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REVIEW / *DERLEME*

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Structure and Function: Planning a New Intensive Care Unit to Optimize Patient Care

Yapı ve Fonksiyon: İdeal Hasta Bakımında Yoğun Bakım Ünitesi Planlanması

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SUMMARY To survey the recent medical literature reporting effects of intensive care unit (ICU) design on patients' and family members' well-being, safety and functionality. Features of ICU design linked to the needs of patients and their family are single-rooms, privacy, quiet surrounding, exposure to daylight, views of nature, prevention of infection, a family area and open visiting hours. Other features such as safety, working procedures, ergonomics and logistics have a direct impact on the patient care and the nursing and medical personnel. An organization structured on the needs of the patient and their family is mandatory in designing a new intensive care. The main aims in the design of a new department should be patient centered care, safety, functionality, innovation and a future-proof concept.

Key Words: Intensive care unit, environment, design, patient centered care

ÖZET Bu derlemede, yoğun bakım mimari planının hastaların ve onların yakınlarının tedavi süresince güvenliği ve kendilerini daha iyi hissetmeleri doğrultusunda etkisini araştıran yakın dönem medikal literatür değerlendirilmiştir.
Yoğun bakım mimari planı ve hasta/hasta ailesi ihtiyaçları ilişkisi tek kişilik yoğun bakım odaları, mahremiyet, sessiz ortam, gün ışığının mevcudiyeti, tabiat görme, infeksiyon korunma yöntemleri, ailenin kalabileceği alanlar ve ucu açık ziyaret saatleri olarak tespit edilmiştir. Diğer ilişkili faktörler olarak güvenlik, çalışma prosedürleri, ergonomi, lojistik, gerek hasta, hemşire gerekse tıbbi personel üzerine etkili olarak saptanmıştır. Yeni bir yoğun bakım planlamasında, hasta ve ailenin ihtiyaçları doğrultusunda bir organizasyonun planlama gerekliliği kaçınılmazdır. Kurulacak departmanın mimari planında ana hedef hasta odaklı güvenlik, işlevsellik, innovasyon ve ileri görüş konsepti olmalıdır.

Anahtar Kelimeler: yoğun bakım ünitesi, ortam, plan, hasta odaklı bakım

Introduction

In 1852, Florence Nightingale observed the importance of keeping critically ill patients together in one separate place for special nursing care (1). One hundred years later, due to several epidemics and catastrophes, the concept of keeping critically ill patients together in one place was created, eventually leading to installation of intensive care units (ICU's) (2,3). The idea to keep patients in special wards together with specialized medical and nursing personnel has resulted in the development of modern ICU's. Most patients would not be surviving before this development. Therefore, during the years of evolution and institutionalization, the nursing and medical care were focused mainly on the improvement of the

patient's illness and less on care of family and safety (4). Recently, more insight was developed concerning the mental stress of being an intensive care patient or a next of kin (5,6). Moreover, the physical and psychological well being of the ICU nursing and medical personnel and the safety of the procedures in patient care have been carefully documented especially during the last decade (7,8**). Due to this reason, today a different approach is necessary in planning, designing and building an ICU. It has been common practice that ICU's were built according to existing working procedures and equipments were bought according to habits and preferences of the nursing and medical personnel. Today and in the future, it is imperative that the working procedures should be modified (7), the equipments should be chosen and ICU's should be built according to the needs of the patient and their relatives.

Where to Begin?

The first step in designing an intensive care is to define a vision in order to create an intensive care department that produces the best possible environment suitable for critically ill patients and their relatives. This environment allows doctors and nursing staff to focus on the patient. Patient centered care, safety, functionality, innovation and future-proof concept should be the main aims in the design of the new department (Table 1) (8-10). Concepts can be developed mainly in two directions. First, patient centered care dictating architecture and interior design and second, functionality and safety defining the concepts to be developed. For the whole procedure, it is important to interview old patients and their family members to evaluate the present condition and shortcomings they have experienced. Finally, as part of a new ICU design or renovation, a patient room mock-up should be constructed in order to test the developed concepts (11).

Patient Centered Care

Patient centered care involves not only the needs of the patient, but also of the family.

Needs of the Patient

Private patient rooms are needed to fulfill some of the needs of ICU patients. Results of several trials have shown that patients can suffer from sleep disturbances and restlessness due to high level of noise in ICU's (12-16**). Private rooms with closed doors can provide quiet environment. Dennis and colleagues (12) have shown that patients were significantly more likely to be observed sleeping when noise and light was reduced. Drouot et al. (13) and Ugras et al. (15) confirmed these findings and identified noise as a cause of sleep disturbances.

Several studies have shown lower rate of infection with private rooms compared to multi-bed environments (17). Based on various studies, Ulrich et al. (8,18**) extensively discuss effect of single-bed rooms in reducing airborne infection and contact transmission. Moreover, Bracco and collegues (19) found the risk of acquisition of pathogens, such as methicillin-resistant Staphylococcus aureus (MRSA), Pseudomonas species, and Candida species, was lower for those cared for in private, compared with open ward or multi-bed rooms. Furthermore, Single-bed rooms appeared to reduce or prevent MRSA infections compared to multi-bed rooms in various health care settings including ICU's (20-22). Considering the complexity of ICU infections, additional information will be necessary on this matter. However, there is strong suggestive evidence in literature, that single rooms limit transmission to roommates.

Private patient rooms also help to ensure patient privacy. The patients must have visual privacy when needed and must be able to talk to family members and care providers without being overheard or interrupted (23*). Electrostatic glass can be used for this purpose. The patients can normally be observed from outside and at the touch of a button it instantly becomes opaque guaranteeing privacy when needed. In a study performed by Fridh et al. (24) the relatives of the dying patients who were transferred to a private room were deeply grateful for the privacy. This way it

Table 1. Features mandatory for future ICU design

Patients-centered care		**Functionality and safety**		
Needs of patient:	Needs of family:	Physician/nurse nearby:	Ergonomics:	Safety:
- Healing environment	- Hospitality	- Space for treatment	- Ceiling service units	- Advanced alarms
- Single rooms	- Open visiting hours	- Remote monitoring		- Adequate supplies
- Privacy	- Bedroom with bathroom for family			- Satellite pharmacy at ICU
- Quiet surrounding	- Clear signage			
- Natural daylight	- Family area with catering and internet facilities			
- Views of nature				
- Prevention of infection				

was possible for the family to have their own private sphere, which only the family members themselves were allowed to enter.

Single rooms are also associated with fewer medication errors, improved social support by patients' families, improved communication between patients and staff, and an overall increase in patients' satisfaction with care (25*).

In designing the room, well-being and orientation of the patient should be the main goals. Therefore, it is important to design the rooms to help re-orientate and maintain a day and night rhythm (16**). Therefore, each patient room should receive natural light. In a review article Trochelman and colleagues (25*) have concluded that natural light in patient care areas reduced agitation in elderly patients, decreased length of stay, lessened the need for pain medication, and reduced depression. Access to daylight also contributes to higher satisfaction for the staff (8**). Natural light can be obtained by designing patient rooms with view outside the hospital. Alternatively, the rooms can be looking to an inside garden or patio. It has been stressed that having views of nature or gardens from patients' rooms reduced stress and pain (9,26-28).

The rooms should also be designed to make the patients feel at home (16**). A clock, armchair, fashionable lamp and sideboard all carefully color coordinated can be used for this purpose. A whiteboard in each room with the names of attending personnel is helpful for the patient and their family. A clear glass wall and door can be used to separate the room from the nursing staff replacing old fashioned curtains. The ceilings in each room should be painted in soft colours with as few irregularities as possible. Delirium often occurs in patients in the intensive care and the resulting disorientation is commonplace. Such patients may imagine strange phenomena emerging from the ceiling whereas in fact it may simply be an air conditioning duct! In a recent study, Zaal and co-workers have shown a shortening of delirium in patients who were admitted to a single-room ICU, designed to reduce noise and with improved exposure to daylight, in comparison to patients admitted to an open ward ICU (29).

Needs of the Family

The benefits of visiting relatives should not be underestimated, both from the positive effects they have on the patient and from the importance of their own comfort and peace of mind. Designing respite areas for relaxation is an important factor (9). A large area with catering and Internet facilities should be reserved for family use. PC's with Internet connection, cable TV, telephone and an outside meeting space to their own cafeteria will make the relatives to feel as welcome and as comfortable as possible.

Signage and way finding is important for the visiting family (16**). Patient room numbers should be clearly marked. Directional signage should be easy to read, understand, and follow. Multilingual signage should be considered if appropriate. Way finding techniques, such as landmarks, art and floor patterns may be considered in symmetrical multi-unit ICU's.

Strict visiting hours is not an applicable concept in a modern ICU. Twenty-four hours visiting policy should be applied for the family members and there should be no restrictions on visiting time (30). This flexibility will result in a quieter atmosphere, as the visits of family members are not concentrated between certain hours.

Bedrooms with bathroom and shower can be built in the unit for those who live far away or for those where the patient is particularly ill. Some ICU's prefer to locate the family rooms next to the patients' rooms (16**). On the other hand, the area chosen for family members can also be situated in a quiet corner of the department. This way, the family is not exposed to the daily activities of the ICU when they are not in the patient room, giving them an atmosphere of privacy, security and trust.

Functionality and Safety

Before deciding to buy any of the necessary medical equipment, concepts have to be developed concerning functionality, safety and innovation. The concepts developed will be leading in the choice of the equipments. Physician and nurse at the bedside or nearby, ergonomics and safety are the main themes in this article.

Physician and Nurse at the Bedside or Nearby

In most ICU settings, when the patient is stable, it is common for the nurses to gather behind the central posts for observing the patients. The physicians could be documenting the patients in a room in the unit allocated for this purpose. This setting allows easier communication of nurses in case of unanticipated changes in a patient's condition, and the ability to quickly engage additional personnel when there is a need for additional assistance (17). A more recent perspective is to decentralize nursing care to facilitate close proximity of the nurse and patient (31). This decentralization has resulted in ICUs in a "race track" configuration with single rooms on the periphery of a common corridor or looking to a patio or inside garden, with workstations and viewing windows in between every two rooms, increased entry of natural lighting, and zones of space dedicated for personnel and family (17,31).

According to this concept there should be a desk with computer seats and monitors outside the rooms allowing visual access to the patients. Computers are certainly connected to the hospital and intensive care patient data

management systems (PDMS), and worldwide Internet. Between patient cares, the nurses can observe their patients outside the room. After examining the patients, the physicians go to the desk and conference the patient with nurses and other colleagues.

Key to the concept's success will be the selection of medical equipment. Simplicity, ease of use and minimal alarms should be all features high on the list. Remote control of the monitors from outside the patient's room also means fewer interactions. With a small nurse station outside each pair of rooms, the monitor at each desk will allow the staff to do exactly what is required: view, control, review and record, all from outside the patient's room. With these measures, the patients are not exposed to unnecessary noise and presence of personnel in the room. Furthermore, spreading the medical and nursing personnel evenly to the floor instead of gathering them to the central post and keeping the doors of the rooms mostly closed creates quiet and peaceful atmosphere. The chosen monitor should have the necessary functions to fulfill these requirements.

Ergonomics

Headwalls or ceiling service units can be used in designing the patient room. The ceiling service units have the advantage that the medical apparatuses, PDMS and the routinely used medical equipments are off the floor. Emergency access to the head of the bed is possible by positioning the ceiling service units. Furthermore, these units allow the flexible positioning of the patient's bed. The bed of the patient can be adjusted for complete sitting position and an awake patient can be positioned easily towards the gardens or the outside view without extensive re-positioning of the other equipments. The positioning of ceiling service units is crucial for their functioning. Mock-up patient room setting should be used to test optimal functioning (11).

Safety

Decentralization of nursing care to facilitate close proximity of the nurse and patient reduces contact among the caring personnel. Nurses should be facilitated with a bleeper or smart phone, which receives specified patient alarms created by mechanical ventilators, infusion or syringe pumps, monitors and other medical devices. The system can be used to call for help in emergency situations. Although the technology is available, a lot of work is needed to achieve a good functioning system. Further details of such devices are outside the scope of this article.

In a qualitative interview study, Gurses et al. (32), reported that he main types of performance obstacles for the nurses were delays in getting medications from pharmacy, inadequately stocked supplies area as well as patient rooms, and misplacement of supplies in the supplies area. To avoid this, supplies at least for the next 24 hours should be prepared and brought daily to the patient's room by the logistics department. A cupboard or mobile cart with drawers can be used for this purpose. Independent of being used or not, changing the drawers every day will shorten the procedure and assure that there are adequate supplies.

In a recent review article Hassan and colleagues (10) have stressed the high incidents of medication errors and adverse drug events. Automated dispensing devices and bar-code medication administration systems are several measures advised to prevent such incidents. Considering the complexity of ICU patients needs a satellite Pharmacy located in the ICU is preferable. The medications for the next 24 hours can be prepared and brought daily to the patient's room by the pharmacy personnel or logistics department after being checked by the pharmacists. The medicines should be prepared and delivered in a ready to use form.

Conclusion

An organization structured on the needs of the patient and the family is mandatory in designing a new intensive care. Concepts should be developed leading to the choice of architecture and the medical equipments. Because of this aspect the concepts developed will survive the test of time. Materials, apparatus and building will get old but the concepts such as daylight, quiet surrounding, privacy, ergonomics and safety will always be the future.

Key Points

- An organization structured on the needs of the patient and the family is mandatory in designing a new ICU.
- Patient-centered care, safety, functionality, innovation and future-proof concepts should be the main aims in the design of the new department.
- Key to the concept's success is prior testing using full-scale models.
- Healthcare equipment must be simple and easy to use, with minimal alarms

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None.

References and Recommended Reading

Papers of particular interest, published within the annual period of review, have been highlighted as:

* of special interest

** of outstanding interest

Additional references related to this topic can also be found in the Current World Literature section in this issue (p. 000).

Conflict of Interest

The authors reported no conflict of interest related to this article.

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