



Article

Essentials of Infection Prevention and Control in Radiology Department, Review

Ahmad Mokhtar Abodahb^{1*}, Aalaa Mohammed Ibraheem²

¹ Department of Diagnostic Radiology, Faculty of Medicine, Sohag University, Sohag 82524, Egypt.

² Infection Control Specialist, Head of Infection Control Team, Almaragha Central Hospital, Sohag Medical Directorate, Sohag, Egypt

*Corresponding author: dr.ahmadabodahab@gmail.com, Ahmed_Abodahab@med.sohag.edu.eg

Article info.

Citation: Abodahab A.M. & Ibraheem A.M., (2024). Essentials of Infection Prevention and Control in Radiology Department, Review. *Sohag Journal of Junior Scientific Researchers*, Vol. 4 (2). 1-12.

10.21608/SJYR.2024.267580.1396

Received: 04/03/2024

Accepted: 26/09/2024

Published: 29/09/2024

Publisher's Note: SJYR stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Abstract

Infection prevention and control now is mandatory in all medical units and specialties with a variable process according to each. Radiology department is one of the frontlines specialties in dealing with wide variety of patients and diseases which needs a quite different measures for controlling infection especially due to the special nature of its procedures and machines. This review article aims to explain basics and essentials of infection prevention and control in radiology department. understanding of basics and Essentials of Infection control in radiology department is essential for all medical and paramedical team working in it. Consulting IPC department is the best solution for updates and dealing with complicated situations. The best disinfectant of every medical imaging machine is that recommended by its vendor, while other surfaces have the better disinfectant according to its nature. Consulting IPC department is the best solution for updates and dealing with complicated situations.

Keywords: Infection Prevention & control, Radiology Department, CT, US, COVID-19.

1. Introduction

Medical imaging units especially those serving emergency and patients of infectious diseases are one of the front lines of medical field that deals with patients just presented to hospital. This makes it more liable for contamination by any organisms that patient may infected or carrying it. It is more complicated if the patient has active bleeding either traumatic or due to medical cause of active bleeding as epistaxis, hematemesis or genitourinary bleeding. Body fluids and discharges are generally a source of good media for infection spread. Understanding basics and essentials of infection control is mandatory either for radiology doctors or for paramedical team and non-medical workers in radiology department (Amer & Rosenthal, 2021).

2. Basics of Infection control

Infection Prevention & control has two main aims, prevention of infection occurrence and control of existing infection to be spread. Infection cycle is mainly formed of source of infection, organism, method of spread and infection host. Breakdown of this cycle in more than one site is the main IPC target, while prevention of the cycle from beginning is the best and the aim of infection prevention. IPC standard precautions should be applied in every medical unit including radiology department, which are hand hygiene, proper using of personal protective equipment, using disposable tools with proper dispose of it, and regular and proper use of disinfectors according to the aim of use. IPC process ideally should be applied from the beginning in the design and structure of the building and proper choose of its finish (e.g., woody floors are not allowed for medical use as it harboring organism with very difficult disinfection of it). Good and standardized ventilation is a main step in IPC which may be different according to type of suspected infection at the targeted room (e.g., Ventilation and air conditioning criteria of chest infections inpatient rooms are much different than non-crowded waiting rooms) (IPC Australian guidelines 2019).

Disinfectors are variable according to type of targeted surfaces and organism. The commonest, most effective and most cheap one is diluted **chlorine** (the only method of floor blood spots disinfection). **Alcohol** is the main for hand hygiene and surfaces contacting hands, while **Cidex** for disinfection of instruments. Other methods of IPC are also available and some of it may have a role in radiology department (eg. Hot ovens and autoclaves for non-disposable instruments compatible with it). Disinfection and sterilization of the same instrument may be differed if it is confirmed to be contaminated by certain organism infected secretions (e.g., Instruments sterilization after procedure of patient infected with TB, HIV or HCV) (Ilyas F. et al., 2019).

3. IPC in Radiology Units :

Radiology is divided into two main branches diagnostic and interventional. IPC is mandatory for both but it may be more complicated in interventional unit because of its more invasive procedures.

Generally, there is shortage of knowledge about IPC among radiology workers (Mirza et al., 2015). The first step for proper infection prevention on the surfaces of different medical imaging machines is consulting vendor for most suitable disinfectant. This is very important for the integrity of the machine according to its structure and how to use it (Abuzaid et al., 2022). IPC parameters and steps are different according to type of contamination, expected organism and type of its spread (e.g., In CT Unit the methods of infection control for blood spots are much different than those for contact with COVID-19). Ultrasound, X ray and CT are the most common Modalities that has direct contact with ER patients which usually not completely prepared for this examination. MRI has relatively less contact with ER or non-scheduled patients, this gives it a better chance for applying of IPC (F. Amer and V. Rosenthal, 2021). The initial and ideal process for infection prevention in radiology department is Specification of imaging machine (CT, or US) for infectious patients if possible and dealing with its waiting rooms as infected zones with required regulations of increase spaces in between persons and decrease waiting time as much as possible with specific passages for this patient and associated using of proper PPE, this is. While if There is only one machine for all patient excessive precautions will be the only way for infection control (Qu & Yang 2020).

4. PPE In Radiology department:

Radiology department has two main types of PPE , The usual disposable PPE for prevention of infection (as disposable latex and plastic gloves, gowns, masks, overhead , over shows , etc.) and other non-disposable heavy lead loaded PPE for radiation (as lead apron , lead goggles, lead gloves, neck collar) which are highly liable for infection and must be properly disinfected according to its material and structure with applying the ideal instructions of keeping (e.g. lead aprons must be kept hanged , never to be crinkled to avoid lead cracks that will permeate X ray through it and defuse its radiation protective function) (Amer & Rosenthal, 2021).

5. IPC in Ultrasound Units:

The ultrasound is relatively the easier modality for applying infection control measures. The probe is mostly the main part of the machine that contacting patients "**Fig 1**" but also Cords and keyboards are liable to infection (Amer & Rosenthal, 2021). Probe contamination with blood or other body fluid needs more cautious disinfection by vendor recommended solution, A disposable sterile

latex covers on top of probe are much more indicated when examining a patient has active bleeding or leakage of body fluids or non-intact skin. This will make the disinfection of the probe easier and more effective than using it uncovered and sterile it after the end of the scan. The integrity of the permanent plastic cover of the probe is mandatory for ultrasound image integrity so the solutions used for sterilization of probe must be compatible with its plastic covering material better to be recommended by vendor) (Thiagarajah et al., 2021).



Fig.1 US Probes (Transducers) the most liable part for contamination and transmitting infection.

Soiling of Ultrasound table is not a challenge as it can be completely changed if it was significantly soiled by body fluid until to be completely disinfected. The situation is more difficult in Computed Tomography, the patient surface area contact with CT is much wider than with Ultrasound, and the parts of CT are fixed and cannot be removed or transported, so in cases of active bleeding or body fluids leakage the table of CT is the most liable for soiling and infection. The disinfecting or sterilizing solutions if used with excess amount especially on motile parts of CT (as table and gantry) this may hurts the electronic boards of it and cause malfunction or complete stop of the machine, Gel temperature increasing can promote infection, although gel warming is important for patient comfort especially children, but it can be a potential source of infection transmission from bottle to other even if bottles are disposable "**Fig 2&3** " (Mirza et al., 2015).



Fig.2 US bottles, better to be disposable after emptying, if necessary, refill must be under caution of contamination with applying date of filling.



Fig 3 US bottle warming device which may be a potential source of infection transmission from bottle to other.

US procedures and probe types are classified into "**table 1**" **non-critical**; examination with healthy skin, **Semi-critical**; endo cavitory procedures contact with mucous membranes (vaginal, rectal, esophageal) or non-intact skin or a device that contacts mucous membranes and **Critical**; intraoperative, immunocompromised, or critically- ill patients, accordingly disinfection occurs as explained in (Australas. J. Ultrasound Med. 2017).

Table 1. Transducer processing according to Spaulding Classification (Rutala & Weber 2020)

Transducer category	Non- critical	Semi- critical	Critical
Decontamination required	Disinfection (Low level) after cleaning	Disinfection (High Level) after cleaning (Or maximum possible disinfection)	Sterilization after cleaning (Or use high level disinfection, then use sterile cover and sterile gel)
	multi-use gel bottle	sterile cover and sterile gel	sterile cover and sterile gel
Cautions		Do not use a multi-use gel bottle	Do not reuse once opened

US gel is a good media for infection transmission, either by gel material or by containing bottle. Using of disposable bottle after every scan is very expensive and mostly non applicable. The rotatory disinfection of bottles with applying dates of use is an alternative solution with caution of using it and avoid any contact between its orifice and any surface especially patient body. Sterile gel must be used semi critical and critical US scans (Amer & Rosenthal, 2021).

6. COVID-19, a real challenge in Radiology Departments:

Infection control at the time of COVID-19 was a challenge in radiology department especially in CT as it is the main modality of choice for diagnosis and differentiation of suspected cases which make Radiology team (Doctors, technician and paramedical personals) were in higher risk to infection, the CT machines and rooms itself were a media of transmission of the virus to others. COVID-19 a type

of coronavirus and the 7th one of this type that attacking human and human to human transmission by droplets and direct contact cause the world wise outbreak that began at China at Dec 2019 and spread day by day all over the world, which became a real challenge for all measures of infection control. radiology units were considered one of the front lines in dealing with this outbreak. Infection with SARS-CoV-2 was an occupational health problem with an unexpected risk of morbidity and mortality exhibited a wide spectrum of disease severity ranging from asymptomatic cases to moderate respiratory illness or other non-respiratory (e.g., GIT) presentation (M. Seif et al., 2021). The virus has been reported to remain viable for 3 hours in aerosols and for up to 72 hours on plastic and stainless-steel surfaces; (median estimated half-lives about 1.1–1.2 h. in aerosols, 5.6 h on stainless steel, and 6.8 h on plastic) makes disinfection procedures more complicated. the use of PPE (protective personal equipment) and applying proper hand-hygiene practice are important protective tools during this pandemic. COVID-19 was a real challenge for radiology department not only for the measures and process of infection control and the load of costs of using proper and enough PPE but also because it add a significant change in the arrangement of department waiting areas and required spaces between patients (Qu. & Yang 2020). The infection control of CT units after scanning of a suspected case of COVID-19 is ideally done use of an air disinfectant that was equipped with a maximum air volume of 4000 m³/h. UV light (30 W; to be effective, and intensity must be > 70 μ W/cm² per meter) should be used for examination room disinfection 3 times / day when examinations are not taking place, at least 30 minutes each time. Non plastic equipment surfaces, radiation protection items, and doorknobs should be disinfected with a solution that is at least 75% alcohol or with alcohol-containing wipes after each scan. Plastic surfaces should be cleaned only with soap solution. For uncertain material of an equipment surface, they should contact the equipment vendor to determine appropriate methods for disinfection. Caution is a must when using disinfectant sprays, because they may penetrate inside equipment, resulting in short circuits, metallic corrosion, or other damages. The floor of scanning room should be disinfected with chlorine (2000 mg Cl / 1 L of water) twice per day or more, any visible contaminants should be completely removed with disposable absorbent material with the surrounding area subsequently disinfected. All patient secretions or body fluids should be regarded as infectious medical waste and managed in strict accordance with regulations on the management of medical wastes (Qu et al. 2020).

Covering CT Table by disposable cover after each scan is not enough alone for infection control in CT unit "Fig 4" as this cover must be has certain physical criteria as to be non-permeable, made of antimicrobial material. Disposing of it will be differ according to its state of integrity or being soiled by any of body fluid or not. Soiling of disposable cover with body fluid needs more caution in dealing with it and proper dispose. CT Unit is one of the main corners of COVID-19 triage units. Limited availability of CT in hospitals dealing with COVID-19 cases make the load higher on hospitals contains CT (for example Sohag university hospital CT unit was serving many central hospitals that did not contains CT which was a real overload on the CT unit and Triage unit of Sohag University

Hospital that make applying of ideal prevention measures with required time gap in between scan of infected cases nearly impossible). The time required for proper disinfection may was an obstacle of using machine especially when single machine used for large number of patients. Injectors are a very common source of infection at CT units which needs more care in handling with a sterile glove and avoid any reuse of disposable part (Amer & Rosenthal, 2021).



Fig.4 Disposable cover's role of CT table

PACS and teleradiology has a very important role in limitation of infection and exposure of radiology doctors to COVID-19 and it was an indirect method of infection prevention and control. Any interruption of PACS at this time was adding a more load on the process and coasts of infection control process (Abodahab et al., 2020). AI "Artificial Intelligence" also has additive role in infection prevention by using the soft wares that enable radiographers to do scan without leaving control room which provide no contact with patients (Qu et al. 2020).

7. Infection control and Interventional Radiology:

The interventional radiology unit is more similar to surgical specialties than medical one. Wide variety of interventions can be done in radiology department either diagnostic or therapeutic. Intervention radiology in general is a minor invasive procedure but still invasive and has more liability of contact to blood, body fluids and/or infected tissues. Most of used instruments are disposable (e.g., cannulas, catheters, torchers, guiding wires) but some of it are non-disposable (as biopsy guns), and needs to be sterilized after each use. Dealing with disposed instruments must be standardized according to types of this wastes. Non-disposable instruments (As biopsy gun) should be disinfected according to material made of, whether it is compatible with heat (Amer & Rosenthal, 2021) (O'Leary et al., 2008).

8. Summary & Recommendations:

In Radiology department the basic hygiene measures are initially requires as any other medical specialty. We can summarize important points as follow:

- IPC is mandatory in radiology department different units due to the wide number and type of patients contact it (in and Outpatients, medical and surgical)
- IPC disinfectors used in radiology department are different according to targeted surface or machine.
- IPC solutions used in general are: Diluted **Chlorine** for floors and surfaces, **Cidex** for instruments, **Alcohol** for hand contacting surfaces and hands hygiene.
- The best disinfectant of every radiology machine is that recommended by its vendor and using it with its recommended way of use. Maintenance contracts with machines vendors must involve these points.
- The steps of IPC are different according to type of organism and its transmission (e.g., IPC of COVID-19 is different than IPC of HCV)
- Using of PPE in radiology department is different according to the procedure and patient suspected infection (e.g., PPE in Usual US scan by using latex gloves and surgical mask, while in contact with suspected patient with COVID-19 more PPE will be needed as gown, N 95 mask for TB protection not usual masks etc.)
- Radiology team must be aware with the basics of IPC and consulting IPC specialist in any emerging or complicated conditions.
- Portable imaging devices "machines or Xray cassettes "**Fig 5**" are a potential source of infection transmission in between different rooms of hospital and must be strictly disinfected
- Consulting IPC department is the best way for proper solution of any emerging or complicated topics.
- **WHO online** free certified training courses are available and recommended (e.g., How to use PPE), Link: <https://openwho.org/courses/>
- **Suggested idea:** "Thin sheathed single use small dose of US gel": US gel supplying in a small thin sheathed plastic sealed covers that's contains small amount of gel for single use "e.g., 50 ml", which will keep it sterile, reduce the price of using disposable bottles or repeated disinfection of it avoid the side effects of repeated use of it.



Fig.5 X ray Cassettes a potential way of infection transmission if not disinfected properly

9. Conclusion :

Infection control is a mandatory process in all medical departments. Radiology department is usually contacting large number of patients of different medical verities which make it more liable for variable infections and needs more measures for infection control. Infection control measures in radiology unites are quite different according to type of infection and nature of imaging machine. Understanding of basics and essentials of infection control is mandatory for radiology doctors, paramedical and non-medical team in radiology department . Other than the usual infection control measures Consulting machine vendor for using appropriate disinfectant for the machine is mandatory for its proper work. Continuous guidance, follow-up and training are very important to improve quality and affectivity of infection prevention and control.

Abbreviations:

- **AI** Artificial intelligence
- **Cl** Chlorine
- **CT** Computed Tomography
- **COVID** Corona Virus Disease
- **h** Hour
- **HCV** Hepatitis C Virus
- **HI** Human Immunodeficiency Virus
- **IPC** Infection Prevention &Control

- **L** Liter
- **MRI** Magnetic Resonance Imaging
- **PACS** Picture Archiving & Communication System
- **PPE** Personal Protective Equipment
- **TB** Tuberculous Bacilli
- **US** Ultrasound
- **UV** Ultraviolet
- **WHO** World Health Organization

References

- Abodahab A.M., Tharwat M., Alserafi A. and Fawzy K. (2020). "Implementations of PACS and Teleradiology Systems: An Updated Review of the Literature". *Journal of Ecology of Health and Environment*. 8, No. 2, 21-25 a1035. <https://doi.org/10.4102/hsag.v24i0.1035>
- Amer F. and Rosenthal V. (2021) "GUIDE TO INFECTION CONTROL IN THE HEALTHCARE SETTING Infection Prevention and Control in the Radiology Department/Service". International society for infectious diseases. Vol 2 "21 – 49"
- Australian-guidelines-prevention-and-control-infectionhealthcare. September, 2022.
- Bryce EA, Scharf S, Walker M, Walsh A. (2007) "The infection control audit: the standardized audit as a tool for change. *Am J Infect Control*"; 35(4):271-83
- Chingarande G.R. & Chidakwa, L., (2014), 'Infection control in a resource constrained radiology department: A case study of a Zimbabwean hospital', *The South African Radiographer* 52(1), 18–21
- Ilyas F, Burbridge B., Babyn P, et al. (2019) Health Care–Associated Infections and the Radiology Department. *Journal of Medical Imaging Radiation Sci.*; 50:596-606
- Jieming Qu, Wenjie Yang, Yanzhao Yang (2020). Infection Control for CT Equipment and Radiographers' Personal Protection During the Coronavirus Disease (COVID-19) Outbreak in China *American Journal of Roentgenology* 215(4):1-5 DOI: 10.2214/AJR.20.23112
- Mohamed M. Abuzaid ,Wiam Elshami, Tekin H. O. (2022) "Infection control and radiation safety practices in the radiology department during the COVID-19 outbreak" *PLOS ONE* 17(12): e0279607. <https://doi.org/10.1371/journal.pone.0279607>
- Mohamed M. AbuzaidID, Wiam Elshami, H. O. Tekin (2019), Infection control and radiation safety National Health and Medical Research Council. Australian guidelines for the prevention and control of infection in healthcare, Canberra Available: <https://www.safetyandquality.gov.au/publications-and-resources/resource-library/>
- Nyirenda, D., Williams, R. & Ten Ham-Baloyi, W., (2019), 'Infection control recommendations for radiology departments in Malawi', *Health SA Gesondheid* 24(0), practices in the radiology department during the COVID-19 outbreak.
- O'Leary, D., McCrann, J., Poulos, A. (2008) Infection control in the mammography units of New South Wales, Australia and the Republic of Ireland. *Breast Cancer Research* 10 (Suppl 3), P64. <https://doi.org/10.1186/bcr2062>
- R. Thiagarajah, S. Creanor, C. Gutteridge, (2021) Infection Control in the Radiology Department. Ravivarma Balasubramaniam 2021
- Rutala WA, Weber DJ (2020), the Healthcare Infection Control Practices Advisory Committee (HICPAC). Guidelines for Disinfection and Sterilization in Healthcare Facilities, 2008, update: May 2019. Page 20;
- Rutala, William A., Weber, David J. (2008): Guideline for disinfection and sterilization in healthcare facilities, Corporate Authors(s): Healthcare Infection Control Practices Advisory Committee (U.S.); Centers for Disease Control and Prevention (U.S.); 1: 1-158

-
- Saif-Al-Islam M., Saad H., Ahmad Mokhtar Abodahab, Doaa Gadallah Hassanin, Magda Mohamed Ali, & Safaa Khalaf (2021) Epidemiological Study of COVID-19 among Healthcare Workers. *The Egyptian Journal of Hospital Medicine* Vol. 84, Page 2391-2399
- Sobia K. Mirza, Tyson R. Tragon, Melanie B. Fukui (2015), *Microbiology for Radiologists: How to Minimize Infection Transmission in the Radiology Department*. *RadioGraphics*; 35:1231–1244
- United States Food and Drug Administration. Guidance for industry and FDA staff: surgical masks—premarket notification [510(k)] submissions; guidance for industry and FDA. Link Published March 5, 2004.
- Yobelli A. Jimenez*, Suzanne Hill, Sarah J. Lewis (2023). "Infection prevention and control in medical imaging surveys: The need to map to guidelines to address systemic issues? Infection", *Disease & Health* 28 :102-114
- Zhonghua L. Xing Bing Xue Za Zhi. (2020) The epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19) in China. *Epidemiology Working Group for NCIP Epidemic Response, Chinese Center for Disease Control and Prevention*. 10;41(2):145-151.

الملخص العربي

اساسيات منع و مكافحة العدوى في قسم الاشعة

احمد مختار ابودهب*1 و الاء محمد إبراهيم 2

1- قسم الاشعة التشخيصية – كلية الطب – جامعة سوهاج

2- اخصائية مكافحة العدوى ورئيس فريق مكافحة العدوى , مستشفى المراغة و مديرية الصحة و سوهاج

المؤلف المختص:

dr.ahmadabodahab@gmail.com, Ahmed_Abodahab@med.sohag.edu.eg

أصبحت الوقاية من العدوى ومكافحتها الآن إلزامية في جميع الوحدات والتخصصات الطبية ولكن خطواتها مختلفة حسب كل منها. يعد قسم الأشعة أحد التخصصات الأمامية في التعامل مع مجموعة واسعة من المرضى والأمراض التي تحتاج إلى إجراءات مختلفة تمامًا للسيطرة على العدوى خاصة بسبب الطبيعة الخاصة لإجراءاتها وآلاتها. تهدف هذه المقالة المرجعية إلى شرح أساسيات الوقاية من العدوى ومكافحتها في قسم الأشعة. حيث يعد فهم متطلبات وأساسيات مكافحة العدوى في قسم الأشعة أمرًا ضروريًا لجميع الفرق الطبية والمساعدة العاملة فيه. تعتبر استشارة قسم مكافحة العدوى هي الحل الأمثل للتحديات والتعامل مع المواقف المعقدة. ويعد أفضل مطهر لكل جهاز تصوير طبي هو الذي يوصي به بائعه، في حين أن الأسطح الأخرى لديها مطهر أفضل وفقًا لطبيعتها. تعتبر استشارة قسم IPC هي الحل الأمثل للتحديات والتعامل مع المواقف المعقدة.

الكلمات الرئيسية: الوقاية من العدوى ومكافحتها، قسم الأشعة، الأشعة المقطعية،

الولايات المتحدة، كوفيد-19