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PRACTICE FORUM

The fundamental role of educational intervention on improving health care workers' knowledge, attitude and practice towards infection control precautions

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Abstract

To evaluate the role of educational intervention on health care workers' (HCWs) compliance to infection control precautions and cleaning of frequently touched surfaces at critical care units, forty-nine HCWs at 2 intensive care units (ICUs) and one neonatology unit at Fayoum University hospital were evaluated for knowledge, attitude and practice (KAP) towards standard precautions as well as obstacles affecting their compliance to standard precautions before and after a 32-hour purposed-designed infection control education program. A structured self-administrated questionnaire as well as observational checklists were used. Assessment of Environmental cleaning was investigated by observational checklist, ATP bioluminescence and aerobic bacteriological culture for 118 frequently touched surfaces. Pre-intervention assessment revealed that 78.6% of HCWs were with good knowledge, 82.8% with good attitude and 80.8% had good practice. Obstacles identified by HCWs were as follow: making patient-care very technical (65.3%), deficiency of hand washing facilities (59.2%), skin irritation resulting from hand hygiene products (51%), and unavailability of PPE (38.8%). High significant improvements of knowledge, attitude and practice were detected after one month of educational intervention ($P < 0.001$). During the pre-interventional period only 30.5% of surfaces were considered clean versus 97.45% post intervention ($P< 0.05$). The highest Median ATP bioluminescence values were obtained from telephone handset, light switches and blood pressure cuffs. *Staphylococcus aureus* was the most commonly isolated organism followed by *Enterococcus* spp. and *Escherichia coli* (52, 38 and 19 surfaces respectively). In conclusion, training of HCWs on standard precautions should be considered a mandatory element in infection control programmes.

Key words: education; behaviour; infection control; disinfection; medical equipment; Egypt

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Introduction

Infection transmission risks are present in all health care settings, with high prevalence in developing countries (30-50%).[1] Many pathogens are implicated in these infections and often multi-drug resistant, most of them are able to survive in the environment for a long period of time. Contaminated hands of healthcare workers had been reported to play a vital role in the spread of these pathogens.[2] Hospitals need to ensure that environmental cleaning and disinfection are integral parts of their infection control programs.[3]

Healthcare personnel are at increased risk of infection from blood borne pathogens like Human Immunodeficiency Virus (HIV), Hepatitis B virus (HBV) and Hepatitis C virus (HCV). Strict adherence by healthcare workers to standard precautions usually prevents a considerable percentage of these risks.[4] Health care workers' knowledge of standard and isolation precautions has been reported to be insufficient[5] and specialised training must be received before a healthcare worker undertake any patient procedure involving sharp devices.[6] Also Mukerji *et al.*[7] reported that interventions to improve hand hygiene compliance are challenging to implement and sustain with the need for ongoing reinforcement and education.

This study aimed to evaluate healthcare workers (HCWs) compliance toward recommended infection control precautions at Intensive Care Units (ICU) and Neonatology Unit (NU) in Fayoum University teaching hospital and to assess the role of educational intervention in improving the knowledge, attitude and practice (KAP) of HCWs towards standard precautions and cleaning of frequently touched surfaces.

Subjects and Methods

A cross-sectional descriptive interventional study (3 Phases) was conducted to assess the healthcare workers (HCWs) adherence to standard precautions at intensive care unit (ICU) and neonatology unit (NU) of Fayoum University hospital, Egypt. The sample was purposive sample including 49 HCWs of different age, sex and experience.

Phase I: A structured self-administrated questionnaire prepared according to international guidelines of standard isolation precautions formed of the following sections: First: demographic data which includes age, sex, occupation, years of experience in the department. Second section included assessment of HCWs KAP with 17 questions about knowledge, 21 questions about attitude, and 10 questions about self-reported practice with respect to definition of healthcare acquired infection (HAI), reservoir of infection in hospital, hand hygiene, prevention of blood-borne diseases and use of personal protective equipment. The right answer was scored as '1' and the wrong answer or "I do not know" was scored as '0'. When more than 75% of answers agreed with norms, these were interpreted as 'good', from 50% to 75% 'moderate' and below 50% as 'bad/unsatisfactory'. The third section considered factors affecting non-compliance of HCWs to standard precaution, source of participant information about infection control measures, previous instructions about infection control, hepatitis B vaccination status and needle stick accidents experienced.

Observational checklist for evaluation of the presence of fundamental elements needed for prevention of infectious agents' transmission in healthcare setting was used.

Phase II: A 32-hour, purposely-designed infection control education program was implemented for HCWs serving ICU and NU at Fayoum University Hospital. It was structured as 2 hours sessions given once a week for 16 weeks. This training consisted of lectures and practical demonstration. The educational program focused on standard precautions as follow: Overview of HAI, hand hygiene, personal protective equipment, environmental cleaning, waste management, prevention of needle stick injuries and sterilisation and disinfection. Participating HCWs were instructed to observe and educate housekeeping workers on standard method for environmental cleaning at their units.

Phase III: After one month of the end of the training program there was another evaluation of their improvement of KAP.

Assessment of Environmental cleaning was investigated by:

Monitoring the cleaning process by Observational checklist: for the availability of housekeeping elements, frequency of cleaning, disinfection and housekeeper performance.

Measuring the outcome of cleaning by ATP bioluminescence: Screening of fixed area of 118 frequently touched surfaces (about 4cm^2) after routine daily cleaning at the three Units was performed. These included: 4 doorknobs, 20 bedside rails, 6 incubator edges, 6 incubator switch buttons, 6 light switches, 16 privacy curtain edges, 2 sinks handles, 3 refrigerator handles, 20 bedside table, 3 telephone handset, 16 control buttons on the monitors, 6 dispensers of alcohol hand rub bottles, 4 blood pressure cuffs and 6 stethoscope's diaphragm. ATP bioluminescence screening was performed using the 3M® Clean-TraceTM system with specialised swabs. The swabs are placed in a detection device after activation and the result is expressed in relative light units (RLUs) which is proportional to the amount of ATP present at the swabbed area. When reading below 250 RLU, the surface is considered clean.[3]

Microbiological Determination of the type of aerobic pathogenic bacterial contamination at tested surfaces: Bacteriological cultures during pre-interventional period (phase I) were taken to determine the type of pathogenic bacteria present at the tested surfaces. Swabbing was performed with a sterile cotton swab, which had previously been immersed in phosphate buffered saline. These swabs were than cultured on Nutrient agar, Columbia blood agar and MacConkey agar (Oxoid LTD, Basingstoke, England). Identification of isolated bacteria was done according to standard microbiological methods.[8] Any oxidase-negative Gram-negative rods were further identified by Microbact (12A) Gram-negative identification system (Oxoid, Basingstoke, UK). Suspected colonies of *S. aureus* was sub-cultured on Mannitol salt agar, oxacillin resistant screening agar base and Baird Parker agar (Oxoid Ltd, Basingstoke, England) to identify MRSA and suspected *Enterococcus* spp. colonies that tested positive for pyrrolidonyl arylamidase were plated on vancomycin-impregnated bile esculin azide agar (Oxoid LTD, Basingstoke, England) to identify VRE.

Statistical analysis:

Data were collected, coded, double entered and analysis using SPSS software version 18 under windows 7. Mean and standard deviation were calculated for quantitative variables in the form of simple descriptive analysis. Categorical data were analysed by computing percentages, and differences were tested statistically by applying Chi square test for comparisons between groups, and p-value of <0.05 was considered statistically significant. Correlations between scores for knowledge, attitude, and self-reported behaviour were calculated with Spearman's rho.

Ethical considerations

This study was reviewed and approved by the Faculty of Medicine Research Ethical Committee. A written permission was obtained from the director of the hospital, the head of ICU and from the head of Paediatric and Neonatology department before starting the study. It was conducted after explaining the study objectives and ensuring confidentiality to the participants. A written consent was obtained from HCWs before distributing the questionnaire. Each one had the right not to participate in the study or withdraw at any time.

Results

Forty nine HCWs participated in this study. These include 15 doctors (30.6%), 29 nurses (59.2%) and 5 assistant nurses (10.2%). The age of participating HCWs ranged from 20 to 30 years with mean age 24.1 ±2.9, females were more than males (55.1% and 44.89% respectively) and their experience in working at health care facility ranged from 6 months to 10 years, with mean year of experience 3 ±2.3 years. Seventy eight percent (78.6%) of HCWs had good knowledge**,** 82.8% had good attitude and 80.8% had good practice**.** Sixty seven percent (67.2%) recap needles. High significant improvements of knowledge, attitude and practice were detected after one month of educational intervention (Table I; data presented as mean ± standard deviation).

Our results revealed that nurses significantly had better self-reported practice score than that achieved by doctors and assistant nurses (Table II; data presented as mean ± standard deviation). No significant correlation was found between months of experience of HCWs and total knowledge, attitude or practice ($p > 0.05$).

Table I. Assessment of KAP of HCWs before & after educational intervention

Variables	Pre (mean±SD)	Post (mean±SD)	*p*-value
Total knowledge score (17)	13.37±1.65	16.67±0.59	<0.001*
Total attitude score (21)	17.39±1.34	20.24±1.05	<0.001*
Total practice score (10)	8.08±1.26	9.96±0.41	<0.001*

**significant*

Improvement of KAP was obtained after educational intervention (Table III).

Thirty percent (30.8%) of HCWs had attended infection control training workshops, while the rest of respondents gain their information by self-learning or practical learning in the ward. Approximately two third of HCWs (63.3%) were instructed about the importance of infection precaution and hospital guidelines for infection control. Reporting rules were given to 26.5% of respondents especially when they discovered symptoms of an infectious disease. Information about job description of professionals responsible for infection control was given to 57.1% of them. Fifty seven percent (57.1%) of HCWs were vaccinated against hepatitis B virus.

About 80.6% of healthcare workers experienced needle stick accidents and 44.9% of the respondents were instructed about what to do after a needle stick injury.

Obstacles identified by HCWs for non-compliance to hand hygiene and personal protective equipment (PPE) is illustrated in Table IV. Observational checklists revealed that there were no hand-washing stations in paediatric ICU, while in the adult ICU, the hand washing station was present outside the unit with no enough alcohol hand rub at both units. Also there are no enough safety boxes at adult ICU. Although HCWs

Table II. Differences between doctors, nurses and assistant nurses in KAP scores before educational intervention (phase I)

Variables	Doctors (mean±SD)	Nurses (mean±SD)	Assistant Nurses (mean±SD)	*p*- value
Knowledge Score (17)	13.27±2.12	13.41±1.40	13.40±1.82	0.962
Attitude Score (21)	17.33±1.35	17.45±1.45	17.20±0.45	0.916
Practice Score (10)	7.73±1.22	8.48±0.91	6.80±2.05	**0.007***

**significant*

Table III. Total levels of improvement in different score

	≥10-20%		>20-30%		> 30		No Change	
Variables	N	%	N	%	N	%	N	%
Total Knowledge Score (17)	25	51.0	21	42.9	2	4.1	1	2.0
Total Attitude Score (21)	41	83.7	6	12.2	0	0	2	4.1
Total Practice Score (10)	30	61.2	7	14.3	6	12.2	6	12.2

Table IV. Non-compliance obstacles identified by HCWs for the standard precautions

Perceiving obstacles	N=49	%
It makes patient-care very technical	32	65.3
No enough hand washing facilities on the ward	29	59.2
Skin irritation effect of hand hygiene product	25	51.0
Others do not follow the guidelines of hand washing	22	44.9
It is not important to wear PPE	21	42.9
No enough aprons or gowns on the ward	19	38.8
Too much time to follow the guidelines	16	32.7
No enough sharp containers	15	30.6
No enough gloves on the ward	13	26.5
Make work harder	12	24.5
The concept of safe blood handling is not clear	6	12.2

wear scrub suit, they freely get in and out the units with the same scrub suit during all working hours.

The environmental cleaning checklist revealed non efficient cleaning process regarding methods and frequency, as well as deficiency of housekeeping supplies. There was no cleaning of bed rails, light switches, telephone handset and dispenser of alcohol hand rub bottles. No disinfection for blood pressure cuffs or stethoscopes' diaphragm had been observed during the pre-interventional period. Cleaning of incubator switch buttons, control buttons on the monitors and privacy curtain were done only on terminal cleaning.

Screening of 118 frequently touched surfaces by ATP bioluminescence during the pre-interventional period revealed that most of surfaces were contaminated (>250 RLU) with exception of incubator edges. Only 36 surfaces (30.5%) were considered clean. The highest Median RLU was obtained from telephone handset, Light switches and blood pressure cuffs. Significant improvements were obtained after educational intervention as 115 surfaces (97.45%) were considered clean (Table V).

S. aureus was the most commonly isolated organism followed by *Enterococcus* spp. and *E. coli (*isolated from 52, 38 and 19 surfaces respectively) (Table VI).

Discussion

Improvement of the practice of (HCWs) is an important aspect of infection control in healthcare facilities. The challenge is not the lack of effective precautions and evidence-based guidelines, but the fact that HCWs apply these measures insufficiently.[9] We investigated KAP toward standard precautions at Fayoum University teaching hospital at adult ICU, paediatric ICU and neonatology unit by means of structured questionnaires. Our results showed that 78.6% of HCWs had good knowledge. Our results higher than those reported by Duerink *et al.*[9] (44%) at two teaching hospitals on the island of Java, Luo *et al.*[10] and Abdulraheem *et al.*[11] observed that only 50% of the HCWs had knowledge of universal precautions. The results of Vaz *et al.*[12] were near to our results (64.0%). Our result was lower than those reported by Danchaivijitr *et al.*[13] who reported that 94.9% of medical doctors in Thailand had good knowledge of standard precautions.

Difference in HCWs knowledge between countries and even hospitals can be attributed to difference in educational background and participation in infection control training programs. Only 30.8% of our HCWs had attended infection control training courses or workshops, while the rest of respondents gain their information by self-learning or practical learning in the ward (bedside).

Table V. Adenosine Triphosphate (ATP) readings of different samples obtained from high-touch surfaces before & after educational intervention

High-Touch Surfaces (No=118)	Before educational intervention (RLUs)					After educational intervention (RLUs)					
	< 250	250-499	500-1000	>1000	Median (RLUs]	< 250	250-499	500-1000	>1000	Median (RLUs]	*p*- value
Doorknobs (No=4)	0	0	4	0	697.5	4	0	0	0	42	0.005 *
Bedside rails (No=20)	1	3	7	9	824	20	0	0	0	51	0.006 *
Incubator edges (No=6)	6	0	0	0	51.5	6	0	0	0	13.5	<0.001**
incubator switch buttons (No=6)	1	3	2	0	346.5	6	0	0	0	13	0.005 *
Light switches (No=6)	0	1	2	3	1051.5	6	0	0	0	40	0.06
Curtain edge (No= 16)	13	2	1	0	85.5	16	0	0	0	22	0.005 *
Refrigerator handles (No=3)	1	1	1	0	497	3	0	0	0	18	0.18
Sinks handles (No= 2)	1	1	0	0	193.5	2	0	0	0	32	0.29
Bedside table (No=20)	13	5	2	0	188	20	0	0	0	37	<0.001**
Telephone handset (No=3)	0	0	0	3	2743	1	2	0	0	252	0.101
Monitors control buttons (No=16)	0	5	9	2	652	16	0	0	0	53.5	<0.001**
Dispensers of alcohol hand rub (No= 6)	0	2	2	2	717.5	5	1	0	0	128.5	0.007 *
Blood pressure cuffs (No=4)	0	0	2	2	1004.5	4	0	0	0	28.5	0.002 *
Stethoscope's diaphragm (No= 6)	0	3	2	1	495	6	0	0	0	17.5	0.007 *
Total	**36 (30.5%)**	**26 (22%)**	**34 (28.8%)**	**22 (18.64%)**	**460.5**	**115 (97.45%)**	**3 (2.54%)**	**0 (0%)**	**0 (0%)**	**38.5**	**<0.001****

**significant, **highly significant*

Table VI. Frequency and type of pathogenic bacteria according to sample site

Sample site (No=118)	*S. aureus*		*Enterococcus* spp.						
	MSSA	MRSA	VSE	VRE	*E. coli*	*K. pneumoniae*	*Pseudomonas* spp.	*Proteus* spp.	*A. baumannii*
Doorknobs (No=4)	**1**	**1**	1	0	1	0	0	0	0
Bedside rails (No=20)	6	4	2	5	2	1	0	0	3
Incubator edges(No=6)	1	0	0	0	0	0	0	0	0
incubator switch buttons(No=6)	1	0	1	0	0	0	0	0	0
Light switches (No=6)	3	1	1	2	1	1	2	1	0
Curtain edge (No= 16)	5	2	2	0	3	0	0	1	1
Refrigerator handles (No=3)	1	0	1	1	1	0	0	0	0
Sinks handles (No= 2)	1	0	0	0	0	0	1	0	2
Bedside table (No=20)	5	1	2	2	3	0	1	0	0
Telephone handset (No=3)	2	0	2	1	2	0	0	0	0
Monitors control buttons (No=16)	7	2	6	2	4	0	1	0	3
Dispensers of alcohol hand rub (No= 6)	3	0	1	3	2	0	0	0	0
Blood pressure cuffs (No=4)	3	0	2	0	0	0	0	0	0
Stethoscope's diaphragm (No= 6)	2	0	1	0	0	0	0	0	0
Total	41 (35.59%)	11 (9.3%)	22 (18.64%)	16 (13.55%)	19 (16.1%)	2 (11.11%)	5 (42.37%)	2 (11.11%)	9 (7.62%)
	52 (44%)		38 (32.2%)						

About 82.8% of HCWs had preferred attitude and 80.8% with desirable practice, which is higher than that reported by Duerink *et al.*[9] (67% and 63% respectively). Similar to our finding, Reda *et al.*[14] documented that 80.8% of HCWs in Ethiopia were regularly follow standard precautions.

Self-reported practice in this study was unsatisfactory for re-sheathing of needles as 67.29% recap needles. Similarly Hesse *et al.*[15] found that as many as 78% of HCWs recap needles while Reda *et al.*[14] in Ethiopia reported 46.9%. In contrast to our finding, Okechukwu and Motshedisi[16] and Sadoh *et al.*[17] reported that recapping of needle after use was low among HCWs in Nigeria.

Nurses in this study found to have a significant better self-reported compliance score than that achieved by doctors and assistant nurses which is in agreement with the results of Labrague *et al.*[18] and *Kim et al.*[19] who reported that student nurses have a high compliance of standard precautions. Similar data were found in another study with nursing staff.[20]

No correlation was found between months of experience of HCWs and total knowledge, attitude or practice scores. The same finding was reported previously.[9,21] Our study estimated that 80.6% of HCWs experienced needle stick accidents at least once which is in agreement with other studies conducted in Alexandria, Egypt,[22] South Africa[23] and Indonesia[9] as 67.9%, 91% and 77% respectively of HCWs reported sustaining needle stick accident. Lower prevalence of NSIs was reported among HCWs in two Malaysian teaching hospitals (31.6% and 52.9% respectively).[24] In Vietnam, 38% of physicians and 66% of nurses reported sustaining a sharps injury.[25]

Worldwide annual proportion of HCWs exposed to HBV infection was about 5.9%.[26] In developing countries, 40-60% of HBV infection in HCWs was attributed to professional hazard while in developed countries the attributed fraction was less than 10% due to vaccination coverage. Assessment of HBV vaccination coverage in health care setting is needed to evaluate the proportion susceptible to HBV infection. In this study 57.1% of the HCWs were vaccinated against hepatitis B virus. According to the WHO estimates, HBV vaccination for HCWs varies from 18% in Africa to 77% in Australia and New Zealand.[26]

Although standard precautions have been routinely recommended, full adherence is unsatisfactory. Non-adherence to standard precautions has been linked to a number of factors. The identified factors include: lack of knowledge, lack of personal protective equipment (PPE), high workload, low risk perception and low perception of institutional safety environment.[9,21]

Our study demonstrated that 59.2% of HCWs were complaining of deficiencies of hand washing facilities on the ward including absence of hand wash stations which was also confirmed by observational checklists, 65.3% complaining of making patient-care very technical, while 51% complaining of irritation effect of hand hygiene product. Similarly Duerink *et al.*[9] reported a striking shortage of hand washing facilities. Also Oliveira *et al.*[27] reported that skin irritation and distance to necessary equipment or facility interfere with compliance to standard precautions.

The inanimate hospital environment (e.g., surfaces and medical equipment) becomes contaminated with healthcare-associated pathogens. Pathogens for which there is more-compelling evidence of survival in environmental reservoirs include *Clostridium difficile*, vancomycin-resistant enterococci (VRE), and meticillin-resistant *Staphylococcus aureus* (MRSA).[28,29] These organisms can contaminate hands of HCWs when touching these surfaces without touching colonized or infected patient.[30,31] Strategies to reduce the rates of HAI with these pathogens should be established.[28,29] So we screened 118 frequently touched surfaces by ATP bioluminescence assay and found that most of the surfaces were contaminated with exception of incubator edges. Only 30.5% of surfaces were considered clean in spit of good KAP score of HCWs pre-intervention this may be due to participated HCWs did not realise (during pre-intervention phase) that they should observe and instruct housekeeping workers during environmental cleaning. Significant improvements were obtained after educational intervention as 97.45% of surfaces became clean. These results are in agreement with those of Zambrano *et al.*[30] who evaluated environmental cleaning of 198 hospital surfaces by ATP bioluminescence and

reported that 25.37% of surfaces were clean before and 80% after the education intervention (p = 0.01). Also Boyce *et al.*[3] reported that the median RLU values of high touched surfaces obtained after educational intervention were significantly lower than those obtained before educational sessions.

Our results also revealed that the deficiency in environmental cleaning and housekeeping supplies were the major problem identified; also there were no efficient cleaning process regarding methods and frequency before educational intervention.

Regarding the type of pathogenic bacteria identified, we found *S. aureus* was the most commonly isolated organism followed by *Enterococcus* spp. (isolated from 52 [44%] and 38 [32.2%] surfaces respectively), MRSA was isolated from 11 surfaces, VRE from 16 surfaces and *A. baumannii* from 9 surfaces. Rates of environmental contamination with MRSA was reported to vary according to the site of infection in source patients as contamination is more common in the rooms of patients with infected wounds or urine than in the rooms of patients with bacteraemia only.[29] It was suggested that contamination of near-patient hand-touch sites provides the highest risk of MRSA acquisition.[28] VRE have been isolated in previous study in up to 37% of samples obtained from the environment and are most often found in association with diarrhoea.[29] Surfaces in surgical ICUs were more likely to be contaminated with MRSA and VRE and particular attention is needed to improve cleaning at these units.[30] In partial agreement with our results Boyce *et al.*[3] found that after cleaning of 100 high touched surfaces, 24% were still contaminated with MRSA, and 16% still yielded VRE. While Goodman *et al.*[31] reported that environmental culture positive for MRSA or VRE were 45% before educational intervention versus 27% after educational intervention.

Although we isolated only 9 *A. baumannii* strains from 118 surfaces, this organism has been marked by increased resistance to antibiotics and linked to many HAI outbreaks.[29] Using proposed standards for hospital hygiene could provide a cost-effective intervention for controlling HAI especially with multidrug resistant organisms.[28]

The results of educational intervention were surprising; there were significant improvement at KAP detected after one month of educational intervention, the total knowledge of 47% of HCWs has been improved by more than 20% after educational intervention, while total attitude of 83.7% of HCWs had been improved by more than 10% and total practice score of 61.2% of HCWs has been improved by more than 10%. In agreement with our results Pittet *et al.*[32] showed that a hospital-wide training including posters and performance feedback led to an increase in hand hygiene compliance rates from 48% to 66% ($p < 0.001$) with a concomitant decrease in HAI rates from 16.9% to 9.9% (p = 0.04).

Huang *et al.*[33] performed a randomised controlled trial of 100 nurses receiving an educational intervention consisting of a 2 hours lecture on blood-borne pathogens and universal precautions and a one hour demonstration of universal precaution techniques. An observation period of 30 minutes noting the number of instances of hand hygiene showed higher compliance 4 months post intervention, indicating sustained benefits of this intervention.

Helder *et al.*[34] studied the effectiveness of a hand hygiene education program on the incidence of infection in an urban neonatal ICU. Hand hygiene compliance increased before patient contact (88% versus 65%, $p < 0.001$) with a statistically significant decrease in infection rates. On the other hand, an earlier study by Gould *et al.*[35] failed to show any effect of an educational campaign on hand hygiene rates.

In conclusion shortage of hand washing facilities and lack of training are the main factors explaining non adherence of HCWs to standard precautions. Training of HCWs and housekeeping workers should be considered a mandatory element in infection control programs which may help in preventing infection in HCWs, patients, as well as visitors.

References

1. Habibi S, Wig N, Agarwal S, *et al*. Epidemiology of Nosocomial infections in medicine intensive care unit at a tertiary care hospital in northern India. *Trop Doc* 2008; **38:** 233-235. http://dx.doi.org/10.1258/td.2008.070395
2. Joseph NM, Sistla S, Dutta TK, Badhe AS, Rasitha D, Parija SC. Role of intensive care unit environment and health-care workers in transmission of ventilator associated pneumonia. *J Infect Dev Ctries* 2010; **4:** 282-291. http://dx.doi.org/10.3855/jidc.800
3. Boyce JM, Havill NL, Dumigan DG, Golebiewski M, Balogun O, Rizvani R. Monitoring the effectiveness of hospital cleaning practices by use of an adenosine triphosphate bioluminescence assay. *Infect Control Hosp Epidemiol* 2009; **30(7):** 678-684. http://dx.doi.org/10.1086/598243
4. Jain M, Dogra V, Mishra B, Thakur A, Loomba PS. Infection control practices among doctors and nurses in a tertiary care hospital. *Annals of tropical medicine and public health* 2012; **5(1):** 29-33. http://dx.doi.org/10.4103/1755-6783.92877
5. Bryce EA, Scharf S, Walker M, Walsh A. The infection control audit: the standardized audit as a tool for change. *Am J Infect Control* 2007; **35:** 271–283. http://dx.doi.org/10.1016/j.ajic.2006.05.293
6. Elliott SKF, Keeton A, Holt A. Medical students' knowledge of sharps injuries. *J Hosp Infect* 2005; **60:** 374–377. http://dx.doi.org/10.1016/j.jhin.2005.01.033
7. Mukerji A, Narciso J, Moore C, McGeer A, Kelly E, Shah V. An observational study of the hand hygiene initiative: a comparison of preintervention and postintervention outcomes. *BMJ Open* 2013; **3:** e003018. http://dx.doi.org/10.1136/bmjopen-2013-003018
8. Mahon CR, Manuselis Jr. G. Diagnostic microbiology. W.B. Saunders Company, Philadelphia; 1165, 2000.
9. Duerink DO, van den Broek PJ, Roeshadi D, Wahyono H**.** Infection control in Indonesian hospitals. Thesis, Leiden University 2009; 90-106
10. Luo Y, He G-P, Zhou J-W, Luo Y. Factors impacting compliance with standard precaution in nursing, china. *International Journal of Infectious Diseases* 2010; **14(12):** e1106-e1114. http://dx.doi.org/10.1016/j.ijid.2009.03.037
11. Abdulraheem IS, Amodu MO, Saka MJ, Bolarinwa OA, Uthman MMB. Knowledge, awareness and compliance with standard precautions among health workers in North Eastearn Nigeria. *J Community Med Health Edu* 2012; **2(3):** 1000131.
12. Vaz K, McGrowder D, Alexander-Lindo R, Gordon L, Brown P, Irving R. Knowledge, awareness and compliance with universal precautions among health care workers at the university hospital of the West Indies, Jamaica. The *International Journal of Occupational and Environmental Medicine* 2010; **1(4):** 171-181.
13. Danchaivijitr S, Tantiwatanapaiboon Y, Chokloikaew S, Tangtrakool T, Suttisanon L, Chitreechuer L. Universal precautions: knowledge, compliance and attitudes of doctors and nurses in Thailand. *J Med Assoc Thai* 1995; **5(78) Suppl 2:** S112- S117.
14. Reda AA, Fisseha S, Mengistie B, Vandeweerd JM. Standard precautions: occupational exposure and behavior of health care workers in Ethiopia. *PLoS One* 2010; **5(12):** e14420. http://dx.doi.org/10.1371/journal.pone.0014420
15. Hesse AAJ, ADU-Aryee NA, Entsua-Mensah K, Wu L. Knowledge, attitude and practice universal basic precautions by medical personnel in a teaching hospital. *Ghana Med J* 2006*;* **40(2):** 61-64. http://dx.doi.org/10.4314/gmj.v40i2.36019
16. Okechukwu EF, Motshedisi C. Knowledge and practice of standard precautions in public health facilities in Abuja, Nigeria. *International Journal of Infection Control* 2012; **8(3):** 1-7. http://dx.doi.org/10.3396/ijic.v8i3.022.12
17. Sadoh WE, Fawole AO, Sadoh AE, Oladimeji AO, Sotiloye OS. Practice of universal precautions among health care workers. *Journal of the National Medical Association* 2006; **98(5):** 722-726.
18. Labrague LJ, Rosales RA, Tizon MM. Knowledge of and compliance with standard precautions among student nurses. *International Journal of Advanced Nursing Studies* 2012; **1(2):** 84-97. http://dx.doi.org/10.14419/ijans.v1i2.132
19. Kim KM, Kim MA, Chung YS, Kim NC. Knowledge and performance of the universal precautions by nursing and medical students in Korea. *Am J Infect Control* 2001; **29:** 295-300. http://dx.doi.org/10.1067/mic.2001.114837
20. Chittaro M, Calligaris L, Farneti F, Faruzzo A, Panariti M, Brusaferro S. Healthcare workers' compliance with hand hygiene after the introduction of an alcohol-based handrub. *Int J Infect Contr* 2009; **5(1):** 1-8. http://dx.doi.org/10.3396/ijic.v5i1.002.09
21. Efstathiou G, Papastavrou E, Raftopoulos V, Merkouris A. Factors influencing nurses' compliance with standard precautions in order to avoid occupational exposure to microorganisms: A focus group study. *BMC Nursing* 2011; **10:** 1-12. http://dx.doi.org/10.1186/1472-6955-10-1
22. Hanafi MI, Mohamed AM, Kassem MS, Shawki M. Needlestick injuries among health care workers of University of Alexandria hospitals. *Eastern Mediterranean Health Journal* 2011; **17(1):** 26- 35.
23. Mingoli A, Sapienza P, Sgarzini G, Modini C. Surgeons' risk awareness and behavioral methods of protection against blood borne pathogen transmission during surgery. *Annals of Surgery* 1999; **230:** 737–738. http://dx.doi.org/10.1097/00000658-199911000-00022
24. Ng YW, Hassim IN. NSI among medical personnel in Accident and Emergency Department of two teaching hospitals. *Medical Journal of Malaysia* 2007; **62:** 9–12.
25. Report on the implementation of the APW of a pilot survey on unsafe injection practice in Vietnam. Hanoi, Vietnam, Ministry of Health, Department of Therapy, 2003: 30.
26. Singhal V, Bora D, Singh S. Hepatitis B in health care workers: Indian scenario. *Journal of Laboratory Physicians* 2009; **1(2):** 41-48. http://dx.doi.org/10.4103/0974-2727.59697
27. Oliveira AC, Cardoso CS, Mascarenhas D. Contact precautions in intensive care units: facilitating and inhibiting factors for professionals' adherence. *Rev Esc Enferm USP* 2010; **44(1):** 161-165. http://dx.doi.org/10.1590/S0080-62342010000100023
28. Dancer SJ. The role of environmental cleaning in the control of hospital-acquired infection. *J Hosp Infect* 2009; **73:** 378-385. http://dx.doi.org/10.1016/j.jhin.2009.03.030
29. Hota B. Contamination, disinfection, and cross-colonization: are hospital surfaces reservoirs for nosocomial infection? *Clin Infect Dis* 2004*;* **39(8):** 1182-1189. http://dx.doi.org/10.1086/424667
30. Zambranoa AA, Jones A, Otero P, Ajenjo MC, Labarca JA. Assessment of hospital daily cleaning practices using ATP bioluminescence in a developing country. *Braz J infect dis* 2014; **18(6):** 675–677. http://dx.doi.org/10.1016/j.bjid.2014.06.008

31. Goodman ER, Platt R, Bass R, Onderdonk AB, Yokoe DS, Huang SS. Impact of an environmental cleaning intervention on the presence of Methicillin-Resistant *Staphylococcus aureus* and Vancomycin-Resistant enterococci on surfaces in Intensive Care Unit Rooms. *Infect Control Hosp Epidemiol* 2008; **29(7):** 593–599. http://dx.doi.org/10.1086/588566
32. Pittet D, Hugonnet S, Harbath S, *et al*. Effectiveness of a hospital-wide programme to improve compliance with hand hygiene. *Lancet* 2000; **356:** 1307–1312. http://dx.doi.org/10.1016/S0140-6736(00)02814-2
33. Huang J, Jiang D, Wang X, *et al*. Changing knowledge, behavior and practice related to universal precautions among hospital nurses in China. *J Contin Educ Nurs* 2002; **33:** 217–224.
34. Helder OK, Brug J, Looman CW, van Goudoever JB, Kornelisse RF. The impact of an education program of hand hygiene compliance and nosocomial infection incidence in an urban neonatal intensive care unit: an intervention study with before and after comparison. *Int J Nurs Stud* 2010; **47:** 1245–1252. http://dx.doi.org/10.1016/j.ijnurstu.2010.03.005
35. Gould DJ, Chamberlain A**.** The use of a ward-based educational teaching package to enhance nurses' compliance with infection control procedures. *J Clin Nurs* 1997; **6:** 55–67. http://dx.doi.org/10.1111/j.1365-2702.1997.tb00284.x