

Establishing A New Pediatric Intensive Care Unit

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Establishing a Pediatric Intensive Care Unit (PICU) is a challenging and stimulating task. Its success is dependent on good organization, availability of skilled personnel, state of the art technology and available resources. It should be a separate unit from the neonatal and adult intensive care units with its own personnel, equipment and pediatric services dedicated to the care of critically ill children. We shall discuss here the factors important in the organization, unit design as well as staffing requirements and ancillary support services of a Pediatric Intensive Care Unit.

Organization

A Critical Care Committee should be established with nursing, administrative, pediatric and pediatric subspecialty representation. Members of the committee should include the medical director of the PICU and the unit head nurse. Recommendations for major equipment purchases, for structure and design changes of the unit should come through the PICU committee.

The committee should approve poli-

cies and procedures such as those pertaining to infection control, pertinent safety practices, traffic control, parent visits, admission and discharge criteria. It should also provide for policies and procedures related to monitoring, life support techniques, and equipment maintenance. An appropriate record keeping system should be developed for both physician and nursing documentation including provision for periodic review, evaluation of morbidity and mortality as well as quality of care.

Unit Design¹⁻³

Even in most ideal circumstances, the designers of PICUs face numerous constraints including financial, geographic, personnel and political issues. It is critical that the unit is designed with long range perspective of the unit's function and requirements in mind. The unit designed for the future must be adaptable and expandable, and must maximize the resources of space, time, equipment, communication and personnel in a most affordable way.

The unit should be structured for controlled access and traffic flow. No traffic to other departments should pass through the unit. It should be located adjacent to or within direct elevator travel to the emergency room, laboratory and

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radiology departments. Ideally, adjacent elevators should have a key control. A physician's on-call room as well as the office of the director and head nurse should be located close to the PICU. Other facilities located nearby should include a staff lounge and personnel locker space. A well-designed PICU should have adequate space for support areas (Table 1).^{4,6}

The ideal size for a PICU is not known. Units smaller than approximately 6 beds risk inefficiency, and units larger than approximately 16 beds may be difficult to manage unless appropriately divided. In general, the number of ICU beds required for a PICU is dependent on the pediatric population of the geographical area, capability of critical care pediatric transport, other competing hospitals in the area and finally the total pediatric ward beds in the hospital.

Room layout should allow actual visualization of all patient areas. A central station provides critical information when personnel are away from the patient's bedside. Central electronic patient monitoring may be utilized, but doesn't substitute for direct observation.

In our experience, it is beneficial to have 50% of patient rooms capable of caring for isolation patients. At least one isolation room should have an anteroom (separate area for hand washing and donning isolation apparel), and negative pressure ventilation. The remaining beds can be in an open area and provide privacy for the patient and family via curtains or screens. Ideally, hand washing facilities must be available in all patient care areas. Gowns and masks are probably necessary only for taking care of patients requiring isolation; however, hand

TABLE 1. Support Areas for a Pediatric Intensive Care Unit

Storage room	- Should be large enough to store beds, cribs and other large equipment.
Dirty utility room	- Should contain sink, bedpan washing apparatus, area for soiled surgical trays, soiled linen and trash.
Clean utility	- Room to store clean and sterile items for patients, infants and adolescents.
Linen	- Include all sizes for patients and beds.
Kitchen/medicine-room	May be combined if space is limited. Medication room must contain medication refrigerator, narcotic cabinet and hand washing facility. Nourishment refrigerator must be separate.
Physician call room	- Must be adjacent to the PICU. Should contain a bed, bathroom facilities, emergency alarm system and phone.
Family waiting area	- Outside of patient care area with bathroom, telephone and shower.
Conference room	- Can be used for nursing education, patient care conferences as well as private family conferences.
Nursing lounge	- Bathroom and lockers within.
Head nurse office	- Adjacent to PICU.
Educator's office	- Adjacent to PICU.

washing before and after patient contact is the best method for infection control, and should be mandated for all PICU personnel and visitors. Space requirements for pediatric intensive care units varies by state regulations. For example, in the state of Texas, pediatric intensive care areas require a minimum square footage of 120 feet and clearance between beds to be 4½ feet.⁷

When designing the head wall, it is generally accepted practice to have a minimum of three (3) vacuum sources to allow for airway, gastric and drain suction. Each bedside should contain at least two oxygen outlets and one compressed air outlet for minimal ventilation capabilities. Electrical outlets on the head wall must be connected to an emergency generator to ensure an uninterrupted power source. Ten to fifteen electrical outlets per bedside is an acceptable number; however, 15 to 20 is ideal. The bedside monitor should be positioned out of the patient's reach, and should allow for maximum visibility by the caregiver (i.e., wall mount). The head wall should also contain an intercom system and an emergency alarm. A bedside table or cart is helpful at each bedside to hold personal belongings and required patient supplies.

Select a decor suitable for pediatric patients of all ages as well as their parents. The use of color can often decrease the frightening sterile appearance of the hospital. When choosing colors, soothing colors such as blue with bright accent colors to add cheerfulness and familiarity should be considered. Natural lighting by windows help patients with day/night orientation, circadian rhythms and may decrease the sense of isolation.

An additional aspect of PICU design is the capability for patient care outside of the pediatric intensive care unit. A pediatric ward as well as a stepdown unit (intermediate care unit) should be available once intensive care is no longer necessary.

Equipment

The selection of equipment should be based on the following criteria : cost/benefit analysis, accuracy and adaptability for the pediatric population, ease of use for caregivers, troubleshooting requirements, documented use on pediatric patients, maintenance requirements and clinical biomedical support of vendor and hospital. Table 2 shows a list of the required and optional equipment for a tertiary care PICU.

Medical Director

There should be a designated Medical Director of the PICU. Director of the PICU should be a physician with training, experience and expertise in pediatric critical care. In addition to being the attending physician for critically ill patients, the Medical Director should have responsibilities which should include, but not limited to coordination of multiple medical, surgical and ancillary services available to the PICU, implementation of all unit policies and procedures, working cooperatively with the head nurse as well as nursing administration for a smooth functioning of the PICU, maintenance and replacement of equipment, collection of statistical data for the evaluation of the units effectiveness as well as coordination of education and research. As mentioned earlier, the PICU committee should share responsi-

TABLE 2. Essential Equipments Required for a PICU

Equipment	Requi- red	Optio- nal	Equipment	Requi- red	Optio- nal
<i>Diagnostic equipment</i>			- Open chest	x	
Otoscope/Ophthalmoscope	x		- Chest tube insertion	x	
Portable EG	x		- Lumbar puncture	x	
Portable x-ray devices and supplies	x		Bronchoscope with light source		x
12-lead EKG-portable	x		<i>Monitoring equipment</i>		
Unit-based blood glucose testing equipment		x	Doppler	x	
<i>Procedural equipment</i>			Electric thermometer		x
Emergency cart	x		Glass thermometer	x	
Ventilators : volume and pressure	x		Automated BP apparatus	x	
Infusion pumps capable of micro-infusion	x		Refractometer		x
Defibrillator and cardioverter	x		Bed scale		x
Portable suction	x		O ₂ analyzers	x	
Resuscitation bag valve mask device	x		Portable monitor	x	
O ₂ tanks	x		ETPCO ₂ machine		x
Heating/cooling machine and blanket	x		Pulse oximetry	x	
Bilirubin light	x		Infant scale	x	
Air oxygen blender	x		Diaper scale	x	
Servo controlled heating units	x		Bedside monitor capable of continuous monitoring of :		
Pacemakers	x		- EKG	x	
Emergency drugs	x		- Respiratory	x	
Tracheal intubation equipment	x		- Temperature	x	
Artificial airways and oxygen administration device	x		- Arterial pressure	x	
Isolation equipment	x		- Central venous pressure	x	
Equipment for vascular access			- Pulmonary artery pressure	x	
- Various sizes of multilumen catheters for central line placement	x		- Intracranial pressure	x	
- Multiple size catheters for peripheral vein and arterial cannulation	x		- Arrhythmias alarm	x	
Sterile trays :			Central monitoring station	x	
- Tracheostomy	x		<i>Miscellaneous equipment</i>		
- Cutdown	x		Rocking chair		x
			Cribs	x	
			Beds	x	
			Bedside table	x	
			Overbed table	x	
			IV pole	x	
			Bedside chair	x	
			Clocks		x
			TV	x	
			Toys	x	

bility in ensuring the implementation of above mentioned tasks and should make recommendations for continued improvement in quality of care.

Physician Staffing

The PICU should have 24-hour in-house physician coverage as well as a pediatric surgeon available at short notice. The pediatric intensive care physician should be well trained in taking care of critically ill children. In addition, pediatric subspecialists such as pediatric cardiologist, neurologist, radiologist, gastroenterologist, nephrologist should be readily available to help the pediatric intensivist with management of complex medical problems which are a common occurrence in the PICU. The pediatric intensive care physician should be primarily responsible for coordinating the overall care of the patient. A well coordinated team approach to manage all critically ill patients is the key to success of a PICU.

Nursing Personnel

A high quality and specially trained pediatric nursing staff is essential to provide 24 hour coverage. The PICU head nurse should have special training in pediatric patient care monitoring and life support, and should be responsible for nursing care and inservice education, staffing and nursing administration. As mentioned previously, the PICU head nurse should be a member of the PICU committee.

The nurse/patient ratio in a pediatric ICU is generally one nurse for every two patients with enough flexibility to allow for one to one or one to three nurse to patient ratio. This should be considered when deciding the number of nursing

personnel necessary to care for patients. PICU patient care routines remain static throughout the twenty-four hour period. Therefore, nursing personnel requirements are the same on all shifts. A unit secretary is helpful during the day when patient mobility, activity and visitors are at their peak. When experienced PICU nurses are unavailable, a mixture of adult ICU nurses and experienced pediatric nurses work well. With a well-planned orientation, both of these groups in our experience transitioned easily into the role of a Pediatric Intensive Care Nurse.

Nursing Education and Training

The management staff of the PICU should all be experienced PICU nurses. This is a valuable asset when educating new personnel. An experienced Clinical Nurse Educator is essential in opening a new unit as well as for providing future education.

Orientation should consist of didactic training and hands-on practice with equipment and supplies. The didactic training of nurses can be done by physicians participating in patient care, management staff and nurse educator. This should include normal and abnormal assessment findings for all ages of pediatric patients. Disease processes seen most frequently including signs, symptoms, lab values, treatment modalities and nursing care specific to each disease should also be discussed.

Pediatric emergency training for nurses must include classroom education as well as practice sessions simulating pediatric emergencies. Dysrhythmia and arterial pressure, as well as central venous pressure waveform interpreta-

tion may be incorporated in emergency training, but should also be taught separately. Commonly used medications (both emergent and nonemergent) should be discussed including preferred routes and methods of administration, side effects, use and action of drugs.

A skills lab is one method of familiarizing nursing staff with new equipment prior to patient use. The equipment company representatives can provide excellent training and troubleshooting skills to the staff. Time should be allotted to each staff member to practice with each piece of equipment to ensure its safe use with patients. The skills lab is also an opportunity to teach staff line placement, aseptic/sterile techniques incorporated with line setup and use. Venipuncture and arterial puncture techniques can also be reviewed at this time.

The emotional stress a family with a critically ill child undergoes is greatly underestimated. Therefore, lectures concerning parental support and psychosocial considerations for the hospitalized child and family should be included in the initial orientation phase. A supportive nurturing environment is crucial for families, patients and staff. A mechanism of staff support is frequently helpful in dealing with the stress of working in a PICU.

Once a new PICU is open and receiving patients, it is beneficial to pair an experienced nurse with a less experienced nurse to build confidence, and to ensure quality patient care.

Ancillary Services

There is a vast network of supportive services that must be available in the management of the critically ill child.

These are as follows :

1. Pediatric emergency services. The emergency room provides a continuum of care from pre-hospital services to the PICU. As such, it should be equipped with pediatric equipment and supplies to treat patients from infancy to adolescence. It is essential that emergency room personnel be trained in pediatric medicine and be experienced in their approach to the pediatric population. An open line of communication and support must exist between the emergency room and PICU personnel to ensure quality care to all pediatric patients and their families.

2. Pediatric operating room. Critically ill or injured children may require the services of the operating room prior to their arrival in the PICU. Therefore, the operating room must be equipped with emergency and stabilization equipment, as well as the anesthesia and surgical supplies and instruments necessary to perform surgery on all pediatric patients. The areas for pediatric care in the operating room must be capable of maintaining the temperature of this age group. The pediatric operating room is generally kept warmer and patient warming devices must be available at all times.

The operating room personnel, surgeons, nurses and anesthesiologists should have special training to provide care for pediatric patients. It is preferred that these services and personnel be available on a twenty-four hour basis either in-hospital or on-call.

3. Respiratory care. The pediatric respiratory therapist is a vital member of the health care team. The vast majority of all

pediatric ICU patients will require some type of respiratory intervention from blow-by O₂ to mechanical ventilation. A therapist specially trained in the care of all pediatric respiratory patients is vital. Their knowledge should range from the pharmacology of respiratory drugs to the management of the ventilated patient including chest physical therapy and ventilator operation. Their approach, like all of those working with children, should be non-threatening and nurturing. A pediatric respiratory therapist must be available in-house twenty-four hours a day.

4. Pharmacy. The PICU should be well-stocked with emergency drugs and intravenous fluids as well as frequently used STAT medications. This is not a substitute for the pharmacy, but merely a means of expeditious medication administration. The pharmacist should be very knowledgeable in pediatric drug administration routes, doses, uses, actions and side effects. The pharmacist must also be aware of the need for fluid conservation in drug preparation, especially for the fluid restricted patient.

A satellite pharmacy close to the PICU is very beneficial. It can promote direct communication between pharmacist, physician, and nurses thus possibly decreasing medication errors. This will also speed the drug availability to the patient.

5. Radiology. A pediatric radiologist is vital for accurate interpretation of diagnostic procedures. Basic equipment suitable for patients of all ages should be available. The radiology department should be capable of portable studies, i.e., ultrasound, x-rays. Technicians

should be trained in pediatric techniques and approach.

6. Physiotherapy. Physiotherapists should be utilized early in the ICU treatment regime. Their expertise in the rehabilitation process can decrease the hazards of immobility while promoting the recovery phase especially in patients who have sustained head injury or a neurological insult (i.e., encephalitis or spastic paraplegia).

7. Dietary. Critically ill children often need dietary consultations for caloric recommendations, formula preparation and, when recovering, meal planning. A capability for preparation of intravenous nutrition should be available because patients on long term mechanical ventilation, or patients with an ileus or post-operative bowel surgery may not tolerate gastric feeds.

8. Blood bank. The blood bank should be prepared to meet all the needs of the pediatric patients. These may range from aliquot units, irradiated blood to cytomegalovirus free blood. With increasing risk of blood transmitted diseases such as AIDS and hepatitis, donor directed blood has also become a popular choice for pediatric blood product administration in the United States. Family members of the patient donate the blood which, if compatible, can be used as needed.

9. Laboratory. Virtually all pediatric patients will require some laboratory testing during their illness. The laboratory must be capable of performing micro-sampling, and must have access to normal pediatric lab values. The lab should be efficient in giving the result of

important blood tests. A blood gas machine should ideally be located in close vicinity of the pediatric intensive care unit with a quick turnaround time.

Patient Medical Record

Designing appropriate forms for documentation of patient care is imperative. There may be existing forms in the hospital that can be used or revised to meet the needs of the PICU. However, it may be necessary to design new forms in order to accommodate the pediatric population. When considering forms for

documentation of pediatric care, it is helpful to remember some key concepts.

A flow sheet should include all the vital information including vital signs such as temperature, heart rate, blood pressure, respiration rate, intake/output, laboratory values and a nursing assessment as well as the time of administration of all the medications, fluids and blood products.

Fluid management is a vital part of the total management of critically ill children; therefore a flowsheet should be designed to give detailed information

TABLE 3. Patients Intake Documented from Left to Right, and Output from Right to Left

	INTAKE				OUTPUT			
	IV	IV	PO	TOTAL	TOTAL	URINE	GI	DRAINS
0900	<input type="text"/>	<input type="text"/>	<input type="text"/>	= <input type="text"/>	<input type="text"/>	= <input type="text"/>	<input type="text"/>	<input type="text"/>
1000	<input type="text"/>	<input type="text"/>	<input type="text"/>	= <input type="text"/>	<input type="text"/>	= <input type="text"/>	<input type="text"/>	<input type="text"/>
1100	<input type="text"/>	<input type="text"/>	<input type="text"/>	= <input type="text"/>	<input type="text"/>	= <input type="text"/>	<input type="text"/>	<input type="text"/>
1200	<input type="text"/>	<input type="text"/>	<input type="text"/>	= <input type="text"/>	<input type="text"/>	= <input type="text"/>	<input type="text"/>	<input type="text"/>
1300	<input type="text"/>	<input type="text"/>	<input type="text"/>	= <input type="text"/>	<input type="text"/>	= <input type="text"/>	<input type="text"/>	<input type="text"/>
1400	<input type="text"/>	<input type="text"/>	<input type="text"/>	= <input type="text"/>	<input type="text"/>	= <input type="text"/>	<input type="text"/>	<input type="text"/>
1500	<input type="text"/>	<input type="text"/>	<input type="text"/>	= <input type="text"/>	<input type="text"/>	= <input type="text"/>	<input type="text"/>	<input type="text"/>
1600	<input type="text"/>	<input type="text"/>	<input type="text"/>	= <input type="text"/>	<input type="text"/>	= <input type="text"/>	<input type="text"/>	<input type="text"/>
1700	<input type="text"/>	<input type="text"/>	<input type="text"/>	= <input type="text"/>	<input type="text"/>	= <input type="text"/>	<input type="text"/>	<input type="text"/>
1800	<input type="text"/>	<input type="text"/>	<input type="text"/>	= <input type="text"/>	<input type="text"/>	= <input type="text"/>	<input type="text"/>	<input type="text"/>

Continues hourly.

about the patient's fluid balance. One format that may aid in this process is to have all information about the patient's intake documented from left to right and output from right to left. This allows the hourly intake and output totals to be side by side. (Table 3).

When designing a nursing assessment form, a systems approach helps organize the data. However, adult assessment forms do not always allow for pediatric information. For example, when charting a neurological assessment on an infant, one should include the condition of fontanelles and the presence or absence of the suck reflex. There will be specific pediatric information in all areas of the physical assessment. It is important to review these before designing a nursing assessment form.

Documentation is a crucial part of any medical record. In pediatrics, proper form design can promote open communication among all health care providers.

SUMMARY

Pediatric intensive care is a collaborative practice of dedicated personnel, advanced technology and a diverse group of support services. Unit design must focus on current patient needs while envisioning the technological and clinical needs of the future. With insight and a cooperative effort, your design team can effectively transform ideas into a unit committed to the care of critically ill children.

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