

Hospital infections in radiology clinics

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ABSTRACT

Hospital infections are serious concerns for health care workers and patients. Needle stick injuries, blood contacts, airborne infections and any kind of contamination pose a risk for hospital infections. The risk of hospital infection has been increased in radiology since the number of the patients and the exposure time between patients and radiology workers have increased especially with the usage of new modalities in the last three decades. Hospital infection risk and some universal standards and policies for protection were summarized in this article.

Key words: • cross-infection • radiology

Radiology clinics have been going through rapid changes in the last three decades. Apart from conventional x-ray applications, techniques that have recently joined the radiology family, namely US, CT, MRI, and DSA, have accelerated the pace of change whereas a new discipline such as interventional radiology has brought new responsibilities. An important outcome of such change has been patient's longer stay in radiology clinics due to the increase in the number of patients and more complicated nature of evaluations.

Interventional radiological applications such as opening an intravenous line, and catheterizations performed for enteroclysis, as well as colonography, cystography and similar examinations require direct contact between patients and health care workers. The use of common instruments and equipment for patients in hygienic conditions and appropriate disposal of wastes attribute serious responsibilities to radiology clinics.

Patients have to be referred to a single center due to the costly and immovable radiological equipment or limited number of radiologists available. This necessitates rendering radiology services in one center to all kinds of patients ranging from hospitalized to outpatients, intensive care to emergency patients, chemotherapy patients to patients with tuberculosis, with the same equipment and within the same environment. The physicians, nurses and technologists working in radiology clinics usually lack the necessary knowledge and skills concerning issues of asepsis and antisepsis. Furthermore, it is a fact that these concepts have not been covered in the professional education of technologists. Therefore, radiology clinics are risky places in terms of hospital infections. In addition, because radiology departments do not have standards to control hospital infections, this risk is further aggravated.

Hospital infections are infections which develop within 48-72 hours after the hospitalization of the patient or in the first 10 days after the patient is discharged (except for infections which need longer incubation time). They occur only in hospitals or are induced by microorganisms acquired from hospitals (1). The importance of hospital infections lies in patient mortality and morbidity and, furthermore, in their impact on the hospital stay and cost (2).

The following is the proposal packages prepared from universally recognized standards that we developed for radiology clinics (1-9). After touching upon these proposal packages briefly, some of them will be dealt in detail.

1. It should be recommended and ensured that all radiology personnel are vaccinated against hepatitis B infection.
2. Personnel should be informed about hospital infections in the beginning of each academic year and the sustainability

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of combating with hospital infections must be ensured.

3. If the clinic where the patients in the wards or intensive care unit are hospitalized or the patients' disease is risky for hospital infections, the x-rays of such patients must be taken by mobile x-ray devices in the relevant wards. Such mobile devices should be parked in appropriate locations that are close to such clinics. If the devices have some parts, which are, or may be, potentially infected, they should be cleaned with disinfectants that are deemed appropriate by the hospital's infection committee. In cases where there is no infection committee, the devices may be cleaned with solutions like biguanid flache.
4. Personnel who go to another department to use x-ray devices must wash their hands before and after using the device. The same personnel must clean the film cassette with the above-mentioned solution.
5. Personnel must acquire the hand washing habit and to this end, hand washing units that are easily accessible, fully equipped, and which have towels must be installed.
6. While planning the set-up of radiology clinics, primary goal must be ventilation and benefiting from sunlight.
7. Radiology personnel should be informed as to what to do in cases of needle stick injuries, scalpel cuts and contact with blood and bloody fluids and this must be based on a previously identified algorithm through protocols developed on this issue.
8. The chain, which ensures the delivery of all wastes in the department to the general waste center, should be well established and checked continuously by control charts.

The above-mentioned items, which have been tackled generally, will be analyzed in depth under the following headings.

Hand washing habit

The hand hygiene and antisepsis of health care workers is alone the most

important controllable factor to prevent the spread of hospital infections (4). The lack of hand washing habit, which is in fact a simple and cheap measure, is responsible for more than 50% of hospital infections (5).

The pathogens in the skin flora are grouped in two categories: permanent and temporary flora. Permanent flora bacteria are not responsible of hospital infections in the absence of severe immune system disorders and prosthetic implantations. Temporary flora consists of pathogens, which are mostly on the skin surface, which are acquired from infected patients, environment or equipment and which have newly developed and have a contamination character. This is the flora group that can be identified on the hands of the health care workers and is held responsible of hospital infections in contrary to the permanent flora. The most common pathogens of the temporary flora are pseudomonas, meticillin-resistant staphylococcus, and coliform bacteria from the Enterobacteriaceae family (5). Although surgical hand washing is necessary to remove or to reduce the permanent flora, hygienic hand washing alone is also enough to remove the temporary flora.

Under which conditions should the radiology personnel wash their hands?

1. Before all interventional radiological procedures,
2. Before and after all intravenous interventions,
3. Before and after colon x-ray, nasogastric tubing and enteroclysis tubing,
4. Before and after endorectal, endovaginal and endoscopic US,
5. Before contact with immune suppressed patients and newborns,
6. Before and after contact with surgical, traumatic and iatrogenic wounds,
7. Before and after the maintenance and irrigation of catheters placed percutaneously or in other ways and the discharge of free drainage bags,
8. Before and after contact with patients in the burn or intensive care units where mobile x-ray services are rendered.

The most important factor, which has a positive impact on hand wash-

ing habit, is the hand washing units that are fully equipped in an organized manner and are easily accessible. The negative factor is the use of gloves. Personnel should be careful to wash their hands in the above-mentioned conditions, even though they wear gloves.

Routine (hygienic) hand washing technique

1. Accessories like jewels are to be taken off before washing hands.
2. The hands are wetted under running water.
3. The wrists, the palm and back of the hands, the tips and sides of fingers and nails are washed with soap scrubbing for at least 20 seconds.
4. The hands are thoroughly rinsed under water.
5. Hands are dried with paper towels beginning from the wrists.
6. The same paper towel is used to turn off the tap.

Interventional radiological procedures must be considered to be surgical operations and the hand washing technique should be the surgical hand washing technique. Small holes even on the quality sterile gloves are possible to occur during the operation. Therefore, long acting agents in the post-contact period are preferred in surgical hand washing technique. Agents like chlorhexidin gluconate, foam type detergent solutions and povidon-iodine are commonly used for this purpose. Since the hands will be washed up to the elbows, short sleeve shirts must be worn before starting the operation.

Surgical hand washing technique

1. All the jewels in the hands are taken off.
2. Surgical cap and mask are worn covering the hair entirely without disturbing the nose and mouth.
3. The tap is turned on automatically by the elbow or the knee. Warm water foams the soap better, therefore water must be adjusted to "warm".
4. The hands are wetted keeping them above the elbow level.
5. The hands are washed with an antiseptic agent such as chlorhexidin gluconate or povidon-iodine in order to

- remove the flora on the skin.
6. Surgical hand soap is taken at an appropriate amount and the hands are washed for 3-5 minutes as follows: Washing begins from the tip of the fingers in circular movements. The soap is foamed up to the elbows. The same procedure is carried out for the other hand. The hands are brushed lightly with a disposable surgical brush, which is preferably sponge on one side and brush on the other side, paying attention to the nails and grooves in the hand.
 7. The hands are kept above the elbow level and both arms are rinsed separately so as to drain the water downwards.
 8. If the tap is not automatic, it is turned off using the elbow or the knee.
 9. The hands are dried separately using sterile towels for both hands.
 10. Sterile scrubs and gloves are worn without touching anything and keeping the hands at the waist level.

General rules to be observed by radiology clinics in patient admission and services

The big and immovable equipment used in the radiology clinics require rendering services to the patients in the radiology clinics. Hospitalized patients and the patients in outpatient clinics and radiology personnel are in contact for long hours on ground floors, which generally have ventilation problems. Therefore, an environment, which is suitable for air-borne diseases, and diseases that spread by contact automatically emerges. The following are the general measures, which can be taken by radiology clinics, to reduce hospital infections:

1. Considering tuberculosis and similar air-borne diseases, the patients with such diseases should be examined in their respective clinics, if possible. If not possible, such patients should be admitted just before the end of the working day and the room must be ventilated at the end of the day by utilizing daylight or ultraviolet light. It should be ensured that the personnel performing the radiological procedures apply the general protection and prevention measures such as hand washing,

- wearing masks and gloves.
2. Patients who have been diagnosed to have meticillin-resistant staphylococcus must be admitted separately following other patients. In case it is necessary to examine the patient urgently, the patient should be separated from the others. All the personnel, who are to be in contact with the patient, should wash their hands, wear their masks and gloves, and the surfaces like the examination table on which the patient will be laid down should be covered with single-use disposable covers. As soon as the patient leaves the examination area, all surfaces, the contact surfaces in particular, and the floor should be cleaned with biguanid flache. If the patient was in a place like an angiography unit, the patient's wastes must be appropriately disposed as soon as possible. Ideally, all the wastes should be removed from the relevant area with automatic waste collection units and the garbage bag, which is automatically tapered, should be sent to the general waste unit.
3. Patients who potentially carry the risk to release blood, blood products or infective fluids, that is, patients who have abscess, empyema drainage catheter or open fistula should undergo procedures as indicated in item 2.
4. It should be ensured that the personnel working in and out of the clinic wear masks and gloves and understand the importance of hygienic hand washing. If it is believed that materials like film cassettes are contaminated after use, such cassettes should not be used before cleaning them with a disinfecting agent such as biguanid flache. Cassettes must not be used for 15 minutes following the cleaning.
5. Mechanical barriers must be used for patients with hematemesis and hematochesia. It is important that the personnel wear scrubs, gloves and masks while performing the procedure.

General rules to be observed by the radiology personnel performing interventional procedures

1. The most important rule to be

- observed by the personnel is to dispose the needles directly in the plastic waste containers without placing the needles back in their plastic cases. The failure to observe this rule is responsible for the majority of needle stick injuries (6). While using biopsy needles like Seldinger and Westcott or sheathed needles like Accustik® (micropuncture), placing such needles back in their metal cases also carry the same risk. Thus, while using the above-mentioned systems, the routine rule should be to illuminate the already dim angiography suites while placing the inner part of the needle in the metal sheath. The ideal is to use illumination systems that dim the light automatically during exposure or fluoroscopy and switches to normal illumination under other circumstances.
2. Sharp and penetrating instruments must never be transferred from hand to hand. Such instruments should be placed down on the sterile cover on the patient, the person putting the instrument on the cover should warn the next person who is to pick up the instrument. The person picking the sharp and penetrating instrument should wait until the person putting the instrument on the cover takes his hand off (6).
3. The waste container for hard plastic penetrating-sharp instruments must have a wide opening and be easily accessible. Such containers should be replaced when full more than half.
4. Suturing should not be made manually, and hemostate should be routinely used. While knotting the sutures, they should be closed in a way to cover the tip of the hemostat needle.
5. Hidden perforation possibility for unused gloves is 1%. Hidden perforation possibility goes up to 23% in cases where procedures last more than two hours (7). Therefore, it is recommended to use double gloves for procedures that will last long.
6. Covering the image enhancer, cold light supply, and command unit, which are connected to the table, with sterile covers

is important to preserve the sterilization of materials used for the patient. Similarly, covering the non-sterile areas like foot pedal with non-sterile nylon covers helps keeping such areas disinfected.

7. Some blood will remain in the syringe while washing with physiologic saline during interventional procedures. This blood and contaminated fluids must be discharged in sterile containers without spilling them into the environment. The ideal thing to do is to discharge such fluids in closed systems that allow for one-way flow.
8. Disposable sterile angiography cover sets must be used where possible. Cotton covers lose their sterility when they are wet.
9. It is important to raise awareness among personnel to wear masks and goggles in order to prevent the spill of wastes and fluids to their eyes and faces.
10. The possibility for the personnel to encounter needle stick risk or infected waste accidents during an interventional radiological procedure is about 3% (8). Such accident rate does not depend on the fact that the procedure is urgent or selective. Upon encountering a needle stick, cut or a similar accident, personnel should immediately stop the procedure. If possible, the contact site should be washed with soap and if it is the eyes or a similar site, physiologic saline should be used. Subsequently, hospital's infection committee and in case there is no such committee, infectious diseases clinic should promptly be contacted.
11. If autoclave is used in the department, the person in charge of sterilization should be trained regarding this procedure. It should be emphasized that it is important to use the sterilization control tape and not to fill the autoclave completely.
12. When possible, re-sterilization must be avoided. For re-sterilization, units like the hospital's general sterilization center, where there are standards and control, should be utilized. It is necessary not to use the

material sterilized by ethylene oxide for two days. It should be acknowledged that using such materials might lead to burns.

13. Antibiotic prophylaxis is defined as the administration of antibiotics before or during the procedure in order to prevent infections. Following are some brief information regarding the use of prophylactic antibiotics in interventional radiology (9):
 - a. *Agreed procedures which require the use of prophylactic antibiotics*
 - i. Biliary intervention and biliary drainage
 - ii. Percutaneous nephrostomy and genitourinary procedures
 - iii. Stent applications through a previously placed vascular sheath or a site where hematoma has developed
 - iv. Liver chemoembolization
 - v. Splenic embolization
 - vi. Patients with endocarditis risk (prosthetic mitral valve, a previous history of endocarditis, complex cyanotic heart disease)
 - b. *Procedures where protection is recommended*
 - i. TIPS procedure
 - ii. Port insertion
 - iii. Cases who have undergone aortobifemoral bypass and who are to undergo femoral approach.
 - c. *Procedures where protection is recommended but there is no agreement*
 - i. Procedures which will exceed three hours
 - ii. Dialysis catheter applications
 - iii. Percutaneous gastrostomy tube applications
 - iv. Percutaneous drainage procedures
 - d. *Procedures where protection is not recommended*
 - i. Diagnostic angiography for cases which do not have the endocarditis risk
 - ii. Angioplasty
 - iii. Routine stent placement
 - iv. TIPS revision
 - v. Vena cava filter placement

Venous catheter and port applications

This section is a summary of the protocols implemented by the Department of Radiology in Louisiana State University, USA, between 2000-2002.

Venous catheters are divided into two as those inserted peripherally and centrally. These two groups are categorized into two as temporary and permanent catheters. Furthermore, temporary central venous catheters are called non-tunneled catheters and permanent ones are called the tunneled catheters. Central catheters are mainly used for dialysis purposes, whereas port and peripheral venous catheters are inserted in order to keep the intravenous line open for short, medium or long term.

Venous catheter and port applications are rapidly increasing. In the beginning, the number of arterial interventions in radiology clinics was higher, but today in many centers venous interventions and the procedures performed to cope up with the short-long term complications of such interventions have out-numbered the arterial interventions.

The most important problem related to the interventions made to open an intravenous line is the infection risk that may develop in a certain period of time. Detailed information concerning this topic is given in other sections. Here the general rules that must be observed by radiology clinics, as being the clinics making such venous interventions, are summarized.

If a patient who has a catheter or port in his venous system developed an infection, and if such infection is seen in the blood culture, catheter and port should be removed and the catheter tip should be kept for culture and antibiogram. If the patient does not need an intravenous access urgently, it is necessary to give the suitable treatment and wait until the blood culture is negative. In cases where intravenous access is urgently needed, the same intravenous line (for instance right internal jugular vein) must be used following a different point and if necessary a different tunnel should be established. Using the existing vein will be the best step to take to prevent the venous narrowing and blockage that may develop in the new vein.

If the patient has severe and extensive stenosis and blockage in the

venous system and, for instance, has the infection of a tunneled catheter, the condition will have a complicated course. In case of the removal of the catheter, if the re-insertion of the catheter will be problematic and if the catheter cannot be inserted through other venous structures, one or two replacement wires can be sent into the old catheter and the new catheter replacement can be done through these wires. Subsequent to this, the patient should be followed up with the appropriate antibiotic treatment.

This article aims at dwelling on the importance of radiology clinics in terms of hospital infections and the general measures to be taken. To summarize, radiology departments are

units that have been unnoticed but deserve attention in terms of hospital infections. There is no doubt that more detailed and precise data and research on this issue will be available in the future.

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