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Occupational Health and Safety in Operating Rooms

Hülya Gül

Abstract

Nurses are one of the most endeavored members of healthcare services. Operating rooms, on the other hand, require special caution and contain various hazards for healthcare professionals. Operating rooms contain various risk factors related to applications, infrastructure and humans. It is one of the areas that need nursing care the most since patients are dependent on their nurses to meet their personal needs. Nurses are exposed to various risk and health problems in operating rooms. Healthcare service provided by nurses working in a healthy environment directly affects the health and quality of life of those who receive the service. In order to prevent these problems, intensive up-to-date educations on occupational risks and employee safety should be provided for the nurses working in operating rooms. In addition to the general occupational hygiene measures, different precautions should be taken for the operating rooms. Working in a healthy and safe environment is a human right that every individual must have. Managers of the medical institutions should be attentive to follow the laws and sanctions on occupational health and safety, institutions should be inspected frequently and monitored carefully. In this section, this subject will be studied in line with actual data and resources.

Keywords: Nurses, hospitals, operating room, occupational health, occupational safety

1. Introduction

It is a legal requirement that employers must provide a safe and healthy working environment their employees. In terms of public health, it is important to control occupational and environmental factors in all workplaces [1]. Health sector is one of the dangerous lines of work in which occupational health and safety (OHS) are becoming increasingly important. Healthcare professionals are faced with many occupational risks while performing their duties. There are also many risk factors for those who work in operating rooms. These include inconvenient physical environment, heavy physical work, working in shifts and working in non-ergonomic positions [2–5]. Employee health is also threatened by stress, mobbing, violence, malnutrition etc. For example, being in close contact with the patient in the operating room increases the risk of infection. Nurses who are likely to come into contact with blood and bodily fluids of the patients during their daily activities at the hospital are in the high risk group for blood-borne diseases. Thus, researches indicate that nurses are mostly faced with biological and psychological risk factors [6].

Operating room employees may experience occupational accidents due to sharp object injuries, contamination with blood and bodily fluids, heavy lifting, falling, hitting, tripping, slipping, being injured etc. [7, 8]. Moreover, traffic accidents during commute and all kinds of accidents that happen at work such as musculoskeletal system wounds, violence, allergic reactions, burnt, poisoning, fire, explosion and electric shock can also be listed among these [9].

However, the duties of healthcare professionals are mostly considered as providing service to patients who need health care. Therefore, it is mostly neglected that healthcare professionals can have occupational problems. In this respect, institutions that provide healthcare service are generally organized to achieve patient care, treatment and satisfaction instead of prioritizing the health and safety needs of healthcare personnel. Work environment, occupational health and safety of the healthcare professionals, who provide service for patients, are mostly overlooked.

The risks of the operating rooms may cause a decrease in productivity, economic loss of the institution, increase in occupational accidents, and putting the people who receive care from healthcare professionals directly at risk. Therefore, hospitals need to be suitable for health and safety measures, environmental precautions should be taken, risk factors should be eliminated or controlled and personal protective equipment should be paid attention to by performing risk assessment and management.

2. Occupational and environmental risk factors

2.1 Physical risk factors

Physical factors take an important place in healthcare institutions. Primary physical factors affecting work in operating rooms can be listed as temperature, noise, lighting, humidity, air-conditioning, air pollutants, ionizing radiation, non-ergonomic work conditions etc. [10].

Work environment should be adequately lighted in order for the healthcare personnel to do their jobs properly and comfortably. Especially in working areas critical for human health such as operating rooms, inadequate lighting negatively affects the personnel's vision and excessive lighting can cause personnel to get exhausted. Researches show that light and electromagnetic fields affect the function of pineal gland. In the long term, this may lead to problems in reproductive functions, depression and especially breast cancer in women. Exposure to light at night or electromagnetic fields decreases the melatonin production of pineal gland which increases the production of estrogen from the ovaries and may cause malignant transformation in breast epithelial cells. Therefore, lighting in healthcare institutions is important especially for those who work in shifts, have night shifts and work at intensive care units.

Operating rooms are desired to be quiet environments. Sound level should not exceed 35–40 decibels in the units where patients are lying. However, it can be noisy during patient visit hours, crowded polyclinic hours and some operations. It is observed that sound level in the operating rooms reaches maximum especially during the preparation to the operation and using the surgical tools during the operation [11]. A study by Juang et al. states that physiological states of the nurses working at intensive care units for over five years are severely affected [12]. It is also stated that these nurses, especially the ones working in different shifts, are extremely sensitive to noise and cannot tolerate it. Varicose vein, the main risk factor of which is to stand still, is seen very often especially in nurses working in operating rooms.

Sharp object injuries, which are generally preventable risk factors for nurses, are mainly caused by tools that disrupt skin integrity. Inadequate number of nurses in operating rooms, shifts, high work circulation, and long working hours also increase the risk of sharp object injuries. Because more risky surgical tools are used in these units besides the tools used by other healthcare personnel. Operating rooms have a risk of fire due to factors such as use of lasers and oxygen. Heating flammable preparation materials pose a serious risk for fire. These agents can easily catch fire with increased temperature. If a flammable preparation material is being used, additional precautions should be taken to avoid surgical fires and burns in patients. Operating room staff should have sufficient knowledge on laser and oxygen use, factors causing fire and how to use fire extinguishers.

Surgical site infections are one of the most difficult postoperative complications which threaten millions of lives every year. Current evidence presents a positive relationship between the infection rate and the concentration of the bacteria-carrying particles in air [13]. Ventilation of the operating room is important to decrease the concentration of bacterial pollutants in air and control the risk of infection. Advanced air conditioning systems are needed to minimize the risk of infection and keep the concentration of microorganisms at the minimum values specified by standards. To that end, ventilation systems of operating rooms should be designed and organized in a way to prevent occupational and healthcare institution originated infections by considering the biological and physical characteristics of the microorganisms.

Air conditioning installation should be performed in frequent intervals determined by laws and elaborately controlled in order to minimize the microorganisms, dust, narcotic gases and bad odors in the hospital, as well as providing comfort conditions in the operating rooms. Inadequate or improper ventilation may cause health problems and employees to breathe more air pollutants.

2.2 Chemical risk factors

Various chemical substances are used in operating rooms to provide healthcare service. These substances are especially used to take hygienic precautions as well as diagnosis and treatment. Healthcare professionals can get exposed to the chemical substances in various ways such as respiratory system, gastrointestinal tract, absorption (skin, eyes) and pinpricks. These chemical substances have acute or chronic effects on healthcare personnel [14, 15]. Effects of chemical substances on healthcare personnel may vary according to duration of contact, way of contact, physical and chemical characteristics of the substance. The effectiveness of the substance can especially vary by the presence of different chemical substances in the work environment, genetic and personal characteristics of the employee and addictions such as alcohol and smoking.

Disinfectants, anesthetic agents, cytotoxic agents, drugs, some heavy metals such as mercury and latex are primary chemicals used in operating rooms [16]. Glutaraldehyde, formaldehyde, ethylene oxide are commonly used in operating rooms for chemical sterilization. Some of them, for example alcohol, have a relatively low toxicity. On the other hand, glutaraldehyde and formaldehyde are extremely irritant for skin, eyes and airways even at very low concentrations and their increased concentrations may result in increased heart rate and pulmonary edema. Formaldehyde belongs to “Group-1 Carcinogenic to humans”, which includes factors proven to cause cancer by International Agency for Research on Cancer [17]. Ethylene oxide, used for the sterilization of heat sensitive materials, shows mutagenic and carcinogenic characteristics as well as toxic and explosive effects. Ethylene oxide is a combustible gas which explodes when it reaches 3% concentration.

Its acute effects are respiratory problems and neurological symptoms. High level of exposure causes cataract. Moreover, the need for a relatively long time for sterilization causes the risk factors to extend over time. Nurses can be exposed to risk while they break the ampoule containing the medicine, dilute the medicine in powder form, spilling the medicine by accident etc. Allergic reactions in nurses working in operating rooms mostly develop as latex allergy due to frequent use of gloves. Latex gloves are flexible, easy to wear and used for every process in the operating room. Latex can cause allergic reactions ranging from mild contact dermatitis to urticaria, conjunctivitis, bronchospasm and anaphylactic shock.

Anesthetic gases take an important place in chemical risks that healthcare professionals are exposed to [18]. Operating room is constantly contaminated by the leakage from the valves of anesthetic devices and even by the anesthetic gases of the expiratory air of the patients. Healthcare professionals are chronically exposed to these gases in operating rooms. Anesthetic gases are highly volatile compounds and especially small indoor places such as operating rooms can get highly contaminated with these gases in a short amount of time. Anesthetic gases can affect employees in the operating room and recovery room [19]. Anesthetic gases spread in a way that harms the environment by leakage from the anesthetic devices, accidental spilling and spreading of the gas, using an unsuitable mask on the patient, poorly inflating the intubation tube and the gas spread by the expiration of the patient. Epidemiological studies show that chronic exposure to anesthetic gases is an occupational risk which has consequences like spontaneous abortion, congenital malformations, premature birth, cancer, liver and kidney diseases, regression in mental functions, headache, fatigue and irritability [20]. Therefore, nurses working in operating rooms, surgical doctors and other personnel working in operating rooms are at high risk of anesthetic gases (nitrous oxide, halothane, isoflurane etc.)

On the other hand, healthcare personnel may be exposed to chemical substances in the hazardous medicine during the preparation, transfer, application, storage and disposal of the medicine. Cytotoxic drugs have the potential to cause serious health problems for people and personnel who come into contact with them. The risks include cancer, malformed, abnormal birth, recurring toxic effects, organ or tissue damage, chromosomal abnormalities. More women are employed in healthcare sector compared to other sectors and majority of the chemically risky actions are performed by nurses, the majority of whom are women. Therefore, another dimension of the danger of the chemical substances is that most of these substances have genotoxic effects (mutagenic, carcinogenic and/or teratogenic) and they may cause spontaneous abortions, low birth weight, babies with anomalies by affecting the reproductive health of the women working in operating rooms.

2.3 Biological risk factors

Healthcare employees are at risk of various infectious diseases at the daily work environment. Thousands of healthcare employees are caught in numerous serious infections such as Hepatitis B, Hepatitis C and AIDS. Respiratory transmitted diseases, which are among the occupational risks for employees in healthcare sector, are huge reasons of loss of work and power. There are two main ways for respiratory transmission which are droplet contact and airborne transmission. Droplet contact refers to contact of the droplets carrying microorganisms from an infected person to conjunctiva, nasal or oral mucosa (by coughing, sneezing, speaking, bronchoscopy or aspiration). Airborne transmission refers to the spread of the droplets carrying microorganisms through air by suspending in air for a long time or contacting dust particles.

A newly identified coronavirus, SARS-CoV-2, has caused a worldwide pandemic. Coronavirus was first identified in December 2019 in China. In February 2020, the World Health Organization (WHO) named it COVID-19. Covid-19 with high transmission level, it has become a serious public health issue. COVID-19 easily is transmitted by respiratory system which causes numerous deaths and it is a serious threat for healthcare professionals. Nurses should act carefully to protect both themselves and the patients from contamination in operating rooms. Personal Protective Equipment (PPE) should be used in accordance with the rules. Surgical nurses should carry out this challenging process with a multidisciplinary approach in issues such as restructuring in operating rooms and reviewing in-hospital triage [21–24]. Surgical smoke may be effective in the spread of coronavirus [25]. Surgical smoke is a potential risk factor for patients, personnel and environment. Mutagen gases, carcinogens, particles containing DNA components or HPV (Human Papilloma Virus) may spread in air via smoke when lasers or electrocauteries are used [26, 27].

Nosocomial infection occurs when pathogens are transmitted by nurses and healthcare personnel who came into contact with intubated patients in intensive care units and patients with intravascular catheters. Nosocomial infections emerge as direct or indirect microbial spread (cross infection) or spread from one's own infected tissue to another tissue (self-infection). Studies show that nosocomial infections are mostly caused by microorganisms in the environment outside of patient and healthcare employees are the primary source of infections. Both the bacteria found in these individuals and the ones that are transmitted to other patients are important sources of nosocomial infections.

Studies on infection prevalence and risk analysis are increasing and new information is obtained day by day. Another of these infections is blood-borne infections [28–30]. Blood-borne infections are of particular importance because of their frequency and long term negative effects. Serious precautions should be taken to protect healthcare professionals from blood-borne infections. Personnel at risk should be included in vaccination program. Hygiene is very important. The labels of bags and containers used to transport waste with risk of contamination should be colored in red and clearly indicate danger. Sharp and penetrating tools should be carried in labeled, special containers in conformity with the standard. There should be no risk of contamination or leakage in these containers. Contaminated laundry should be carried in special, marked bags which should be labeled as dangerous. The use of gloves is very important. Biological risk factors can be controlled as well as employee safety if risk factors are known by all employees and necessary precautions are taken.

2.4 Psychological risk factors

Nurses have a very active role in every field of healthcare service present in operating rooms. Nurses are under more pressure and experience more psychological reactions due to the occupational differences in working conditions [31–34]. Therefore, more satisfied, happier and more productive nurses are important to increase the quality of the service provided. However, job satisfaction of nurses can be negatively affected by hopeless thoughts on the future of occupation, the fact that nursing is considered as an auxiliary occupation and difficult work conditions, which is the foremost problem in nursing. Nurses need to work in shifts since healthcare institutions provide service for 24 hours. This may have negative effects on the biological, psychological and social lives of nurses. Working in shifts disrupts body's normal biological rhythm and may cause chronic fatigue and disruption in person's family and social lives. The fact that nurses have to work at nights and on

the weekends besides the traditional working hours is a cause of stress on its own. Nurses may have problems in communication due to the way they work. Moreover, reversed biological clock may cause chronic fatigue, tiredness and depression. Overtime work causes a decrease in attention level in operating rooms where attention is very important and this causes an increase in the possibility of making mistakes and decrease in the quality of work. Therefore, operating room nurses experience stress and homeostatic deterioration comes with sleep disorders and have significant effects on the quantity of life and performance of people.

Surgical teams in the operating rooms generally differ by the type of operation. However, anesthetic team generally remains constant and works longer times in shifts. Thus, health problems are more common in this group.

Workplace violence is the most common situation that healthcare professionals encounter. Violence against doctors and healthcare personnel have been rapidly increasing in recent years. Healthcare employees are a specific group in terms of facing stress and exposure to violence is quite high in this group. There many different factors of violence such as patients, relatives, coworkers in healthcare institutions. Hospitals are becoming more dangerous for healthcare personnel day by day [35]. In that case doctors and healthcare personnel do not feel safe themselves in their workplaces. In a Turkish study by Ayranci et al., on healthcare professionals, it was identified that 50.8% of the healthcare professionals were subjected to one or more type of violence while they were working, practitioners were subjected to violence the most (67.6%) and 58.4% of the nurses were subjected to violence [36]. A research in Turkey by Gokce and Dundar on doctors and nurses stated that 71.4% of the doctors and 90% of the nurses were subjected to violence [37].

2.5 Ergonomic risk factors

Healthcare professionals try to do their best in their jobs, just like the employees in other sectors. In order for healthcare personnel to efficiently perform what is expected from them, work environment should be designed in a way that allows moving comfortably. Ergonomics refers to designing and organizing the workplace and equipment in the most physically suitable way for the users. No matter how perfect they are technically, if the tools and equipment, tables, chairs and methods used by healthcare personnel are not suitable for themselves, a high performance should not be expected. In other words, if they are designed without considering the characteristics, abilities and disabilities of the people, employees cannot perform with high performance. Ergonomic stress factors are very common in operating rooms. Especially the nurses who provide service to the complete dependent patients help them with all activities such as getting dressed, eating, going to bathroom etc. This may cause musculoskeletal injuries, especially due to overload, in healthcare personnel. Researches on nurses identified that bad back problems are more common in nurses compared to the people working in fields requiring heavy physical work. Hospital employees are in the risk group for backache; occupational activities such as lifting patients in improper positions, leaning forward, turning around and standing still for a long time may cause biomechanical stress in vertebra and backache [38–41].

2.6 Radiation risk factors

Another important risk factor in hospitals is radiation. Regulations on this subject must be followed carefully [42–45]. Radiation in operating rooms can be emitted from mobile rontgen devices, fluoroscopy devices and non-ionizing devices like lasers [46]. Radiation exposure is caused by working with fluoroscopy and

radioactive substance application in operating rooms. Long term effects of low dose radiation use for a long time in operating rooms are not known. Biological effects of the ionizing radiation in the tissue differ by the total dose, dose rate, amount of body receiving radiation, radio sensitivity and the type of radiation and it may have stochastic and deterministic (non-stochastic) effects. Adverse effects of radiation exposure can occur within hours or years. Thyroids, eyes, hands and gonads are among the regions that are most affected by radiation. Radiation safety is important for employee safety as it is for patient safety. In studies conducted on operating room workers, it was determined that healthcare workers ignored protective measures regarding radiation safety [47–49]. The main reason for this was explained by the lack of knowledge of the employees on the physical characteristics and biological effects of radiation. Yet, setting and applying basic principles of radiation protection is important for employee and patient safety. Therefore, attention should be paid for in-service trainings for operating room personnel, inspection of the application and having informed and certified personnel to use fluoroscopy.

3. Conclusion

OHS aims to minimize occupational accidents and diseases and to keep the health of employees at the best level in all the world. With OHS studies, dangers and risk factors should be determined and controlled at their source. Operating rooms are complex places where the most advanced technology and systems are used and qualified employees work at. The most threatening factors for employee safety in operating rooms are contaminated, sharp object injuries and material splashes. The most common ones are pinprick injuries. Allergies to latex gloves and hand washing solutions in the operating rooms may cause serious problems. Ergonomics is an important yet ignored topic. If the actions such as positioning and lifting patients, transferring patients from the bed to the stretcher and carrying patients are performed without being careful, they may cause serious musculoskeletal problems for employees. Factors such as excessive amount of time spent in work environment, shifts and insufficient number of nurses may cause an increase in work intensity and a decrease in motivation for nurses.

Critical decisions on the lives of patients are taken and applied in operating rooms which have high level of psychological and physical stress. Therefore, they require concordant team work and moderate work environment. Use of too many technological devices, necessity to make fast decisions and risks caused by the nature of the operating rooms also pose some risks for the employees. Nurses working in operating rooms may encounter various risky conditions as explained above. Unsuitable physical environment, heavy physical work, frequent criminal activities, working late at night with fewer people, working in non-physiological positions, non-ergonomic conditions, stress, discomfort, workplace conditions which makes healthy diet difficult, commute problems are factors threatening employee safety. Since numerous factors might have negative effects on the safety and health in operating rooms, risk assessment should be performed and reformative-preventive actions should be taken in order to identify characteristics such as what these factors are, at what level they are present and who they affect. Occupational health problems caused by the risks in the workplace can be reduced and the rates of serious injuries and damages can be decreased with proper and efficient risk management.

Operating room nurses should be trained on subjects such as general environmental pathogens, ergonomics, blood-borne pathogens, protective equipment, radiation safety, fire safety, general safety, use of hazardous material (substances),

emergency situation management, protection against airborne diseases, mobile liquefied oxygen, communication and enlightenment on dangers, medical equipment care and safety of tap water.

Primary precautions to reduce exposure to chemical substances include using materials with low danger potential, paying attention to the allowed concentrations, frequently ventilating the environment, hand washing, using personal protective equipment such as aprons and masks, updating old methods and equipment, measuring and monitoring samples taken regularly, biological monitoring. In addition to these, there are many precautions that are customized according to the characteristics and risks of the chemical substances.

Preoperative, intraoperative and postoperative management of the patients with suspected or diagnosed new coronavirus pneumonia should be known and defined in detail. All healthcare professionals, particularly surgeons and nurses, should be provided with advantages in protection from the disease. All patients should be managed as Covid-19 patients until the results are confirmed. Risk of Covid-19 should be considered for general surgery emergencies and personal protective equipment should be used accordingly. Patients should be transferred to the operating rooms by service nurses and nurses should wear N95 masks, goggles/face shields, waterproof aprons and overshoes. Patients should also wear a surgical mask and transferred to the operating room via the shortest way with least contact with others.

Hospital management should take precautions against the risk of infection, nurses should gain more awareness and pay attention to using protective equipment such as gloves and masks. Ventilation of the healthcare institutions is important to protect patients and healthcare personnel and to prevent the infections caused by the institution. For this purpose, various air conditioning systems are developed, each of which has its pros and cons. It is thought that improving environmental conditions of the operating rooms would increase the chance of preventing surgical infections, decrease complications, increase the quality of the operation, increase the quality of healthcare service by decreasing cost and reduce the stress of the operating room personnel.

Multidimensionality of the concept of health and the need for interdisciplinary cooperation and several approaches are some of the most important elements that form the basis of nursing education. Nurses who are educated on occupational risks and employee safety can have the ability to define and control the possible risk factors. Nurses undertake many duties besides patient care in operating rooms, which are not their essential duties. Excessive workload and transfer of the duties of other disciplines to nurses leads to the emergence of an unhappy occupational group which works hard yet does not have time to practice their own profession. This situation should be prevented and it should be ensured that nurses do the duties they have been trained for.

Concordance and productivity of the team depend on the position and role of each member of the team being defined and recognized. It also depends on each member having the capability and possibility to perform their own roles at their best. Therefore, nurses' roles should be defined and nurses should be capable of performing those, and roles of nurses should be known, recognized, accepted and respected by the other members of the team. In order to establish such an environment, besides following the law and legislation, employees and employers should accept their roles that prioritize health and safety, believe that safety would be maintained in the institution, adopt an appropriate attitude and display social responsibilities.

As described above safe working environment is important for all hospital workers, especially for those who work in operating rooms. Necessary precautions

should be taken and controlled regularly in order for surgical nurses to perform their duties successfully. Employees should be informed about work safety precautions and most importantly push for these precautions. In addition to patient and employee safety in operating rooms, environmental safety also has an important place. Environmental risk analysis should be performed by experts in the operating rooms at regular intervals and risk management should be implemented by the occupational health and safety committees in the hospital.

Conflict of interest

The author declares no conflict of interest.

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