

Knowledge, Attitudes, and Practices of Radiographers Towards Aseptic Techniques in Emergency and Trauma Imaging

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ABSTRACT

Emergency and trauma imaging is one area in radiology where cross-contamination frequently occurs. Therefore, radiographers must have adequate knowledge, positive attitudes, and safe practices of aseptic techniques in this area to reduce infection and prevent its associated health risks. This study aims to determine the knowledge, attitudes, and practices (KAP) towards aseptic techniques in emergency and trauma imaging and its association with demographic profile of radiographers in Northern Mindanao, Philippines. Convenience sampling was used to recruit 74 radiographers from seven tertiary care hospitals in Northern Mindanao, Philippines. An adapted questionnaire was used to measure radiographers' KAP level towards aseptic techniques in emergency and trauma imaging. Results showed that most radiographers have positive attitudes but have inadequate knowledge and unsafe practice of aseptic techniques in emergency and trauma imaging. Radiographers who have earned a graduate or postgraduate degree were more likely to have adequate knowledge and safe practices of aseptic techniques. Older and experienced radiographers were more likely to have safe practices of aseptic techniques towards emergency and trauma imaging. Given the results, further training is required for radiographers in Northern Mindanao, Philippines, regarding aseptic technique practices in emergency and trauma imaging, targeted to less experienced and younger radiographers.

KEYWORDS: aseptic techniques; emergency department; KAP; radiographers; trauma imaging

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1. Introduction

Infections acquired in healthcare settings within 48 hours of admission, three days after discharge, or 30 days after surgery are known as nosocomial infections [1,2]. These are most often bacterial, but they may also be viral or fungal in nature [3]. Air,

contact, drink, droplet, food, and vectors are all vehicles by which pathogens spread [4]. In developed countries, the infection affects 3.5-12 percent of patients, while it is more common in developing countries, such as Jordan, where it affects 5.7-19.1 percent [3].

Higher rates of nosocomial infections are linked to higher rates of healthcare-related mortality, cost, length of stay, and microorganism resistance [5,6]. As a result, it is important to investigate the possible causes of high nosocomial infection rates in developing countries.

At least one-third of nosocomial infections can be avoided if infection management procedures are followed properly [7]. The Centers for Disease Control and Prevention of the United States of America's Healthcare Infection Control Practices Advisory Committee issued recommendations for infection prevention strategies that extend to all patients in 2007 [7]. These recommendations are based on a collection of isolation and infection prevention documents known as Standard Precautions [8], which have been published since 1970. The aim of Standard Precautions is to avoid nosocomial infection transmission and protect healthcare workers from cross-infection [9].

Though invasive procedures and instruments such as urinary and central venous catheters are responsible for a large proportion of preventable nosocomial infections [10], cross-contamination may also occur after handling infected equipment or other fomites [11]. The emergency department (ED) is one of the most prominent areas where cross-contamination can occur. It is an important part of the healthcare system, and its impact is growing as more people seek treatment and are admitted to hospitals through it [12]. Invasive procedures such as central lines are being placed more often in the ED, but best practices (i.e., full barrier precautions) are not always followed [13,14]. In addition to crowding, frequent interruptions in care delivery, the use of non-traditional care areas such as hallways and conference rooms, and the proximity of patients, who are frequently separated only by curtains, ED clinicians face a number of workflow problems that may contribute to the spread of infections [15, 16]. Given that many of these barriers have been established as infection prevention risks, knowing the ED areas where the majority of the procedures were performed is important [17]. The radiology department is one of these areas.

Every day, hundreds of patients visit the radiology unit. Any of them may be a source of nosocomial infections or be prone to them. Furthermore, due to the rise in the number of targeted patients and the difficulty of the procedures, advancements in diagnostic and interventional radiology over the last three decades have resulted in longer stays in the radiology department [18].

During their time in the radiology unit, patients come into contact with a range of radiographic equipment. Fomites that have been shown to harbor nosocomial pathogens include lead aprons, image receptors, and adhesive tape used to bind radiographic markers [19]. Direct interaction between patients and healthcare staff has also been identified as a major source of cross-bacterial infection [20]. Invasive procedures, such as interventional radiology and operating room imaging, are also the most common source of nosocomial infections [21].

In terms of nosocomial infection prevention, radiographers are essential members of the radiology department. They have direct and indirect communication with patients as part of their job. They deal with a variety of imaging modalities and participate in ED procedures. Radiographers often move between departments to conduct tasks ranging from basic X-ray inspections to long, invasive, complex, and aseptic procedures in the operating room under fluoroscopic guidance.

Inadequate knowledge has been established as a major factor in poor adherence to the Standard Precautions [22,23]. Despite the fact that guidelines and recommendations on Standard Precautions and basic infection prevention procedures have been provided since the 1970s, no Filipino research has evaluated radiographers' knowledge in these areas. The literature on this subject is sparse all over the world. A previous study assessed the level of infection management knowledge among Egyptian healthcare providers from various disciplines. Radiographers had the lowest level of expertise among those surveyed [24]. Another study described radiographers in Sri Lanka as having strong knowledge of nosocomial infection prevention and Standard Precautions [25]. Still, infection management procedures unique to the radiography profession's evaluation were not included in any of the previous reports.

This study aims to assess the knowledge, attitudes, and practices (KAP) towards aseptic techniques in emergency and trauma imaging and its association with radiographers' demographic profile in Northern Mindanao, Philippines. The study's findings may be used to guide the development of guidelines to improve aseptic practices in the hospitals' emergency and trauma imaging departments.

2. Methodology

2.1 Study Design and Period

This was a prospective, cross-sectional study. The study was conducted from September 2020 to February 2021.

2.2 Study Setting

The research was conducted at the Radiology and Imaging Departments of seven tertiary care hospitals in Northern Mindanao, Philippines.

2.3 Sampling Technique

Convenience sampling was used. A total of 74 radiographers were included in the study. During the study period, approximately 120 radiographers were employed in the study setting.

2.4 Study Variables

Independent variables included age, sex, educational status, years in practice, and monthly income. The outcome variable was KAP towards aseptic techniques.

2.5 Inclusion and Exclusion Criteria

Radiographers practicing for 1–8 years in the emergency and trauma imaging area were included in the study. During the study period, radiographers under the age of 23 and above 40 years were considered vulnerable to COVID-19 by the tertiary care hospitals in the study area. Because these age groups were considered high-risk for COVID-19, their clinical duty was limited only to administrative tasks. Hence, they were not included in the study.

2.6 Data Collection Tool

The data collection tool consisted of four parts. The first part sought to determine radiographers' demographic profile, while parts two to four sought to measure the KAP towards aseptic techniques. KAP scale items were adopted from a previous study [26]. The questionnaire was modified to fit the emergency and trauma imaging context. The modified questionnaire was used in a pilot study including 20 radiographers in emergency and trauma imaging departments using a four-week retest design to check the reliability of the questionnaire. Pearson's correlation coefficient was computed, which showed high reliability of the modified version of questionnaire ($r = 0.871$, $p < 0.001$).

The knowledge section had 10 items and each question was answered 'true' or 'false'. Correct answers scored 1 and incorrect answers scored 0. The attitude section had six items, and items were responded with either agree (1 point) or disagree (0 point). The practice section had six items and each item was answered 'yes' (1 point), 'no' (0 point) or 'sometimes' (0 point). The questionnaire was prepared in English (English and Filipino are the official languages of the Philippines). The questionnaire had a cutoff point of about 50%. Radiographers who attained a 50% correct mark were deemed to have adequate knowledge, while those who scored below 50% were inadequate. Similar scoring was employed in the attitude (positive/negative) and practice (safe/unsafe) sections.

2.7 Ethical Consideration

This research was approved by the Institutional Ethics Review Committee of Iligan Medical Center College. Before the administration of the questionnaire, written informed consent was obtained from the radiographers. Radiographers were fully aware that the survey responses from the study will be used exclusively for the research. Furthermore, the radiographers were given the choice to answer the items in the survey questionnaires. All responses were kept confidential.

2.8 Data Collection

Permission from the hospital administration was sought. Questionnaires were then administered through an online survey to the respondents after approval was granted. Finally, questionnaires were collected immediately after completion.

2.9 Data Management and Statistical Analysis

Descriptive and inferential statistics were used to analyze the data. Frequency and percentage were used for categorical variables, while the mean was employed for continuous variables. Binary logistic regression was used to determine the association between the demographic profile and KAP level. A p-value less than 0.05 was considered statistically significant.

3. Results

3.1 Demographic Profile

The demographic profile of the radiographers is shown in Table 1. All of the 74 radiographers sampled in the study completed the online-based survey questionnaire. Of the 74 radiographers included in the study, 48 (64.86%) were in the age group of 32-40 years, while 26 (35.14%) were in the age group of 23-31 years. There were more male radiographers (n=39, 52.70%) compared to female (n=35, 47.30%). In terms of educational status, most radiographers were B.Sc. holders (n=59, 79.73%), while the remaining were either M.Sc. or Doctoral holders (n=15, 20.27%). There were more radiographers who practiced the profession for 5-8 years (n=47, 63.51%) compared to those who practiced for 1-4 years (n=27, 36.49%). The majority of the respondents (n=42, 56.76%) earned less than 20,000 Philippine Peso (PhP).

3.2 KAP Level

KAP level of the radiographers towards aseptic techniques in emergency and trauma imaging is shown in Figure 1. Most of the radiographers have positive attitudes (57%) towards aseptic techniques in emergency and trauma imaging. However, most of them also have inadequate knowledge (59%) and unsafe practice (63%) of aseptic techniques.

3.3 Association Between Demographic Profile and KAP

Table 2 shows that radiographers who were in the age group of 32-40 years were 2.86 times more likely to have adequate knowledge (OR: 2.86, CI: 1.96-4.19) and 1.53 times more likely to have safe practices (OR: 1.53, CI: 1.06-2.21) of aseptic techniques towards emergency and trauma imaging compared to those who were in the age group of 23-31 years. Female radiographers have 2.42 times more positive attitude (OR: 2.42, CI: 1.28-3.56) towards aseptic techniques in emergency and trauma imaging compared to male radiographers. Radiographers with either M.Sc. or Doctoral degree were 2.01 more likely to have adequate knowledge (OR: 2.01, CI: 1.75-2.26) and 3.71 times more

Table 1. Demographic profile of the radiographers.

Profile	Frequency (n)	Percentage (%)
Age (mean=30 years), years		
23-31	26	35.14
32-40	48	64.86
Sex		
Male	39	52.70
Female	35	47.30
Educational Status		
B.Sc.	59	79.73
M.Sc. / Doctoral	15	20.27
Years in Practice		
1-4	27	36.49
5-8	47	63.51
Monthly Income, Philippine Peso (PhP)		
< PhP 20,000	42	56.76
> PhP 20,000	32	43.24

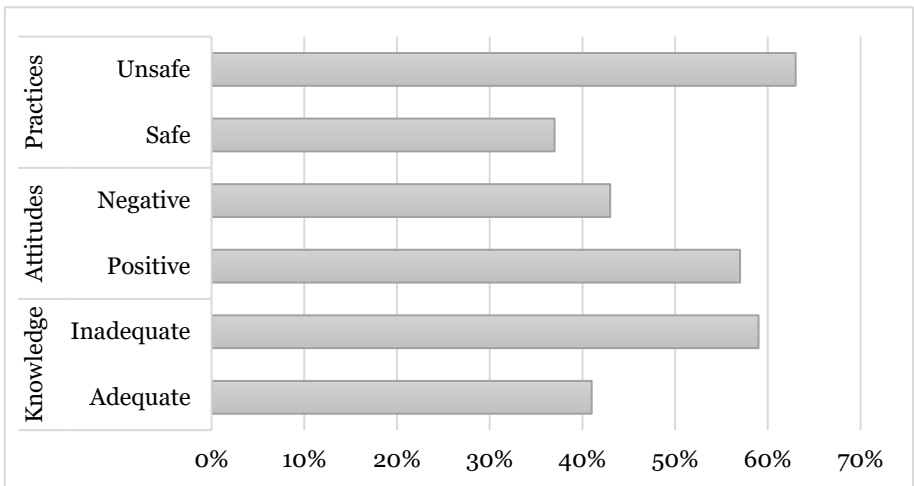


Figure 1. KAP towards aseptic techniques in emergency and trauma imaging among the radiographers.

Table 2. Association between demographic profile and KAP, n=74.

Profile	OR (95% CI)		
	Knowledge	Attitudes	Practices
Age, years			
23-31	1	1	1
32-40	2.86 (1.96-4.19) *	1.01 (0.55-1.47)	1.53 (1.06-2.21) *
Sex			
Male	1	1	1
Female	1.44 (0.3-2.58)	2.42 (1.28-3.56) *	1.39 (0.02-2.76)
Educational Status			
B.Sc.	1	1	1
M.Sc. / Doctoral	2.01 (1.75-2.26) *	1.39 (0.47-2.31)	3.71 (3.43-3.99) *
Years in Practice			
1-4	1	1	1
5-8	1.24 (0.96-1.52)	1.31 (0.35-2.27)	5.06 (4.75-5.36) *
Monthly Income, PhP			
< PhP 20,000	1	1	1
> PhP 20,000	1.08 (0.79-1.37)	1.32 (0.38-2.26)	1.06 (0.76-1.36)

*significant at p<0.001.

likely to have safe practices (OR: 3.71, CI: 3.43–3.99) of aseptic techniques towards emergency and trauma imaging. Finally, radiographers who practiced the profession for 5-8 years were 5.06 more likely to have safe practices (OR: 5.06, CI: 4.75–5.36) of aseptic techniques towards emergency and trauma imaging compared to those who practiced for 1-4 years. All other variables were statistically not significant.

4. Discussion

To the best of the authors' knowledge, no studies were conducted to determine the radiographers' KAP level towards aseptic techniques in emergency and trauma imaging. This study reported that most radiographers in the tertiary care hospitals of Northern Mindanao, Philippines, have inadequate knowledge and unsafe practices of aseptic techniques in emergency and trauma imaging. This result is concordant to the level of knowledge and practices reported in previous studies at the University of Namibia and at hospitals in Sri Lanka, suggesting that the radiographers' knowledge and practices in the prevention and control of nosocomial infections and standard precautions were inadequate and unsafe [25, 27, 28]. However, in the reported studies, the areas where knowledge and practices of the radiographers were assessed, covered all radiological modalities. Therefore, it is clearly difficult to compare the present study results to the previous literature as the present study covered only the emergency and trauma imaging area. Nevertheless, the inadequate knowledge and unsafe practices of radiographers in aseptic techniques in radiological areas, especially in emergency and trauma imaging, may be used as stimulus for radiology department administrators to formulate programs that improve the knowledge and safe practices of radiographers.

In the aspect of age and years in practice, this study showed that experienced (5-8 years) and older radiographers (32-40 years) were more likely to have adequate knowledge and safe practices of aseptic techniques towards emergency and trauma imaging compared to less experienced (1-4 years) and younger radiographers (23-31 years). This result emphasizes the need to create training regarding aseptic technique practices in emergency and trauma imaging targeted to less experienced and younger radiographers. This finding is also a clear message to the educational institutions that principles of aseptic technique should be included or more stressed in the undergraduate radiography curricula.

It is noteworthy to report that radiographers who have earned an advanced graduate or postgraduate degree were more likely to have adequate knowledge and safe practices than radiographers with only an undergraduate degree in radiography. This result showed how knowledge and practice levels differed between radiographers with varied educational attainment. Radiographers who pursued further educational degrees develop higher-order theoretical and clinical skills, which could be applied in the actual professional practice. The assumption was that radiographers who have earned additional degrees might have attended educational training in emergency and trauma imaging than radiographers with only an undergraduate radiography degree, which might have enhanced their knowledge and safe practices of aseptic techniques in emergency and trauma imaging. More studies are needed to confirm this assumption by adding more factors affecting KAP in the logistics analysis to possibly control for confounders.

This study is limited as it was unable to explore the reasons for the radiographers' inadequate knowledge and practice levels towards aseptic techniques in emergency and trauma imaging. Therefore, it is recommended that a qualitative study will be conducted to explain more the reasons behind this interesting result. Further, it is recommended that an aseptic technique program, which is included in the infection control policy or regional guideline, be implemented in emergency and trauma imaging areas of radiology departments in Northern Mindanao, Philippines, to increase the KAP level of the radiographers.

A standardized tool with established statistical reliability and validity is needed to accurately measure the radiographers' KAP level towards aseptic practices in emergency and trauma imaging areas in the radiology departments of Northern Mindanao, Philippines. Although a pilot study was conducted to ensure the questionnaire's reliability and validity, English-written questions and instructions could have been misunderstood. Further adjustment and confirmatory factorial analysis for testing the reliability and validity questionnaire are recommended.

The small sample size is also a limitation of the study as it is not a reflection of the radiographers' population in Northern Mindanao, Philippines. More radiographers should be included in the future to describe the KAP level towards aseptic practices in emergency and trauma imaging among radiographers in the study area. Due to the unprecedented circumstances of COVID-19 in the studied tertiary care hospitals, stringent inclusion and exclusion criteria were applied in the study. Hence, these may reduce the generalizability of sample study findings to the target population. Further, this research should be repeated in other regions of the Philippines to understand better the KAP level towards aseptic practices in emergency and trauma imaging from both national and regional perspectives.

5. Conclusions

This study showed that the majority of the radiographers in tertiary care hospitals in Northern Mindanao, Philippines, have positive attitudes towards aseptic techniques in emergency and trauma imaging. However, most of them have inadequate knowledge and unsafe practice of aseptic techniques. Radiographers who were in the older age group and have earned a graduate or postgraduate degree were more likely to have adequate knowledge and safe practices of aseptic techniques towards emergency and trauma imaging. Experienced radiographers were more likely to have safe practices of aseptic techniques towards emergency and trauma imaging. The findings of the study emphasized the need to create training and guidelines regarding aseptic technique practices in emergency and trauma imaging, targeted to less experienced and younger radiographers. A radiology department program that seeks to improve the radiographers' KAP level towards aseptic techniques, should be initiated in the tertiary care hospitals of Northern Mindanao, Philippines, to reduce nosocomial infections and prevent its associated health risks in the emergency and trauma imaging areas.

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Conflict of Interest Statement

The authors declare no conflict of interest.

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References

1. Choi, J.; Kwak, Y.; Yoo, H.; Lee, S.O.; Kim, H.; Han, S.; Kim, T. Trends in the incidence rate of device-associated infections in intensive care units after the establishment of the Korean Nosocomial Infections Surveillance System. *J Hosp Infect* **2015**, *91*, 28-34.
2. Khan, H.A.; Baig, F.K.; Mehboob, R. Nosocomial infections: Epidemiology, prevention, control and surveillance. *Asian Pac J Trop Biomed* **2017**, *7*, 478-482.
3. Allegranzi, B.; Nejad, S.B.; Combescure, C.; Graafmans, W.; Attar, H.; Donaldson, L.; Pittet, D. Burden of endemic health-care-associated infection in developing countries: systematic review and meta-analysis. *The Lancet* **2011**, *377*, 228-241.
4. Ling, M.L.; Apisarnthanarak, A.; Madriaga, G. The burden of healthcare-associated infections in Southeast Asia: A systematic literature review and meta-analysis. *Clin Infect Dis* **2015**, *60*, 1690-1699.

5. Chacko, B.; Thomas, K.; David, T.; Paul, H.; Jeyaseelan, L.; Peter, J.V. Attributable cost of a nosocomial infection in the intensive care unit: A prospective cohort study. *World J Crit Care Med* **2017**, *6*(1), 79-84.
6. Heister, T.; Kaier, K.; Wolkewitz, M. Estimating the burden of nosocomial infections: Time dependency and cost clustering should be taken into account. *Am J Infect Control* **2017**, *45*, 94-95.
7. Barchitta, M.; Matranga, D.; Quattrocchi, A.; Bellocchi, P.; Ruffino, M.; Basile, G.; Agodi, A. Prevalence of surgical site infections before and after the implementation of a multimodal infection control programme. *J Antimicrob Chemother* **2011**, *67*, 749-755.
8. Siegel J.D.; Rhinehart E.; Jackson M.; Chiarello L. 2007 guideline for isolation precautions: Preventing transmission of infectious agents in health care settings. *Am J Infect Control* **2007**, *35*, 65-164.
9. Amin, T.T.; Al Noaim, K.I.; Saad, M.A.; Al Malhm, T.A.; Al Mulhim, A.A.; Al Awas, M.A. Standard precautions and infection control, medical students' knowledge and behavior at a Saudi university: The need for change. *Glob J Health Sci* **2013**, *5*, 114-125.
10. Marchetti A; Rossiter R. Economic burden of healthcare-associated infection in US acute care hospitals: societal perspective. *J Med Econ* **2013**, *16*, 1399-1404.
11. Hardy, K.J.; Oppenheim, B.A.; Gossain, S.; Gao, F.; Hawkey, P.M. A study of the relationship between environmental contamination with methicillin-resistant *Staphylococcus aureus* (MRSA) and patients' acquisition of MRSA. *Infect Control Hosp Epidemiol* **2006**, *27*, 127-132.
12. Schuur, J.D.; Venkatesh, A.K. The growing role of emergency departments in hospital admissions. *N Engl J Med* **2012**, *367*, 391-393.
13. Glickman, S.W.; Krubert, C.; Koppenhaver, J.; Glickman, L.T.; Schulman, K. A., & Cairns, C. B. Increased rate of central venous catheterization procedures in community EDs. *Am J Emerg Med* **2010**, *28*, 208-212.
14. LeMaster, C.H.; Agrawal, A.T.; Hou, P.; Schuur, J.D. Systematic review of emergency department central venous and arterial catheter infection. *Int J Emerg Med* **2010**, *3*(4), 409-423.
15. Hoot, N.R.; Aronsky, D. Systematic review of emergency department crowding: Causes, effects, and solutions. *Ann Emerg Med* **2008**, *52*, 126-136.
16. McNaughton, C.; Self, W.H.; Jones, I.D.; Arbogast, P.G.; Chen, N.; Dittus, R.S.; Russ, S. ED crowding and the use of non-traditional beds. *Am J Emerg Med* **2012**, *30*, 1474-1480.
17. Venkatesh, A.K.; Pallin, D.J.; Kayden, S.; Schuur, J.D. Predictors of hand hygiene in the emergency department. *Infect Control Hosp Epidemiol* **2011**, *32*, 1120-1123.
18. Üstünsöz, B. Hospital infections in radiology clinics. *Diagn Interv Imaging* **2005**, *11*, 5-9.
19. Boyle, H.; Strudwick, R.M. Do lead rubber aprons pose an infection risk? *Radiography* **2010**, *16*, 297-303.
20. Bhalla, A.; Pultz, N.J.; Gries, D.M.; Ray, A.J.; Eckstein, E.C.; Aron, D.C.; Donskey, C.J. Acquisition of nosocomial pathogens on hands after contact with

- environmental surfaces near hospitalized patients. *Infect Control Hosp Epidemiol* **2004**, *25*, 164-167.
21. Reed, D.; Kemmerly, S.A. Infection control and prevention: a review of hospital-acquired infections and the economic implications. *Ochsner J* **2009**, *9*, 27-31.
 22. Luo, Y.; He, G.P.; Zhou, J.W.; Luo, Y. Factors impacting compliance with standard precautions in nursing, China. *Int J Infect Dis* **2010**, *14*, 1106-e1114.
 23. Suchitra, J.; Devi, N.L. Impact of education on knowledge, attitudes and practices among various categories of health care workers on nosocomial infections. *Indian J Med Microbiol* **2007**, *25*, 181-187.
 24. El-Gilany, A.; Badawy, K.; Sarraf, B. Mansoura Üniversitesi Eğitim Hastanesi Sağlık Bakımı Çalışanlarının Standart Önlemler ve Enfeksiyon Kontrolü Bilgileri, Mısır. *TAF Prev Med Bull* **2012**, *11*, 1-6.
 25. Ojulong J.; Mitonga K.H.; Iiping S.N. Knowledge and attitudes of infection prevention and control among health sciences students at University of Namibia. *Afr Health Sci* **2013**, *13*, 1071-1078.
 26. Gezie H.; Leta E.; Admasu F.; Gedamu S.; Dires A.; Goshiye D. Health care workers knowledge, attitude and practice towards hospital acquired infection prevention at Dessie referral hospital, Northeast Ethiopia. *Clin J Nurs Care Pract* **2019**, *3*, 59-63.
 27. Jayasinghe, R.D.; Weerakoon, B.S. Prevention of nosocomial infections and standard precautions: knowledge and practice among radiographers in Sri Lanka. *J Med Allied Sci* **2014**, *4*, 9-16.
 28. Yakob, E.; Lamaro, T.; Henok, A. Knowledge, attitude and practice towards infection control measures among Mizan-Aman general hospital workers, South West Ethiopia. *J Community Med Health Educ* **2015**, *5*, 1-8.

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