



*Improving critical care quality and outcomes for all children through collaborative high quality data management and actionable comparative reports for clinicians and other health care leaders.*

# **Shaping the Future of Pediatric Critical Care Through Collaborative Improvement**

**Virtual Pediatric Systems, LLC  
2016**

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## Executive Summary

**Virtual Pediatric Systems, LLC (“VPS”)** has grown from a small group of intensivists to a national organization with over 135 hospital members and over 1,000,000 patient admission records. The data base is one of the largest collaboratives for quality improvement based on severity of illness adjusted comparisons of actual, detailed patient records in pediatric critical care. This is a unique achievement.

Based on this achievement, VPS provides state of the art quality reports that are detailed, actionable, comparative and comprehensive for practitioners and hospital administrations. VPS has improved the quality of critical care, built one of the largest national research collaboratives, supported the publication of over 100 papers and contributed to saving thousands of children’s lives.

In the future, VPS will be able to expand from providing quality assessments to providing decision support, detailed outcomes tracking, discovery and comparative effectiveness research on critically ill children. This can be achieved by integrating VPS’s already successful and vibrant clinical critical care network with automated data collection and sophisticated data analysis currently being pioneered by researchers working with Virtual Pediatric Intensive Care Unit (VPICU) in developing an advanced computational framework for decision support in critically ill children.

## Introduction to VPS

In 1997, the Laura P. and Leland K. Whittier Virtual Pediatric Intensive Care Unit (“VPICU”) was founded by a generous grant to Children’s Hospital Los Angeles from the Whittier Foundation, under the direction of **Dr. Randall Wetzel**. VPICU focuses on bringing information technologies to serve pediatric critical care medicine by supporting patient care, quality improvement, distance learning and research. At the same time the PICU Focus Groups, sponsored by the National Association of Children’s Hospitals and Related Institutions (“NACHRI”), needed a software tool to facilitate multisite quality improvement and research. Both organizations realized that a poor understanding of pediatric critical care practice, coupled with the lack of even simple descriptive statistics, meant that *we did not know how critical care was practiced for children*. At that time, ICUs were neither connected to the internet nor effectively comparing or sharing data. Facilitated by **Dr. Thomas Rice**, and with the leadership of **Mary Gorman** of NACHRI, VPICU and NACHRI collaborated in a development process that included 15 pediatric intensivists. The result was a demographic, diagnostic and severity of illness adjusted software tool that collected information from member units, on all patients, with actual outcomes collected. For the first time, it was possible to start understanding how critical care was practiced across the United States.

The original intensivists continued to suggest improvements, reports, research projects, and comprehensive development, along with new VPS users, for improving the data collection and reporting. By this time, in recognition of the importance of quality data for quality improvement, The National Outcomes Center (“NOC”) at Children’s Hospital and Health Systems, Milwaukee, under the direction of **Dr. Ramesh Sachdeva**, had become a third party providing value for VPS members. The data quality and comparative reports improved tremendously. In addition, the scientific rigor applied to data acquisition, data validity and data quality set a high standard, yet to be met by others, in pediatrics. With inter-rater reliability results of greater than 97%, the data collected for nearly 20 years from over one million cases is of such high

quality that it allows for reliable and reproducible generation of meaningful, actionable information for intensivists, hospital executives and for the service of critically ill children. VPS maintains the highest level of quality data possible with the following quality efforts contributing to the overall high quality of the data.

In 2005, the close working relationship among the three entities (VPICU, NACHRI, NOC) was formalized and culminated in the formation of a new corporate entity, Virtual PICU Systems, LLC. Today, the ownership is between the not-for-profit owners of Children’s Hospital Los Angeles (“CHLA”) and Children’s Hospital Association (“CHA”). A research committee, a panel of advisors and user groups have been established to assure the ongoing growth of VPS. Today, VPS has a unique system widely recognized as a leader in pediatric quality improvements.

#### **Primary Components of the VPS Data Quality Assurance**

- Pre-Training Orientation Call
- Credential Requirements for Data Collectors
- Definitions / Operations Manual
- Ongoing Educational Training for Data Collectors
- Trainings: Onboarding and Updates
- Annual Certification Exam
- 1:1 Site Coordinator Orientation
- Quarterly V.A.L.U.E. Trainings
- HelpCenter Resource Center
- Initial and Quarterly Inter-Rater Reliability (IRR)
- Automated Data Entry Validations
- Automated and Manual Data Cleaning Process
- Listserv Communication
- User Testing and Collaboration
- Advisory Group / Clinical Consultants
- HelpDesk for User Questions and Clarifications
- Verification of Completeness of Data Collection of Non-Required Fields
- On-Going Clinical Support for Definition Interpretation
- Data Base Surveillance to Ensure Data Integrity

**VPS is the Leader in Bridging the ICU Continuum  
of Research, Quality Improvement  
and Operational Management.**

The VPS system is a clinical database dedicated to standardized data sharing and benchmarking among pediatric ICUs. All participants collect information on patient and hospital stay measures, diagnoses, interventions, discharge, organ donation, and pediatric severity of mortality scores for all pediatric ICU admissions. Users may also choose to collect additional data for quality improvement, multisite research studies, and other internal research needs through customizable interfaces.

**VPS: A Unique System in Children’s Health Care**

- Developed by pediatric intensivists
- Clinical database of over 1,000,000 patient records
- Representing more than 135 hospital units
- Standardized, validated, severity adjusted and reliable clinical data
- Data elements covering the complete continuity of care from PICU admission through discharge;
  - Patient demographics
  - ICD-10 diagnostic coding
  - Unlimited diagnoses per case
  - Interventions; intubations, mechanical ventilation, venous/arterial lines and catheters, and complications
  - Severity of illness – risk adjustments
  - Risk-adjusted length of stay
  - Neurocritical Care module (“NCC”)
  - Cardiac enhancements
  - PICSIM: A novel risk adjustment score for the pediatric cardiac surgical population
  - Diagnostic and surgical coding compatible with STS
  - Uniquely packaged and customizable reports

As VPS continues to expand its customer base, the number of patient cases added into the collaborative system grows every day (averaging over thirty-five-thousand cases each quarter). VPS is intended and designed to be open, collaborative and inclusive. To this end, collaborations, projects and extensive product development have occurred with many national partners including:

- The American Board of Pediatrics
- The American Academy of Pediatrics
- The National Quality Forum (“NQF”)
- Agency for Healthcare Research and Quality (“AHRQ”)
- The Society of Thoracic Surgeons - pediatric congenital heart group (“STS”)
- American Academy of Pediatric Surgeons
- Children’s Hospital Association (“CHA”)
- Pediatric Acute Lung Injury and Sepsis Investigators (“PALISI”)
- California Children’s Services (“CCS”)

These collaborations have led to considerable modification of the available data elements and reports to meet the needs of these diverse but critical groups. They resulted in the launching of VPS Cardiac in 2009 specifically designed for units caring for the pediatric cardiac population. In 2016, VPS initiated national collaborations for the development of a neonatal intensive care unit product, *VPS NICU*.

### **Transforming VPS into a Web Application**

In 2009, VPS embarked on reorganizing the information delivery approach. Hitherto, the services had been provided on local desktop software at multiple institutions. To enhance the flexibility, timeliness, quality and facility of data entry, the decision was made to convert VPS to a web-based data entry and reporting system. This required a major reprogramming effort as well as development of databases for acquisition and reporting that met the highest standards of quality, security and customer availability. The data application was designed to have numerous enhancements, guided by the collaborations among clinicians, and designed by intensivists and hospital administrators.

### **VPS's Web Application**

Users can experience significant enhancements, expanded areas of patient care content, higher quality and superb functionality with the redesigned web application at [www.MyVPS.org](http://www.MyVPS.org). Other features include;

- Integrated and greatly extended interventions and procedures
- Expanded diagnoses
- Refined quality checks at every step
- Captures National Quality Forum critical care quality measures
- Collects and benchmarks cardiac data using STS nomenclature
- Includes cardiac surgical scoring for complexity and acuity
- All the benefits of web flexibility and accessibility
- Incorporated the highest levels of security including that of HiTrust certification

VPS is one of the largest pediatric critical care data repositories in existence. The importance of this high-quality data cannot be overestimated for future research, patient care and administrative understanding of pediatric intensive care medicine. Its strengths are highly regarded by the critical care community and it provides value for clinicians and administrators Internationally.

#### **Strengths of VPS**

- Credibility with Clinicians
- Strict Definitions and Quality Control Training
- Flexibility to Meet Growing Demands of End Users
- Focus on Quality, Safety, and Research
- Multiple Severity Adjustments
- Continuous Feedback from End Users to Maximize Ease of Use

### **Value for Clinicians**

- Valid, Comprehensive Clinical Data
- Severity Adjustment for All Cases
- Means for Internal and Peer Benchmarking
- Tool for Multi-Institutional Studies and Research
- Ability to Deliver Custom Dashboards via Email (regularly scheduled or on demand)

### **Critical Care Core Measures**

VPS captures data for national reporting required by the National Quality Forum and other national quality initiative standards.

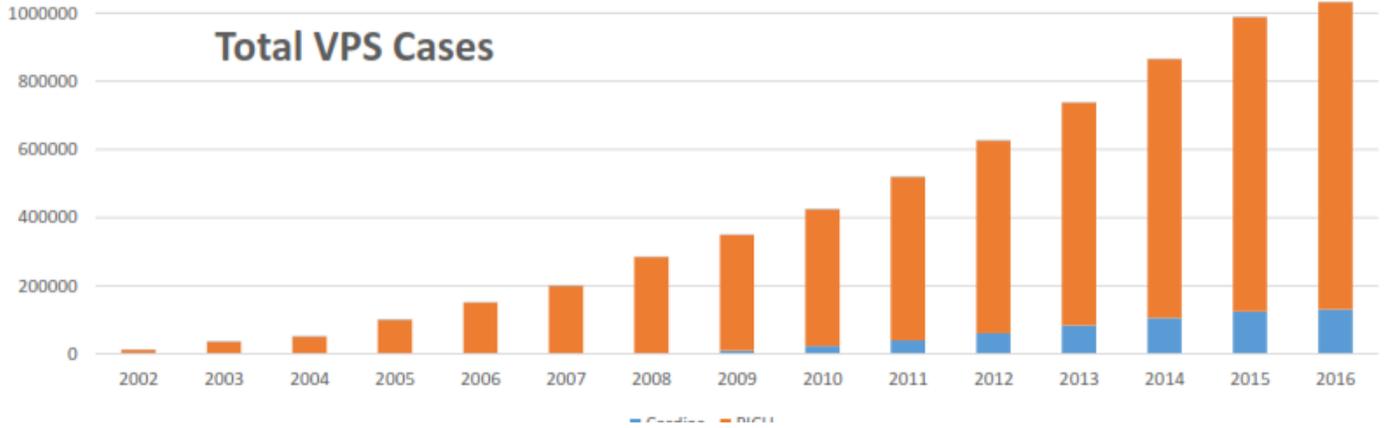
### **State Wide Collaboratives**

In 2014, California Children's Services began requiring all State funded PICUs to submit their annual VPS performance reports. This impacts initiatives for quality improvement. Other States are launching similar efforts.

## The Growth of VPS

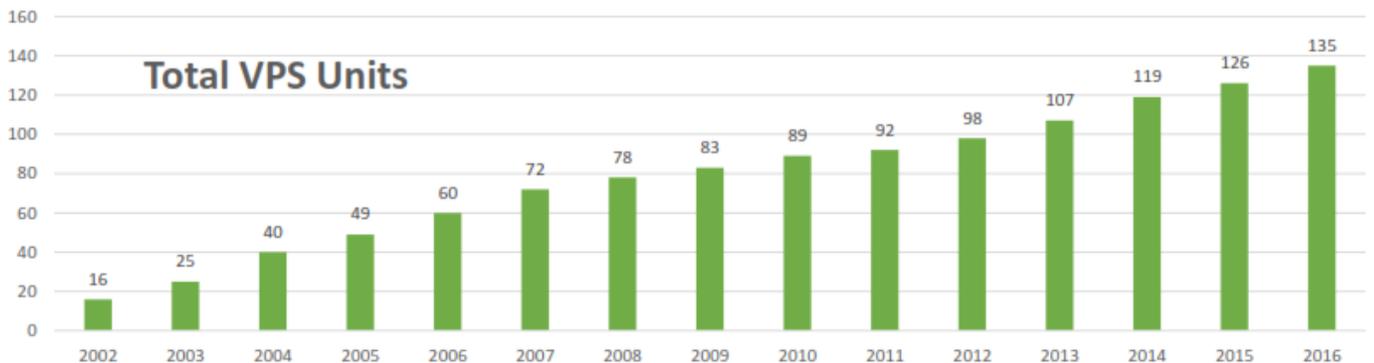
Number of harvested cases in VPS

- 2002: 12,719 cases
- 2016: 1,033,661 cases
  - 130,947 are Cardiac-specific cases



Number of active VPS units

- 2002: 16 units
- 2016: 135 units
  - Includes 47 mixed CTICUs
  - Includes Canada and Saudi Arabia



## **The VPS Reports: Current User Access to VPS Data**

### **Standardized Reports**

VPS currently provides online access to twelve (12) standardized reports. These standardized template reports enable reporting of VPS data from all fields as needed. The VPS users from the individual units have permission and access to running the standardized reports as needed. The reports available on-demand to VPS users include:

- **Standardized Cardiac Overview Report**
  - **Standardized Hospital Referral Source Summary Report**
  - **Standardized ICU Executive Procedure Report**
  - **Standardized Length of Stay Report**
  - **Standardized NQF Pediatric Critical Quality Measures Report**
  - **Standardized Patient Demographic and Summary Report**
  - **Standardized Patient Mortality Report**
  - **Standardized Procedure Detail Report**
  - **Standardized Procedure Summary Report**
  - **Standardized Procedures by Operator Report**
  - **Standardized Unplanned Readmissions within 24 hours Report**
  - **Standardized ICU Summary Report**
- 
- **MyReports**

A tool that allows on demand querying of data by users with requisite access. The ability to build specialized queries on custom populations containing the user defined output in a quick and easy format. A library of the most commonly requested VPS reports as well as the ability to add reports to your unit or personal library allows for viewing data in a like format over time.
- 
- **VPS Analytics**

Interactive dashboards with both pre-built dashboards and the ability to create dashboards of the user's own design. With the, ability to customize the dashboard, add filters and scheduled automated report delivery, the analytic tool provides state of the art functionality.
- 
- **Data Downloads**

The data download functionality enables users to have access to their own site's data to download and filter for the unit's needs. Users with access to data manipulation competencies have been very positive about the download functionality.

### **Annual and Quarterly Program Performance Reports**

- Sites begin to receive comparative reports once four (4) consecutive quarters of data have completed the data validation process.
- Annual reports enable custom selection of the comparison group by each site, comprehensive statistical analysis, and a call with VPS staff to discuss interpretations of the data and to generate recommendations, which are included in the final version of the report. Marrying the statistical results with the clinical picture allows for granular discussion of the site-specific indicators. This value-added bonus provides guided direction to successfully implement performance improvement projects.
- Quarterly reports are provided with each subsequent submission of data, using a comparison group that meets the unit's specific requirements. These reports provide participating teams with an updated comparative report of their data that may be helpful in evaluating the effectiveness of various improvement projects.

### **Ad Hoc Data Requests**

- VPS staff supports user access to VPS data when other options are not available through the ad hoc data request process.
- VPS staff has experienced an exponential increase in ad hoc requests for data as it reflects innovative reporting and data usage strategies from members throughout the VPS Community.

### **VPS Research Requests**

- Scientists / investigators from VPS participating sites have the capability to request access to de-identified case level data based upon research requests that are approved by the VPS Research Committee.
- Researchers receive a high level of support in defining data needs for research, discussing opportunities and limitations of the data, organization of the data, and ongoing support for potential interpretations of preliminary and final results.

### **Customized Research and Quality Module Development**

- Investigators with interest in developing customized data entry modules for use by select VPS sites are supported throughout the development process with the creation of an estimated budget and production timeline for the project.
- VPS staff provides consultation on the various stages of development and data quality control to ensure that the module supports data capture in a manner that results in optimal utilization of the data.

## VPS Program Performance Reports

In addition to the numerous comparative reports, research support and unit descriptive statistics, VPS has developed a unique, highly valued, state of the art **VPS Program Performance Report**. These reports are structured to provide breadth and depth in evaluating performance of ICUs over time and comparing to other similar ICUs in the U.S. Key aspects of these reports are an initial high level executive summary, which can be used to facilitate communication with senior administrators within children's hospitals, and detailed data presentations and analyses for review with clinical teams in the ICU to enhance improvement.

The program performance reports are structured using the framework proposed by the Institute of Medicine (IOM) to evaluate quality, based on the six dimensions of quality. These six dimensions are measures for effectiveness, efficiency, equity, patient centeredness, safety and timeliness of care. Several quality and related to the six outcomes indicators are routinely measured in dimensions of quality the VPS system and are reported as part of the program performance reports. If other indicators are not routinely measured in VPS, hospitals have the opportunity to link the VPS data system to internal databases and data reporting systems. For example, patient satisfaction is not measured as part of the VPS system, but is an important measure for patient centeredness dimension of quality. Accordingly, patient satisfaction survey data can be included in the reports evaluating quality for the ICU, which are subsequently presented for review by the hospitals.

**These reports are unique in pediatric medicine and they provide an expert analysis of critical care practice that adds tremendous value for our customers.**

Another important aspect of program performance reports produced by VPS relates to risk adjustment. Risk adjustment ensures that the differences of patient severity of illness across PICUs have been appropriately adjusted to allow meaningful comparisons of outcomes of care. VPS utilizes a physiologic risk adjustment in the ICU and has continued to evolve risk adjustment methodologies, such as the PICSIM tool, to allow for meaningful comparisons of performance and outcomes of ICUs using the VPS system. VPS is an International leader in this crucial quality area.

Measuring and reporting quality and outcomes is an important aspect of quality improvement. This is of even greater significance in the current era of health care reform with its growing emphasis on performance measurement, transparency, and accountability, and outcomes reporting for purposes of pay for performance. The program performance report format meets the traditional reporting requirements for hospitals for groups such as The Joint Commission, facilitate quality improvement by providing comparative trends to clinicians, and provide the framework for linking outcomes indicators to reimbursement in a pay-for-performance and accountability environment. Further, by ensuring that data reported in the clinical program reports have a high level of accuracy and validity, the reports receive successful buy-in from clinicians. Finally, by adopting a robust statistical analytic outcomes framework, the results emerging from these comparative reports are evaluated not only for statistical significance, but also for clinical relevance. This, in turn, has encouraged successful adoption of the results emerging from the program performance reports for knowledge sharing and continued rapid process improvement.

## The Program Performance Reports

These comprehensive reports provide clinicians and administrators valid and reliable measures of outcomes **to monitor clinical improvement**. These customized reports use a standardized presentation of key unit indicators arrayed against peers, interpreted by statisticians and assessed through clinical consultation.

- Annual report provides customized comparison group, statistical interpretation, and clinical consultation for a scientific analysis and meaningful interpretation of comparative data.
- New quarterly reports update indicators for more real-time trending and progress tracking.
- Current and potential applications: quality improvement, outcomes enhancement, accreditation (Joint Commission, Leapfrog), administrative reports (board and community), clinical transformation, pay for performance.
- Clinical foundation: measures identified (national search and clinical input) and customized to PICU, validated data, internal trends, and national comparison.
- Administrative relevance: reports uniquely packaged for review by hospital administration, submitted to board of directors, application during hospital budget process.

## **VPS Collaborative Quality Improvement Projects**

The VPS database drives advances in pediatric critical care that have improved care for children. Member projects performed using VPS include:

### **Reduce Risk and Improve Patient Safety**

- ✓ Through analysis of VPS data, **Children's Hospital (Colorado)** and **Inova Fairfax Hospital for Children** changed policy and practice to reduce the rate of unplanned extubations, a known highrisk complication in critical care.
- ✓ **Akron Children's Hospital** used VPS data to evaluate the effectiveness of its Medical Response Team (MRT), implemented in 2006 to identify and support patients at risk for deterioration outside the PICU. PIM 2 scores (a measure of baseline severity of illness in the PICU) decreased by 40 percent for patients transferring from acute care units over the three-year timeframe since the MRT began, although the characteristics and primary diagnoses did not change substantially. The interpretation of results: Children at risk for deterioration were identified and successfully transitioned to a higher level of care prior to deterioration.

### **Improve Utilization of Existing Resources**

- ✓ **Children's Hospital of Wisconsin (CHW)** led a multi-center improvement initiative using VPS data to reduce unnecessary delays in transfers for patients no longer requiring ICU care, thus increasing available nursing care hours by over 14,600 hours during a two-year period, allowing these resources to be effectively reallocated at CHW. This quality improvement initiative has demonstrated sustainability with continued reduced discharge delay for more than 5 years.
- ✓ **Multicare Mary Bridge Children's Hospital and Health Center, Helen DeVos Children's Hospital, St. Joseph Children's Hospital (Paterson, NJ) and The Children's Hospital (Boston)** have used admission, discharge and transfer data to modify the staffing model to shift nursing and other support resources to times of peak activity, improving the effectiveness of existing resources.
- ✓ **Inova Fairfax Hospital for Children** used VPS data to review the impact of selected strategic changes on care delivery. For example, VPS data were used to support decision making development of an intermediate care (IMC) unit and, later for considering of expansion of admission criteria for patients cared for in the IMC.

- ✓ **Akron Children's Hospital** utilizes daily Pediatric Logistic Organ Dysfunction data as an objective measure of patient acuity in order to better utilize nursing resources through more effective patient assignments.

### **Expand Disaster Preparedness**

- ✓ **Inova Fairfax Hospital for Children** used VPS to review its role in communitywide disaster preparedness. VPS comparative data revealed that Inova had higher volumes of patients from the emergency department than the reference group. This signaled the need to expand disaster readiness. Inova initiated outreach efforts to improve disaster readiness in response to the VPS data.

### **Improve Financial Position and Fiscal Responsibility**

- ✓ **Inova Fairfax Hospital for Children** and **LeBonheur Children's Hospital** compared VPS data with hospital billing data and discovered that financial systems were not completely capturing PICU admissions/procedures, allowing greater revenue capture.
- ✓ **University of Minnesota Amplatz Children's Hospital** used VPS data to discover up to a 30 percent billing discrepancy for cardiac catheterizations and observation only patients, leading to improved revenues.

### **Meet Reporting Requirements**

- ✓ **California Children's Services (CCS)** requested the support of VPS to develop customized comparative reports for the pediatric ICUs in California that accept CCS reimbursement to evaluate the quality of care. VPS has provided a customized report to CCS annually for the purposes of quality improvement since 2015.
- ✓ VPS has developed a module to enable VPS sites to document their performance related to the pediatric critical care core measures endorsed by the **National Quality Forum**. Each site can generate standardized reports on demand for accreditation activities.

### **Research Contributions to Evidence-Based Practice**

- ✓ VPS has become a valued platform for federally funded multi-center research, including the **NIH funded Clinical and Translational Science Awards (CTSA) Consortium for Pediatric Congenital Heart Centers (Gurney, PI, University of Michigan C.S. Mott Children's and Von Voigtlander Women's Hospital)** and the **AHRQ funded Pediatric Measurement Centers of Excellence (Sachdeva, PI, Children's Hospital of Wisconsin)**. VPS has become a valued platform for privately funded multi-center research, including

the **Childress Institute for Pediatric Trauma** funded Pediatric Trauma and Assessment Management (PTAM)

### **Research Contributions to Evidence-Based Practice *Continued***

- ✓ The **Society of Critical Care Medicine** awarded the **2009 annual Epidemiology/Outcomes Specialty Award** to VPS researchers (**Wetzel, PI, Children’s Hospital Los Angeles**) for demonstrating the impact of “drift” in the effectiveness of severity of illness tools used to perform risk-adjusted comparisons of mortality in pediatric intensive care units
- ✓ A team of VPS researchers conducted studies that improved the performance of severity of illness tools, which have strengthened the capability of VPS to provide meaningful comparative data, including the development of a severity of illness tool specifically for children with cardiac issues PICSIM (**Jeffries, PI, Seattle Children’s Hospital**).
- ✓ Since 2004, researchers have utilized VPS data to conduct studies, leading to well over 125 published manuscripts, abstracts and presentations (these data are likely under reported due to a historic lack of systems to accurately track publications and presentations).

## Examples of How VPS Has Impacted Critical Care in the U.S.

### Reduced Risk & Improved Patient Safety

- Children’s Hospital Colorado and Inova Fairfax Hospital for Children changed policy and practice to reduce rate of unplanned extubations.
- Kosair Children’s Hospital identified trends, isolated cause and reversed a practice change that was implemented for post-extubation stridor.
- Akron Children’s identification of children at risk for deterioration and transport to a higher level of care.
- Children’s Mercy Hospital used VPS data to evaluate effectiveness of their transport team in stabilizing patients prior to PICU admissions.
- CHLA-demonstrated impaired outcomes resulting in increased mortality, instituted a rapid response team saving 30 lives a year.

### Improved Resource Utilization

- Akron Children’s Hospital used PELOD data for more effective nursing assignments.
- Children’s Hospital of Wisconsin reduced delays in transfer of patients no longer requiring ICU care resulting in an increase in available nursing care hours by 14, 600 hour over 2 years and sustained decrease in delays for >5 years.
- Mary Bridge Children’s Hospital, Helen DeVos Children’s Hospital, Emanuel Children’s Hospital, St. Joseph Children’s, and Children’s Hospital Boston utilized VPS data to modify their staffing models.
- Children’s Mercy Hospital utilizes VPS data to analyze patient placement decisions for patients requiring unplanned upgrade in care.

### Improved Financial Position and Fiscal Responsibility

- Inova Fairfax Hospital for Children’s and LeBonheur Children’s Hospital compared hospital billing data to VPS data resulting in increased revenue for missing PICU admits.
- Amplatz Children’s Hospital discovered 30 percent billing discrepancy for cardiac catheterization and observation patients.
- Children’s Mercy Hospital utilized VPS data to demonstrate need for additional acute care beds/unit.

### Practice Innovation

- Kosair Children’s Hospital developed child abuse screening tool based on observations made by VPS data collection team.
- Guided the establishment of a rapid response team at CHLA.

### Reporting Requirements

- Customized comparative reports are prepared for all pediatric ICUs in California that accept California Children’s Services reimbursement.
- Development of a module for documentation of performance for NQF pediatric critical care core measures.

### Research Contributions to Evidence-based Practice

- VPS has provided for federally funded multi-center research.
- Awarded the 2009 Annual Epidemiology/Outcomes Specialty Award by the Society of Critical Care medicine.
- Society of Critical Care Medicine 2015 Annual CPS/Resuscitation Specialty Award, *Epidemiology and Outcomes of In-Hospital Cardiac Arrest in Critically Ill Children across Hospital of Varied Center Volume: A Multi-Center Analysis*
- Improved severity of illness tools and developed PICSIM, a cardiac specific severity of illness tool.
- Numerous published manuscripts, abstracts and poster presentations (see following).

## **Research and Multi-Institutional Studies Affiliated with VPS**

**VPS is the largest research association in pediatric critical care internationally.** Extensive research has been generated from, supported by and completed within VPS. As part of the original VPS vision, support for pediatric critical care research has always been a primary motivator. VPS has a research committee acting as an internal IRB and assumes a cooperative and supportive function in facilitating pediatric research. Nevertheless, many studies are done using VPS without our knowledge; thus the tracking of projects is incomplete.

An approved or pending list of VPS research projects and notes related to publication or presentation of the research results may be found on the VPS Web Site at [www.myvps.org](http://www.myvps.org).

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