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The Contribution Of Nursing And Laboratory Practices In Preventing Healthcare Associated Infection

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Abstract:

Background: *Healthcare-associated infections (HCAIs) are the most important source of morbidity and mortality as well as are the second popular reason for death. Moreover, it was recorded that every one-hundred patients went to hospital, seven patients in high-income economies and ten in low-income economies infected with one type of HCAI at least. Nowadays, most pathogenic agents become resistant against antimicrobial drugs; on the other hand very little new antimicrobial drugs are being recognized and recorded in market.*

Objective: *This review provides an update on Healthcare-associated infections (HCAIs) beside infection prevention and control as well as general principles and microbiology laboratory role*

Methods: *The literature was performed by searching on PubMed, Cochrane database, different online Journals and Google Scholar provided by the University Pertahanan Nasional Malaysia (UPNM) The N[1]ational Defence University of Malaysia, Kuala Lumpur, Malaysia and The University of the West Indies, St. Augustine, Trinidad, and Tobago. for relevant articles on HCAIs. Preferred reporting items of systematic reviews and meta-analyses guidelines were followed for selection.*

Results:

More than the half of 35 acceptable articles, reported that Klebsiella spp., Staphylococcusaureus, Escherichia coli and Pseudomonas spp. were the famous infectious microorganisms recorded in both bloodstream and urinary tract infection including catheter-associated infections, surgical site infection and healthcare-

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associated pneumonia. Add to this methicillin-resistant S. aureus represent (3.9% - 56.8%) however Gram-negative bacilli which produce broad-spectrum beta-lactamase represent (1.9% - 53.0%) considered the major antimicrobial resistant pathogens.

However hand hygiene considered an old method, but remain the first technique applied to control HCAIs in all the world. It represents one of the steps used to clean and maintain a safe hospital environment and to control the transmission of contagious and infectious pathogens which have resistance against several antimicrobial drugs. Finally, antibiotic also play a critical function in decreasing HCAIs potential by conserving available antimicrobials.

***Discussion**: The preventing of healthcare associated infection highlighted in the discussion, which summarizes the findings of the literature review. It also focused on how to control HCAIs and antimicrobial resistance additional to general principles and microbiology laboratory role.*

***Keywords:** Hand Hygiene, Healthcare Workers, Strategies for Improvement, Prevention, Environmental Hygiene, Antibiotic Stewardship, Hospital Infections, and Healthcare-Associated infections.*

Introduction:

The healthcare-associated infections considered the major universal problem and reason for death in hospitalized patients. Healthcare-associated infection including intrinsic and extrinsic risk factors. age, weight at birth, underlying diseases, and immunity are the main intrinsic factors whereas the main extrinsic factors including the presence of invasive devices and procedures. HAIs also induce wide range of complications between healthcare workers, patients, and visitors. These complications are very expensive from the humanitarian and economic aspects and increase the healthcare resources waste so result in increasing drugs and medical supplementation needed, continuous uses of diagnostic laboratory services, large elevation in rates of admission to the hospital and other harmful effects on patient's life. HAIs produce additional suffering and generate high costs for patients and all the family. Because of the infections, patients spend long periods in hospital as well as increase the resistance against antimicrobial drugs.

This essay seeks to emphasize the vital factors reduce healthcare-associated infections (HAIs) as well as the roles that healthcare professionals play in preserving patient safety. The following are some of the paper's goals:

1- Studying the existing literature on the complications incidence by HAIs between healthcare workers, patients, and visitors.
2- Assessing current strategies and interventions aimed at controlling compliance among healthcare workers.
3- Focus on the general practices of infection prevention and control.
4- The effective job of laboratory specialists in controlling the infection, so decrease hospital infections and resistance developed against antimicrobials and allow safe area for the patient.

5- Proposing effective strategies for reducing the risk of HAIs **(Gould et al., 2008; McGuckin et al., 2009; Mathai et al., 2010)**

Literature Review

Infection prevention and control (IPC) subject to control infections that widely spread in healthcare community **(WHO 2004 and WHO 2016).**

Great effort must be done by medical technologist/microbiologist to understand the characters of infectious illness examination and send data helpful for practices who must pay attention to be a good practitioner of IPC to decrease infections in hospitals. One of the most advantages in HAIs prevention and control is the presence of microbiology laboratory which must be inside the hospital and working all the day **(Kalenić and Budimir 2009).**

The main Infection Prevention and Control measures:

The cycle of infection may be explained as a chain through which pathogens transmitted from a source of infection to a susceptible host. If the bond is broken at any part of this chain we can control the infection and so decrease danger microorganisms' transmission. The chain of infection consist of six bonds which are the infectious agent, reservoir, portal of exit, mode of transmission, portal of entry, and susceptible host **(Dicker et al., 2012).**

The cycle of infection Transmission may be broken when:

* The pathogenic microorganism is eliminated, become inactive or unable to be alive in the reservoir by quick identification of microorganisms, continuous washing as well as environmental disinfection.

* Control the site of exit by applying infection prevention and control measurements which include hand hygiene, good use of PPE, good packaging and disposal of waste.

* Good infection prevention and control practices are applied as hand hygiene, isolation of infected patients, air flow control the transmission of microorganisms will not be occurred.

* The portal of entry can be controlled through aseptic non-touch technique, safe catheter care and wound care.

* The susceptibility of patients receiving healthcare is decreased by treating the underlying disease and determining the high risk patients **(Dicker et al., 2012)**

Infection prevention and control program (IPCP) is a scientific applicable solution established to control the infection occurred to hospitalized patients and health care workers (HAWs).

The main importants of the infection prevention program are:

- Development and implementation of guidelines/manual.
- Main measures to control the infection.
- Education and training of health care workers.
- Protection of health care workers through immunization, detection of hazards and reduce risks.
- Control the infection by using good practices for examples (aseptic techniques, reprocessing of instruments, antimicrobial usage etc..) **(WHO 2004 and WHO 2016).**

The organizations of infection control program

Infection control committee (ICC): consist of several members as medical, nursing, pharmacy, microbiology laboratory, engineering, administration and central sterile services department. The role of Infection control committee is developing and updating HAIs prevention manual that must include practices and instructions needed for patient care and put the annual plan of work with adequate resources for the Infection prevention and control program **(WHO 2004 and Sydnor and Perl 2011).**

Infection control team (ICT): It include specialized members with specific knowledge in IPC. This team includes the microbiologist that will be the infection control officer, infection control nurses and staff of the scientific or technical persons who responsible for infection control. This team play important role in:

- Inspection of infections and detect the methods of control.
- Quick investigation of outbreaks.
- Give consultation if the infected patients must be isolated or not.
- Follow up with members in all areas.
- Controlling and evaluating strategies to prevent infections to wide spread.
- Training the staff and provide educational programs.
- put the annual IPCP and sending to the ICC. **(Barrett 2002, Fraise and Bradley 2009 and Bhattacharya 2010)**

Infection Control Officer: ICO is a member who ready access to meetings and sufficient authority to command respect and good qualified and interested in infection prevention and control. The member of choice is the microbiologist. His functions including:

- Assess the dangers of infection.
- Giving consultation on preventive practices and checking the affectivity in all the hospital as catering, laundry and CSSD in domestic, clinical as well as pharmaceutical and other areas.
- Recommending the antibiotics strategy used in different parts of the hospital.
- ICO also represent measures for aseptic, isolation and antiseptic technique; evaluate outbreaks and determine the suitable practices; follow up the biomedical waste management measurements; supervision protocols for airborne isolation. **(Fraise and Bradley 2009 and Thakuria and Pandey 2018).**

Infection Prevention and Control Practice

The good defense against HAIs and resistance against antimicrobs is strict of HAWs, patients and visitors closely contact to IPC practices. These measures including the standard infection control and transmission-based practices. **(Burnett 2018).**

Standard precautions consist of :-

Personal protective equipments: Healthcare facilities must have special equipment to provide protection to all HAWs, patients as well as visitors. The equipments consist of gloves, aprons, face visors, long-sleeved gowns, surgical and respirator masks. The initial risk assessment that determines the need of PPE is based on the level of risk of transmission to and from the patients. **(Habboush and Guzman 2019)**

The skin must not be nicked when PPE has used; instructions regarding wearing and taking off PPE to be displayed inside the whole hospital; PPE must be kept well to avoid contamination in a clean/dry place to be used; PPE should be single-use only. PPE must be changed immediately after each patient. PPE must be disposed of after use into the correct waste **(WHO 2004).**

The gloves: Gloves provide protection for HAWs and control the spreed of micro-organisms to patients so gloves should be:

- Worn in case of exposure to any body fluids or blood.
- Immediately changed after each patient and/or after finish a procedure or task.
- Changed in case of a perforation or puncture occur **(Weston 2008).**

Gowns as well as Aprons: provide the protection to the patients against infections and contamination. Full body /Fluid repellent coveralls in case of extensive splashing of blood and/or other body fluids, for example in the operating theatre, as well as must be worn when a disposable apron provides inadequate cover for the procedure/task being performed. **(Weston 2008 and Cooper and Percival 2014).**

Eye and face protection: Goggles, masks, and visors provide protection to the eyes and mouth. Avoid touching eye/face protection during worn by the hand. **(Weston 2008).** Face masks/surgical masks must be single used and loose fitting. All patients with cough and positive TB patients must use face masks to decrease infections transmission to other patients, and HAWs **(NHMRC 2010).**

Preventions of injury from needles and sharps:

Using sharp instruments increase the incidence of injury to HAWs and potential exposure to blood borne infectious microorganisms for examples hepatitis B, C viruses and HIV **(NHMRC 2010)**. These instruments must be arranged for safe use and disposed in good way. The employees must be provided with the enough informations about this objects and training how to use them. Needles must not be re-sheathed/recapped **(Cooper and Percival 2014).**

Reducing risks if a sharps injury occurred:

In case of the skin is penetrated the following instructions must be followed:

- Immediately wash the affected area with soap and water.
- If soap and water are not available, Alcohol-based hand rub can be used to clean the injured area.
- Avoid squeezing the affected area.
- Immediately report the accident.
- Follow-up must be done soon after the to be effective.
- Accident report form should be completed , including all the data about the accident that occurred **(NHMRC 2010).**

Hand hygiene: it is the most important step to decrease the spread of infections. It is recommended that hand hygiene must be done before any step; WHO detect five points that healthcare staff must do hand hygiene:

1. Before dealing with a patient.

2. Soap must be used before clean/aseptic practices.

3. After exposed to body fluid.

4. After dealing with a patient.

5. After touching a patient's surrounding environment (**Pegram and Bloomfield 2014).**

The Methodology of Hand washing:

<u>Washing hand with soap and water</u>:

This method is applied when hands are dirty or soiled with blood or after toilet as well as after exposure to spore-forming pathogens (**Pegram and Bloomfield 2014).**

<u>Alcohol-based hand rubs:</u>

This method is applied in case of touching any surfaces or objects, before and after touching the patient, after contact with the body fluids and excretions, mucus membrane or wound dressing and in case of moving from a contaminated body side to another one as well as after removing sterile or non-sterile gloves **(Pegram and Bloomfield 2014).**

Cleaning of patients care environment: It is important to keep the patient environmental area clean to prevent infection spread. The environment must be clean, free from any objects which are non-essential and equipment in order to clean easy. The staff must have training to know how use the chemicals as well as specific disinfection and sterilization procedures. **(Flanagan et al., 2016)**.

Disinfection and sterilization of equipments:

Any instrument will be used again must be cleaned, disinfected and/or sterilized. According to the degree of risk for infection involved when use of the items the system based on instruments for patient care is classified into critical, semi-critical and non-critical. Disinfection can defined as the process which make non-sporing infectious agents inactive, by using thermal (moist or dry heat) or chemical methods. It is important to clean the object before disinfection. Whereas sterilization kills all microorganisms on the surface, so prevent transmission of illness by using this instrument.

Biomedical waste management:

Sharps waste: Sharps like needles, hypodermic needles, scalpels, and other blades, knives, infusion sets, saws, broken glass, and pipettes may induce cuts or puncture wounds so should be treated as potentially infected whether or not they are infected as they considered highly hazardous healthcare waste.**(Chartier 2014)**

Infectious wastes: Are the objects that may contain pathogens like bacteria, viruses, parasites or fungi at concentration or quantity enough to induce disease which include:

- Waste contaminated with blood or other body fluids.
- Cultures and stocks of infectious agents from laboratory.
- Waste from infected patients. **(Chartier 2014)**

The system of waste segregation consist of:-

- Black Plastic bags: that contains domestic wastes.
- Yellow containers: Which contain highly infected and contaminated waste. So these containers must be strong, made from leak-proof plastic bag or container can be autoclaved, Puncture-proof container. These containers must be marked “SHARPS” and with a biohazard symbol refer to sharps.
- Brown containers/plastic bags: Which contain chemicals and pharmaceutical wastes must be marked with the appropriate hazard symbol. **(Chartier 2014)**

Transmission-based precautions

Transmission-based precautions help in reduction the danger of airborne and contact transmission and helpful with standard precautions to detect patients susceptible to highly transmissible or epidemiologically pathogens. **(Harte 2010 and Mehta et al., 2014)**

Infectious microorganisms can be suspended in the air in the form of small particles, aerosols or dust and have the ability to infect as Mycobacterium tuberculosis, varicella zoster virus, herpes zoster and measles. It is important to isolate the patient in a room with

certain ventilation (isolation room). Safety precautions should be applied during entrance the isolation room as using the disposable mask, which must be fits tightly to give protection against all droplets. These precautions must be applied on every person entering the room, including visitors. **(Harte 2010)**

It is very important to control the spread of microorganisms through direct contact with respiratory secretions or mucous membranes as some pathogens have the ability to spread during sneezing, coughing and speaking as influenza virus, Bordetella pertussis, Mycoplasma pneumoniae, severe acute respiratory syndrome-associated corona virus, Group A Streptococcus, adenovirus and rhinovirus. **(Harte 2010 and Mehta et al., 2014)**

Improvement of Healthcare Infection Control practices

Using certain Technologies to Control the exposure to occupational hazards so protect the workers. This hierarchy technologies consist of three categories:

(1) engineering controls.
(2) administrative and work practice controls.
(3) personal protective equipment (PPE). **(Thorne et al., 2004)**

The main role of Laboratory in Infection Prevention and Control

Microbiology laboratories (MLs) play important role in the infection control program. **(Kalenić and Budimir 2009, Diekema and Saubolle 2011 and Simões et al., 2016)** Microbiology laboratories roles including:

1- Evaluation and identification the microorganisms.
2- Testing the antimicrobial susceptibility of organisms.
3- Surveillance.
4- Detection and management of outbreak.
5- Participate in the ICC.
6- Education of HAIs.

The ability of the microbiology laboratories to identify and isolate microorganisms is as critical important to control the infection so MLs work hardly to increase their efficiency in recognizing and identification microorganisms through:

1- Using new instruments and devices that become widely available.
2- Using newer tests allowing the identification of agents of nosocomial infection as well as rapid diagnosis of both new and old pathogens as immunologic and nucleic acid testing.

Several serological tests are performed in MLs on blood, cerebrospinal fluid, urine, stool, wound exudate or swab, respiratory secretions as HIV, HBV, HCV, influenza. **(Kalenić and Budimir 2009)**

Evaluation Methods:

The WHO adopted multimodal strategies which are effective in controlling and preventing infection as well as reduce HAIs and combat AMR. **(Storr et al., 2017)** These strategies including the areas of system change, training and education, monitoring and feedback, reminders and communications and cultural change that support IPC in a patient safety perspective**. (WHO 2018)**

Several methods used for evaluating hand hygiene compliance, including direct observation, self-reporting, and the use of electronic monitoring systems. It highlights the

strengths and limitations of each approach and emphasizes the importance of valid and reliable data collection methods **(Dai et al., 2018; Thompson et al., 2020).**

Discussion:

Some studies recorded the evidence that WHO designed different strategies that help in decreasing respiratory infections and organism infections which develop resistance against many drugs. Multimodal strategies applied by WHO proved their affectivity in IPC practice as hand hygiene practices. **(Lee el. at., 2019)**

One of the factors that control cross-transmission risk and prevent HAIs as well as the spread of AMR in health care facility are addressing bed occupancy and staffing factors. Several studies recorded by **(Zing et al., 2015)** proved that infection spread with MRSA was related with bed occupancy and with low number of staff and nurse-to-patient ratios. Large numbers of workers as well as raise nurse-to-patient ratios will decrease HAIs. Low staff number and high workload result in elevation of MRSA infections. Add to this long work hours also lead to increasing in rates of HAIs. **(Zing et al., 2015)**

Other studies focused on antimicrobial stewardship as a group of actions prepared to use antimicrobial drugs **(Dyar et al., 2017)**. It is very important to determine the suitable pattern of antibiotic that will give a good result with pathogenic agents inducing HAIs is critical for individual patient care. Add to this help in designing antibiotic strategy and local antibiotic formulary. **(Diekema and Saubolle 2011 and Morency-Potvin et al., 2017)**

Conclusion

Medical laboratory specialists are the most important part of infectious diseases diagnosis. Highly qualified specialists have good background about microbiology and epidemiology that include clinical chemistry, microbiology, hematology, immunology, and histopathology. MLs is the best department that help in understanding the culture results, give the consultations about the use of microbiological measurements to control an infection and make specific reports to the ICC.**(Barrett 2002, Bhattacharya 2010, Diekema and Saubolle 2011, Pegues 2018 and Sarojini and Misra 2019)**

So it is recommended that the medical laboratory specialists be in connection with physicians and pharmacists to decide the suitable antibiotics will be effective so that well connection between the laboratory, IPCP, pharmacy and a stewardship team are very important **(Diekema and Saubolle 2011and Morency-Potvin et al., 2017).** which result in a valuable and effective role in the field of infection control and prevention, thereby preventing hospital infections and antibiotic resistance and providing a safe environment for the patient, health care providers and the community.

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