

Special Article

Worker Safety in Hybrid Operating Rooms

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Abstract

As a medical term “hybrid interventions” denotes performing various special treatments together with each other. Especially on high-risk patients and in treatments of complex pathologies, hybrid surgery where minimal invasive surgical techniques utilized together with invasive catheter interventions is a very effective treatment method.

Hybrid operating rooms (OR) are treatment centers where; in patients advanced imaging for the purpose of diagnostics, surgery, stent or balloon applications, endovascular interventions, and/or if necessary, various combinations of those are employed and all sorts of interventions are applied on patients in the same environment. For that reason hybrid OR workers, in addition to the same risks other sector employees are faced with, are exposed to more different risks due to the nature of their occupation.

Health-threat posing harms and risks to the health of healthcare workers employed in hybrid OR are defined as; biological, physical, chemical, ergonomic and psychological.

Adversity in hybrid OR environments and workplace conditions negatively affect workers’ physical and mental health, work satisfaction, success and productivity. Therefore, probable harms and risks in hybrid OR should be defined and necessary precautions should be taken, should be inspected periodically and necessary trainings should be given to the healthcare workers.

Key words: Healthcare Worker, Safeguarding, Surgical Nursing

Introduction

As a medical term “hybrid interventions” denotes performing various special treatments together with each other. Especially on high-risk patients and in treatments of complex pathologies, hybrid surgery where minimal invasive surgical techniques utilized together with invasive catheter interventions is a very effective treatment method (Demir Korkmaz & Yavuz Karamanoğlu 2012, Çicek Goker 2013, Karaveli 2015). Thus, hybrid operating theatres are environments where cutting-edge life support tools and high performance imaging and interventional radiology devices are present and rigorous asepsis rules are enforced (Demir Korkmaz & Yavuz Karamanoglu 2012).

Workers’ health is defined as; elevation of workers’ physical, mental and social standings to the highest possible levels, application of preventive methods to minimize probable harms to their health, appropriateness of the work to the person and the person to the work. For that reason hybrid OR workers, in addition to the same risks other sector employees are faced with, are exposed to more different risks due to the nature of their occupation (Karaveli 2015).

Health-threat posing harms and risks to the health of healthcare workers employed in hybrid OR are defined as; biological, physical, chemical, ergonomic and psychological (workplace stress, work overload due to understaffed personnel, effects of workplace

violence, etc.) (Aren 2008, Eti Aslan & Kan Onturk 2011, Ozturk, Babacan & Ozdaş Anahar 2012, Goodman & Spry 2014, Karaveli 2015, Tastan 2015, Tas 2016).

The hybrid operating theatre and negative working conditions adversely affect the physical and psychological health, job satisfaction, success and productivity of employees (Tas 2016). This compilation was planned in order to identify the biological, physical, chemical, ergonomic and psychological risk factors that adversely affect employee safety in hybrid operating theatres; and to take the necessary measures in order improve the physical and psychological health, job satisfaction, success and productivity of employees.

1) Biological Risks and Measures that Need to be Taken

Blood and blood products, bodily fluids and air constitute biological hazards.

HIV, Hepatitis B, C, D viruses that spread through blood, blood products and bodily fluids may threaten the future health of the employees mostly through piercing and cutting instruments and infected blood or bodily fluids splashing on the mucosa. In the operating theatre, injector piercing injuries occur generally while closing the lid of the injector after use; piercing tool injuries generally occur during sutures, while handing the knife or suture to the surgeon, or while the tools are being disposed of in the waste bin; or while trying to move very quickly in emergency operations where each second is important for the patient, and due to direct contact with bodily fluids during the operation (Aren 2008, Eti Aslan & Kan Onturk 2011, Tastan 2015, Tas 2016, file:///C:/Users/USER/Downloads/ameliyatortam indariskler.pdf).

Hybrid operating theatre workers have to use protective equipment such as gloves, hand sanitizers, masks, goggles and aprons and take universal precautions. Disposable scalpels have to be used during surgical operations; cutting tools have to be placed towards the back of the mayo table, and have to be removed from the incision area while not in use. Gloves have to be put on during invasive procedures, special implements have to be used to put on/pull off needles/scalpels, oral warnings have to be given while transferring cutting/piercing tools. During incisions and sutures, hands have to be removed

from the surgical area and people must not bend excessively over the surgical area. Moreover, direct hand-to-hand transfer of cutting/piercing tools has to be avoided; the tools have to be placed in a container or to a place within the surgical zone, and picked up from there. Injectors used during surgical operations have to be disposed in the yellow waste bin without closing the lid. Gloves have to be used during the packaging and labeling of blood, culture, biopsy and pathology pieces that are taken from the patient and these have to be sent to the laboratory inside non-leaking, capped containers. In hybrid operating theatres, registration forms must not be touched with dirty hands or gloves. Institutions have to create risk definitions for the operation area, and determine policies and procedures. Moreover, institutions have to inform and supervise the employees concerning safety measures through training programs. If the healthcare workers contact blood or bodily fluids, they have to immediately wash the affected area with water and soap, and use suitable antiseptics as necessary. In mucosal contamination, saline solution has to be used for irrigation, and infection control department has to be contacted as soon as possible to report the incident, and this has to be relayed to the relevant units. Healthcare workers have to be immunized against Hepatitis B infections that spread through blood (Aren 2008, Eti Aslan & Kan Onturk 2011, Tastan 2015, Tas 2016).

Another one of the biological risk factors that healthcare workers encounter is the tuberculosis infection that spreads through air. Operating on a patient with tuberculosis during the active phase of the disease, lack of effective ventilation in the operating theatre, negative pressure rooms, not taking breaks after circulation-based cleaning in operations, and not placing the tuberculosis patients to the end of the operation list increase the risk of tuberculosis (Tas 2016). Thus, the operating theatre where the tuberculosis patient undergoes operation has to have negative air pressure, have adequate air circulation, and the patient has to be the last patient to undergo operation in that theatre.

Contaminated equipment has to be closed off with a cover in the operating theatre. Bags and containers carrying bodily fluids that can cause contamination have to be labeled red and have to clearly show the hazard. Cutting and piercing tools have to be carried in standards-compliant special containers with labels. These containers

have to be leak-proof and without risk of contamination. Contaminated textiles have to be carried in special and marked bags, and have to be labeled to inform that they are hazardous (Aren 2008).

2) Physical Risks and Measures that Need to be Taken

Physical risks in hybrid operating theatres are risks that endanger the bodily health and tissue integrity of healthcare workers. Most frequently encountered physical risks in the operating theatre include exposure to radiation, laser and surgical fumes, and lack of good noise, acclimatization and lighting systems (Tastan 2015).

Radioactive materials damage cells and cause chromosomal defects, cancer and cataracts (Aren 2008). Thus, radiation protection measures must not be ignored. The operating theatre has to be plated with radiation-resistant lead plates (2-3 mm) and warning signs have to be placed. Moreover, radiation protection equipment such as lead aprons, thyroid protectors, gonad protectors and protective goggles have to be present and used. People who work in irradiated areas have to use dosimeters and have to undergo annual total radiation exposure measurements. The harmful effects of irradiation have to be considered, and radiation applications that do not provide a net gain have to be avoided. Laminar air circulation ventilation systems have to be installed in irradiated areas. Fluoroscopy duration has to be short. While working with fluoroscopy and C-arm fluoroscopy devices, the x-ray tube has to be under the table or on the other side of the staff. The surgical team has to be as far as possible from the source of radiation, has to stand on the other side (Aren 2008, Goodman & Spry 2014, Bartal et al. 2014, Tastan 2015, Tas 2016).

If a hybrid operating theatre worker is exposed to radiation during pregnancy, still-births, trisomia, miscarriages, microcephaly, mental problems, immune system disorders, leukemia and thyroid cancer (especially in children) may arise (Aren 2008). Thus, pregnant workers have to be kept away from operating theatres where radiation sources are used, have to leave the room when X-rays are being used, have to wear lead shirts and have to stand as far away as possible from the source (Ozturk, Babacan & Ozdas Anahar 2012, Bartal et al. 2014, Tas 2016).

Surgical fumes frequently arise due to the laser devices used in hybrid operating theatres burning living tissue, fat and protein. This chemical fume that arises creates aerosols that contain living cells, viruses and blood and cause irritating, toxic, mutagenic, cytotoxic and carcinogen effects on human health. To prevent exposure to surgical fumes, the duration of exposure to fumes has to be shortened, goggles and specially designed filtration masks have to be used, and appropriate ventilation systems have to be set up in operating theatres to minimize contact with fumes and aerosols. All workers who will use the laser device have to receive basic training concerning laser use, the hazards due to laser use and the required safety measures. The theatres where laser surgery is being conducted must not have windows, the ceiling and walls of the room have to be covered with a non-laser-reflecting material and a fume evacuation system has to be installed. Moreover, flammable liquid must not be stored in these areas. Warning signs have to be placed on the doors of the halls where laser is being used. These signs have to be placed outside the door of the hall where laser is used, and have to specify the type of laser, its maximum power rating, in addition to a warning reminding that laser goggles have to be used. All the staff in the operating theatre during laser surgeries have to use personal protective equipment such as laser goggles, protective clothing, gloves, protective caps and masks (Goodman & Spry 2014, Tastan 2015).

In hybrid operating theatres, the fact that workers speak in loud voices due to the noise from monitors and the machinery needed for operation, heating and cooling systems, aspirators, the clanging of surgical tools and human movement, cause the working environment to be noisy (Tastan 2015, Tas 2016). Noise may cause psychological effects such as restlessness, frustration, anger; temporary and permanent hearing loss; fatigue, sleeping disorders, and headaches. To control the noise, the volumes of monitors may be decreased, noisy machines may be periodically maintained, the floors and walls in the building may be covered with noise-absorbing materials, and healthcare workers may speak in lower voices (Tastan 2015).

Adequate lighting in hybrid operating theatres increase vision sharpness and protects healthcare workers' eye health. Inadequate or improper lighting in hybrid operating theatres may cause

fatigue, distraction, low morale, and anger (Tastan 2015, Tas 2016). Moreover, light and electromagnetic fields affect the functioning of the pineal gland and may cause breast cancer, reproductive disorders and depression (Tas 2016). Thus, indirect or partially-indirect lighting have to be selected for hybrid operating theatres instead of direct lighting, and lamps that provide a light close to the light of the sun have to be used. Color, light intensity, shadow, flickering, heat emission, and movement ability have to be considered in lighting. Moreover, the light diameter has to be adjustable, it should not cast shadows, it has to be adjustable to any position and angle, it has to produce minimum heat and has to be easily cleanable. Good lighting in the working environment protects the physical and psychological health of the workers and allow for maximum efficiency, in addition to providing a comfortable working environment (Wong et al. 2010, Tas 2016).

To minimize infection risks at a minimum in hybrid operating theatres where high-risk invasive surgeries are performed, and to avoid the toxic effects of dusts, anesthesia gases and disinfectants, laminar clean air flow systems are recommended. The temperature has to be between 20 and 24 °C, and the relative humidity has to be between 30 and 60% in order to provide comfort for workers in hybrid operating theatres and to prevent distractions (Tastan 2015, Tas 2016). In order to achieve this, operating theatres have to undergo daily temperature, humidity and pressure controls. The air in operating theatres has to be filtered through High Efficiency Particulate Air (HEPA) filters, which remove particles of 0.3 µ diameter with 99.97% efficiency (Tastan 2015).

Hybrid operating theatres are oxygen-rich environments that contain many sources that can cause fire. Fires due to surgical operations may cause injuries or deaths (Tastan 2015). Electrosurgical unit, laser, fiber-optic light sources, electrical hand tools, defibrillator spoons, patient covers, bedsheets, body tissues, patient hairs and intestinal gases are among the sources that may cause fires in hybrid operating theatres. Fire alarm, extinguishing and sensing systems have to be installed, fire escape signs have to be placed in appropriate places, the controls of electrical systems have to be performed by the technical staff regularly, an emergency response protocol has to be prepared for fire incidents, a detailed and comprehensive

evacuation plan has to be prepared and periodically revised as measures that will be adopted to protect healthcare workers against fire. Moreover, the operating theatre workers have to receive continuous and applied training concerning fire hazards and measures to be adopted (Andsoy 2013, Tastan 2015).

3) Chemical Risks and Measures that Need to be Taken

Healthcare employees in hybrid operating theatres encounter chemical factors such as anesthetic materials, cytotoxic materials, and materials that are used in sterilization and disinfection. Moreover, chemical agents that adversely affect individuals' health such as latex, mercury, inorganic lead, radiation, laser, pharmaceutical and cytotoxic materials, surgical fumes and plastics are frequently used (Eti Aslan & Kan Onturk 2011, Tastan 2015, Karaveli 2015, Tas 2016).

These chemical substances that threaten the health and safety of operating theatre workers may cause allergic reactions, skin and respiratory disorders, mutations, teratogenic and carcinogenic effects (Aren 2008, Tas 2016).

Hybrid operating theatre workers may experience skin damage such as itches, eczemas, and contact dermatitis due to frequent hand washing with antiseptic solutions during the day. Moreover, scrubbing the hands before the first surgery of the day, and prior to high-risk operations also causes skin irritations (Taş 2016). Antiseptic solutions that contain alcohol, which are used during surgical hand-washing have dehydrating and irritating effects on the skin and their long-term use has a toxic effect on the liver. Studies have shown that batticon solutions that are used as soap have allergic and toxic effects in individuals who are sensitive against these solutions, and that they affect thyroid functions (Eti Aslan & Kan Onturk 2011, Demir Korkmaz & Yavuz Karamanoglu 2012, Tas 2016).

As latex-containing materials are frequently used in hybrid operating theatres, the healthcare workers who work in these environments are under high-risk of latex allergies (Tastan 2015). Latex allergy may cause itching hands and contact dermatitis due to constant exposure (Demir Korkmaz & Yavuz Karamanoglu 2012, Goodman & Spry 2014, Tas 2016). Healthcare workers who are allergic to latex have to absolutely put on synthetic gloves, and must not

use materials containing natural rubber latex (Goodman & Spry 2014, Tastan 2015).

Another risk and hazard in hybrid operating theatres are anesthesia gases. Healthcare workers who are overexposed to anesthesia gases during their works may experience acute effects such as headaches, dizziness, nausea, sleepiness, cognitive changes, attitude and behavior changes, liver and kidney problems. Adverse physiological effects such as spontaneous abortions, premature birth, low birth weight, and congenital anomalies may arise for pregnant women (Eti Aslan & Kan Onturk 2011, Karaveli 2015, Tastan 2015, Tas 2016). To control waste anesthesia gases, direct contact with anesthesia gases has to be prevented, an appropriate ventilation system has to be set up, low-leak anesthesia equipment has to be used, gas evacuation equipment and ventilation system has to be installed. The maintenance of the anesthesia machine has to be properly made by qualified employees, daily leaking tests have to be conducted prior to equipment use, gas source has to be shut off prior to the removal of the respiration unit, and the mask has to be properly placed on the patient's face prior to starting the gas flow (Tastan 2015).

In hybrid operating theatres, bleach based disinfectant agents that are used to clean sterile areas may cause respiratory irritation or allergic reactions depending on overdose or sensitivity of workers. Moreover, chemical substances such as glutaraldehyde which is used to sterilize non-heat-resistant tools, formaldehyde which is used to preserve pathology pieces, and the ethylene oxide gas which is used for sterilization also present risks for healthcare workers. Overexposure to all chemical substances and inadequate ventilation may cause reactions such as respiratory irritation, eye and throat burns and rashes, coughing, tachycardia, headaches and allergies (Eti Aslan & Kan Onturk 2011, Karaveli 2015, Tas 2016). To avoid these chemical risks, hybrid operating theatres have to be well ventilated, the workers have to wear masks, gloves and goggles, and the instructions in the MSDS of the chemical substances have to be followed.

4) Ergonomic Risks and Measures that Need to be Taken

Hybrid operating theatre halls and the practices within have to be designed suitably for the muscle and skeleton systems of the workers.

Actions such as overworking, prolonged standing in the same position, patient transfer operations, lifting a material or object, pushing and dragging tools, positioning the patient for surgical procedures, lifting the patient, transferring the patient from the stretcher to the table, if conducted non-ergonomically, may cause back and lower back pains (Aren 2008, Goodman & Spry 2014, Tastan 2015, Karaveli 2015, Tas 2016,

file:///C:/Users/USER/Downloads/ameliyatortam indariskler.pdf). Moreover, standing at the same position for a long time may cause leg pains, varicose veins, spinal pressure, chronic venous deficiency, increase the risk of carotid atherosclerosis and risks of heart attacks and strokes, and cause edemas in lower extremities (Demir Korkmaz & Yavuz Karamanoglu 2012).

The hybrid operating theatre working environment has to be planned and arranged ergonomically for the worker. Engineering measures include: back belts and ties for lifting and positioning individuals under anesthesia, electrical operation tables, and inflatable lateral positioning tools. Administrative measures include algorithms and instructions for the position and positioning of the anesthetized patient, and determining the maximum load capacities for instrument tables (Aren 2008, Tastan 2015, Tas 2016). AORN, recommends a weight limit to reduce the risk of back injuries during patient lifting operations or during the transfer of sterile tool trays from the autoclave. Individual measures include the healthcare workers learning the proper practice of body mechanics. Moreover, to prevent injuries, non-slipping shoes have to be used, housekeeping has to be performed, cabinet doors and room doors have to be kept closed, spills have to be immediately cleaned and wastes have to be removed from the floor. Adequate workers and materials have to be planned and provided in advance for the safe transport of the patients. Pushing or pulling have to be preferred to move materials in the hybrid operating theatre instead of lifting, and the wires and cables on the floor have to be covered (Tastan 2015). In a working environment made ergonomic in this manner, work accidents will also be minimized. Moreover, in long surgical operations, ensuring that the staff works in shifts, providing resting areas, and selecting workers who are suitable for the work that will be performed will contribute to reducing the risks (Tas 2016).

5) Psychological Risks and Measures that Need to be Taken

In hybrid operating theatres, irregular working hours, working in shifts, watch duties, sleeplessness, inadequate number of workers, facing risky patients, inappropriate nutrition and resting environments cause work stress and exhaustion syndrome for the workers. Moreover, situations such as hierarchical and unbalanced power relations, interpersonal conflicts, bullying, oral harassment, horizontal violence, abuse, mobbing may cause stress (Tastan 2015, Tas 2016). Stress may cause stomach-intestine disorders, headaches, sleeplessness and chronic fatigue, hypertension, coronary artery diseases in addition to behavioral and psychological problems. The problems may cause the risk of errors due to distractedness, lower work efficiency, disrupt the worker's motivation, and may cause psychosocial issues such as substance addiction (cigarettes, medication, alcohol, drugs), obsessive behaviors, isolation feelings, insecurity, anxiety and depression (Karaveli 2015, Tastan 2015).

The workers have to be provided with psychological support in areas where exhaustion syndrome and motivation loss are observed. The workers have to be consulted in order to minimize stress, trainings concerning coping with stress have to be emphasized, and the stress in the working life has to be addressed by the hospital administration (Tas 2016). To ensure a healthy working environment in the operating theatre, the team members have to be frequently evaluated in terms of respect, communication, team work, learning environment and satisfaction. Moreover, a zero-tolerance policy has to be practiced against people who engage in aggressive behaviors to ensure colleague cooperation against violence (Tastan 2015). In cases where psychological support is not enough, the working area has to be changed appropriately. Social events such as picnic organizations have to be organized to improve morale (Aren 2008, Tas 2016).

Identifying current biological, physical, chemical, ergonomic and psychological risk factors that adversely affect the safety of hybrid operating theatre workers and taking the necessary measures has to be a policy of public and private hospitals. Protocols and algorithms required to increase the healthcare workers' safety in line with a health and safety policy have

to be prepared, applied and evaluated specially and in an up-to-date manner for hospitals. Moreover, healthcare workers have to periodically receive up-to-date information about safety measures, and on-the-job interactive training programs or certificate programs have to be offered. Physical and psychological health of healthcare workers, their job satisfaction and efficiency has to be evaluated once per year.

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