Impact of increasing bed-space area on invasive device-related infections seen in the intensive care unit

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Patients admitted to the intensive care unit (ICU) are those with severe underlying diseases, whose host defense mechanisms are impaired, and in whom invasive procedures are frequently performed. For that reason, infections in these units are 5-10 times greater than in other departments, and can have very severe consequences.[1] Most infections in the ICU develop in association with invasive devices employed, and are the leading cause of mortality in such patients.[1] In addition to host-associated factors, the physical conditions in the ICU and errors made in the provision of health services in these units, may also play a role in the development of these infections.[1] It was even mentioned that physical conditions must be shaped in accordance with the standards from the initial ICU planning stage.[2]

A number of important problems face ICU patients, particularly infections.[1] Unfortunately, many existing ICUs in Turkey lack the scientifically recommended standard physical conditions, and the requisite care and importance have clearly not been shown. Infection will be inevitable in an ICU, in which physical conditions are not up to standard norms, no matter what precautions may be taken in practice. The objective of this study was to investigate the effect of increasing bed-space area, one component of physical conditions, on the development of ICU infections.

This observational, retrospective study was performed, between November 2008 and May 2009 at the Karadeniz Technical University, Faculty of Medicine, Anesthesiology and Reanimation Intensive Care Unit (ARICU) in accordance to the principles of Helsinki Declaration. The hospital Ethical Committee approval was obtained before commencement of this study. The ARICU is an 8-bed tertiary unit, providing intensive care, with 15 nurses, and 8 health technicians assigned in this unit. Our ARICU, a tertiary unit, is the first ICU established in the hospital, and also a most important ICU for our region. Patients hospitalized in the unit are constantly monitored by day by specialists, and all efforts are made to provide a high-quality health service, with the support of adequate numbers of nurses and technicians. Most of our technicians graduated from high school, and they provide assistance to doctors and nurses. As required of tertiary ICUs, intensive care specialists are constantly on duty, and the unit applies all modes of long-term artificial respiration, and advanced monitoring. Services are provided for general surgery, orthopedic, and ear nose and throat patients with a multi-disciplinary approach. Problems involving specialist departments are resolved by the consultants concerned; management of the ARICU, general medical care, treatment, consultation requests and treatment planning are performed by an anesthesiology and reanimation specialist. Training is conducted with Infection Control Committee (ICC) for ICU personnel from time to time, but not such a regular training a part of a bundle. The unit had a total floor area of 272 m^2, 8 m^2 per patient. There was one antiseptic solution but no hand washbasin between every other bed. We use alcohol-based hand antiseptic in our unit. There were no cubicle and isolation room.

However, the fact that despite all these endeavors, infection rates are still higher than anticipated, was the main reason behind the planning of this study. Physical alterations were made in order to bring the floor space per patient in line with standards between February 2009 and May 2009, and the total floor area was raised to 540 m^2, or 15 m^2 per patient. No change was made in terms of other parameters that might affect infection rates, such as health personnel, sink numbers, duty distribution, and training. In order to evaluate the effect of floor space per patient on infection rates, invasive device-related infection (IDRI) rates were investigated in the previous 3 months before physical alterations were made (Period 1), and in the 3 months after the alterations (Period 2). The IDRI's were defined according to the diagnostic criteria of the Centers for Diseases Control and Prevention, and IDRI rates were calculated on the basis of National Nosocomial Infections Surveillance System recommendations, using the formula: (number of invasive device-related infections/device days)x1000.[3]

Descriptive statistical analysis was performed for all studied variables by Statistical Package for Social Sciences version 13 (SPSS Inc, Chicago, IL, USA). Data in conformity with normal distribution were analyzed using Student's t-test, and those not conforming to normal distribution using the Mann-Whitney-U test. Data obtained by measurements are expressed as mean±standard deviation. The chi square test was used to compare IDRIs rates in both periods, with significance set at $p<0.05$.

In our study, most of the demographic characteristics and underlying conditions were similar between the patients both in 2 period (**Table 1**). There were also no significant differences between the 2 periods in terms of

Table 1 - Demographic characteristics and underlying conditions of the ARICU patients.

Variables	Period 1 (n=63)		Period 2 (n=88)		*P*-value
Age, mean ± SD	47.8 ± 26.4		46.3 ± 31.6		0.706
Gender	n (%)				0.584
Male	40	(63.5)	52	(59.0)	
Female	23	(36.5)	36	(41.0)	
Hospitalization day, mean ± SD	14.2 ± 10.8		16.7 ± 12.4		0.872
Underlying disease	n (%)				
Respiratory failure	20	(32.0)	27	(31.0)	0.889
Renal failure	3	(12.5)	2	(7.0)	0.399
Abdominal surgery	6	(25.0)	4	(13.0)	0.225
Trauma	34	(54.0)	55	(62.5)	0.293
APACHE II score, mean ± SD	12.5 ± 6.6		16.3 ± 5.7		<0.0001

ARICU - Anesthesiology and Reanimation Intensive Care Unit; SD - standard deviation

healthcare personnel education. The IDRIs developed in 29 (46%) of the 63 patients monitored in Period 1. Of these, 18 (62%) were ventilatory associated pneumonia (VAP), 7 (24%) central venous catheter-related blood stream infection (CVC-BSI), and 4 (13.7%) catheter-related urinary tract infection (CR-UTI). The IDRI was identified in 18 (20.4%) of the 88 patients monitored in Period 2, 7 (39%) VAP, 8 (44%) CVC-BSI, and 3 (17%) CR-UTI. Invasive device use ratios in Periods 1 were: 0.55 for mechanical ventilator (MV); 0.53 for central venous catheter (CVC); and 0.84 for urinary catheter (U); and for Period 2 were: 0.59 for MV; 0.66 for CVC; and 1.00 for UC.

Infection agents may exhibit transmission horizontally, between intensive care patients via health personnel, or as the result of direct contact.[4] For that reason, compliance with hand hygiene is one of the simplest, and also the most important approach for reducing the risk of cross-transmission.[4] The World Health Organization recommends that hospitals have policies in place for monitoring, and encouraging hand hygiene practice in health care workers (HCWs), however, only 30-40% of HCWs adhere to this measure.[4]

A number of professional and scientific bodies in the UK and USA have published guidelines on the design and layout of ICUs.[2,5] Maintaining distances between patients' beds in accordance with specific standards is the one of the most important physical precaution to be taken to control these infections. However, there is an increasing requirement for ICUs in Turkey, and standards can be breached in these units in order to respond to greater numbers of patients. The idea that physical conditions in particular, should be brought up to standard in order to reduce infections to a minimum level represented the basis of the current study.

The VAP is the most popular reason of IDRIs and mortality, which was seen in ICU patients, and there are too many risk factors for developing VAP, and that is, patient-, treatment-, intervention-, and infection control- related.[6] The VAP ratios, which were seen in our ARICU are too high so are the other IDRIs, and unfortunately most of the causative risk factors are infection control-related, which could be preventable. It was found in the current study that, although the patients had higher Acute Physiology and Chronic Health Evaluation (APACHE II) scores, the IDRIs rates were seen much lower in Period 2. We interpreted this result as a positive impact of increasing bed-space area on IDRIs as seen in the ARICU. This could be able to hamper the transition of microorganism from patient to patient via healthcare personnel.

The study is limited by its retrospective nature and relatively small number of patients in one unit. Future research should focus on novel innovative methods, to increase compliance with infection control measure in the ICUs.

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