

Original Article

Infection Control Procedures and Practices in Intensive Care Units of a General Hospital, Sana'a, Yemen

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Abstract

Background: Patients admitted to intensive care units (ICUs) are at a greatest risk of health care associated infections (HAIs). Adherence to infection control (IC) precautions helps to prevent HAIs.

Objective(s): To assess the infection control (IC) procedures and practices in intensive care units (ICUs).

Methods: A cross sectional survey was conducted in ICUs of Althawra General Hospital in Sana'a, Republic of Yemen. All ICUs and their managers (n=12) and health care workers (n=200) made the target of the study. Data were collected using the IC assessment tool designed by the United States Agency for International Development (US-AID). It comprises modules for IC procedures and observation checklists for IC practices.

Results: The IC procedures were poor regarding hand hygiene practices (49.1%), injection practices (25%), and type of catheters used in ICUs (16.7%). The IC practices of HCWs were poor regarding hand hygiene practices (30.2% in 46% of the ICUs), injection administration practices (35.7% in 34.5% of the ICUs) and waste disposal practices (23.5% in 92.5% of the ICUs).

Conclusion: Infection control procedures and practices in ICUs of Althawra General Hospital were poor with respect to injection practices, type of catheters used in ICUs, hand hygiene practices, injection administration, and waste disposal.

Recommendations: Improving the IC procedures regarding hand hygiene practices, injection practices, and type of catheters used in ICUs and addressing the IC practices of HCWs is a necessity.

Keywords: Infection control, intensive care units, practices of HCWs.

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INTRODUCTION

Healthcare associated infections (HAIs) can be defined as infections occurring in a patient in a hospital or other health care facility in whom the infection was not present or incubating at the time of admission. This includes infections acquired in the hospital but appearing after discharge and occupational infections among staff of the facility. HAIs are one of the common problems faced by hospitals in all countries around the world. They are associated with increased morbidity and mortality among hospitalized patients and predispose the health care workers (HCWs) to infections.⁽¹⁾

The World Health Organization (WHO) reported in 2010 that in high income countries, approximately 30% of patients in intensive care units (ICUs) were affected by at least one HAI. In low and middle-income countries, the frequency of HAIs was at least 2-3 folds higher than in high income countries.⁽¹⁾ Patients admitted to ICUs are at risk of acquiring HAIs partly because of their serious underlying diseases and exposure to life-saving invasive

procedures.⁽²⁾ That is why the rates of infections in ICUs are approximately three times higher than elsewhere in hospitals and patients in ICUs have a higher risk of HAIs than those in non-critical care settings. The need for IC in ICUs was born out of the need to prevent HAIs.⁽³⁾ A study conducted in medical ICUs in USA (1999), showed that urinary tract infections (UTIs) were the most frequent infection (31%), followed by pneumonia (27%) and primary bloodstream infections (19%). Eighty-seven percent of primary bloodstream infections were associated with central lines, 86% of nosocomial pneumonia was associated with mechanical ventilation, and 95% of UTIs were associated with urinary catheters.⁽⁴⁾

In 2006, a study in 55 ICUs of 8 developing countries revealed an overall rate of 14.7%. Ventilator associated pneumonia posed the greatest risk, followed by central venous catheter related blood stream infections and catheter associated UTIs. They constituted 41%, 30% and 29% of all device associated infections respectively.⁽⁵⁾ In Egypt, the risk of HAIs is especially significant in the ICUs. Approximately 30% of ICU patients are affected by

one or more episodes of HAIs.⁽⁶⁾ A study conducted in Egypt (2012), showed an overall rate of device associated HCAIs of 32.8% in ICUs. The central line associated blood stream infection rate was 20%, the ventilator associated pneumonia rate was 52% and the catheter associated UTI rate was 28%.⁽⁷⁾

The need for infection control in healthcare facilities is born out of the need to prevent HAIs.⁽²⁾ In Argentina (2003) a study conducted in ICUs showed that the implementation of an infection control program, using education and performance feedback, resulted in significant reductions in rates of infection in ICUs.⁽⁸⁾

A study conducted in neonatal ICUs in USA (2004), revealed that 76% of HCWs reported wearing gloves, and 81% reported routine hand washing. HCWs who knew that bacterial hand counts are higher with rings, long and artificial fingernails are associated with higher gram negative bacterial hand contamination constituted 35%, 30% and 35% respectively.⁽⁹⁾

A study conducted in a neonatal ICU, Embaba Hospital, Giza governorate, Egypt (2011), showed that performance of hand hygiene was scored poor (67%) before patient contact and good (84%) after patient contact. Compliance to standard was scored good in hand washing and intravenous fluid preparation (82% and 87% respectively), while it was poor in cannula insertion (74%).⁽¹⁰⁾

A study conducted in ICUs in Jordan (2014), showed that 78.9% of HCWs reported that they always wash their hands before and after giving care to patients, and 63.2% reported that they always wash their hands before and after using gloves. About one quarter (23.5%) of the nurses reported that they always recap needles.⁽¹¹⁾

Literature review revealed that in Yemen, research conducted on IC practices in ICUs was mainly done on selected ICU devices such as central venous catheters. A survey conducted in Sana'a hospitals (2010) to describe the ICUs current IC practices regarding the management of central venous catheters, showed that there was a low adherence with hand hygiene (40-72%) before and after insertion, use and care of central venous catheters.⁽¹²⁾

The aim of the study was to assess the infection control (IC) procedures and practices in ICUs at Althawra General Hospital in Sana'a, Yemen.

METHODS

A cross sectional survey was conducted in ICUs of Althawra General Hospital. All ICUs (n=12) in the hospital were visited, all HCWs (physicians and nurses) (n=200) and all managers (n=12) of the ICUs were included in the study.

Data were collected from beginning of August 2016 to the end of September 2016 by one of the researchers using the IC assessment tool designed by the United States Agency for International Development (USAID)^(13,14) which consists of IC assessment modules and observation

checklists. Seven IC control assessment tool modules were applied once for each ICU and managers of the ICUs were interviewed to complete their questions. Three observation checklists for assessment of IC practices of HCWs.

Regarding the IC assessment modules, each module is divided into sections to assess performance in particular areas of the practice. Managers were interviewed to complete the questions of the modules which included the following:

- Staffing, general practices in the ICU, mechanical ventilation and prophylaxis and monitoring:
 - Staffing including the number of beds and the number of nurses in the shift.
 - General practices including the frequency of cleaning of ICU, wearing cover gowns or special shoes to enter ICU, and performing hand hygiene prior to entering the ICU.
 - Mechanical ventilation including handling of ventilator circuits and humidifiers, frequency of changing ventilator circuit, type of humidifier in ventilator circuit, type of water used to fill the humidifier, and use of bacterial filters in ventilator circuits.
 - Prophylaxis and monitoring including prophylaxis for a number of conditions such as deep vein thrombosis, stress ulcers or gastritis, monitoring sedation, and blood glucose.
- Airway suctioning including type of fluid used in airway suctioning, frequency of changing of suction catheters, use and supply of gloves and masks during suctioning, frequency of changing nebulizers, and type of cuff used on endotracheal tubes.
- Hand Hygiene including
 - Hand hygiene equipment and supplies: number of hand washing stations and beds, source of water used for hand washing, availability of running water, type of soap used, method of drying of hands, and use of waterless alcohol-based hand antiseptic.
 - Hand hygiene practices: situations where doctors and nurses practice hand hygiene, policy on covering skin lesions and cuts with waterproof dressing, keeping finger nails short, wearing gloves instead of hand washing, and dealing with empty hand lotion containers.
- Injections including injection practices (availability of auto disable needle and swabbing the top of the vial with alcohol), and injection policies and education (following the WHO guidelines for safe use of needles and having routine training about safe injection).
- Intravenous catheters including types of catheters used, type of skin antiseptic used, changing of intravenous catheters, type of dressing used to cover the catheter insertion site, reuse of intravenous catheters, and barrier precautions used during catheter insertion.
- Intravenous fluids and medications including preparation of fluids and medications, frequency of changing infusion tubing, frequency of using single dose

vials, disinfection of multi-dose vials before use, and procedures for using multi-dose vials of injectable fluids.

- Isolation and standard precautions including policies and precautions for isolating patients with potential contagious infections, policies for cleaning and fumigation of rooms, type of isolation precautions, supplies for isolation precautions, precautions for airborne diseases, and precautions for viral hemorrhagic fever.

Each section in each module has its own possible total score and performance rating. There is also a total score and an overall performance rating for the module as a whole. For each response a point value of one indicates a recommended practice and a point value of three indicates a highly recommended practice. Responses with no point value attached are generally not recommended. A score of more than 75% indicates that the recommended practices are followed consistently and thoroughly, a score of 50-75% indicates that the recommended practices are usually followed while a score of less than 50% indicates that training is needed on the recommended practices.

Concerning the checklists, the following are the checklists that were used to assess the IC practices of HCWs:

- Observation checklist for hand hygiene practices including type of health worker, type of patient contact, type of hand hygiene before and after patient contact, and type of hand hygiene before an antiseptic procedure.
- Checklist for injection administration including the person giving the injection, practice of hand hygiene before injection, use of sterile syringe and needle, disinfection of vial, use of sterile gauze to break the ampoules, use of gloves for intravenous injection, disinfection of skin before intravenous injection, disposal of sharps in sharps container, use of sterile gauze to break ampoules, and practice of hand hygiene after injection.
- Checklist for waste disposal including disposal of sharps, disposal of gloves, disposal of contaminated materials and disposal of non-contaminated materials.

Regarding the total score given to the practices of HCWs in ICUs, responses with no point value attached are generally not recommended. A point value of one indicates a recommended practice while a point value of three indicates a highly recommended practice. A score of more than 75% indicates that the recommended practices are followed consistently and thoroughly, a score of 50-75% indicates that the recommended practices are usually followed while a score of less than 50% indicates that training is needed on the recommended practices.

Data management and statistical analysis

Data entry was performed after coding using SPSS program and descriptive statistics were used for summarization. The scoring assessment recommended by USAID was used to assess different sections of the modules.

Ethical Statement

The study was approved by the Ethics Committee of the High Institute of Public Health. The researchers complied

with the International Guidelines for Research Ethics. Verbal consent was taken from the study participants after explanation of the purpose and benefits of the research. Anonymity and confidentiality were assured.

RESULTS

Results of IC assessment tool modules

Each module is divided into sections to assess performance areas of practice. Interviewing the managers of the ICUs gave the following responses:

1. ICU information module:

Patients admitted to the ICU were adults in 41.7% of the ICUs. The number of beds per nurse was ≤ 2 beds per nurse in 83.4% of the ICUs. Patients' care areas were cleaned at least daily and between patients in all ICUs. HCWs and visitors were required to perform hand hygiene prior to entering the ICU in 8.3% of the ICUs. Position of the head of the bed in mechanically ventilated patients was stated to be elevated greater than 30 degrees in half of the ICUs. Less than 50% of the ventilated patients received routine deep vein thrombosis (DVT) prophylaxis in 41.7% of the ICUs. In one third of the ICUs, 50-75% of patients received routine DVT prophylaxis while more than 75% of patients received prophylaxis in a quarter of the ICUs. Daily assessment of lung mechanics was mentioned to be done in all ICUs. The same suction catheter was not used more than once in ventilated patients in all ICUs. The type of water used to fill the humidifier was distilled water in 41.7% of the ICUs, tap water in one third of the ICUs and sterile water in one quarter of the ICUs.

Score was excellent for characteristics of ICUs (87.5%) and prophylaxis and monitoring (90.2%) while it was good for general practices in the ICUs (54.1%) and mechanical ventilation (72.2%) (Table 1).

2. Airway suctioning module

The type of fluid instilled for airway suctioning was sterile saline and was dispensed through single dose drawn from a multi-dose container. The airway suction catheters were changed more than once per shift, and suction catheters and masks were not used for more than one patient without reprocessing in all ICUs. Medication nebulizers were mentioned to be changed approximately every day in 8.3% of the ICUs and were only changed for use in another patient in 91.7% of the ICUs. The score was excellent (82.5%) (Table 1).

3. Hand hygiene module

The number of hand washing stations and beds was fewer than one hand washing station per two beds in all ICUs. The source of water for hand washing was running water from sinks in all ICUs. Plain liquid soap was used in 91.7% of the ICUs. Liquid soap dispensers were refilled without cleaning in two thirds of the ICUs and were emptied, washed, and dried before refilling in one third of the ICUs. Hands were washed after contact with patients or their immediate environment in all ICUs, after removing

gloves in 91.7% and after touching potentially contaminated objects or surfaces in 66.7% of the ICUs. Score was good for hand hygiene equipment and supplies (66.2%) while it was poor for hand hygiene practices (49.1%) (Table 1).

4. Intravenous catheters module

All patients required peripheral IV catheters in 41.7% of the ICUs which were changed after or within 72 hours in 45.5% the ICUs. The score was good (64.6%) (Table 1).

5. Intravenous fluids and medications module

The place of admixing IV fluids used in the ICU was where patient care is performed. Single-dose vials were always used for injectable fluids/medications in 91.7% of the ICUs and opened vials were not marked with date and time of expiration in 58.3% of the ICUs. The score was good (66.7%) (Table 1).

6. Injections module

Auto-disable needles were never available in 83.3% of the ICUs and were sometimes available in 16.7% of the ICUs

as stated by the managers. Tops of the multi-dose vials were not swabbed with alcohol before puncturing with a needle in 58.3% of the ICUs. Needles were left in multi-dose vials to withdraw solution for multiple patients in 16.7% of the ICUs. Routine training sessions for the HCWs about safe injection practices were conducted in only one quarter of the ICUs. WHO Safe Injection Global Network guidelines for safe use of needles were not followed in 75% of the ICUs. The score was poor for injection practices (25%) and injection policies and education (27.7%) (Table 1).

7. Urinary catheters module:

Commercially manufactured indwelling urinary catheter without antimicrobials were used in all ICUs. They were not routinely changed in two thirds of ICUs. The score was excellent for procedures for insertion and maintenance of urinary catheters (94.2%), while it was good for procedures for use of indwelling urinary catheters (61.1%) and poor for types of catheter used in this unit (16.7%) (Table 1).

Table 1: Total score given to infection control assessment modules for intensive care units, Althawra General Hospital, Sana'a (2015-2016)

Modules	Module section	Assessment total	Possible total	Percent score	Rating based on percent score
ICUs information	Characteristics	21	2 × 12 = 24	21/24 × 100 = 87.5%	A
	General practices	39	6 × 12 = 72	39/72 × 100 = 54.1%	B
	Mechanical ventilation	52	6 × 12 = 72	52/72 × 100 = 72.2%	B
	Prophylaxis and monitoring	249	23 × 12 = 276	231/249 × 100 = 90.2%	A
Airway suctioning	Airway suctioning	109	11 × 12 = 132	109/132 × 100 = 82.5%	A
Hand hygiene	Equipment and supplies	151	19 × 12 = 228	151/228 × 100 = 66.2%	B
	Practices	59	10 × 12 = 120	59/120 × 100 = 49.1%	C
Intravenous catheters	Intravenous catheters	155	20 × 12 = 240	155/240 × 100 = 64.6%	B
Intravenous fluids and medications	Preparation of fluids	160	20 × 12 = 240	160/240 × 100 = 66.7%	B
Injections	Practices	18	6 × 12 = 72	18/72 × 100 = 25%	C
	Policies and education	10	3 × 12 = 36	10/36 × 100 = 27.7%	C
Urinary catheters	Types	4	2 × 12 = 24	4/24 × 100 = 16.7%	C
	Procedures for use	110	15 × 12 = 180	110/180 × 100 = 61.1%	B
	Procedures for insertion and maintenance	113	10 × 12 = 120	113/120 × 100 = 94.2%	A

- **Assessment total:** sum of points for all marked responses

- **Possible total:** sum of all possible points for the question

- **Percent score:** (column 1/column 2) × 100

- **Rating:**

✓ Excellent (A) >75%

✓ Good (B) 50-75%

✓ Poor (C) < 50%

Results of observation of IC practices of HCWs:

The IC practices of all HCWs in the studied ICUs were observed using three observation checklists:

Figure 1 shows that hand hygiene was not performed before patient contact, after patient contact, after body fluid

A. Checklist for hand hygiene practices:

exposure, after contact with patient surroundings, and before an aseptic procedure in 71.5%, 23.5%, 17%, 60% and 65.5% of the observations respectively.

The total score was excellent in 24.5% of the HCWs while it was good in 29.5% of the HCWs and poor in 46% of the HCWs (Table 2).

B. Checklist for injection administration:

Figure 2 shows that hand hygiene was not practiced before injection in 65.5% of the observations. Sterile needles and syringes were not used in 6% of the observations. Vials of medication were not disinfected with alcohol in 32.5% of the observations. Sterile Cotton or gauze was not used to break ampoules in 61.5% of the observations. Closed

storage of multi-dose vials after use was not present in 2.5% of the observations. Clean single-use gloves for IV injection were not used in 12.5% of the observations. Skin and IV ports were not disinfected with alcohol in 13.5% of the observations.

Disposal of sharps in yellow sharp containers was not done in 92.5% of the observations. Hand hygiene was not performed after giving the injection in 26% of the observations. The total score was excellent in 12% of the HCWs while it was good in 53.5% and poor in 34.5% of the HCWs in the studied ICUs (Table 2).

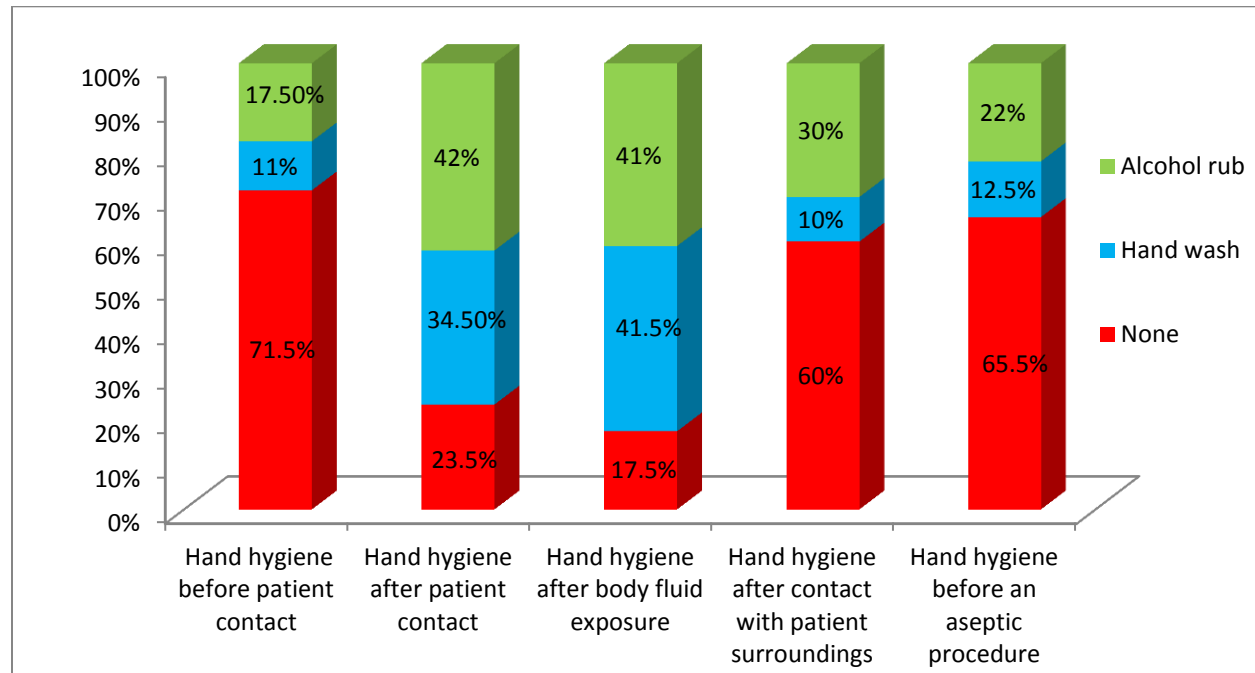


Figure 1: Hand hygiene practices of health care workers, Althawra General Hospital, Sana'a (2015-2016)

Table 2: Scores given to observations of infection control practices of health care workers, Althawra General Hospital, Sana'a (2015-2016)

Score	HCWs* (n=200)	
	No.	%
Hand hygiene		
Excellent	49	24.5
Good	59	29.5
Poor	92	46.0
Injection safety		
Excellent	24	12.0
Good	107	53.5
Poor	69	34.5
Waste disposal		
Excellent	0	0.0
Good	15	7.5
Poor	185	92.5

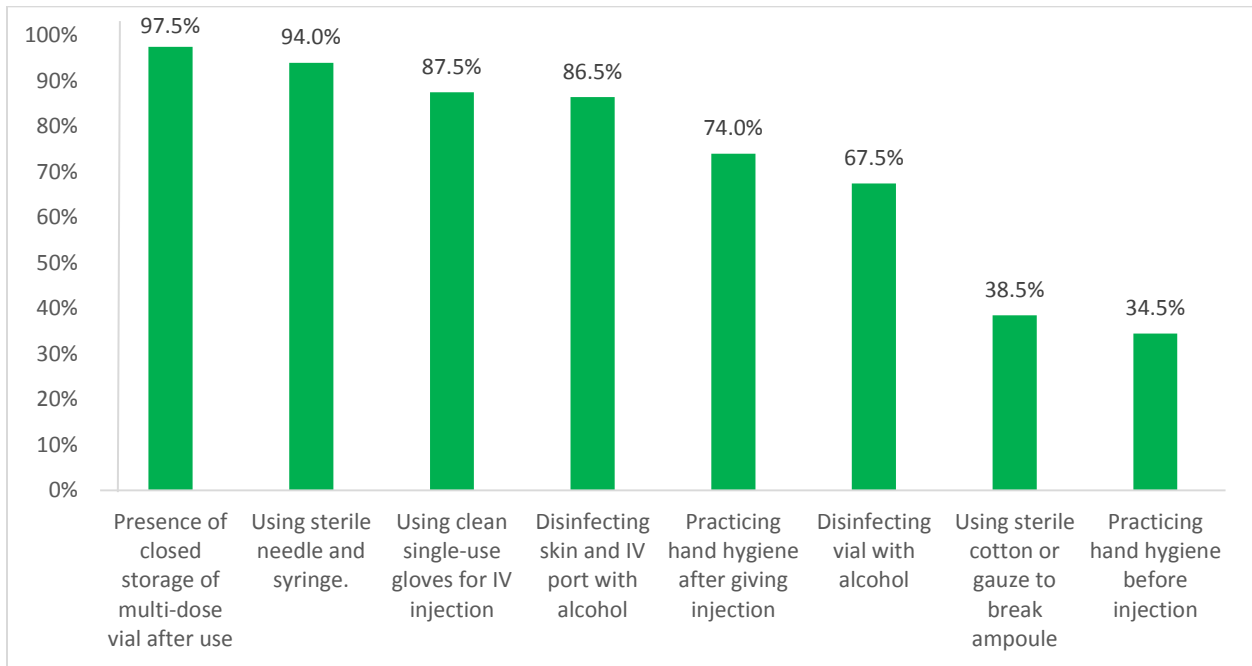


Figure 2: Injection administration practices done by health care workers, Althawra General Hospital, Sana’a (2015-2016)

A. Checklist for waste disposal

Figure 3 shows that sharps were not disposed in yellow sharp containers in 92.5% of the observations. Gloves, swabs and other contaminated materials were not disposed in red containers for contaminated materials in all

observations. Non-contaminated materials were not disposed in a container for general waste in 5.5% of the observations only. The total score was good in 7.5% of the HCWs and poor in 92.5% of the HCWs in the studied ICUs. (Table 2)

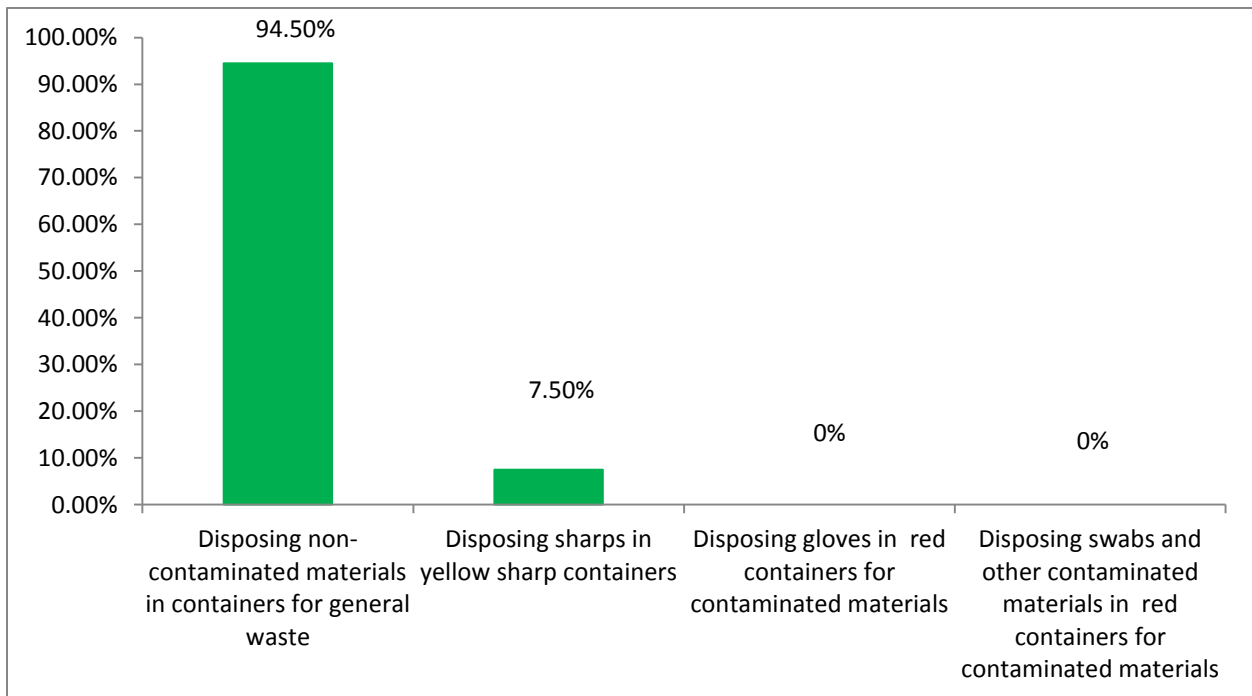


Figure 3: Waste disposal practices done by health care workers, Althawra General Hospital, Sana’a (2015-2016)

DISCUSSION

Infection control assessment tool modules

The study showed that the number of beds per nurse was ≤ 2 in 83.4% of the ICUs. A study conducted in USA (1994) revealed that the average nurse to patient ratio was m and the Australian College of Critical Care Nurses more than one nurse for every two patients.⁽¹⁵⁾ The CDC guidelines recommend that a nurse to patient ratio is 1:1 for each patient on assisted ventilator support or patient on mechanical support for organ function. According to both guidelines, patient ratio and number of nursing staff required depends on: total number of patients, severity of illness of patients, and individual policies for support and monitoring in each unit.^(16,17)

The study revealed that HCWs and visitors were required to perform hand hygiene prior to entering ICUs in 8.3% of the ICUs. A study in ICUs of a tertiary hospital in USA showed that 71% of HCWs performed hand hygiene before entering ICUs.⁽¹⁸⁾ In Egypt (2013), a study in an ICU of Children Cancer Hospital (57357) showed that nurses had unsatisfactory performance regarding all standard precautions including hand hygiene.⁽⁶⁾ Hand hygiene between patients and before entering the ICUs is necessary to minimize transmission of infection from one patient to another.

Hand washing stations and beds were fewer than one station per two beds in all ICUs in the study. In USA (2015), a study revealed that the ratio of beds to sinks was 1:1 in medical ICUs and 4:1 in surgical ICUs, however the increase in number of sinks in medical ICUs had no effect on hand hygiene frequency.⁽¹⁹⁾ The Egyptian guidelines for IC part 2 recommend a ratio of beds to sinks of 4:1 in ICUs.⁽²⁰⁾

The study revealed that hands were washed after removing gloves and after touching potentially contaminated objects or surfaces in 91.7% and 66.7% of the ICUs respectively. Hands were washed before contact with patients and before manipulating medical devices in 25% and 8.3% of the ICUs respectively. A study conducted in Virginia Hospital in USA (2000) showed that in a medical ICU, hand washing was performed by HCWs before and after contact with the patients in 10% and 22% of the observations respectively. Hand washing was also performed by 4% and 13% of the HCWs in a cardiac surgery ICU before and after contact with patients respectively.⁽²¹⁾

The Egyptian guidelines for IC part 1 recommend the personnel to always wash their hands after removing gloves, before and after contact with patients, before clean aseptic procedures, after touching patient surroundings, after completing invasive procedures and after dealing with wounds, whether surgical, traumatic or associated with an invasive device.⁽²²⁾

In the study, the WHO SIGN guidelines for safe use of needles were not followed in three quarters of the ICUs. This might be attributed to lack of training of staff. Studies

in USA (2004) showed that education on injection and catheter insertion reduced the infection rate by 41% to 66% in ICUs.⁽²³⁾ Providing education and training to healthcare staff is an important strategy in implementing an infection prevention program.⁽²⁴⁾ Education has a positive impact on retention of knowledge and practices of staff and has a positive effect on their compliance with IC practices.

Infection control assessment tool observation checklist

Although transmission of microorganisms from hands of HCWs is the main cause of infection and hand washing remains the basic IC practice for preventing cross infection, the observed compliance of HCWs with hand hygiene in the study was much less than ideal. Hand hygiene was performed before and after patient contact by 28.5% and 76.5% of HCWs respectively.

The study conducted in USA (2004) in neonatal ICUs revealed that hand washing was performed before and after patient contact in 40% and 39% respectively.⁽²⁵⁾ Another study conducted in a neonatal ICU in Embaba Hospital, Giza governorate, Egypt (2011) showed that the compliance with hand hygiene was poor (67%) before patient contact and good (84%) after patient contact.⁽²⁶⁾ In the current study, lack of compliance with IC practices could be attributed to absence of required policies and IC manuals, lack of training and educational programs for staff and the staff/patient ratio.

The WHO guidelines on hand hygiene recommend that there are five moments for hand hygiene: before touching a patient, before clean aseptic procedure, after touching a patient, after body fluid exposure risk and after touching a patient surroundings.⁽²⁷⁾

The study showed that hand hygiene was performed after body fluid exposure and after contact with patient surroundings and before an aseptic procedure in 82.5% and 40% and 34.5% of the observations respectively. A study conducted in neonatal ICUs in Europe (2011) showed that the compliance rates were significantly higher before patient contact and aseptic tasks (78%), than after patient contact, patient body fluid contact, or contact with a patient surroundings (57%).⁽²⁸⁾ HCWs who performed hand hygiene practice before injection constituted 34.5% and those not using gloves for IV injection constituted 12.5%. A study conducted in Egypt (2017) showed that 41.9% of HCWs cleaned their hands with soap and water or alcohol-based hands rub and 58.1% of HCWs were not wearing gloves during IV injection.⁽²⁹⁾ The study revealed that the vial was disinfected with alcohol in 67.5% of the observations. A study conducted in USA (1994) showed that the vials were disinfected with alcohol and povidone-iodine in 95% of the observations.⁽³⁰⁾ The difference between the current study and the USA study may be attributed to absence of policies and lack of training about IC practices. In our study, IV ports were disinfected with alcohol in 86.5% of observations. A similar finding was shown in a study conducted in USA (2006) where most health care practitioners disinfected IV ports with 70% alcohol before accessing them.⁽³¹⁾

This study showed that sterile needles and syringes were used in 94% of the observations and sharps were disposed in yellow sharps containers in only 7.5% of the observations. A study conducted in Swaziland (2004) showed that disposing sharps in a safe container was done in 75% of the observations.⁽³²⁾ In Iran (2004), disposing sharps in sharp containers was done in nearly three quarters (76%) of the observations.⁽³³⁾

The difference between the study and other studies may be attributed to lack of regular supply of sharp containers in the ICUs. The prevailing security situation and shortage of funds may be contributing to the shortage in the required supplies.

CONCLUSION AND RECOMMENDATIONS

Infection control procedures and practices in ICUs of Althawra General Hospital were poor with respect to injection practices, type of catheters used in ICUs, hand hygiene practices, injection administration, and waste disposal.

Improving the IC procedures regarding hand hygiene practices, injection practices, and type of catheters used in ICUs and addressing the IC practices of HCWs is a necessity.

Monitoring of the IC procedures and practices by the hospital IC team and implementation of an IC health education program based on the needs are needed.

Conflict of Interest: There was no conflict of interest.

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