

EVIDENCE FOR DESIGN OF PEDIATRIC ICUS

RELEVANT CADRE RESEARCH:

Title: **Influence of Positive Distractions on Children in Hospital Waiting Areas**

Funds: American Art Resources, Catherine Meyers Fine Art, Henry Domke Fine Art, Mohawk Carpets

Period: January 2008 to August 2009

Collaborator: Children's Medical Center Dallas

Location: Children's Medical Center Dallas

Findings: Positive distractions help focus attention, increase calm behavior, decrease fine and gross movement; multi-sensory (distractions with sound) attract greater attention.

Title: **A Multi-Dimensional Comparative Assessment of Headwall Versus Ceiling Booms in Intensive Care Units**

Funds: Getinge USA Grant

Period: December 2007 to May 2008

Collaborator: University of Texas Southwestern

Location: Children's Medical Center Dallas

Findings: Booms have a considerable advantage over headwalls in the case of high acuity patients and when procedures are performed inside patient rooms.

Title: **Relationships between Exterior Views and Nurse Stress: An Exploratory Examination**

Period: June 2006 to May 2007

Collaborator: Children's Healthcare of Atlanta

Location: Children's Healthcare of Atlanta at Egleston and Scottish Rite

Findings: View duration has significant influence on both acute stress and alertness, second in magnitude to organizational stress on its impact on alertness and second in magnitude to environmental stress on its impact on acute stress.

RESEARCH ARTICLES

CADRE Publications

Pati, D. and U. Nanda (2011). "Influence of positive distractions on children in two clinic waiting areas." Health Environments Research & Design Journal, 4(3): 124-140.

OBJECTIVE: To examine the influence of positive distraction on the behavior and activity of children in two clinic waiting areas.

BACKGROUND: People spend a considerable proportion of time waiting in hospitals. Studies show that the quality of waiting environments influences the perception of quality of care and caregivers, that perception of waiting time is a better indicator of patient satisfaction than actual waiting time, and that the waiting environment contributes to the perception of wait time. In fact, the attractiveness of the physical environment in waiting areas has been shown to be significantly associated with higher perceived quality of care, less anxiety, and higher reported positive interaction with staff. Can positive distractions in waiting areas improve the waiting experience, as indicated by the behavior and activities of children waiting for treatment?

METHOD: Five distraction conditions were randomly introduced in the waiting area of the dental and cardiac clinics of a major pediatric tertiary care center through a single plasma screen intervention. The attention, behavior, and activities of waiting children were recorded. Data on 158 pediatric patients were collected over 12 days during December 2008 and January 2009.

RESULTS: Data analysis shows that the introduction of distraction conditions was associated with more calm behavior and less fine and gross movement, suggesting significant calming effects associated with the distraction conditions. Data also suggest that positive distraction conditions are significant attention grabbers and could be an important contributor to improving the waiting experience for children in hospitals by improving environmental attractiveness.

Pati, D. P., et al. (2008). "Relationships Between Exterior Views and Nurse Stress: An Exploratory Examination." Health Environments Research & Design Journal, 1(2008 Winter): 27-38.

Objective: Examine the relationships between acute stress and alertness of nurse, and duration and content of exterior views from nurse work areas.

Background: Nursing is a stressful job, and the impacts of stress on performance are well documented. Nursing stress, however, has been typically addressed through operational interventions, although the ability of the physical environment to modulate stress in humans is well known. This study explores the outcomes of exposure to exterior views from nurse work areas.

Methods: A survey-based method was used to collect data on acute stress, chronic stress, and alertness of nurses before and after 12-hour shifts. Control measures included physical environment stressors (that is, lighting, noise, thermal, and ergonomic), organizational stressors, workload, and personal characteristics (that is, age, experience, and income). Data were collected from 32 nurses on 19 different units at two hospitals (part of Children's Healthcare of Atlanta) in November 2006.

Results: Among the variables considered in the study view duration is the second most influential factor affecting alertness and acute stress. The association between view duration and alertness and stress is conditional on the exterior view content (that is, nature view, non-nature view). Of all the nurses whose alertness level remained the same or improved, almost 60% had exposure to exterior and nature view. In contrast, of all nurses whose alertness levels deteriorated, 67% were exposed to no view or to only non-nature view. Similarly, of all nurses whose acute stress condition remained the same or reduced, 64% had exposure to views (71%

of that 64% were exposed to a nature view). Of nurses whose acute stress levels increased, 56% had no view or only a non-nature view.

Conclusions: Although long working hours, overtime, and sleep deprivation are problems in healthcare operations, the physical design of units is only now beginning to be considered seriously in evaluating patient outcomes. Access to a nature view and natural light for care-giving staff could bear direct as well as indirect effects on patient outcomes.

Pati, D., et al. (2008). "An exploratory examination of medical gas booms versus traditional headwalls in intensive care unit design." Critical Care Nursing Quarterly 31(4): 340-356.

Should power, medical gases, and monitoring and communications systems be located in a headwall or a ceiling-mounted boom in intensive care unit (ICU) rooms? Often, only the financial costs could be determined for the options, whereas data regarding its potential influence on teamwork, safety, and efficiency are lacking. Hence, purchase decisions are more arbitrary than evidence based. This study simulated care delivery in settings with a traditional headwall and a ceiling boom. Observed were the way the following elements were managed and the extent either system affected flexibility, ergonomics, and teamwork: tubing for intravenous fluids, medical gases, and suction drainage; monitoring leads and equipment power cords; and the medical equipment itself. Simulation runs involving 6 scenarios were conducted with the voluntary participation of 2 physicians, 2 nurse practitioners, 2 respiratory therapists, and 4 registered nurses at a children's tertiary care center in December 2007. Analysis suggests that booms have an advantage over headwalls in case of high-acuity ICU patients and when procedures are performed inside patient rooms. However, in case of lower-acuity ICU patients, as well as when procedures are not typically conducted in the patient room, booms may not provide a proportionate level of advantage when compared with the additional cost involved in its procurement.

Ritchey, T. and D. Pati (2008). "Establishing an acute care nursing bed unit size: employing a decision matrix framework." Health Environments Research & Design Journal, 1(4): 122-132.

Determining the number of patient rooms for an acute care (medical-surgical) patient unit is a challenge for both healthcare architects and hospital administrators when renovating or designing a new patient tower or wing. Discussions on unit bed size and its impact on hospital operations in healthcare design literature are isolated, and clearly there is opportunity for more extensive research. Finding the optimal solution for unit bed size involves many factors, including the dynamics of the site and existing structures. This opinion paper was developed using a "balanced scorecard" concept to provide decision makers a framework for assessing and choosing a customized solution during the early planning and conceptual design phases. The context of a healthcare balanced scorecard with the quadrants of quality, finance, provider outcomes, and patient outcomes is used to compare the impact of these variables on unit bed size.

INDUSTRY PUBLICATIONS

CADRE Publications

Pati, D. (2010). Positive distractions in waiting areas could be an advantage for hospitals. Healthcare Design Magazine, 10(3): 28-34.

Thomas, J., Thomas, S., Pati, D., Evans, J. and Waggener, L. (2008). The Right Context to Invest in Medical Gas Ceiling Booms. Children's Hospital Today, Spring 2008, 30-31.

Early adoption of technology and peer competition frequently vie with such considerations as cost, patient safety and clinician efficiency in making decisions about provision of medical gases in patient rooms.

Ritchey, T., Pati, D., and Harvey, T. (2008). Taking Care of Nurses. Advance for Nurses, March 10, 2008, 27-28

RESEARCH ARTICLES

Non-CADRE Publications

DESIGN

Pelly, N., et al. (2013). "Utilizing integrated facility design to improve the quality of a pediatric ambulatory surgery center." Paediatr Anaesth **23**(7): 634-638.

AIM: The aim was to use Integrated Facility Design (IFD) to design a surgery center that enhances the delivery of health care by developing processes that provide highly efficient patient, family, and provider flows while adding value and utilizing costly resources effectively. **BACKGROUND:** Integrated Facility Design is an adaptation of the Toyota 3P (Production, Preparation, Process) Program. The goal of IFD is to accelerate development time and lower start-up costs. **RESULTS:** The use of IFD produced a savings of \$30 million in project costs and enabled a completion date 3.5 months ahead of schedule. The designed patient flow processes resulted in dramatic improvements in patient, family, and provider throughput. **CONCLUSIONS:** The use of IFD in the design of a pediatric ambulatory clinic and surgery resulted in significant cost savings and improved clinical efficiency.

Smith, T. J. (2012). "A comparative study of occupancy and patient care quality in four different types of intensive care units in a children's hospital." Work **41 Suppl 1**: 1961-1968.

This paper reports a comparative study of occupancy and patient care quality in four types of intensive care units in a children's hospital: an Infant Care Center (ICC), a Medical/Surgical (Med/Surg) unit, a Neonatal Intensive Care Unit (NICU), and a Pediatric Intensive Care Unit (PICU), each featuring a mix of multi-bed and private room (PR) patient care environments. The project is prompted by interest by the project sponsor in a pre-occupancy analysis, before the units are upgraded to exclusive PR designs. Methods comprised, for each unit: (1) observations of ergonomic design features; (2) task activity analyses of job performance of selected staff; and (3) use of a survey to collect perceptions by unit nursing and house staff (HS) of indicators of occupancy and patient care quality. **Conclusions:** (1) the five most common task activities are interaction with patients, charting, and interaction with equipment, co-workers and family members; (2) job satisfaction, patient care, work environment, job, patient care team interaction, and general occupancy quality rankings by ICC and/or NICU respondents are significantly higher than those by other staff respondents; and (3) ergonomic design shortcomings noted are excess noise, problems with equipment, and work environment, job-related health, and patient care quality issues.

Ozcan, H. (2004). Healing design: a phenomenological approach to the relation of the physical setting to positive social interaction in pediatric intensive care units in the United States and Turkey. Architecture. College Station, TX, Texas A&M University. **PhD**: 363.

This study examines the impact of the physical setting in the care and healing process of hospitalized children, their families, and the caregivers in two selected pediatric intensive care units (PICUs) in the U.S. and Turkey. A holistic, cross-cultural, comparative, and naturalistic approach emphasized the importance of the total (i.e., physical, social, cultural, spiritual,

organizational, political) environment and quality of life to health and healing. Information was gathered through qualitative methods such as participant observations, behavioral maps, in-depth interviews, and floor plan analysis. Despite some universal features of the PICU atmosphere, the value and place ascribed to pediatric critical care in Turkey and the U.S. present different worldviews. Field studies revealed social interaction as a universal healing function despite its cultural specificity stemming from socio-cultural, ethnic, economic, and religious differences between different groups.

Crowding, parental absence, and over-stimulation, which stem from the lack of individual patient rooms, and organizational problems related with human resources and staffing shortage play against the critically ill child's deep need to heal in the Turkish PICU. Despite spatial limitations, informal social interactions and cooperative relationships among caregivers, their devotion, and their ability to adapt to the existing physical and social environment enable care delivery. While staffing shortage continues to be a crucial problem in the U.S. model, specialization of labor and the systemic organization in general support care delivery, reducing the importance of informal social interactions and cooperation among caregivers. However, emphasizing the role of the family in the child's care, social interaction is also identified as a healing function in this setting. Therefore, despite the significant role the physical setting may play in healing, social interaction is found to be more important for improving patient outcomes and the well-being of families and caregivers. The study focuses on six healing design interventions to increase the chances for positive social interaction and collaboration. These are programmatic (provisional, scale, locational), functional, ambient, symbolic, social and psychological interventions.

FAMILY CENTERED CARE

Macdonald, M. E., et al. (2012). "An office or a bedroom? Challenges for family-centered care in the pediatric intensive care unit." *Journal of Children's Health Care*, 16(3): 237-249.

Although the modern pediatric intensive care unit (PICU) has followed general pediatrics and adopted the family-centered care model, little is known about how families prospectively experience PICU care. The authors' goal was to better understand the experiences of families whose child was hospitalized in a PICU. They conducted a 12-month prospective ethnographic study in a PICU in a tertiary care hospital in a large North American urban center. Data were obtained via participant-observation and formal and informal interviews with 18 families and staff key informants. Findings revealed a disconnect between the espoused model of family-centered care and quotidian professional practices. This divergence emerged in the authors' analysis as a heuristic that contrasts a professional "office" to a sick child's "bedroom." PICU practices and protocols transformed the child into a patient and parents into visitors; issues such as noise, visitation, turf, and privacy could favor staff comfort and convenience over that of the child and family. The authors' discussion highlights suggestions to overcome this divergence in order to truly make the PICU family centered.

Davidson, J. E., et al. (2007). "Clinical practice guidelines for support of the family in the patient-centered intensive care unit: American College of Critical Care Medicine Task Force 2004-2005." *Critical Care Medicine*, 35(2): 605-622.

OBJECTIVE: To develop clinical practice guidelines for the support of the patient and family in the adult, pediatric, or neonatal patient-centered ICU.

PARTICIPANTS: A multidisciplinary task force of experts in critical care practice was convened from the membership of the American College of Critical Care Medicine (ACCM) and the Society of Critical Care Medicine (SCCM) to include representation from adult, pediatric, and neonatal intensive care units. EVIDENCE: The task force members reviewed the published literature. The Cochrane library, Cinahl, and MedLine were queried for articles published

between 1980 and 2003. Studies were scored according to Cochrane methodology. Where evidence did not exist or was of a low level, consensus was derived from expert opinion.

CONSENSUS PROCESS: The topic was divided into subheadings: decision making, family coping, staff stress related to family interactions, cultural support, spiritual/religious support, family visitation, family presence on rounds, family presence at resuscitation, family environment of care, and palliative care. Each section was led by one task force member. Each section draft was reviewed by the group and debated until consensus was achieved. The draft document was reviewed by a committee of the Board of Regents of the ACCM. After steering committee approval, the draft was approved by the SCCM Council and was again subjected to peer review by this journal.

CONCLUSIONS: More than 300 related studies were reviewed. However, the level of evidence in most cases is at Cochrane level 4 or 5, indicating the need for further research. Forty-three recommendations are presented that include, but are not limited to, endorsement of a shared decision-making model, early and repeated care conferencing to reduce family stress and improve consistency in communication, honoring culturally appropriate requests for truth-telling and informed refusal, spiritual support, staff education and debriefing to minimize the impact of family interactions on staff health, family presence at both rounds and resuscitation, open flexible visitation, way-finding and family-friendly signage, and family support before, during, and after a death.

Smith, A., et al. (2007). "Parent Bed Spaces in the PICU: Effect on Parental Stress." [Pediatric Nursing](#).

The purpose of this comparative descriptive study was to identify the impact of providing a parent bed space in the PICU, allowing for continual parental presence, on stress of the parents of critically ill children. Data were collected from parents (n = 86) at two children's hospitals 3 months prior to the opening of new PICUs with parent bed spaces. Following a transition period, data were collected from a sample of parents (n = 92) who had used the parent bed to stay overnight with their child. Parental stress was measured with the Parental Stressor Scale: Pediatric Intensive Care (PSS: PICU). Stress scores were significantly lower (p = .02) for parents who utilized the parent beds in the new PICUs. New PICU environments that facilitate continual parental presence may reduce parental stress related to a child's hospitalization.

Petersen, M. F., et al. (2004). "Family-centered care: do we practice what we preach?" [Journal of Obstetric, Gynecology and Neonatal Nursing](#) **33**(4): 421-427.

OBJECTIVE: To determine nurses' perceptions and practices of identified elements of family-centered care. **DESIGN:** Descriptive.

SETTING: Neonatal intensive care unit (NICU), pediatrics, and pediatric intensive care unit (PICU) in an acute care hospital.

PARTICIPANTS: Sixty-two licensed nurses, 37 working in the NICU and 25 working in pediatrics or the PICU. **MAIN OUTCOME MEASURES:** Scores for the Necessary and Current scales of the Family-Centered Care Questionnaire.

RESULTS: Scores representing current nursing practice of family-centered care were significantly lower than those representing its necessity (p = .000). Nurses with 10 years or fewer of neonatal or pediatric experience scored significantly higher on both the total Necessary Scale (p = .02) and total Current Scale (p = .017) than did those with 11 years or more. Nurses who work in the NICU scored significantly lower on the total Necessary Scale (p = .013) than did nurses who work in pediatrics or PICU.

CONCLUSIONS: Although nurses agree the identified elements of family-centered care are necessary, they do not consistently apply those elements in their everyday practice. Years of experience and clinical work setting influenced both perceptions and practices of family-centered care.

Powers, K. S. and J. S. Rubenstein (1999). "Family presence during invasive procedures in the pediatric intensive care unit: a prospective study." Archives of Pediatrics and Adolescent Medicine, **153**(9): 955-958.

OBJECTIVES: To determine if allowing 1 or both parents to be present during invasive procedures reduces the anxiety that parents experience while their child is in the pediatric intensive care unit; to evaluate if the parent's presence was helpful to the child and parent; and to determine whether this presence was harmful to the nurses or physicians.

DESIGN: A prospective study using surveys (5-point Likert scale) of parents of children requiring intubation, placement of central lines, or chest tubes. Additional surveys were completed by bedside nurses to evaluate the effects of parental presence.

SETTING: A 12-bed pediatric intensive care unit in upstate New York.

PARTICIPANTS: The study population consisted of the parents of 16 children undergoing 1 or more procedures; 7 had undergone intubation, 11 had central lines placed, and 2 had chest tubes placed. The control population consisted of the parents of 7 children undergoing 1 or more procedures; 7 had undergone intubation, 5 had central lines placed, and 3 had chest tubes placed.

RESULTS: Parental presence significantly reduced the parental anxiety related to the procedure ($P = .005$; Mann-Whitney test), but did not change condition-related anxiety ($P = 0.9$; Mann-Whitney test). Thirteen of 16 parents found their presence helpful to themselves (10 very, 3 somewhat) and the medical staff (11 very); 14 of 16 found their presence helpful to their child (11 very). Fifteen (94%) of 16 parents would repeat their choice to watch. Fifteen (94%) of 16 nurses found parents' presence helpful to the child (9 very) and to the parents (10 very). One nurse found a parent's presence somewhat harmful to nurses and very harmful to the parent. Thirteen (72%) of 18 nurses indicated that allowing parents to observe procedures was an appropriate policy. There were no significant differences noted in response of nurses based on years of experience.

CONCLUSIONS: Allowing parental presence during procedures decreases procedure-related anxiety. The implications of such a policy change on physicians and other aspects of pediatric intensive care, including medical education, need further evaluation.

FAMILY SATISFACTION

Board, R. and N. Ryan-Wenger (2003). "Stressors and stress symptoms of mothers with children in the PICU." Journal of Pediatric Nursing **18**(3): 195-202.

The purpose of this study was a description of sources of stress and stress symptoms over time for mothers with a child in the pediatric intensive care unit (PICU) and a comparison with mothers with a child in a general care unit (GCU). The sample contained 31 PICU mothers and 32 GCU mothers who were studied during four time periods over 6 months using the Parental Stressor Scale: PICU and the Symptom Checklist-90-Revised. Findings showed all the PICU mothers were stressed from the total intensive care experience and the use of monitors. PICU mothers experienced more stress symptoms than the GCU mothers did during all four time periods. This is valuable information because nurses should know how mothers of critically ill children feel and what stresses them in order to help the mothers and teach them about what changes to expect in themselves. Nursing practice must enable parents to continue in their family roles to be effective and therapeutic to their children. Copyright 2003, Elsevier Inc. All rights reserved.

Koontz, V. S. (2003). Parental satisfaction in a pediatric intensive care unit. United States -- West Virginia, Marshall University.

Purpose: The purpose of this study was to identify if the factors which indicate parental satisfaction of parents who have children admitted to the Pediatric Intensive Care Unit (PICU) were being attained. This study used McPherson's Parental Satisfaction Survey (PSS).

Design: The PSS is a 24 question survey scored using a Likert scale and a socio-demographic survey.

Method: Data was collected from 101 parents whose child received care in this Appalachian PICU. The PSS measured three domains of caring: (a) hospital environment, (b) patient care, and (c) communication. **Findings:** The results of this study found very high correlations for hospital environment ($r = .75, p < .01$), patient care ($r = .86, p < .01$), and communication ($r = .92, p < .01$) indicating that there is a very high level of parental satisfaction in the PICU.

Conclusion: The results of the PSS report a Cronbach's coefficient alpha yielding $\pm = .89$, indicating that the study is reliable.

INFECTION CONTROL

Chen, Y.-C. and L.-C. Chiang (2007). "Effectiveness of hand-washing teaching programs for families of children in paediatric intensive care units." *Journal of Clinical Nursing* **16**(6): 1173-1179.

Aims: The authors developed a video-centred teaching program based on social learning principles to demonstrate hand-washing technique. A comparison was made between families who viewed the video and families who were taught the same techniques with the aid of an illustrated poster in terms of compliance and improvement in hand-washing skills.

Background: Nosocomial infections are a significant cause of morbidity and mortality in paediatric intensive care unit patients. Hand hygiene is considered the most important preventive action against hospital-acquired infections. A number of studies have shown that increased compliance with hand-washing guidelines for health-care workers leads to decreases in nosocomial infection rates. Furthermore, recommendations have been made to ensure that parents who visit their children in intensive care units wash their hands first.

Study design: Quasi-experimental time series. Compliance and accuracy measurements were collected during one to five visits following the initial teaching intervention.

Methods: A total of 123 families, who visited paediatric intensive care units, were recruited and assigned to two groups-one experimental (61 families) and the other a comparison group (62). Participants in the comparison group were taught hand-washing skills using simple illustrations. A 20-item hand-washing checklist was used to examine hand-washing compliance and accuracy.

Results: No significant differences were noted in terms of demographics between the two groups. Results from a general estimated equation analysis showed that families in the experimental group had higher compliance and accuracy scores at statistically significant levels.

Conclusion: The video-based teaching program was effective in increasing compliance and accuracy with a hand-washing policy among families with children in intensive care units.

Relevance to clinical practice: The education program is a simple, low-cost, low technology intervention for substantially reducing the incidence of nosocomial infection.

Hussein, R., et al. (2007). "Hand hygiene practices in adult versus pediatric intensive care units at a university hospital before and after intervention." *Scandinavian Journal of Infectious Diseases* **39**(6-7): 566-570.

Observations of hand hygiene practices of the health care workers (HCWs) were carried out at a tertiary care center by a single observer in all adult and pediatric intensive care units (ICUs) before and after educational programs. Access to alcohol-based hand rub was also increased. A survey of HCWs was carried out to determine knowledge of hand hygiene. Before interventions, mean adherence to hand hygiene in all ICUs was 54% with significant difference

between adult and pediatric ICUs ($p < .0001$) (35% vs 90%, respectively). Traditional handwashing versus alcohol-based hand rub use was 72% versus 28%, respectively. Following the interventions, there was a significant increase ($p < .0001$) in hand hygiene adherence in adult ICUs (81%). 46% of survey respondents believed that alcohol-based hand rub could not be used for methicillin resistant *Staphylococcus aureus* infection and 21% believed that alcohol-based hand rub could be used if hands were soiled. Overall, adherence to hand hygiene in adult ICUs improved with institution of an educational program and increase in accessibility of alcohol-based hand rub. There was a statistically significant increase in the frequency of alcohol-based hand rub use; however, traditional handwashing was still preferred. The survey of HCWs revealed gaps in knowledge regarding methods of hand hygiene.

Fleming, K. and J. Randle (2006). "Toys - friend or foe? A study of infection risk in a paediatric intensive care unit." *Paediatric Nursing* **18**(4): 14-18.

Toys are an established part of the hospital experience for the child and family. They are seen as a source of comfort and security and form part of the child-friendly environment. However, they can also act as a source of healthcare associated infection which can be harmful to children, especially those who are in intensive care environments. This small-scale study was conducted in a paediatric intensive care unit at a large teaching hospital and involved swabbing those toys that had been brought in by families and those that were provided by the hospital. Findings show that 85 per cent of the toys harboured viable bacteria, which could be damaging to the child's health. Recommendations for practice are identified to ensure that toys remain a component of the child's hospitalisation yet are safe in relation to the transmission of infections not just in PICU but in all paediatric settings.

Larson, E. L., et al. (2005). "Hand hygiene behavior in a pediatric emergency department and a pediatric intensive care unit: Comparison of use of 2 dispenser systems." *American Journal of Critical Care* **14**(4): 304-310.

BACKGROUND: Adherence to hand hygiene standards is poor. Approaches and systems to improve hand hygiene practices warrant testing.

OBJECTIVE: To compare the frequency of use of manually operated and touch-free dispensers of sanitizer for hand hygiene.

METHODS: Manual and touch-free dispensers of alcohol sanitizer were placed in the emergency department and an intensive care unit of a large pediatric hospital for two 2-month periods for each type of dispenser. Counting devices installed in each dispenser and direct observations were used to determine actual frequency of and indications for hand hygiene.

RESULTS: The touch-free dispensers were used significantly more often than were the manual dispensers. The means for the number of episodes of hand hygiene per hour were 4.42 for the touch-free dispensers and 3.33 for the manual dispensers ($P = .04$); the means for the number of episodes per patient per hour were 2.22 and 1.79, respectively ($P = .004$); and the means for the number of uses of the dispenser per day were 41.2 and 25.6, respectively ($P = .02$). However the overall compliance rate was 38.4% (2136 episodes of hand hygiene per 5568 indications for hand hygiene).

CONCLUSIONS: The scope of dispensing system influenced hand hygiene behavior. Nevertheless, overall hand hygiene compliance remained low. In order for interventions to have a major effect on hand hygiene, multiple factors must be considered.

Urrea, M., et al. (2003). "Prospective incidence study of nosocomial infections in a pediatric intensive care unit." *Pediatric Infectious Disease Journal* **22**(6): 490-493.

Background: Nosocomial infections are important causes of substantial morbidity, mortality and prolonged hospital stay in pediatric intensive care units (PICU).

Methods: A prospective surveillance study was performed in the PICU at a university hospital in Barcelona during the 6 months from May through October 2000 to describe the

epidemiologic profile of nosocomial infections. Centers for Disease Control and Prevention criteria were used as standard definitions for nosocomial infections. Data including extrinsic risk factors (invasive devices) associated with nosocomial infections were recorded and device-associated infections were calculated for the specific site.

Results: During the study period 257 patients were admitted; 15.1% (39) patients had a total of 58 nosocomial infections. The incidence of nosocomial infection was 1.5 per 100 patient-days. Patients with cardiac surgery had the highest nosocomial infection rate, 2.3 per 100 patient-days. Bacteremia (51.7%), respiratory infection (19.0%) and urinary tract infection (17.2%) were the most frequent nosocomial infections observed, and these were associated with use of invasive device. Coagulase-negative staphylococci (39%) and *Pseudomonas aeruginosa* (24%) were the most common organisms isolated. Nosocomial infection rates per 1000 device days were 23.9 for respiratory infection, 12.4 for bacteremia and 10.7 for urinary tract infection. The durations of hospitalization for patients with and without infection were 22.5 and 9 days, respectively ($P < 0.001$).

Conclusions: Performance of surveillance highlights the importance of nosocomial infections and their influence in the hospital stay and can guide selection of prevention and control measures to reduce morbidity and mortality in a PICU.

Ben-Abraham, R., et al. (2002). "Do isolation rooms reduce the rate of nosocomial infections in the pediatric intensive care unit?" *Journal of Critical Care* **17**(3): 176-180.

PURPOSE: To determine the effect of isolation rooms on the direct spread of nosocomial infections (NIs) owing to cross-colonization in a pediatric intensive care unit (PICU).

MATERIALS AND METHODS: This 6-month comparative clinical study used retrospective data from 1992 (an open single-space unit) and prospective surveillance from 1995 (individual rooms) to assess the effectiveness of the latter design on the control of NIs in critically ill pediatric patients. Patients admitted to the PICU for at least 48 hours underwent a microbiologic survey.

RESULTS: The average number of NIs per patient was higher in 1992 (3.62 +/- 0.7, 78 patients) compared with 1995 (1.87 +/- 0.2, 115 patients). Bacterial NIs were caused by gram-positive cocci (33.3%) and aerobic gram-negative bacilli (66.6%). Fungemia in all cases was caused by *Candida albicans*. Similarly, length of stay was significantly higher in 1992 compared with 1995 (25 +/- 6 and 11 +/- 6 days, respectively; $P < .05$). There was a significant reduction of respiratory and urinary tract episodes of NI as well as catheter-related infections in the separate room arrangement.

CONCLUSIONS: Our preliminary analysis suggests a possible beneficial effect of single isolation rooms in reducing NI rate in the PICU. Hence, the influence of room isolation on NIs in pediatric intensive care warrants further investigation.

Harbarth, S., et al. (2001). "Compliance with hand hygiene practice in pediatric intensive care." *Pediatric Critical Care Medicine* **2**(4): 311-314.

Objective: To determine the frequency and predictors of compliance with hand hygiene (HH) practice in pediatric intensive care.

Design: Observational, prospective cohort study performed from February to April 2000.

Setting: Three intensive care units at a tertiary care children's hospital.

Participants: Nurses, physicians, respiratory therapists, and other healthcare workers.

Methods: During 156 30-min daytime observation periods, an unidentified observer monitored 2811 opportunities for HH during patient care and recorded HH compliance.

Measurements and Main Results: Average HH compliance was 34% (946/2811). It was higher ($p < 0.001$) among respiratory therapists (68%; 171/251) than physicians (37%; 157/426) or nurses (29%; 587/2031). Contact with body fluid secretions was associated with the highest compliance (77%; 46/60), and contact with wounds (71%; 10/14) or indwelling devices (66%; 110/167) were associated with somewhat lesser compliance. The following were important

predictors of compliance (all $p < 0.01$): being a respiratory therapist (odds ratio [OR], 5.1); working in the neonatal intensive care unit (OR, 1.6); and contact with invasive devices (OR, 2.5), wounds (OR, 6.9), or body fluids (OR, 11.5). Compliance was lowest after interrupted patient-care activities (9%; OR, 0.15). Surprisingly, decreased patient-to-nurse ratio (mean, 1.3 +/- 0.3) or opportunities per hr of care (mean, 37 +/- 7) were not independent predictors of compliance.

Conclusions: Average HH compliance was low, but it increased during high-risk patient-care activities. Intensified efforts are necessary to increase caretakers' compliance and the awareness of the risk of bacterial contamination after interrupted patient-care activities.

Donowitz, L. G. (1987). "Handwashing technique in a pediatric intensive care unit." *American Journal of Diseases of Children*, **141**(6): 683-685.

A one-year prospective study of 454 patients in a pediatric intensive care unit was performed to determine whether the rate of breaks in handwashing technique was different between medical professionals and to determine whether these rates were altered by the use of the overgown. A handwashing break in technique was defined as not washing your hands after direct contact with either patients or support equipment before contact with another patient or departure from the unit. Ninety-four two-hour sessions were monitored by a research nurse during four cross-over periods of gown and no-gown use. Physicians did not wash their hands in 834 (79%) of 1056 contacts, nurses in 1073 (63%) of 1714 cases, occupational therapists in 21 (62%) of 34 cases, respiratory therapists in 269 (78%) of 346 cases, and radiology technicians in 59 (78%) of 76 cases. Nurses used significantly better technique when compared with physicians, respiratory therapists, and radiology technicians. Gown usage overall did not affect these breaks in handwashing technique rates. Physicians did not wash their hands 75% of the time when gowns were not used and 82% of the time when gowns were used. Handwashing rates were unaffected by gown use in all other professionals. Handwashing remains an important but neglected method of interrupting the transmission of hospital pathogens.

NOISE

Bailey, E. and S. Timmons (2005). "Noise levels in PICU: an evaluative study." *Paediatr Nurs* **17**(10): 22-26.

High levels of noise in the hospital environment can have an impact on patients and staff increasing both recovery time and stress respectively. When our seven-bedded paediatric intensive care unit (PICU) is full, noise levels seem to increase significantly. This study measured noise levels at various times and places within a PICU using Tenma sound level meter which simulates the subjective response of a human ear. Noise levels were often excessive, exceeding international guidelines. Staff conversation was responsible for most of the noise produced; medical equipment, patient interventions, telephones, doorbell and the air shoot system were also responsible for causing high levels of noise. More can be done to reduce noise and its effects on patients and staff.

Carvalho, W. B., et al. (2005). "Noise level in a pediatric intensive care unit." *Jornal De Pediatria* **81**(6): 495-498.

OBJECTIVE: The purpose of this study was to verify the noise level at a PICU.

METHODS: This prospective observational study was performed in a 10 bed PICU at a teaching hospital located in a densely populated district within the city of São Paulo, Brazil. Sound pressure levels (dBA) were measured 24 hours during a 6-day period. Noise recording equipment was placed in the PICU access corridor, nursing station, two open wards with three and five beds, and in isolation rooms. The resulting curves were analyzed.

RESULTS: A basal noise level variation between 60 and 70 dBA was identified, with a maximum level of 120 dBA. The most significant noise levels were recorded during the day and were produced by the staff. CONCLUSION: The basal noise level identified exceeds International Noise Council recommendations. Education regarding the effects of noise on human hearing and its relation to stress is the essential basis for the development of a noise reduction program.

Board, R. (2005). "School-age children's perceptions of their PICU hospitalization." *Pediatric Nursing* **31**(3): 166-175.

The aim of this cross-sectional study was to explore the effects of a PICU hospitalization on critically ill school-age children. Few studies have examined the impact of the PICU experience on children themselves. A convenience sample was recruited of 21 developmentally appropriate children who were aged 7-12 years and had never been hospitalized. Children were asked open-ended questions related to their PICU experience, frequency and effectiveness of coping strategies was measured, and drawings were used to evaluate anxiety. Although not detailed, most children did have some recollection of their PICU stay. People in the PICU (i.e., nurses, physicians) were remembered as good, while feelings the children had (i.e., tired, didn't like it) were described as what was bad about the PICU. Children's coping strategies scores were very low. Most children had an average level of anxiety based on analysis of their drawings. Children's repertoire of coping strategies may be limited by the PICU, especially while intubated. Nurses should never underestimate the effect their behavior and responsiveness has on children. Feasible coping strategies and use of therapeutic play for PICU children should be explored further.

Evans, R. and B. Madsen (2005). "Culture Clash: Transitioning from the Neonatal Intensive Care Unit to the Pediatric Intensive Care Unit." *Newborn and Infant Nursing Reviews* **5**(4): 188-193.

The hospitalization of a child is one of the most traumatic episodes of parenthood. The fear, frustration, anger, and loss of control can be overwhelming to the parents of the critically ill child. Acute care hospitalizations such as those that occur in the neonatal intensive care units (NICUs) and pediatric intensive care units (PICUs) are especially distressing to every member of the family. Unfortunately, families subjected to both NICU and PICU admissions experience two distinctive cultures with very different philosophies and goals. In spite of the best intentions of health care providers, the obvious cultural differences between the NICU and PICU potentially aggravate the stress suffered by families. Unfortunately, most NICU and PICU staff members are unfamiliar with the contrasting cultures. Utilizing specific examples from Phoenix area facilities, the purpose of this article is to describe the many factors that shape and influence the NICU and PICU experience for families.

Trapanotto, M., et al. (2004). "Behavioural and physiological reactivity to noise in the newborn." *Journal of pediatrics and child health* **40**(5-6): 275-281.

Objective: To assess the electromyographic (EMG) and behavioural reactivity of a group of newborn infants exposed to noisy stimulation of various intensity recorded in the Paediatric intensive care Unit (PICU).

Methods: The study was performed at the nursery of the Paediatrics Department (University of Padova) on a group of 21 healthy newborns (mean 39 weeks of gestation), assessed between 24 and 72 h after birth. The study involved taking EMG recordings of the corrugator supercilii muscle and assessing the infant's behaviour at the baseline (15 seconds before stimulation), during noisy stimulation (for 1-2 seconds) and during recovery (15 seconds in three subphases). The noises, previously recorded in PICU, had four different intensities and were administered in random order to all infants. Descriptive analysis and repeated-measures analysis of variance (ANOVA) were performed on the EMG and behavioural data.

Results: The infants demonstrated a significant reaction to the noises both in the EMG recordings and in behavioural changes, especially during intense noisy stimulation. The

reaction lasted longer than the stimulation period, preventing the infants from returning to the baseline condition.

Conclusions: Exposure to high-intensity noise produced in PICU causes evident behavioural and physiological effects (EMG). This is a field of study that could have important repercussions, given the medium- and long-term effects of repeated noise stimulation.

Milette, I. H. and F. A. Carnevale (2003). "I'm trying to heal...noise levels in a pediatric intensive care unit." Dynamics **14**(4): 14-21.

The literature demonstrates clearly that most intensive care units exceed the standard recommendations for noise levels in hospitals, and that high noise levels have negative impacts on patients and staff. The purpose of this study was to evaluate the level of noise in a PICU and compare it to the recommendations of international bodies. We outline recommendations to promote the awareness of this problem and suggest strategies to decrease the level of noise in a PICU. The orientations of these strategies are threefold: 1) architectural-acoustic design, 2) equipment design and, most importantly, 3) staff education.

Morrison, W. E., et al. (2003). "Noise, stress, and annoyance in a pediatric intensive care unit." Critical Care Medicine **31**(1): 113-119.

Objective: To measure and describe hospital noise and determine whether noise can be correlated with nursing stress measured by questionnaire, salivary amylase, and heart rate. Design: Cohort observational study.

Setting: Tertiary care center pediatric intensive care unit. Subjects: Registered nurses working in the unit.

Interventions: None.

Measurements and Main Results: Eleven nurse volunteers were recruited. An audiogram, questionnaire data, salivary amylase, and heart rate were collected in a quiet room. Each nurse was observed for a 3-hr period during patient care. Heart rate and sound level were recorded continuously; saliva samples and stress/annoyance ratings were collected every 30 mins. Variables assessed as potential confounders were years of nursing experience, caffeine intake, patients' Pediatric Risk of Mortality Score, shift assignment, and room assignment. Data were analyzed by random effects multiple linear regression using Stata 6.0. The average daytime sound level was 61 dB(A), nighttime 59 dB(A). Higher average sound levels significantly predicted higher heart rates ($p = .014$). Other significant predictors of tachycardia were higher caffeine intake, less nursing experience, and daytime shift. Ninety percent of the variability in heart rate was explained by the regression equation. Amylase measurements showed a large variability and were not significantly affected by noise levels. Higher average sound levels were also predictive of greater subjective stress ($p = .021$) and annoyance ($p = .016$).

Conclusions: In this small study, noise was shown to correlate with several measures of stress including tachycardia and annoyance ratings. Further studies of interventions to reduce noise are essential.

Berens, R. (1999). "Noise in the Pediatric Intensive Care Unit." Journal of Intensive Care Medicine **14**(3): 118-129.

The pediatric intensive care unit is an environment filled with dedicated caregivers, state-of-the-art monitors, and machines that collectively work to provide the best care possible for critically ill children. A previously unappreciated result of having these resources mingled together is the elevated level of environmental noise. Although the levels of noise do not reach OSHA levels (>85 dB for 8 continuous hours) that cause noise-induced hearing loss, the patients are exposed to continuous moderate noise levels that may cause hearing impairment if mixed with other ototoxic agents. In addition, these noise exposures may result in abnormalities in the stress response as well as in sleep patterns. This article reviews the physiology of hearing, the consequences of noise pollution as it relates to pediatric patients,

and preventive measures used to reduce noise pollution in a pediatric intensive care setting. Considerations for further research efforts are also discussed.

POSITIVE DISTRACTIONS

Nanda, U., et al. (2009). "Pediatric art preferences: Countering the "one-size-fits-all" approach." Health Environment Research and Design Journal, 2(4), Summer, 46-61.

Objective: To determine the stated art preferences of pediatric patients through an art survey and determine whether preferences vary, with different age groups associated with different stages of cognitive development.

Background: Exposure to visual art has been shown to have an impact on improved health and satisfaction outcomes. However, there is little literature on the effect of art on pediatric patients. While designing pediatric wards, a common assumption is to use fantasy and Disney-like themes; but research across all age groups on whether children prefer these themes is limited.

Methodology: A survey including 20 images with a variety of subject matter and styles was administered to 64 pediatric inpatients (ages 5-17) at Memorial Hermann Hospital in Houston, TX. Children were asked to rate the selection of, and their emotional response to, the images in the survey. Qualitative comments were recorded. Results were analyzed for each of the three age groups (5-6, 7-10, and 11-17 years) according to Piaget's developmental stages, as well as across all age groups.

Results: There were significant differences in art preferences across the different age groups, especially with respect to child art (art created by children). Overall, the results for 5-10-year-olds were more significant than those for 11-17-year-olds (adolescents). Nature elements were preferred across all age groups, but all nature images were not rated similarly. Images that were bright and colorful were rated better than images that were pale. The presence of a strong context that children could associate with was a defining feature of preferred images. Content drove preference more than style, though color was a key determinant. Comments on the artwork tended to be more objective/absolute for the youngest patients and more subjective/relative for the oldest.

Conclusions: The combination of bright colors, engaging themes, and nature content is consistently highly rated by pediatric patients. However, pediatric preferences vary significantly among the three operational stages, so one should be careful before using the "one-size-fits-all" approach. Child art, typically used in pediatric wards, is better suited for younger children than for older children.

Battles, H. and L. Wiener (2002). "STARBRIGHT World: Effects of an Electronic Network on the Social Environment of Children with Life-Threatening Illnesses." Children's Health Care 31(1): 47-68.

STARBRIGHT World (SBW) is a virtual environment designed to link seriously ill children into an interactive online community in which they can play games, learn about their medical condition, or talk with other chronically ill children. This study evaluated the impact of SBW on pain, mood, anger, loneliness, problem behavior, and willingness to return for treatment of children receiving outpatient treatment at the National Institutes of Health (NIH). To test the hypothesis that SBW provides benefit through distraction, a restricted alternating treatments design was utilized to measure anger, pain, and mood. To test the more long-term benefits of SBW, loneliness and problem behavior were measured at baseline and at the end of the study. Willingness to return was measured at each hospital visit made during the study. Process information was also collected during each SBW session (e.g., ease of use, frustration, and general enjoyment of the system). Thirty-two children participating in pediatric clinical trials at the NIH and their caregivers participated in the study. Seventy-eight percent of participants, ages 8 to 19 years, were HIV infected and the remaining 22% had varied, but potentially life-

threatening, illnesses. Children reported significantly less loneliness and were significantly more willing to return to the hospital for treatment from baseline to follow-up. They were marginally less worried after using SBW than after using the regular playroom. Parents reported that their children experienced significantly less withdrawn behavior and needed significantly less help with both anxiety and resistance in returning to the hospital for treatment after using SBW. They also reported that SBW helped their children to feel decreases in loneliness and depressed mood, and increases in energetic mood. SBW is a potentially useful tool to improve the hospital experience for seriously ill children, reduce their feelings of loneliness and isolation, and help them to be less socially withdrawn.

Bers, M., et al. (2001). "Zora: a pilot virtual community in the pediatric dialysis unit." Medinfo **10**(Part 1): 800-804.

We describe a five-month pilot project conducted in the dialysis unit at Boston's Children's Hospital. Pediatric patients with renal disease used the Zora therapeutic community program while undergoing hemodialysis. Zora is a 3D multi-user computer environment designed at the MIT Media Laboratory to help young people explore issues of identity, while engaging in a virtual community. Users build "virtual rooms" and populate them with objects and characters, program them with storytelling behaviors, and converse with other young people in real-time through a virtual character representing themselves. It was specifically designed to help young people explore issues of identity, while engaging in a participatory virtual community. This paper presents the experience and evaluates the feasibility and safety of using Zora in a hospital setting. It describes how Zora facilitated explorations of identity and mutual patient support and interaction. Finally it also presents design recommendations for future interventions of this kind. More generally, this paper explores the potential of technology specifically designed with therapeutic purposes to help patients cope with their illness.

Too, C. and K. Song (1999). "The effects of music therapy on vital signs and pulsatile oxygen saturation of pediatric intensive care unit children." Journal of Korean Academy of Fundamental Nursing **6**(3): 381-396.

This study was attempted to prove the effect of emotional stability and vital signs applying music therapy program to the children admitted in the PICU. Data were collected from July to September, 1997. The subjects were 30 patients admitted in the PICU of 'S' University Hospital which were divided into two groups of experimental and control. Each group had 15 subjects. Method was nonequivalent control group pretest-posttest repeated design, observing vital signs and activity of subjects prior, during, and after the music intervention. The study tools were cassette tapes of "Mother's music whose babies want to listen" and Space-lab patient monitor. Data were analyzed using the SPSS/PC+; χ^2 test and t-test to analyze of the general characteristics; paired t-test to prove hypo-theses. Result were as follows;1. Infants lower than seven months showed changing into stable vital signs from applying the music therapy, however infants from eight months to three-year old showed no change in vital signs.2. Vital signs changed to stabilized condition in infants lower than seven months were heart rate and respiration rate.3. The stability of vital signs during music therapy turned back to the previous state while terminating music therapy.4. The effect of music therapy in the state of activity had on both infants group of lower than seven months and from eight months to three-year old, particularly more effective in the later group. I recommend follows on the base of above results;1. As above results shows, listening to music is effective on infants and toddler, intervention with music therapy appropriate to children's age is hot recommended.2. Comparative study with noise blocking effect and music therapy effect within the ICU environment be recommended.3. The repeated study on when the exact time is and how many repeat the music therapy to show the above mentioned effect be recommended.4. We recommend this music therapy to be done in the recovery room, isolating room, operating room as well as ICU.

QUALITY OF CARE

Smith, T. J. (2012). "A comparative study of occupancy and patient care quality in four different types of intensive care units in a children's hospital." *Work* 41 Suppl 1: 1961-1968.

This paper reports a comparative study of occupancy and patient care quality in four types of intensive care units in a children's hospital; an Infant Care Center (ICC), a Medical/Surgical (Med/Surg) unit, a Neonatal Intensive Care Unit (NICU), and a Pediatric Intensive Care Unit (PICU), each featuring a mix of multi-bed and private room (PR) patient care environments. The project is prompted by interest by the project sponsor in a pre-occupancy analysis, before the units are upgraded to exclusive PR designs. Methods comprised, for each unit: (1) observations of ergonomic design features; (2) task activity analyses of job performance of selected staff; and (3) use of a survey to collect perceptions by unit nursing and house staff (HS) of indicators of occupancy and patient care quality. Conclusions: (1) the five most common task activities are interaction with patients, charting, and interaction with equipment, co-workers and family members; (2) job satisfaction, patient care, work environment, job, patient care team interaction, and general occupancy quality rankings by ICC and/or NICU respondents are significantly higher than those by other staff respondents; and (3) ergonomic design shortcomings noted are excess noise, problems with equipment, and work environment, job-related health, and patient care quality issues.

Kanter, R. and J. Moran (2007). "Pediatric hospital and intensive care unit capacity in regional disasters: expanding capacity by altering standards of care." *Pediatrics* 119(1): 94-100.

BACKGROUND: Federal planners have suggested that one strategy to accommodate disaster surges of 500 inpatients per million population would involve altering standards of care. No data are available indicating the extent of alterations necessary to meet disaster surge targets. **OBJECTIVE:** Our goal was to, in a Monte Carlo simulation study, determine the probability that specified numbers of children could be accommodated for PICU and non-ICU hospital care in a disaster by a set of strategies involving altered standards of care.

METHODS: Simulated daily vacancies at each hospital in New York City were generated as the difference between peak capacity and daily occupancy (generated randomly from a normal distribution on the basis of empirical data for each hospital). Simulations were repeated 1000 times. Capacity for new patients was explored for normal standards of care, for expansion of capacity by a discretionary 20% increase in vacancies by altering admission and discharge criteria, and for more strictly reduced standards of care to double or quadruple admissions for each vacancy. Resources were considered to reliably serve specified numbers of patients if that number could be accommodated with a probability of 90%.

RESULTS: Providing normal standards of care, hospitals in New York City would reliably accommodate 250 children per million age-specific population. Hypothetical strict reductions in standards of care would reliably permit hospital care of 500 children per million, even if the disaster reduced hospital resources by 40%. On the basis of historical experience that as many as 30% of disaster casualties may be critically ill or injured, existing pediatric intensive care beds will typically be insufficient, even with modified standards of care. **CONCLUSIONS:** Extending resources by hypothetical alterations of standards of care would usually satisfy targets for hospital surge capacity, but ICU capacity would remain inadequate for large disasters.

SLEEP

Al-Samsam, R. and O. Cullen (2005). "Sleep and adverse environmental factors in sedated mechanically ventilated pediatric intensive care patients." *Pediatric Critical Care Medicine* **6**(5): 562-567.

OBJECTIVE: To document the quantity and architecture of sleep using objective electrophysiologic assessment in sedated mechanically ventilated pediatric intensive care unit patients over a 24-hr period and to investigate the effect of noise and staff interventions on sleep pattern in these subjects.

DESIGN: Prospective observational study.

SETTING: Pediatric intensive care unit at a university hospital.

PATIENTS: A total of 11 patients studied between September 2000 and June 2001, with ages ranging from 3 to 21 months. All patients were intubated, mechanically ventilated, and sedated with morphine and midazolam infusions.

INTERVENTIONS: Limited sleep polysomnograph, staff interventions, and noise levels were continuously monitored during a 24-hr period.

MEASUREMENTS AND MAIN RESULTS: Noise levels were consistently >48 dB(A); the highest night peak reached 103 dB(A). Staff interventions lasted for a mean of 240 (SD 90) mins in a 24-hr period. There was no significant difference in the number of interventions between day and night. Severe alterations to sleep architecture were found throughout the 24 hrs, with no diurnal variations. Active sleep was severely reduced to a mean of 3% (SD 4%; range, 0-11%) of total sleep time. There was severe sleep fragmentation as reflected by the high number (mean, 40 [SD 20]) of wake episodes.

CONCLUSION: The above findings suggest a significant electrophysiologic abnormality of sleep in the pediatric intensive care unit patients. Our pediatric intensive care unit environment is characterized by both, high noise levels and frequent staff interventions. This study has several limitations and future studies are needed, with larger sample size and an attempt to manipulate the environmental factors to minimize their negative effects on sleep.

Corser, N. C. (1996). "Sleep of 1- and 2-year-old children in intensive care." *Issues in Comprehensive Pediatric Nursing* **19**(1): 17-31.

Physiologic and psychologic changes associated with sleep disturbance decrease the ability of a critically ill child to adapt to hospitalization and thus hamper recovery. Research demonstrates that intensive care settings interfere with sleep of adults, but little is known about the impact of these settings on children's sleep. An exploratory field study was conducted to describe the sleep-wake patterns of 1- and 2-year-old children in intensive care, identify intensive care environmental stimuli associated with sleep and waking states, compare the intensive care sleep-wake pattern to the pre-illness sleep-wake pattern, and determine the time required for children to return to their pre-illness sleep-wake pattern. Twelve children aged 13 to 35 months composed the sample for the study. Pre-illness and post-discharge sleep patterns, sleep patterns during a 12-hour night in the pediatric intensive care unit (PICU), and external and internal environmental stimuli were measured. Prior to hospitalization, subjects demonstrated sleep similar to that documented in healthy children. Children in the PICU experienced a significant loss of sleep, frequent awakenings, and a virtual rapid eye movement (REM) sleep deprivation. External environmental stimuli of light, noise, and caregiver activity were negatively correlated with sleep state. Pain and treatment with benzodiazepines were associated with sleep acquisition. Sleep changes persisted after discharge from the PICU and the hospital. Total sleep time recovered more rapidly than nighttime awakening. Parents perceived that their child's sleep remained different longer than total sleep time and night awakening values demonstrated.

Cureton-Lane, R. A. and D. K. Fontaine (1997). "Sleep in the pediatric ICU: an empirical investigation." American Journal of Critical Care **6**(1): 56-63.

BACKGROUND: Although sleep is important for physical and psychological health, no research has assessed the sleep of children in a pediatric ICU and the factors that affect sleep. **OBJECTIVES:** To observe the sleep of children in a pediatric ICU and to determine the relationship of noise, light, contact with caregivers, parental presence, and severity of illness to the sleep obtained by children in a pediatric ICU during a 10-hour night.

METHODS: At 5-minute intervals from 8 PM until 6 AM, a convenience sample of nine patients was observed. Sleep state, noise and light levels, contact with caregivers, and parental presence were recorded. Severity of illness was measured on admission and within 26 hours of data collection. **RESULTS:** Subjects slept for a mean total of 4.7 hours (SD = 0.49) during the 10-hour night, interrupted by a mean of 9.8 awakenings (SD = 2.48). The mean length of a sleep episode was only 27.6 minutes (SD = 25.85). Mean noise level was 55.1 dB(A) (SD = 6.82), with sudden, sharp elevations of up to 90 dB(A). Probit analysis indicated that noise, light, and contact with caregivers were significant predictors of sleep. Parental presence and severity of illness were not.

CONCLUSIONS: Patients in the pediatric ICU sleep significantly less than is normal for children of the same ages, and their patterns of sleep are seriously disturbed. Because noise, light, and contact with caregivers are significant predictors of sleep state, health professionals can use these findings to structure the environment and the care they give to promote the sleep of critically ill children.

MISCELLANEOUS

O'Flaherty, L. A., et al. (2012). "Aromatherapy massage seems to enhance relaxation in children with burns: an observational pilot study." Burns **38**(6): 840-845.

OBJECTIVE: This observational pilot study investigated effects of aromatherapy massage in paediatric burn patients.

METHODS: The setting was a 17 beds level I burn unit in Cape Town, South Africa. Between January and October 2009 heart rates and respiratory rates of patients who underwent aromatherapy massage sessions were read before and after the sessions. Primary outcomes were decline in heart rates and respiratory rates, a sign of relaxation. Behavioural responses (sleep/awake state, facial expression, body posture) were documented as secondary outcomes.

RESULTS: A convenience sample of 71 paediatric burn patients (median age 3 years) underwent a total of 126 massage sessions. Mean heart rate decreased significantly from 118 (SD 20) to 109 (SD 21), $t=9.8$, $p<0.001$. Mean respiratory rate decreased significantly from 34 (SD 8) to 30 (SD 8), $t=10.2$, $p<0.001$. Most massage sessions (92.8%) elicited positive behaviour to the massage, e.g. the child fell asleep, calmed or asked to continue. Nine patients (7.2%) with a median age of 15 months who underwent a single massage session did not show positive behaviour but cried, wriggled or were distressed.

CONCLUSIONS: Aromatherapy massage seems to be a helpful nonpharmacological approach to reduce hospitalized paediatric burn patients' distress. Future studies with better research designs and validated outcome measures should confirm our findings.

Meert, K. L., et al. (2008). "Exploring Parents' Environmental Needs at the Time of a Child's Death in the Pediatric Intensive Care Unit." Pediatric Critical Care Medicine **9**(6): 623-628

Objective: Many childhood deaths in the United States occur in intensive care settings. The environmental needs of parents experiencing their child's death in a pediatric intensive care unit must be understood to design facilities that comfort at the time of death and promote healing after loss. The purpose of this study is to explore parents' environmental needs during

their child's hospitalization and death in the pediatric intensive care unit. Design: Descriptive qualitative study. Setting: A university-affiliated children's hospital. Participants: Thirty-three parents of 26 children who died in a pediatric intensive care unit. Interventions: Semistructured, in-depth, videotaped interviews were conducted with parents 2 yrs after their child's death. Interviews were analyzed by an interdisciplinary research team using established qualitative methods. Measurements and Main Results: Environmental themes identified through parent interviews included 1) places remembered, 2) spatial characteristics, 3) services for daily living, 4) parent caregiving, 5) access, and 6) presence of people. Places remembered by parents in most detail included the pediatric intensive care unit patient rooms and waiting room. Spatial characteristics pertaining to these places included the need for privacy, proximity, adequate space, control of sensory stimuli, cleanliness, and safety. Parents needed facilities that enabled self-care such as a place to eat, shower, and sleep. Parents also needed access to their child and opportunities to participate in their child's care. Parents described the physical presence of people, such as those who provide professional and personal support, as another important environmental need. Conclusions: The pediatric intensive care unit environment affects parents at the time of their child's death and produces memories that are vivid and long lasting. Positive environmental memories can contribute to comfort during bereavement whereas negative memories can compound an already devastating experience. Parents' perspectives of the pediatric intensive care unit environment can provide insight for adapting existing spaces and designing new facilities.

Rice, B. A. and C. Nelson (2005). "Safety in the Pediatric ICU: The Key to Quality Outcomes." Critical Care Nursing Clinics of North America **17**(4): 431-440.

Patient safety is a major concern in the pediatric ICU. The acuity has never been higher, patient needs are extremely complex, and the margin for error is small. The concentration on safety needs to revolve around designing safe systems and processes. This article discusses communication, patient identification, catheter-related bloodstream infections, unplanned extubations, restraints and medication administration. The health care system of the future must be transparent, making safety information to insurers, patients and health care providers easily available.

Dominguez, T. E., et al. (2001). "The impact of adverse patient occurrences on hospital costs in the pediatric intensive care unit." Critical Care Medicine **29**(1): 169-174.

Objectives: To study the influence of adverse patient occurrences defined as airway complication (AC), vascular complication (VC), and infectious complication (IC) on intensive care unit (ICU) costs and length of stay (LOS).

Design: Retrospective, cohort study

Setting: An urban, tertiary care children's hospital in Philadelphia, PA.

Patients: All children admitted to a multidisciplinary pediatric ICU during the fiscal year 1994.

Interventions: None

Measurements and Main Results: Demographic data, diagnoses, Pediatric Risk of Mortality scores, LOS, and deaths were recorded. Hospital charges were converted into costs by using cost-to-charge ratios. There were 23 AC, 35 VC, and 40 IC events. Multiple regression in models adjusting for age, Pediatric Risk of Mortality score, mortality, chronic disease, and diagnosis by using AC, VC, and IC indicator variables was performed on the dependent variables of LOS and total costs. IC was associated with an increase in total costs of \$50,361.89 ($p < .001$), an increased LOS of 15.6 days ($p < .001$), and no significant increase in daily costs. There were no significant increases in costs or LOS seen with the AC and VC variables. In a matched analysis, the total costs attributable to IC averaged \$32,040 per patient.

Conclusions: The occurrence of complications in the pediatric ICU is associated with meaningful increases in LOS and hospital costs. ICs are more important predictors of costs

than ACs or VCs. Continuing efforts should be made to minimize adverse occurrences to improve patient care and reduce costs.

Weigle, C., et al. (2001). "The internet, the electronic medical record, the pediatric intensive care unit, and everything." Critical Care Medicine **29**(8): SN166-SN176.

This article details how computers have changed life for those of us in pediatric intensive care. A week of clinical activity is described, with a focus on the interactions with computer systems that have become an integral part of patient-care activities for many of us. It becomes clear that the boundaries between personal computers, hospital systems, and the Internet are often not sharply defined. Resources that are used every week may include those residing on a personal digital assistant, on the hospital's electronic medical record, or on a distant site on the World Wide Web. Key resources on the Internet (World Wide Web and e-mail) are identified. The technical underpinnings, particularly the network that provides the infrastructure for various resources, are described.

Redman, J. F. and S. J. McNatt (2000). "Portable Cushioned Operating Table Siderails: An Adjunct To Pediatric Surgery." Southern Medical Journal **93**(11): 1081-1082.

Presents information on a study which examined the use of portable cushioned operating table siderails developed in an effort to prevent falls of pediatric surgical patients from the operating table. Description of the siderails; Techniques of use; Effectiveness of the siderails.

ADDITIONAL RESOURCES

From: Ozcan, H. (2004). Healing design: a phenomenological approach to the relation of the physical setting to positive social interaction in pediatric intensive care units in the United States and Turkey. *Architecture*. College Station, TX, Texas A&M University. **PhD:** 363.

TABLE 5.1
Infection Control Function – Problems and Solutions

Infection Related Problem	Proposed Solution
<p>1. <i>Clean utility:</i> Clean linens are not kept separately under sterile conditions.</p>	<p>1. Provide separate rooms for clean and soiled utility, and enough support space for ICU inside or outside the unit.</p>
<p>2. <i>Separate toilets for patients and staff:</i> Caregivers and patients share the same toilet, which family members also utilize against the rules.</p>	<p>2. Provide separate restrooms for staff, patients, and families (outside the ICU).</p>
<p>3. <i>Handwashing facilities:</i> 1) There are no separate sinks for handwashing and urine disposal. 2) They have an isolation room, yet it is insufficient, and does not have a sink. 3) There are no separate sinks and disinfections at each patient's bedside.</p>	<p>3. Provide: 1. Separate sinks/areas for urine disposal and handwashing. 2. A sink in the isolation room and at each patient's bedside. 3. Develop appropriate standards and guidelines for the use of sinks and mandatory handwashing.</p>
<p>4. <i>Bathroom:</i> There is no tub or bathroom to wash the patients: Currently, they wash the babies in the sinks and clean the older children with wipes (Figure 6.4).</p>	<p>4. Provide a bathroom for washing patients, who stay for many days.</p>
<p>5. <i>Refrigerator:</i> There is only one refrigerator for the patients. Yet staff members store their food and beverages in the same fridge. Due to lack of space it gets overly packed, causing food and drink items to drop and explode, creating unsterile conditions.</p>	<p>5. Provide a separate staff refrigerator in the staff lounge.</p>
<p>6. <i>Equipment disinfection:</i> Nurses disinfect used equipment such as oxygen pumps and masks, and dry them on clean towels laid on unoccupied patient beds.</p>	<p>6. Provide: 1. A clean space. 2. A disinfection unit for sterilizing used equipment. 3. Hire a professional cleaning team.</p>
<p>7. <i>Waste containers:</i> They use open plastic bins, which are not durable or operable.</p>	<p>7. Provide durable and operable containers, which are preferably stainless steel and specially designed.</p>
<p>8. <i>Gloves/Galoshes:</i> Gloves are not used during all medical and nonmedical procedures, including drawing blood. Masks and galoshes are not mandatory for visitors.</p>	<p>8. Provide gloves and portable glove box holders, and make their use mandatory.</p>

Existing Culture and Organization	Architectural Solutions
NORTH AMERICAN PICU	
The desire to progress with FCC approach	1) Provision of new spaces to provide families with alternatives and a more active function in care, including family resource center with Internet accessibility, medical library and education rooms 2) Transforming the character of the family space at the patient's bedside, and exploring a new parental role, which is more competent in her or his knowledge regarding their child's disease and care (intellectual transformation of family space)
Nurse-patient interaction time should be increased	1) Nurses' walking distances in the ICU can be reduced with a more compact arrangement. 2) A nurse functions in two adjacent rooms, yet if these rooms were visually and physically connected, it would reduce walking and enable her or him to spend more time with each patient.
Nurse charting time should be decreased	1) The CM (clinical manager) called for a return to paper charting, yet it does not look realistic. 2) Creating a new specialty of labor for nurses doing only documentation: Space can accommodate this type of fragmentation of nursing activities. This can also help with the nursing shortage and resulting strategies for creating new yet less credentialed areas.
Due to the severe nursing shortage, healthcare industry is moving towards the creation of new and less credentialed areas, separating the general tasks of the traditional nurse.	
Nurse-physician relationship can still be improved	Separate staff lounges for nurses and doctors Provision of common (dining) areas and kitchen to bring them together for leisure activities, such as preparing healthy drinks or sharing meals
Increasing staff cooperation and collaboration	Constant visibility for all caregivers in different patient rooms to see and support one another continuously, and more careful planning of the location of each ICU room (so no room is outside the kinship of other rooms)
Families' dual need for privacy and interaction	1) Design of the interior settings in the waiting room to encourage interaction & support between families 2) Creating private modules in the waiting room for their need for separation and isolation when needed 3) Providing alternative and flexible settings
Increasing social relationships among staff	Provision of comfortable and private spaces for staff interaction during breaks
Staff socialization during the family's presence	Provision of an attractive and comfortable lounge for socialization, which has visual access to the PICU so nurses are more open to taking a break more often
Staff need for resting intermittently during the day	Staff lounge with a massaging chair, healing music, nature views, and other consciously chosen amenities for effective relaxation (rather than the TV)