

Guidelines and levels of care for pediatric intensive care units

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The practice of pediatric critical care medicine has matured dramatically during the past decade. These guidelines are presented to update the existing guidelines published in 1993. Pediatric critical care services are provided in level I and level II units. Within these guidelines, the scope of pediatric critical care services is discussed, including organizational and administrative

structure, hospital facilities and services, personnel, drugs and equipment, quality monitoring, and training and continuing education. (Crit Care Med 2004; 32:2117-2127)

KEY WORDS: pediatric critical care medicine; administrative structure; hospital facilities and services; personnel; drugs and equipment; quality monitoring; continuing education

The practice of pediatric critical care has matured dramatically throughout the past 3 decades. Knowledge of the pathophysiology of life-threatening processes and the technological capacity to monitor and treat pediatric patients suffering from them has advanced rapidly during this period. Along with the scientific and technical advances has come the evolution of the pediatric intensive care unit (PICU), in which special needs of critically ill or injured children and their families can be met by pediatric specialists. All critically ill infants and children cared for in hospitals, regardless of the physical setting, are entitled to receive the same quality of care.

In 1985, the American Board of Pediatrics recognized the subspecialty of pediatric critical care medicine and set criteria for subspecialty certification. The American Boards of Medicine, Surgery, and Anesthesiology gave similar recogni-

tion to the subspecialty. In 1990, the Residency Review Committee of the Accreditation Council for Graduate Medical Education completed its first accreditation of pediatric critical care medicine training programs. In 1986, the American Association of Critical Care Nurses developed a certification program for pediatric critical care, and in 1999, a certification program for clinical nurse specialists in pediatric critical care was initiated.

In view of recent developments, the Pediatric Section of the Society of Critical Care Medicine and the Section on Critical Care Medicine and Committee on Hospital Care of the American Academy of Pediatrics believe that the original guidelines for levels of PICU care from 1993 (1) should be updated. This report represents the consensus of the three aforementioned groups and presents those elements of hospital care that are necessary to provide high-quality pediatric critical care. The concept of level I and level II PICUs as established in the guidelines set forth in 1993 will be continued in this report. Individual states may have PICU guidelines, and it is not the intent of this report to supersede already established state rules, regulations, or guidelines; however, these guidelines represent the consensus report of critical care experts.

Pediatric critical care is ideally provided by a PICU that meets level I specifications. The level I PICU must provide multidisciplinary definitive care for a wide range of complex, progressive, and rapidly changing medical, surgical, and traumatic disorders occurring in pediatric patients of all ages, excluding premature newborns. Most, although not all,

level I PICUs should be located in major medical centers or within children's hospitals. It is also recognized that in the appropriate clinical setting and as a result of many forces, including but not limited to the presence of managed care, the insufficient supply of trained pediatric intensivists, and geographic and transport limitations, level II PICUs may be an appropriate alternative to the transfer of all critically ill children to a level I PICU.

The level I PICU should provide care to the most severely ill patient population. Specifications for level I PICUs are discussed in detail in the text and are summarized in Table 1. Level I PICUs will vary in size, personnel, physical characteristics, and equipment, and they may differ in the types of specialized care that are provided (e.g., transplantation or cardiac surgery). Physicians and specialized services may differ between levels, such that level I PICUs will have a full complement of medical and surgical subspecialists, including pediatric intensivists. Each level I and level II PICU should be able to address the physical, psychosocial, emotional, and spiritual needs of patients with life-threatening conditions and their families.

Some pediatric patients with moderate severity of illness can be managed in level II PICUs. Level II PICUs may be necessary to provide stabilization of critically ill children before transfer to another center or to avoid long-distance transfers for disorders of less complexity or lower acuity. It is imperative that the same standards of quality care be applied to patients managed in level II PICUs and level I PICUs. Requirements for level II

All committee reports from the American Academy of Pediatrics automatically expire 5 yrs after publication unless reaffirmed, revised, or retired at or before that time.

The American College of Critical Care Medicine (ACCM), which honors individuals for their achievements and contributions to multidisciplinary critical care medicine, is the consultative body of the Society of Critical Care Medicine (SCCM) that possesses recognized expertise in the practice of critical care. The College has developed administrative guidelines and clinical practice parameters for the critical care practitioner. New guidelines and practice parameters are continually developed, and current ones are systematically reviewed and revised.

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Table 1. Minimum guidelines and levels of care for pediatric intensive care units (PICUs)

	Level I	Level II
I. Organization and administrative structure		
A. Category I facility	E	E
B. Organization		
1. PICU committee	E	E
2. Distinct administrative unit	E	E
3. Delineation of physician and nonphysician privilege	E	E
C. Policies		
1. Admission and discharge	E	E
2. Patient monitoring	E	E
3. Safety	E	E
4. Nosocomial infection	E	E
5. Patient isolation	E	E
6. Family-centered care	E	E
7. Traffic control	E	E
8. Equipment maintenance	E	E
9. Essential equipment breakdown	E	E
10. System of record keeping	E	E
11. Periodic review		
a. Morbidity and mortality	E	E
b. Quality of care	E	E
c. Safety	E	E
d. Critical care consultation	E	E
e. Long-term outcomes	D	D
f. Supportive care	D	D
D. Physical facility—external		
1. Distinct, separate unit	E	D
2. Distinct unit (not necessarily physically separate) with auditory and visual separation	E	E
3. Controlled access (no through traffic)	E	E
4. Located near:		
a. Elevators	E	D
b. Operating room	D	D
c. Emergency room	D	D
d. Recovery room	D	D
e. Physician on-call room	E	D
f. Nurse manager's office	D	D
g. Medical director's office	D	D
h. Waiting room	E	D
5. Separate rooms available		
a. Family counseling room	E	D
b. Conference room	D	D
c. Staff lounge	D	D
d. Staff locker room	D	D
e. Storage lockers for patients' personal effects (may be internal)	E	E
f. Family sleep area and shower	E	D
E. Physical facility—internal		
1. Patient isolation capacity	E	E
2. Patient privacy provision	E	E
3. Satellite pharmacy	D	O
4. Medication station with drug refrigerator and locked narcotics cabinet	E	E
5. Emergency equipment storage	E	E
6. Clean utility (linen) room	E	E
7. Soiled utility (linen) room	E	E
8. Nourishment station	E	E
9. Counter, cabinet space	E	E
10. Staff toilet	E	E
11. Patient toilet	E	E
12. Hand-washing facility	E	E
13. Clocks	E	E
14. Televisions, radios, toys	E	E
15. Easy, rapid access to head of bed	E	E
16. ≥ 12 electrical outlets per bed	E	E
17. ≥ 2 oxygen outlets per bed	E	E
18. ≥ 2 compressed air outlets per bed	E	E
19. 2 vacuum outlets per bed	E	E
20. Computerized laboratory reporting or efficient equivalent	E	D
21. Building code or federal code conforming for:		
a. Heating, ventilation, air conditioning	E	E
b. Fire safety	E	E
c. Electrical grounding	E	E
d. Plumbing	E	E
e. Illumination	E	E

Table 1. (Continued)

	Level I	Level II
II. Personnel		
A. Medical director		
1. Appointed by appropriate hospital authority and acknowledged in writing	E	E
2. Qualifications		
a. Board certified or actively pursuing certification in one of the following:		
i. Pediatric critical care medicine	E	E
• Initial board certification in pediatrics	E	E
• Co-director if director is not a pediatrician	E	D
ii. Anesthesiology with practice limited to infants and children and special qualifications in critical care medicine	E	E
iii. Pediatric surgery with added qualification in surgical critical care medicine	E	E
3. Responsibilities documented in writing	E	E
a. Acts as primary attending physician	D	D
b. Has authority to provide consultation for any PICU patient on a daily basis	E	E
c. Assumes patient care if primary attending physician is not available	E	E
d. Participates in development, review, and implementation of PICU policies ^a	E	E
e. Maintains database and/or vital statistics ^a	E	E
f. Supervises quality control and quality assessment activities (including morbidity and mortality reviews) ^a	E	E
g. Supervises resuscitation techniques (including educational component) ^a	E	E
h. Ensures policy implementation ^a	E	E
i. Coordinates staff education ^a	E	E
j. Participates in budget preparation ^a	E	E
k. Coordinates research ^a	E	D
4. Substitute physician available to act as attending physician in medical director's absence	E	E
B. Physician staff		
1. A physician in-house 24 hrs/day	E	E
a. A physician at the postgraduate year 2 level or above assigned to the PICU	E	D
b. A physician at the postgraduate year 2 level or above available to the PICU (advanced practice nurse or physician assistant may be used)	E	E
c. A physician at the postgraduate year 3 level or above (in pediatrics or anesthesiology) in house 24 hrs/day	E	O
2. Available in ≤30 mins (24 hrs/day)		
Pediatric intensivist or equivalent	E	D
3. Available in ≤1 hr		
a. Anesthesiologist	E	E
i. Pediatric anesthesiologist	E	D
b. General surgeon	E	E
c. Surgical subspecialists		
i. Pediatric surgeon	E	D
ii. Cardiovascular surgeon	E	O
• Pediatric cardiovascular surgeon	D	O
iii. Neurosurgeon	E	E
• Pediatric neurosurgeon	E	O
iv. Otolaryngologist	E	D
• Pediatric otolaryngologist	D	O
v. Orthopedic surgeon	E	D
• Pediatric orthopedic surgeon	D	O
vi. Craniofacial, oral surgeon	D	O
4. Pediatric subspecialists		
a. Intensivist	E	E
b. Cardiologist	E	D
c. Nephrologist	E	D
d. Hematologist/oncologist	D	D
e. Pulmonologist	D	D
f. Endocrinologist	D	D
g. Gastroenterologist	D	D
h. Allergist	D	D
i. Neonatologist	E	E
j. Neurologist	E	D
k. Geneticist	D	D
5. Radiologist	E	E
a. Pediatric radiologist	E	O
6. Psychiatrist or psychologist	E	D
C. Nursing staff		
1. Manager/director	E	E
a. Training and clinical experience in pediatric critical care	E	E
b. Master's degree in pediatric nursing or nursing administration	D	D
2. Nurse-to-patient ratio based on patient need	E	E
3. Nursing policies and procedures in place	E	E
4. Orientation to PICU	E	E
5. Completion of clinical and didactic critical care course	E	E
6. Address psychosocial needs of patient and family	E	E
7. Participate in continuing education	E	E
8. Completion of critical care registered nurse (pediatric) certification	D	D
9. Completion of PALS or an equivalent course	D	D
10. Nurse educator on staff (clinical nurse specialist)	E	D
a. Responsible for pediatric critical care in-service education	E	D

Table 1. (Continued)

	Level I	Level II
11. Nurse coordinator for regional continuing education	O	O
D. Respiratory therapy staff		
1. Supervisor responsible for training registered respiratory therapy staff	E	E
2. Maintenance of equipment and quality control and review	E	E
3. Respiratory therapist in-house 24 hrs/day assigned primarily to PICU	E	D
4. Respiratory therapist in-house 24 hrs/day	E	E
5. Respiratory therapists familiar with management of pediatric patients with respiratory failure	E	E
6. Respiratory therapists competent with pediatric mechanical ventilators	E	E
7. Completion of PALS or an equivalent course	D	D
E. Other team members		
1. Biomedical technician (in-hospital or available within 1 hr, 24 hrs/day)	E	E
2. Unit clerk on staff 24 hrs/day with a written job description	E	D
3. Child life specialist	E	D
4. Clergy	E	E
5. Social worker	E	E
6. Nutritionist or clinical dietitian	E	E
7. Physical therapist	E	E
8. Occupational therapist	E	E
9. Pharmacist (24 hrs/day)	E	E
10. Pediatric clinical pharmacist	D	D
11. Radiology technician	E	E
12. Bereavement coordinator	D	D
III. Hospital facilities and services		
A. Emergency department		
1. Covered entrance	E	E
2. Separate entrance	E	D
3. Adjacent helipad	D	D
4. Staffed by physician 24 hrs/day	E	E
a. Trained in pediatric emergency medicine	D	D
5. Resuscitation area		
a. ≥ 2 areas with capacity and equipment to resuscitate medical, surgical, and trauma pediatric patients	E	D
b. ≥ 1 areas as described previously	E	E
B. Intermediate care unit or step-down unit separate from PICU and PACU	D	D
C. Pediatric rehabilitation unit	D	D
D. Blood bank		
1. Comprehensive (all blood components)	E	E
2. Type and cross-match within 1 hr	E	E
E. Radiology services and nuclear medicine		
1. Portable radiograph	E	E
2. Fluoroscopy	E	D
3. Computed tomography scan	E	E
4. Magnetic resonance imaging	E	D
5. Ultrasound	E	E
6. Angiography	E	O
7. Nuclear scanning	E	O
8. Radiation therapy	D	O
F. Laboratory with microspecimen capability		
1. Available within 15 mins		
a. Blood gases	E	E
2. Available within 1 hr		
a. Complete blood cell, platelet, and differential counts	E	E
b. Urinalysis	E	E
c. Chemistry profile (electrolytes, BUN, glucose, calcium, and creatinine)	E	E
d. Clotting studies	E	E
e. Cerebrospinal fluid analysis	E	E
3. Available within 3 hrs		
a. Ammonia concentration	E	E
b. Drug screening	E	E
c. Osmolality	E	E
d. Magnesium, phosphorus concentrations	E	E
e. Toxicology screen	E	D
4. Preparation available 24 hrs/day		
a. Bacteriology (culture and Gram stain)	E	E
5. Point of care diagnostic testing	D	D
G. Department of surgery		
1. Operating room available within 30 mins, 24 hrs/day	E	E
2. Second operating room available within 45 mins, 24 hrs/day	E	D
3. Capabilities		
a. Cardiopulmonary bypass	E	D
b. Bronchoscopy (pediatric)	E	D
c. Endoscopy (pediatric)	E	D
d. Radiograph in operating room	E	E

Table 1. (Continued)

	Level I	Level II
H. Cardiology department with pediatric capability		
1. Electrocardiography	E	E
2. Echocardiography		
a. Two-dimensional echocardiography with Doppler	E	E
3. Catheterization laboratory (pediatric)	D	O
I. Neurodiagnostic laboratory		
1. EEG	E	E
2. Evoked potentials	D	D
3. Transcranial Doppler flow	D	O
J. Hemodialysis	E	O
K. Peritoneal dialysis or continuous renal replacement therapy	E	O
L. Pharmacy with pediatric capability	E	E
1. Available 24 hrs/day for all requests	E	E
2. Located near PICU and PACU	D	O
3. Urgent drug dosage form at bedside	E	E
4. Satellite pharmacy located in PICU	D	O
5. Pediatric pharmacist available for medical rounds	D	O
M. Rehabilitation department with pediatric capability		
1. Physical therapy	E	E
2. Speech therapy	E	E
3. Occupational therapy	E	E
IV. Drugs and equipment		
A. Emergency drugs	E	E
B. Portable equipment		
1. Emergency cart	E	E
2. Procedure lamp	E	E
3. Doppler ultrasonography device	E	E
4. Infusion pumps (with microinfusion capability)	E	E
5. Defibrillator and cardioverter	E	E
6. Electrocardiography machine	E	E
7. Suction machine (in addition to bedside)	E	E
8. Thermometers	E	E
9. Expanded scale electronic thermometer	E	E
10. Automated blood pressure apparatus	E	E
11. Otoscope and ophthalmoscope	E	E
12. Automatic bed scale	E	D
13. Patient scales	E	E
14. Cribs (with head access)	E	E
15. Beds (with head access)	E	E
16. Infant warmers, incubators	E	E
17. Heating and cooling blankets	E	E
18. Bilirubin lights	E	E
19. Transport monitor	E	D
20. EEG machine	E	E
21. Isolation cart	E	E
22. Blood warmer	E	E
23. Pacer (transthoracic or transvenous)	E	E
C. Small equipment		
1. Tracheal intubation equipment	E	E
2. Endotracheal tubes (all pediatric sizes)	E	E
3. Oropharyngeal and nasopharyngeal airways	E	E
4. Vascular access equipment	E	E
5. Cut-down trays	E	E
6. Tracheostomy tray	E	E
7. Flexible bronchoscope	E	D
8. Cricothyroidotomy tray	E	E
D. Respiratory support equipment		
1. Bag-valve-mask resuscitation devices	E	E
2. Oxygen tanks	E	E
3. Respiratory gas humidifiers	E	E
4. Air compressor	E	E
5. Air-oxygen blenders	E	E
6. Ventilators of all sizes for pediatric patients	E	E
7. Inhalation therapy equipment	E	E
8. Chest physiotherapy and suctioning	E	E
9. Spirometers	E	E
10. Continuous oxygen analyzers with alarms	E	E

Table 1. (Continued)

	Level I	Level II
E. Monitoring equipment		
1. Capability of continuous monitoring of:		
a. Electrocardiography, heart rate	E	E
b. Respiration	E	E
c. Temperature	E	E
d. Systemic arterial pressure	E	E
e. Central venous pressure	E	E
f. Pulmonary arterial pressure	E	D
g. Intracranial pressure	E	D
h. Esophageal pressure	D	O
i. Capability to measure 4 pressures simultaneously	E	D
j. Capability to measure 5 pressures simultaneously	D	D
k. Arrhythmia detection and alarm	E	E
l. Pulse oximetry	E	E
m. End-tidal CO ₂	E	E
2. Monitor characteristics		
a. Visible and audible high and low alarms for heart rate, respiratory rate, and all pressures	E	E
b. Hard copy capability	E	E
c. Routine testing and maintenance	E	E
d. Patient isolation	E	E
e. Central station	E	E
V. Prehospital care		
A. Integration and communication with EMS system	E	E
B. Transfer arrangements with referral hospital	E	E
C. Transfer arrangement with level I PICU	NA	E
D. Educational programs in stabilization and transportation for EMS personnel	E	D
E. Transport system (including transport team)	E	O
F. Emergency communication into PICU and PACU (e.g., phone, radio) 24 hrs/day	E	E
G. Communication link to poison control center	E	E
VI. Quality improvement		
1. Collaborative quality assessment	E	E
2. Morbidity and mortality review	E	E
3. Utilization review	E	E
4. Medical records review	E	E
5. Discharge criteria (planning)	E	E
6. Safety review	E	E
7. Long-term follow-up of patients and family	D	D
VII. Training and continuing education		
A. Physician training		
1. Unit in facility with accredited pediatric residency program	D	O
2. Unit provides clinical rotation for pediatric residents in pediatric critical care	D	O
3. Fellowship program in pediatric critical care	D	O
4. Cardiopulmonary resuscitation certification	E	E
5. PALS or advanced pediatric life support	E	E
6. Ongoing continuing medical education for physicians specific to pediatric critical care	E	E
7. Staff physicians to attend and participate in regional and national meetings in areas related to pediatric critical care	E	E
B. Unit personnel		
1. Cardiopulmonary resuscitation certification for nurses and respiratory therapists	E	E
2. Resuscitation practice sessions	E	E
3. Ongoing continuing education (on-site and/or off-site workshops and programs for nurses respiratory therapists, clinical pharmacists)	E	E
4. Certified by the American Association of Critical Care Nurses	D	D
5. PALS or advanced pediatric life support certification	E	E
6. Critical care registered nurse certification	D	D
C. Regional education		
1. Participation in regional pediatric critical care education	E	O
2. Service as educational resource center for public education in pediatric critical care	D	D
3. Prehospital care and interhospital transport	D	O

E, essential; D, desired; O, optional; NA, not applicable; PALS, pediatric advanced life support; PACU, pediatric acute care unit; BUN, blood urea nitrogen; EEG, electroencephalogram; EMS, emergency medical services.

^aIn conjunction with nurse manager.

PICUs differ from those for level I PICUs primarily with respect to the type and immediacy of physician presence and hospital resources. A level II PICU does not require a full spectrum of subspecialists, as outlined in the Table. Level II

units should be located according to documented demand or need and in concert with accepted principles of regionalization of medical care (2). Each level II unit must have a well-established communications system with a level I unit to allow

for timely referral of patients who need care that is not available in the level II PICU. Although other special care units may be appropriate for hospitals with small pediatric inpatient services, they should not be considered PICUs.

Cooperation among hospitals and professionals within a given region is essential to ensure that the appropriate numbers of level I and level II units are designated. Duplication of services may lead to underutilization of resources and inadequate development of skills by clinical personnel and may be costly. Detailed discussion of the importance of regionalization of critical care services has been provided by the American College of Critical Care Medicine and the American Academy of Pediatrics (3).

This report provides the minimum acceptable guidelines for the following aspects of pediatric critical care: organization and administrative structure, personnel, hospital facilities and services, drugs and equipment, prehospital care, quality improvement, and training and continuing education (Table 1). These guidelines are intended to assist hospitals, in properly determining resource allocation and equipment needs; physicians, as a reference for referral and care of critically ill infants and children; emergency medical services (EMS) personnel, for proper prehospital triage; and level I and level II PICUs, as a means of ensuring proper patient care.

In preparing this report, significant efforts were made to build on previous work describing regional and national guidelines and standards that apply to these guidelines and, when possible, to incorporate those previous recommendations. The existing guidelines for PICUs established by the American Academy of Pediatrics and the Society of Critical Care Medicine were used as the major reference source (1). In addition, this report incorporates the experience, expertise, and opinions of pediatric caregivers including pediatric critical care physicians and nurses representing diverse regions of the country and types of practice.

ORGANIZATION AND ADMINISTRATIVE STRUCTURE

The level I and level II PICU will be a distinct, separate unit within the hospital that is equal in status to all other special care units. There should be a distinct administrative structure and staff for the PICU regardless of its location. A PICU Committee will be established as a standing (interdisciplinary) committee within the hospital, with membership including physicians, nurses, respiratory therapists, clinical pharmacists, social workers, child life specialists, and others directly in-

involved in PICU activities. The committee should provide input regarding the delineation of privileges for all personnel (physician and nonphysician) working in the PICU consistent with hospital policies.

The medical director and nurse manager/nursing director should establish policies in collaboration with the PICU Committee. Such policies shall govern matters including but not limited to safety procedures, nosocomial infection, patient isolation, visitation, traffic control, admission and discharge criteria, patient monitoring, equipment maintenance, patient record keeping, family care management (including family meetings, support groups, and sibling support), and bereavement care. A manual of these policies will be available for reference in the PICU.

Physical Design and Facilities

The physical facilities for PICUs will vary as a result of differences in hospital architecture, size, space, and design. Access to the PICU should be monitored to maintain patient and staff safety and confidentiality. The PICU should be located in proximity to elevators for patient transport, to the physicians' on-call room, and to family waiting and sleep areas. Proximity to the emergency department, operating room, and recovery room is desirable. Access to the medical and nursing directors will be improved by having their offices located near the PICU. When designing a PICU, the psychological, spiritual, cultural, and social needs of the patient and family should be taken into consideration, and policies should reflect a patient- and family-centered approach.

Floor Plan

Several distinct room types are required within the PICU, including rooms for patient isolation and separate rooms for clean and soiled linens and equipment. A laboratory area for rapid determination of blood gases and other essential studies is desirable, assuming compliance with national, state, and local regulations.

Space will be allocated for a medication station (including a refrigerator and a narcotics locker), a nourishment station, counters, and cabinets. It is desirable to have a satellite pharmacy within the PICU that is capable of providing routine and emergency medications at the

point of ordering. A computerized link to the laboratory or another rapid and reliable system should be available for reporting laboratory results.

A separate room for family counseling is necessary for private discussions between the staff and the family. An area for storing patients' personal effects is also desirable. A conference area for staff personnel is highly desirable and should be located near the unit. A staff toilet is essential. Separate facilities for patient's families, including space for sleeping and bathing, are essential for level I and level II PICUs.

Bedside Facilities

PICUs with individual patient rooms should allow at least 250 ft (2) per room (assuming there is one patient per room), and ward-type PICUs should allow at least 225 ft (2) per patient. The head of each bed or crib shall be rapidly accessible for emergency airway management. Electrical power, oxygen, medical compressed air, and vacuum outlets sufficient in number to supply all necessary equipment should meet local code and other accrediting requirements. In most cases, 12 or more electrical outlets and a minimum of two compressed air outlets, two oxygen outlets, and two vacuum outlets will be necessary per bed space. Reserve emergency power and gas supply (oxygen, compressed air) are essential. All outlets, heating, ventilation, air conditioning, fire safety procedures and equipment, electrical grounding, plumbing, and illumination must adhere to appropriate local, state, and national codes. Walls or curtains must be provided to ensure patient privacy.

PERSONNEL

Medical Director

A medical director will be appointed. A record of the appointment and acceptance should be made in writing. Medical directors of level I and level II PICUs must meet one of the following requirements:

1. Initially board certified in pediatrics and board certified or in the process of certification in pediatric critical care medicine
2. Board certified in anesthesiology with practice limited to infants and children and with special qualifications (as defined by the American

Board of Anesthesiology) in critical care medicine

3. Board certified in pediatric surgery with added qualifications in surgical critical care medicine (as defined by the American Board of Surgery)

If the medical director is not a pediatrician, a pediatric intensivist will be appointed as co-director. This is essential for level I PICUs and desirable for level II PICUs. Medical directors must achieve certification within 5 yrs of their initial acceptance into the certification process and must maintain active certification in critical care medicine.

The medical director, in conjunction with the nurse manager, should participate in developing and reviewing multidisciplinary PICU policies, promote policy implementation, participate in budget preparation, help coordinate staff education, maintain a database that describes unit experience and performance, ensure communication between the intensivists and referring primary care and/or subspecialty physicians, supervise resuscitation techniques, and in coordination with the nurse manager, lead quality improvement activities and coordinate medical research. Others may supervise these activities, but the medical director shall participate in each.

The medical director will name a qualified physician to fulfill his or her duties during absences. The medical director or designated substitute will often serve as the attending physician on patients in the unit. In addition, the medical director or designated substitute should have the institutional authority to provide primary or consultative care for all PICU patients. This authority should be codified in institutional policy and will also include providing daily consultation and intervention in the event that the primary attending physician is not available. Direct physician-to-physician contact should be made for all patients admitted to the PICU, including patients transferred from other institutions, as well as patients admitted from the emergency department or operating room.

Physician Staff

Studies suggest that having a full-time pediatric intensivist in the PICU improves patient care and efficiency (4–8). At certain times of the day, the attending physician in the PICU may delegate the care of patients to a physician of at least the

postgraduate year 2 level (in a level I PICU, this physician must be assigned to the PICU, and in a level II PICU, this physician must be available to the PICU) or to an advanced practice nurse or physician's assistant with specialized training in pediatric critical care. These nonphysician providers must receive credentials and privileges to provide care in the PICU only under the direction of the attending physician, and the credentialing process must be made in writing and approved by the medical director. An in-house physician at the postgraduate year 3 level or above in pediatrics or anesthesiology is essential for all level I PICUs. In addition, all hospitals with PICUs must have a physician in house 24 hrs/day who is available to provide bedside care to patients in the PICU. This physician must be skilled in and have credentials to provide emergency care to critically ill children.

Depending on the unit size and patient population, more physicians at higher training levels may be required. Other physicians, including the attending physician or his or her designee, should be available within 30 mins to assist with patient management. For level I units, available physicians must include a pediatric intensivist, a pediatric anesthesiologist, a pediatric cardiologist, a pediatric neurologist, a pediatric radiologist, a psychiatrist or psychologist, a pediatric surgeon, a pediatric neurosurgeon, an otolaryngologist (pediatric subspecialist desired), an orthopedic surgeon (pediatric subspecialist desired), and a cardiothoracic surgeon (pediatric subspecialist desired). For level II PICUs, pediatric subspecialists (with the exception of the pediatric intensivist) are not essential but are desirable, a general surgeon and neurosurgeon are essential, and an otolaryngologist and orthopedic surgeon are desirable (pediatric subspecialists optional). For level II PICUs, a cardiovascular surgeon is also optional.

For level I PICUs, it is desirable to have available on short notice a craniofacial (plastic) surgeon, an oral surgeon, a pediatric pulmonologist, a pediatric hematologist/oncologist, a pediatric endocrinologist, a pediatric gastroenterologist, and a pediatric allergist or immunologist. These physicians should be available for patients in level II PICUs within a 24-hr period.

Nursing Staff

A nurse manager with substantial pediatric expertise should be designated for

level I and level II PICUs. A master's degree in pediatric nursing or nursing administration is desirable. In collaboration with the nursing leadership team, the nurse manager is responsible for assuring a safe practice environment consisting of appropriate nurse staffing, skill level mix, and supplies and equipment. The nurse manager shall participate in the development and review of written policies and procedures for the PICU; coordinate multidisciplinary staff education, quality assurance, and nursing research; and prepare budgets together with the medical director. These responsibilities can be shared or delegated to advanced practice nurses, but the nurse manager has responsibility for the overall program. The nurse manager shall name qualified substitutes to fulfill his or her duties during absences.

An advanced practice nurse (clinical nurse specialist or nurse practitioner) should be available to provide clinical leadership in the nursing care management of patients. This is recommended for level I PICUs and optional for level II PICUs. The clinical nurse specialist should possess a master's degree in nursing, pediatric critical care nurse specialist certification, and clinical expertise in pediatric critical care. The nurse practitioner should hold a master's degree in nursing and national pediatric nurse practitioner certification and have completed a preceptorship in the management of critically ill pediatric patients. Expanded role components of the advanced practice nurse should match the clinical needs of patients within the particular PICU and health care system.

The department of nursing or patient care services should establish a program for nursing orientation, yearly competency review of high-risk low-frequency therapies, core competencies based on patient population, and an ongoing educational program specific for pediatric critical care nursing. Program content should match the diverse needs of each unit's patient population. It is desirable that most nursing staff working in level I and level II PICUs obtain pediatric critical care certification.

Patient care in level I and level II PICUs should be carried out or supervised by a pediatric critical care nurse. All nurses working in level I and level II PICUs should complete a clinical and didactic pediatric critical care orientation before assuming full responsibility for patient care. Pediatric advanced life support

(PALS) or an equivalent course should be required. Nurse-to-patient ratios should be based on patient acuity, usually ranging from 2:1 to 1:3.

Respiratory Therapy Staff

The respiratory therapy department should have a supervisor responsible for performance and training of staff, maintaining equipment, and monitoring multidisciplinary quality improvement and review. Under the supervisor's direction, respiratory therapy staff primarily designated and assigned to the level I PICU shall be in house 24 hrs/day. Hospitals with level II PICUs must have respiratory therapy staff in house at all times; however, this staff need not be dedicated to the PICU (unless patient acuity so dictates). All respiratory therapists who care for children in level I and level II PICUs should have clinical experience managing pediatric respiratory failure and pediatric mechanical ventilators and should have training in PALS or an equivalent course.

Ancillary Support Personnel

An appropriately trained and qualified clinical pharmacist should be assigned to the level I PICU; this is desirable for the level II PICU. Staff pharmacists must be in house 24 hrs/day in hospitals with level I PICUs, and this is desirable in hospitals with level II PICUs.

Biomedical technicians must be available within 1 hr, 24 hrs/day for level I and level II PICUs. For level I PICUs, unit secretaries (clerks) should have primary assignment in the PICU 24 hrs/day. A radiology technician (preferably with advanced pediatric training) must be in house 24 hrs/day in hospitals with level I PICUs, and this is strongly recommended for those with level II units. In addition, social workers; physical, occupational, and speech therapists; nutritionists; child life specialists; clinical psychologists; and clergy must be available (this is essential for level I and desirable for level II PICUs).

Hospital Facilities and Services

The level I or level II PICU should be located in a category I facility as defined by the American Hospital Association. The emergency department should have a separate, covered entrance. An adjacent helipad is desirable. For hospitals with level I PICUs, two or more areas within

the emergency department will have the capacity and equipment to resuscitate any pediatric patient with medical, surgical, or traumatic illness. Hospitals with level II units need have only one such area. The emergency department will be staffed by physicians 24 hrs/day in all hospitals with PICUs. Hospitals with level I PICUs should have separate pediatric emergency departments and should have physicians trained in pediatric emergency medicine in house 24 hrs/day.

The department of surgery in hospitals with a level I or level II PICU will have at least one operating room available within 30 mins, 24 hrs/day, and a second room available within 45 mins. Capabilities in the operating room in hospitals with level I PICUs must include cardiopulmonary bypass, pediatric bronchoscopy, endoscopy, and radiography.

The blood bank must have all blood components available 24 hrs/day in hospitals with a level I or level II PICU. Unless unusual cross-matching issues are encountered, blood typing and cross-matching shall allow transfusion within 1 hr.

Pediatric radiology services in hospitals with a level I or level II PICU must include portable radiography, fluoroscopy, computerized tomography scanning, and ultrasonography. Nuclear scanning angiography and magnetic resonance imaging should be available at all times in hospitals with level I PICUs and must be available within 4 hrs in hospitals with level II PICUs. Facilities must be able to provide for the age-adjusted needs of pediatric patients (thermal homeostasis, sedation). The availability of radiation therapy is desirable for level I PICUs and optional for level II PICUs.

Clinical laboratories in hospitals with a level I or level II PICU will have microspecimen capability and 1-hr turnaround time for complete blood cell, differential, and platelet counts; urinalysis; measurement of electrolytes, blood urea nitrogen, creatinine, glucose, and calcium concentrations and prothrombin and partial thromboplastin time; and cerebrospinal fluid analysis. Blood gas values must be available within 15 mins. Results of drug screening and levels of serum ammonia, serum and urine osmolality, phosphorus, and magnesium should all be available within 3 hrs for level I PICUs. Results of Gram stains and bacteriologic cultures should be available 24 hrs/day. Point of care diagnostic testing capabilities are desirable for level I and II PICUs (9).

The hospital pharmacy must be capable of dispensing all necessary medications for pediatric patients of all types and ages 24 hrs/day. A satellite pharmacy close to the unit is desirable. A qualified pediatric clinical pharmacist is highly desirable for hospitals with level I PICUs and optional for hospitals with level II PICUs. A pharmacist should be available for participation in medical rounds, monitoring of drug therapy, the provision of drug information to PICU practitioners, and the evaluation of pertinent drug-related issues (10). At each bedside, there should be a reference that lists urgent and resuscitation drugs with dosages appropriate for the individual patient.

Diagnostic cardiac and neurologic studies will be available for infants and children in hospitals with level I PICUs and are optional for hospitals with level II PICUs. Technicians with special training in pediatrics should be available to perform these studies. Electrocardiograms, two-dimensional echocardiograms with color Doppler, and electroencephalograms should be available 24 hrs/day for level I and level II PICUs. A catheterization laboratory or angiography suite equipped to perform studies in pediatric patients should be present in hospitals with level I PICUs and is optional in hospitals with level II PICUs. Doppler ultrasonography devices and evoked potential monitoring equipment are desirable in hospitals with a level I or level II PICU.

Hemodialysis equipment and technicians with pediatric experience should be available 24 hrs/day in hospitals with level I PICUs and are optional for hospitals with level II PICUs.

Hospital facilities should include a comfortable waiting room, private consultation areas, dining facilities, a conference area, and sleeping accommodations and telephone, shower, and laundering facilities for patients' families. Facilities and personnel should also be available to meet the psychological and spiritual needs of patients and their families. Medical staff, patients, and patient families must have 24 hrs/day access to competent, nonfamily member, language interpreter services for non-English-speaking patients and families.

Drugs and Equipment

Drugs for resuscitation and advanced life support must be present and immediately available for any patient in the PICU. These drugs should be available in

accordance with advanced cardiac life support and PALS guidelines and should include all those necessary to support the patient population that the PICU serves. The life-saving, therapeutic, and monitoring equipment detailed in this section must be present or immediately available in each level I and level II PICU.

Portable Equipment

Portable equipment will include an emergency ("code" or "crash") cart, a procedure lamp, pediatric-sized blood pressure cuffs for systemic arterial pressure determination, a Doppler ultrasonography device, an electrocardiograph, a defibrillator or cardioverter with pediatric paddles and preferably with pacing capabilities, thermometers (with a range sufficient to identify extremes of hypothermia and hyperthermia), an automated blood pressure apparatus, trans-thoracic pacer with pediatric pads, devices for accurately measuring body weight, cribs and beds with head access, infant warmers, heating and cooling devices, lights for photo therapy, temporary pacemakers, a blood warming apparatus, and a transport monitor. A suitable number of infusion pumps with microcapability (0.1 mL/hr) must be available. Oxygen tanks are needed for transport and backup of the central oxygen supply. Similarly, portable suction machines are needed for transport and backup.

Additional equipment that must be available includes volumetric infusion pumps, air-oxygen blenders, an air compressor, gas humidifiers, bag-valve-mask resuscitators, an otoscope and ophthalmoscope, and isolation carts. A portable electroencephalography machine must be available in the hospital for bedside recordings in level I and level II PICUs. Televisions, radios, and chairs should be available for patients and families who would benefit from their use.

Small Equipment

Certain small equipment appropriately sized for pediatric patients must be immediately available at all times. Such equipment includes suction catheters, tracheal intubation equipment (laryngoscope handles, sizes and types of blades adequate to intubate patients of all ages, and Magill forceps), endotracheal tubes of all sizes (cuffed and uncuffed), oropharyngeal and nasopharyngeal airways, laryngeal mask airways, central catheters

for vascular access, catheters for arterial access, pulmonary artery catheters, thoracostomy tubes, transvenous pacing catheters, and surgical trays for vascular cutdowns, open-chest procedures, cricothyroidotomy, and tracheostomy. Hospitals with level I and level II PICUs should have pediatric-sized equipment for flexible bronchoscopy available. This is essential for level I PICUs and desirable for level II PICUs.

Respiratory Equipment

Mechanical ventilators suitable for pediatric patients of all sizes must be available for each level I and level II PICU bed. Equipment for chest physiotherapy and suctioning, spirometers, and oxygen analyzers must always be available for every patient. Oxygen monitors (pulse oximeters and transcutaneous oxygen monitors) and CO₂ monitors (transcutaneous and end-tidal) are required; portable (transport) ventilators are desired.

Bedside Monitors

Bedside monitors in all PICUs must have the capability for continuously monitoring heart rate and rhythm, respiratory rate, temperature, 1 hemodynamic pressure, oxygen saturation, end-tidal CO₂, and arrhythmia detection. Bedside monitoring in level I PICUs must be capable of simultaneously monitoring systemic arterial, central venous, pulmonary arterial, and intracranial pressures. The capability for a fifth simultaneous pressure measurement is desirable but not essential. Monitors must have high and low alarms for heart rate, respiratory rate, and all pressures. The alarms must be audible and visible. A permanent hard copy of the rhythm strip must be available in level I and level II PICUs. Hard copy and trending capability for all monitored variables is desirable. All monitors must be maintained and tested routinely.

Prehospital Care

Often, patients requiring admission to a PICU are transported from the scene of an injury or from another hospital. Accordingly, PICUs shall be integrated with the regional EMS system. The method of communication may vary, but a standard written approach to emergencies involving the EMS system and the PICU should be prepared. All level I and level II PICUs must have multiple telephone lines so

that outside calls can be received even at very busy times. Rapid access to a poison control center is essential. A fax machine is essential for level I and level II PICUs.

Each level I and level II PICU must endeavor to meet the needs of other hospitals less well equipped to handle certain types of care. Formal transfer arrangements are encouraged. Each PICU will have or be affiliated with a transport system and team with advanced pediatric training to assist other hospitals in arranging safe patient transport (11, 12). Ideally, such transport teams should be able to deliver PICU care during transport. Supervisory physicians must be available for consultation during the interfacility transport process. These transport teams must have appropriately sized pediatric equipment to anticipate and manage the diverse health care needs of pediatric patients in this environment (11, 12). Telemedicine capabilities should be considered and will be desirable as technology becomes more widely available.

Policies should describe mechanisms that achieve smooth and timely exchange of patients between emergency room, operating room, imaging facilities, special procedure areas, regular inpatient care areas, and the PICU.

Quality Improvement

The PICU must employ a multidisciplinary collaborative quality assessment process. Objective methods should be used to compare observed and predicted morbidity and mortality rates for the severity of illness in the population examined. Benchmarking methods should be used to compare outcomes between similar PICUs.

Training and Continuing Education

Each PICU should train health care professionals in basic aspects of, and serve as a focus for, continuing education programs in pediatric critical care. In addition, all health care providers working in the PICU should routinely attend or participate in regional and national meetings with course content pertinent to pediatric critical care.

Many level I PICUs and some level II PICUs will possess sufficient patient volume, teaching expertise, and research capability to support a fellowship program in pediatric critical care medicine. Programs providing subspecialty training in pediatric critical care medicine must

have approval by the Residency Review Committee of the Accreditation Council on Graduate Medical Education.

Nurses, respiratory therapists, and physicians must have basic life support certification, must participate in resuscitation practice sessions, and should be encouraged and supported to attend appropriate on-site or off-site educational programs. Successful completion and current reaffirmation of PALS or a similar course should be required.

It is desirable for level I PICU personnel to participate in regional pediatric critical care education for EMS providers, for emergency room and transport personnel, and for the general public. Some level I and level II PICUs will be suited to serve as an educational resource for public education in areas pertinent to pediatric critical care.

Research is essential for improving the understanding of the pathophysiology affecting vital organ systems as well as appropriate symptom management and psychosocial supportive interventions for the patient, family, and bereaved survivors. Such knowledge is a vital component in improving patient care techniques and therapies and thereby decreasing morbidity and mortality. All level I PICUs and some level II PICUs can serve as laboratories for clinical research.

The recommendations in this report do not indicate an exclusive course of treatment or serve as a standard of medical care. Variations, taking into account individual circumstances, may be appropriate.

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