissible within their budgetary and personnel constraints. We found that "one size does not fit all." Pediatric CACUs have a variety of ancillary personnel requirements, including pharmacists, occupational and

physical therapists, and dieticians. Complex therapy is offered in most units, including vasoactive drug infusions, respiratory support, and circulatory assist devices. Further study is necessary to understand if some combination of nursing staffing ratios, ancillary support services, and permitted acuity level provide safer, more efficient methods of caring for this cohort of patients with challenging medical needs. This PAC$^3$ hospital survey defines the environment, care team, and practice patterns, which is a first step to understanding the diversity in structure and practice.

The process of designing, implementing, and reviewing survey results has already led to practice change across the collaborative, most frequently related to resource utilization and patient management policies of the CACU. Although the delineation between a critical care and an acute care patient at each institution can be based on financial resource availability, this process is often grounded in tradition. By sharing practice trends across centers throughout North America, the default to tradition has been challenged. The strength of the collaborative is illustrated by outlier units leveraging requests and implementation of new therapies that were previously restricted to critical care, such as high flow nasal cannula oxygen and near-infrared spectroscopy monitoring. As registry data is collected, the safety and efficacy of newly adapted practices can be further supported.

Moving forward, the PAC$^3$ registry database will capture process and outcome data needed to identify associations between unit structure, practice patterns, and superior results. Although quality work often focuses on identification of best practices and improved outcomes, we recognize that providing the same excellent care at less cost and with more efficient resource utilization are equally important. This model is well established in adult cardiac medicine, as demonstrated by the Advanced Cardiovascular Imaging Consortium, a Blue Cross Blue Shield of Michigan collaborative quality initiative designed to encourage appropriate and judicious use of coronary computed tomography angiography.[6] It is our goal that the PAC$^3$ registry database will help to redesign more sustainable CACUs that achieve cost efficient practices and enhanced patient experience without compromising outcomes and patient safety.

This survey was completed by 31 North American centers, which could potentially limit our ability to generalize results to all institutions that care for children and young adults with CHD. Although PAC$^3$ is an inclusive organization that does not turn away any center that requests to participate, member centers are a self-selected group often associated with an academic medical center or university. Recruitment and inclusion of additional centers in the future could increase diversity of the responding units and help to address this potential limitation.

In summary, this report from the PAC$^3$ hospital survey is the most thorough and extensive description of the current state of CACUs across North America. We discovered heterogeneous and diverse unit structures, resource utilization, and clinical practices. These discoveries have already promoted sharing amongst PAC$^3$ member sites in an effort to improve practices. We look forward to the time when we can link these process data to outcome data, thus enabling local and multi-site improvement initiatives to improve quality, value, and experience for our CHD patients.



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Amanda Hoerst MSN: concept/design, data analysis/interpretation, drafting article, critical revision/approval
Adnan Bakar MD: drafting article, critical revision/approval
Steven C. Cassidy MD: drafting article, critical revision/approval
Martha Clabby MD: concept/design, data analysis/interpretation, drafting article, critical revision/approval
Erica Del Grippo DO: drafting article, critical revision/approval
Margaret Graupe MS: drafting article, critical revision/approval
Ashraf S. Harahsheh MD: data analysis/interpretation, drafting article, critical revision/approval

Anthony M. Hlavacek MD: concept/design, data analysis/interpretation, drafting article, critical revision/approval

Stephen A. Hart MD: data analysis/interpretation, drafting article, critical revision/approval

Alaina K. Kipps MD: drafting article, critical revision/approval

Nicolas L. Madsen MD: concept/design, critical revision/approval

Dora D. O'Neil BSN: drafting article, critical revision/approval

Sonali S. Patel MD: data analysis/interpretation, statistics, critical revision/approval

Courtney M. Strohacker MD: data analysis/interpretation, drafting article, critical revision/approval

Ronn E. Tanel MD: data analysis/interpretation, drafting article, critical revision/approval

References

1. Jacobs JP, He X, Mayer JE, Austin EH, Quintessenza JA, Karl TR, Vricella L, Mavroudis C, O'Brien SM, Pasquali SK, Hill KD, Husain SA, Overman DM, St Louis JD, Han JM, Shahian DM, Cameron D, Jacobs ML. Mortality trends in pediatric and congenital heart surgery: An analysis of the Society of Thoracic Surgeons congenital heart surgery database. Ann Thorac Surg 2016;102:1345–1352.
2. Mott AR, Neish SR, Challman M, Feltes TF. Defining pediatric inpatient cardiology care delivery models: A survey of pediatric cardiology programs in the USA and Canada. Congenital Heart Disease 2017;12:294-300.
3. Kipps AK, Cassidy SC, Strohacker CM, Graupe M, Bates KE, McLellan MC, Harahsheh AS, Hanke SP, Tanel RE, Schachtner SK, Gaies M, Madsen N. Collective quality improvement in the pediatric cardiology acute care unit: Establishment of the Pediatric Acute Care Cardiology Collaborative (PAC3). Cardiol Young 2018;28:1019-1023.
4. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap) - A metadata-driven methodology and

workflow process for providing translational research informatics support. J Biomed Inform 2009;42:377–381.

5. Jones DA, DeVita MA, Bellomo R. Rapid-response teams. N Engl J Med 2011;365:139–146.
6. Chinnaiyan KM, DePetris AM, Al-Mallah M, Abidov A, Ananthasubramaniam K, Gallagher MJ, Girard S, Goraya TY, Kazerooni EA, Patel S, Peyser P, Poopat C, Raff GL, Saba S, Song T, Share D. Rationale, design, and goals of the Advanced Cardiovascular Imaging Consortium (ACIC): A Blue Cross Blue Shield of Michigan collaborative quality improvement project. Am Heart J 2012; 163: 346-353.

Table 1. Unit size as a function of surgical volume

| | <250 surgical cases | 251-325 surgical cases | 326-500 surgical cases | >500 surgical cases |
|---|---|---|---|---|
| 5-10 beds | 3 | | 1 | |
| 11-20 beds | 1 | 4 | 4 | |
| 21-30 beds | 2 | 2 | 4 | 6 |
| 31-40 beds | | 1* | 1 | 1 |
| >40 beds | | | | 1 |

* Acuity adaptable unit; surgical cases, total number of surgical cases for the past calendar year using the Society for Thoracic Surgeons definition which excludes chest closures and extracorporeal membrane oxygenation procedures

Table 2. Level of acuity and resource utilization

| *Respiratory therapy* | n, % |
|---|---|
| Nasal cannula, 100% FiO2 | 30, 97% |

| | |
|---|---|
| High flow nasal cannula, initiation | 18, 58% |
| High flow nasal cannula, up-titration | 19, 61% |
| CPAP/BiPAP, initiation | 5, 16% |
| CPAP/BiPAP, for sleep | 25, 81% |
| CPAP/BiPAP, continuous | 16, 52% |
| *Vascular Access* | |
| Peripherally inserted central catheter (PICC) | 31, 100% |
| Central venous, Broviac | 28, 90% |
| Central venous, femoral | 24, 77% |
| Central venous, subclavian | 23, 74% |
| Central venous, umbilical | 5, 16% |
| *Vasoactive infusions* | 25, 81% |
| Milrinone | 25, 100% |
| Dopamine | 13, 52% |
| Dobutamine | 11, 44% |
| Epinephrine | 2, 8% |
| Combination therapy | 8, 32% |
| *Mechanical support* | 18, 58% |
| Pulsatile, internal | 18, 100% |
| Continuous, internal | 17, 94% |
| Continuous, external | 9, 50% |
| Temporary | 1, 6% |

CPAP, continuous positive airway pressure; BiPAP, bilevel positive airway pressure

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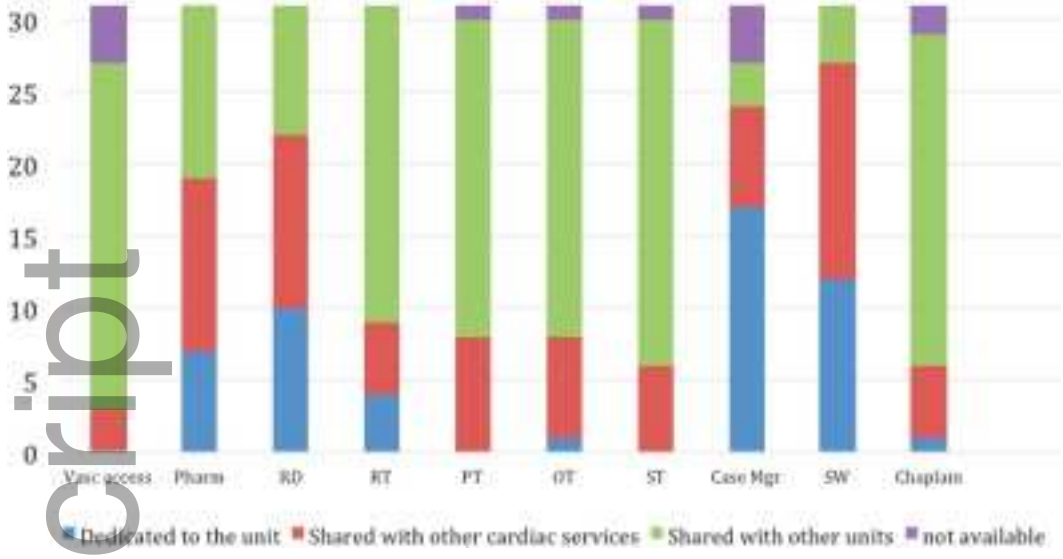


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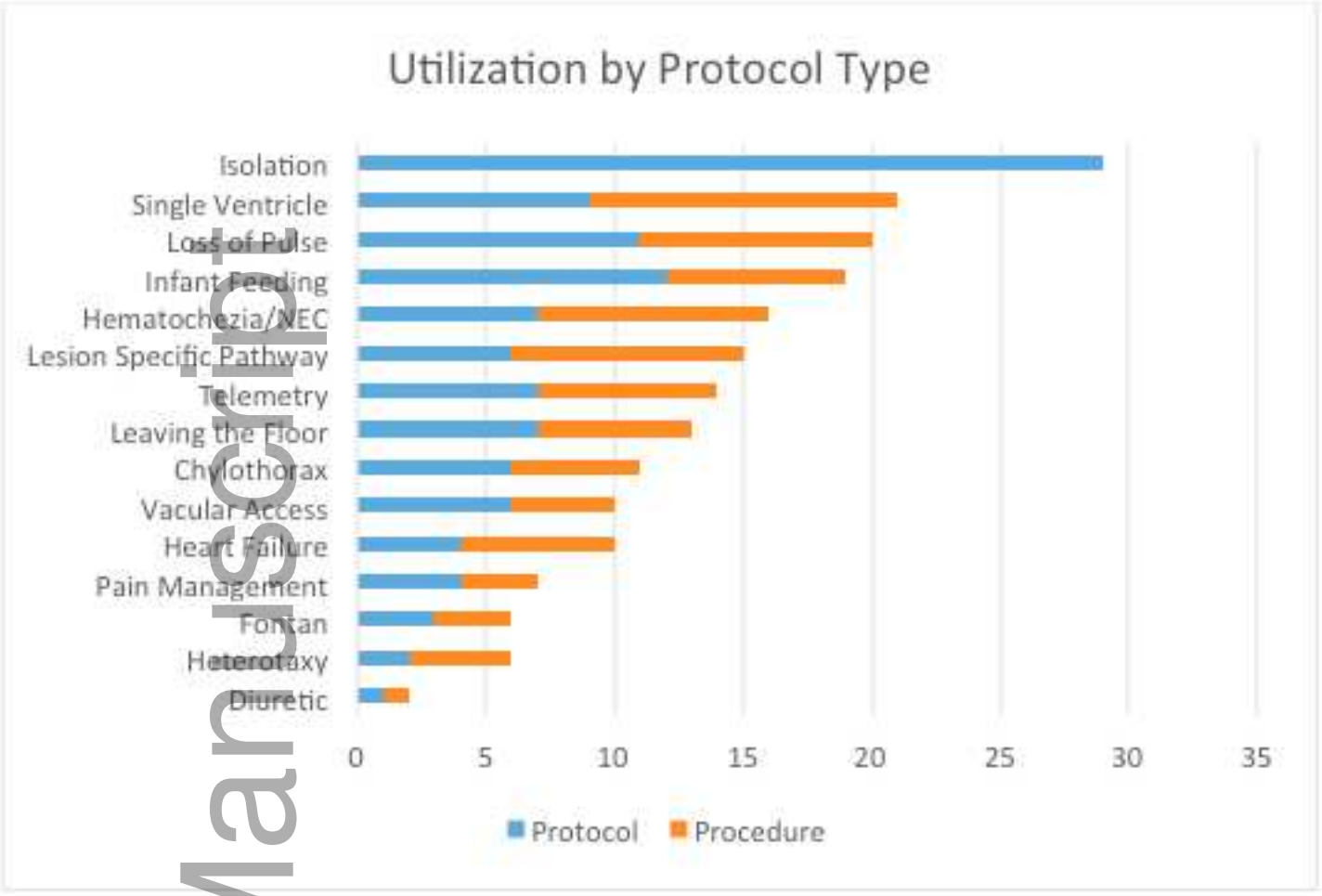


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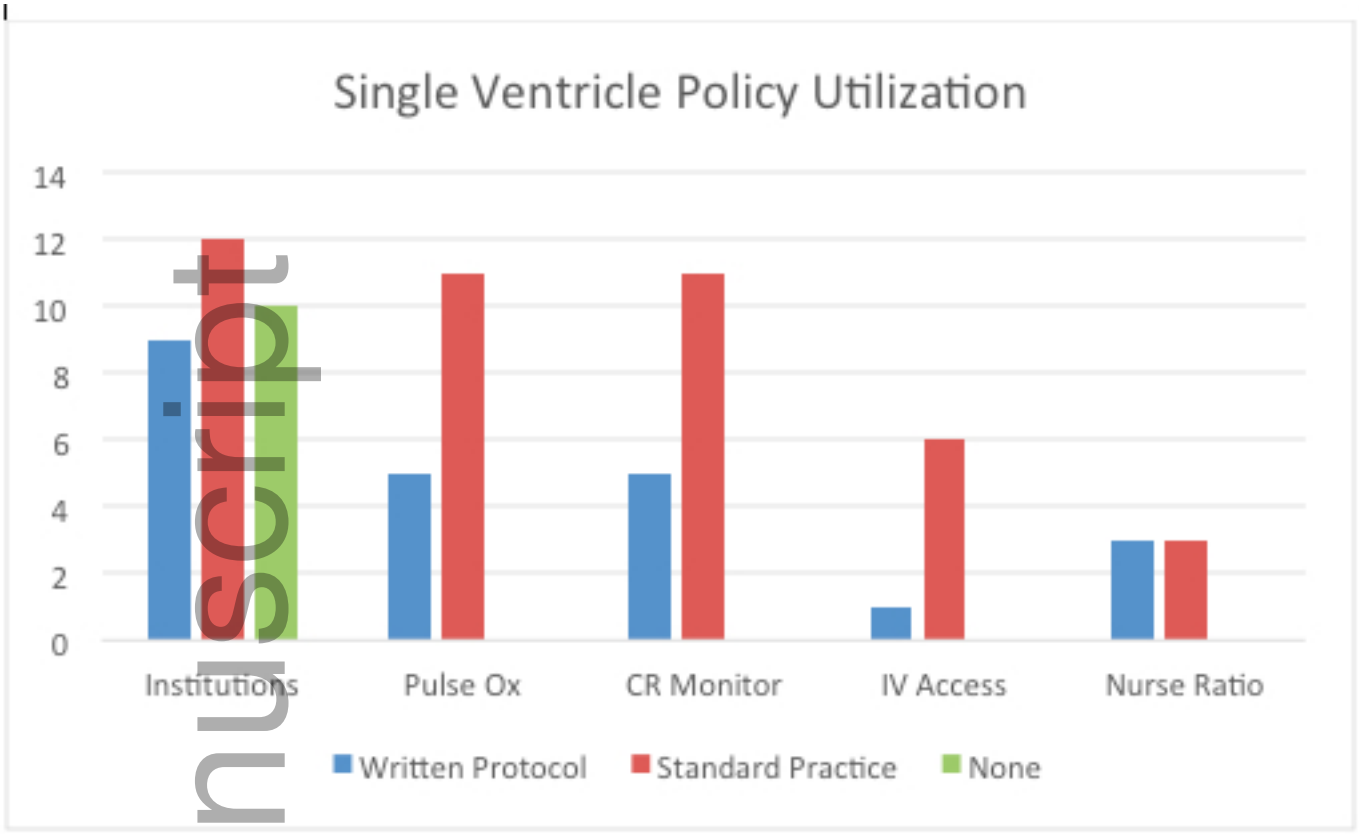


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