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# Compliance With Infection Control Guidelines in the Operating Rooms

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Infection control, Operating rooms, Safety, Standards

## ABSTRACT

**Introduction:** Compliance with the safety standards in the operating rooms, as one of the most complex work environments in the health care systems, is very important. One of the safety measures is the infection control standard.

**Objective:** This study aimed to investigate compliance with infection control standards in the operating rooms of teaching hospitals in Rasht City, Iran.

**Materials and Methods:** This research was an analytical cross-sectional study. A researcher-made checklist was used to examine physical structure, equipment and facilities, and the personnel performance of 11 operating rooms in six teaching hospitals affiliated to the Guilan University of Medical Sciences in Rasht City with respect to infection control standards. The obtained data were analyzed using descriptive statistics and Fisher test.

**Results:** The rate of compliance with infection control standards associated with the physical structure of the operating room was 72.7% and for equipment and facilities as well as personnel performance was 59.1%. There was no statistically significant relationship between compliance with infection control standards in the area of personnel performance, work shift, or the number of elective and emergency operations.

**Conclusion:** The compliance of physical structure, equipment and facilities, and the personnel performance of the operating rooms with infection control standards were at moderate level. Thus, the operating rooms in our hospitals may need monitoring and examination.

## Introduction

Safety refers to escape from conditions that can cause death, physical harm, occupational diseases, and damage to the environment and equipment [1]. On the other hand, due to special circumstances, if hospitals fail to comply with the safety principles, the occurrence of incidents such as fire, elec-

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tric shock and exposure to the unauthorized amounts of risk factors in the work place will be inevitable [2]. It is imperative to provide services in operating rooms, in accordance with existing safety standards, because this unit is a very technical environment associated with environmental and biological contaminants. Having well-established principles of protection and safety and identifying work-related hazards and how to protect staff are of most importance. In this hospital unit, the protection consists of the safety of patients and the operating room staff. The safety and the extent to which a place is safe is not absolute, but even high-risk activities become safer with the use of safety methods [3, 4].

One of the main standards in the operating rooms that can affect the level of safety is infection control which has a global and regional priority concept. Statistics show that, 5% to 10% of hospitalized patients in developed countries and 25% in developing countries, suffer from hospital-acquired infections. Each body organ can be infected in the hospital, but surgical wound infection (24%), urinary tract infection (42%) and lower respiratory tract infection (15%–20%) are very essential. Unfortunately, there is neither a proven history of controlling nosocomial infections nor a statistical evidence in Iran. As a result, control of hospital infections are far from ideal, in Iran. According to unofficial statistics, 12 million dollars are spent on hospital infections, in Iran, per year [5].

Considering the role of hospital infections in increasing the hospitalization, probability of death, hospital costs, and health hazards in the community [6, 7] on one hand and common conditions in the operating rooms including high workload, high number of staff, high commuting, patient deterioration, and presence of blood and infectious secretions on the other hand, the priorities would be achieving the most effective, least expensive and most desirable methods for its prevention of nosocomial infection [8]. Accordingly, the operating rooms should be designed and constructed to prevent surgical site infection and its spread from the operating room to the other wards of the hospital [9]. In this respect, the operating rooms should have three sterilized, clean and protected zones [6]. Other techniques include equipping the operating rooms with a ventilated system (providing filtered air 20-25 times per hour), enabling vertical airflow to the room, providing facilities affecting the growth of microorganisms on the surfaces and equipment of the room, observing the full cycle of sterilization, and avoiding irrational use of antibiotics for controlling the resistance of existing microorganisms [10, 11].

Another effective factor in preventing the spread of hospital infection is the awareness of the operating room personnel about the prevention of infection [12]. In this regard, hand hygiene is still one of the most important, most effective and cheapest ways to prevent infection [9]. Although the effect of hand hygiene on infection control is still highlighted, the results of a study show that hand washing is moderately practiced. The majority (67.9%) of operating room staff wear gloves during patient care, but only 4.4% before and 12.5% after taking care of the patient wash their hands with soap and water [13]. Other procedures such as the use of aseptic technique during work, and wearing gloves during surgery can be involved in preventing infection in operating rooms [9].

It seems that the transmission of infection and disease in healthcare centers is still a major concern for personnel and patients. Therefore, in order to prevent the transmission of biologic risks, both personnel and patients should take actions to prevent infections in operating rooms that requires the implementation of infection control measures based on scientific principles [4]. In light of these issues which all emphasize on compliance with the safety standards for infection control in operating rooms, the status of the operating rooms regarding the observance of these standards should be examined and monitored. In this regard, this study aimed to investigate the rate of compliance with infection control standards in the operating rooms of hospitals affiliated to the Guilan University of Medical Sciences in Rasht City, Iran.

## Materials and Methods

This was an analytical cross-sectional study. Study population consisted of six teaching hospitals affiliated to the Guilan University of Medical Sciences (GUMS) in Rasht, Iran. Samples were 11 operating rooms (general, neurological, orthopedic, reconstructive, burn, thoracic, urology, ophthalmology, ear, nose, and throat, cardiothoracic, and gynecological surgery). They were examined and observed in terms of physical conditions, equipment and personnel performance with respect to infection control.

Data collecting tool was a researcher-made checklist consisting of 132 items: 19 items related to physical structure; 27 related to equipment and facilities; 82 related to personnel performance; and 4 related to the characteristics of the research environment (the type of work shift and number of operations) and infection control standards. It was based on a simplified scoring

system (Yes/No). According to a similar study [14], a total score of 0%–50% was interpreted as a "poor" level of compliance; 50%–75% as "moderate"; and 75%–100% as "favorable." To determine the validity of the instrument, content validity method was used and the tool was then sent to ten faculty members of GUMS. Content Validity Ratio (CVR) and Content Validity Index (CVI) were determined based on the Lawshe Table. Based on the coefficients obtained for each item, none was deleted and the validity of the tool was approved. Test-retest method was used to determine the reliability of the instrument. The kappa coefficient of 0.84 confirmed its inter-rater reliability.

The observation was performed by two different observers twice at the intervals of one week for each operating room in the morning and afternoon shifts (all operating rooms were active in these shifts). The inter-rater reliability was confirmed by Kappa coefficient (0.94). The study data were collected through interviews with the authorities and the staff of the operating rooms, and reviewing relevant documentation such as education and the health records of staff in 2015. For analyzing data, descriptive statistics and Fisher exact test were used that were calculated in SPSS (V. 16).

## Results

Table 1 presents the statistics related to physical structure, equipment and facilities, and personnel performance. According to the results, Ear, Nose, and Throat (ENT) and ophthalmology surgery rooms had the highest rate (83.3%) of compliance with infection control standards related to physical structure, while gynecology operating rooms showed the lowest rate (27.78%) of compliance. With regard to the equipment and facilities associated with infection control standards, neurological surgery room (81.48%), burn surgery on the morning (81.48%) and afternoon shifts (77.78%), reconstructive surgery (77.8%), and cardiothoracic surgery (77.78%) showed the highest rate of compliance. In terms of personnel performance, the operating rooms of neurological surgery (75.61% at both morning and afternoon shifts), and cardiothoracic surgery in the morning (87.8%) and afternoon shifts (89.02%) had the highest rate of compliance with infection control standards.

Based on the data collected via the designed checklist about the physical structure of the operating rooms, the room had three sterilized, clean and protected zones, and the place for storing sterilized appliances was in the restricted area. There was no sewer beneath the floor in any operating room. In 90.9% of the operating rooms, there was a room for washing hands and packing the appliances with proper conditions. In all operating rooms, the exterior side of the windows could not be opened. Only 27.3% of the rooms had a roof with flat surface and without corners. The patient admission pathway in 81.8% of the operating rooms was shared by the entry and exit pathways for personnel. In 72.7% of the operating rooms, there was no place to store dirty cloths and in 54.5% of the rooms there was a ventilation system which was not standard in 90.9% of the cases (15 air changes per hour with at least 3 fresh air) [8].

**Table 1.** Disturbance of infection control in operation rooms

| Infection Control Domains | | N (%) | | | Sig.* |
|---|---|---|---|---|---|
| | | Morning Shift | Afternoon Shift | Total | |
| Physical structure | Poor | 1(9.1) | 0(0) | 2(9.1) | 0.1 |
| | Moderate | 8(72.7) | 0(0) | 16(72.7) | |
| | Favorable | 2(18.2) | 0(0) | 4(18.2) | |
| Equipment and facilities | Poor | 0(0) | 0(0) | 0(0) | 0.66 |
| | Moderate | 7(63.6) | 6(54.5) | 13(59.1) | |
| | Favorable | 4(36.4) | 5(45.5) | 9(40.9) | |
| Personnel performance | Poor | 0(0) | 1(9.1) | 1(4.5) | 0.18 |
| | Moderate | 5(45.5) | 8(72.7) | 13(59.1) | |
| | Favorable | 6(54.5) | 2(18.2) | 8(36.4) | |

*Fisher test

Regarding the equipment and facilities for infection control, there were enough sets and packs according to the number of patients and only sterile and clean instruments were used in surgery, in all operating rooms, the location of clean and dirty shoe had been separated and there was no potted or artificial flowers in the rooms. About 81.8% of the operating rooms had an air disinfection system and there was enough detergent and disinfectant in 81.8% of the operating rooms. Also there were enough protective equipment such as glasses, aprons and gloves in 90.9% of the rooms, but there was no high-performance mask in 72.7% of them. About 54.5% of the used surgical gowns were fabric and not resistant to the penetration of blood, also 45.5% of the operating rooms had washer disinfectors and there were ovens in 63.6% of the rooms. The air handling unit was separated from other hospital units only in 36.4% of the study rooms; suction dishes were disposable in 27.4% of the rooms, and they were washed out after each use in other operating rooms. Finally, anesthetic devices such as breathing circuits and masks were disposable in 81.8% of the rooms.

The data regarding personnel performance showed that, in all study operating rooms, the chairs and stretchers outside of the room were not allowed to enter the clean zone. The shoes were replaced with clean ones when entering the operating room. Also a weekly cleaning of the operating room was performed. All staff were trained on infection control, environmental health and occupational health. The equipment of the operating room were cultivated every 6 months. The suction machine, if not used, was kept clean, dry, without solution, and unattached to the catheter. No waste was accumulated in the operating room and was sent out of the room. The used masks were made from disposable papers.

The operating room personal were vaccinated with 3 doses of hepatitis B vaccine and hepatitis antibody titration was examined for all personnel in the operating room. The sets were packaged with two separate two-layer drapes. The expiry date of the threads and other appliances in the operating room were checked weekly, and the expiry date of the sterile equipment was examined every 14 days. Sharp tools, blades and needles were collected in a safety box and was replaced with a new one after the box was filled. The working hours of personnel exceeded 12 hours a day in 45.5% of the rooms. The personnel put their masks covering the mouth and nose completely in 63.6% of the rooms in the morning shifts and 36.4% in the afternoon shifts. In 90.9% of the operating rooms, staff did not wear ornaments in the morning shift, while in the afternoon shift they observed this rule only in 18.2% of rooms. Only in 45.5% of the rooms, the personnel covered their hair completely. Daily laundry was done in 27.3% of the rooms in the morning shift, while it was done in 9.1% of the rooms in the afternoon shifts.

Correct principles of hand scrub were performed in only 36.3% of the rooms. Waste containers were washed daily in 9.1% of the rooms. Linoleums and bedspreads for each patient were changed in 63.6% of the

**Table 2.** Disturbance in the operation rooms performance infection control

| Operation | Personnel Performance | N (%) | | | Sig.* |
|---|---|---|---|---|---|
| | | Poor and Moderate | Favorable | Total | |
| Elective | <10 | 8(53.3) | 7(46.7) | 15(100) | 0.193 |
| | >10 | 6(85.7) | 1(14.3) | 7(100) | |
| | Total | 14(63.6) | 8(36.4) | 22(100) | |
| Emergency | Without | 8(66.7) | 4(33.3) | 10(100) | 0.1 |
| | With | 6(60.0) | 4(40.0) | 22(100) | |
| | Total | 14(63.6) | 8(36.4) | 14(100) | |
| Elective and emergency | <10 | 7(50) | 7(50) | 14(100) | 0.167 |
| | >10 | 7(87.5) | 1(12.5) | 8(100) | |
| | Total | 14(63.6) | 8(36.4) | 22(100) | |

*Fisher test

rooms. The suction machine was drained and washed after each operation in 81.8% of the operating rooms, in the morning shifts, while it was done in 45.5% of the rooms in the afternoon shifts. Cleaning tools inside and outside the operating rooms were marked only in 36.4% of the rooms. The disinfection of non-disposable anesthesia tools was performed in all operating rooms in the morning shifts, and in 63.6% of the rooms in the afternoon shifts. The personnel of surgery and anesthesiology group used protective tools in 36.4% of the central strile room while used them in 54.5% of the rooms.

Only in 18.2% of the rooms patients were shaved by machine, and only in 27.3% of the rooms patients were showered one day before the surgery. The patients' status for hepatitis and AIDS were examined in 36.4% of the rooms in the morning shifts and in 27.3% in the afternoon shifts. About 81.8% of the operating rooms were disinfected after each contaminated surgery in the morning shifts and 36.6% of them in the afternoon shifts by the personnel. The contaminated surgeries were not performed in separate rooms in 72.7% of the operating rooms. In 90.9% of the operating rooms, personnel did not bath after infectious surgeries, and they did not change their slippers, gowns and gloves when leaving the room in 63.6% of the cases. The door of the operating room was closed in 54.5% of the rooms, while the door of the sterile room was closed in 36.4% of the rooms. Insects such as mosquitoes, flies and bees were observed in 27.3% of the rooms, the contents of the suction machine before drainage were disinfected in all operating rooms, all personnel's shoes were washable, and they were washed at the end of each working day, and cloths and appliances were disinfected according to the type of microbial contamination.

Table 2 presents the results of Fisher test indicating no statistically significant relationship between the performance of operating room personnel with respect to infection control and the number of operations (elective and emergency).

## Discussion

The present study indicates the moderate level of physical structure, equipment and facilities, and the personnel performance of the operating rooms on the morning and afternoon shifts. Thus many standards are not respected in the study areas. For example, the patient admission pathway was shared by the entry/exit route of the personnel which contradicts the safety standards associated with infection control. This finding is consistent with the findings of Alaedini study [12]. The operating rooms should be designed to prevent the spread of infection into the surgical site and to prevent the infection from spreading to the other parts of the hospital [15].

There was no place to store dirty cloths, and they were kept in the corner of the operating rooms. This indicates the old structure of the operating rooms that had no standard design for the required spaces in the operating room. However, the structural principles had not been respected in the recently renovated rooms, either. This may be due to the lack of designing based on the opinions of experts such as operating room officials and academic architects with experience in designing hospital environments. Ventilation systems did not have desirable quality and function, in the operating rooms. Evidently, due to authorities' inattention to ventilation systems, no action had been taken to establish an efficient ventilation system, and in some cases, head nurse correspondence in this regard was overlooked due to the high cost for hospitals.

Our study findings with regard to equipment and facilities for infection control indicate that there was enough protective equipment such as glasses, aprons and gloves, but in spite of carrying out many surgeries and exposure to high blood and body fluids, the used gowns were not resistant to blood penetration. According to Sadati [8], the gowns used during surgery should act as a physical barrier, preventing the transmission of microorganisms from the personnel to the sterile field and the patient, as well as the transmission of the blood and body particles of patients to the clothes and skin of personnel. In this regard, the use of disposable and impermeable gowns provides better safety.

According to the findings, almost none of the operating rooms had a separate air handling unit. The operating room air handling unit should be completely independent of other parts of the hospital and should be visited periodically [6, 15]. There were washer disinfectors and ovens only in half of the operating rooms. The washer disinfector with automatic washing and disinfecting tools and reducing the contact of personnel with tools can play an important role in infection control [16]. It seems that many of the operating room officials do not have enough awareness, and knowledge in this area otherwise, steps should be taken to install or use them in the operating rooms. These findings emphasize the importance of conducting retraining classes for the managers of health centers.

The results showed that suction containers were washed in many study rooms after each use. The use of disposable products is as an effective way to control infection and reduces the risk of contamination when they are not used more than once and not rinsed again [8]. Results also show that personnel performance in relation to compliance with infection control standards was at moderate level which is in agreement with the results of Rostaminejad et al. [17] and Musavi studies [18] but inconsistent with the findings of Majidi et al. [19] study. This inconsistency, given that both studies had been carried out in the same setting, can be related to the differences in the contents of the used checklists and more detailed examination, performed in this study.

Although there was no statistically significant relationship between personnel performance with regard to infection control on the morning and afternoon shifts, the better performance on the morning shifts indicates that the more supervision in the morning by the head nurses and supervisors, affects personnel performance. The working hours of the personnel exceeded 12 hours a day, in half of the operating rooms. This increase in working hours can affect the performance of the personnel due to tiredness. Failure to perform infection control principles in the operating room can be related to the lack of the personnel knowledge or the lack of positive attitudes towards compliance with infection control standards and or to the lack of monitoring systems.

Considering the importance of controlling the infection, it is suggested that the improvement of these conditions be considered as the priorities of the hospitals. Attention should be paid to old physical spaces and inappropriate structural conditions in some operating rooms, which indicate the need for their renewal. Also, equipping the operating rooms with a standard ventilation system, applying suitable and durable disinfectants and conducting periodic inspections can be helpful. Holding regular training and retraining courses is also important. Although these measures cannot reduce the level of non-compliance with infection control standards to zero, they can minimize the cost of treatment, hospitalization and, most importantly, morbidity and mortality [20].

Since the compliance with infection control standards in the operating rooms is essential, it is recommended that, through carrying out in-service programs for personnel, providing sufficient staff for operating rooms, selecting well-trained young service staff for operating rooms, and emphasizing the importance of controlling and monitoring, more accurate and effective monitoring of compliance with infection control principles in the operating rooms be performed in periodic inspections.

## Ethical Considerations

### Compliance with ethical guidelines

This research was registered with the code of ethics as IRGUMS.REC.1394.21.

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### Conflict of interest

The authors certify that they have no affiliation with or involvement in any organization or entity with any financial interest, or non- financial interest in the subject matter or materials dismissed in this manuscript.

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