

Knowledge and practice of medical students of the usage of personal protective equipment: A comparison of two cohorts of students at the International Medical University

Thiruselvi Subramaniam, Rosalind Chi Neo Loo

Introduction: Standard precautions in health care is the essence of medical practice encompassing the safety of patients and health care workers including medical students. Barriers to the proper use of personal protective equipment (PPE) exist across the world but identification of areas of weaknesses and appropriate remedies will reduce them. This study assesses knowledge and use of PPE among fourth year students after a period of educational interventions.

Objective: To evaluate appropriate use, awareness and knowledge about PPE among fourth year students after interventions.

Method: A cross-sectional study where forty year 4 students (Group B) were randomly observed and later asked to answer a questionnaire. Students had undergone interventions to improve PPE use, which included lectures and video sessions during each posting. Results were compared with a previous group (Group A). Chi-square test or Fisher's exact test was used to analyse the data.

Results: There was statistically significant improvement in the use of PPE like wearing and removing mask during invasive procedures ($p < 0.001$) and hand-washing before and after a non-invasive task ($p < 0.001$). Comparison of Groups A and B on the results of the questionnaire for 'Questions in which more than 10% students answered incorrectly', showed that there was improvement in Group B in all the questions, some being statistically significant with p value=0.01.

Conclusion: An overall improvement in the use of the PPE and knowledge was noted. Sometimes, students' attitude and personality may be a challenge and these students may defy changes, but this can be overcome if the strategies are embedded in the curriculum and taught from as early as the first semester.

IeJSME 2015 9(2): 25-31

Keywords: Personal protective equipment (PPE), standard practice, patient safety, attitudes, medical students

Introduction

The topic of standard precautions in health care is a very old one but one that is of utmost importance as it is the essence of medical practice encompassing the safety of patients and health care workers including medical students. Awareness alone is not enough as without the right attitude and proper use of the devices, the goals of safety cannot be achieved. Data regarding medical students' attitude, knowledge and use of PPE are relatively few. However, some of the available studies showed that there is poor knowledge regarding infection control and PPE use among students^{1,2,3,4,5}. There is also evidence that though knowledge among students is good, there is lack of adherence and compliance to the safe practice.^{6,7} There is also not much information about the outcome of training medical students on PPE use.^{8,9}

In the year 2009, a study (pilot) was conducted on the use and awareness about PPE devices amongst semester 8 (year 4) medical students (Group A) during their accident and emergency (A&E) posting. The students were observed on their use of these protective devices when dealing with patients. They were given a questionnaire to fill at the end of the posting, testing their knowledge on the use of the PPE devices. It was found that though the students fared quite well in their questionnaire, they did not do so well when they faced patients and situations in the A&E⁷. Taking that into account, efforts were made to improve their awareness and put into practice what they seem to have good knowledge in.

We felt that awareness needed to be implemented early and continued throughout the clinical years if there was to be long term improvement, thus we did not reassess the same group. Instead, we decided to introduce the awareness strategies on students who came into the clinical phase for the first time. The aim of this follow-up study was to identify if there was improvement after changes were made to increase awareness, knowledge and use of PPE among students after entry to clinical

Clinical Skills and Simulation Centre, Department of Anaesthesia, Clinical School, International Medical University, 70300 Seremban, Negeri Sembilan, MALAYSIA

Address for Correspondence:

Dr Thiruselvi Subramaniam, Head of Clinical Skills and Simulation Centre, Department of Anaesthesia, Clinical School, International Medical University, 70300 Seremban, Negeri Sembilan, MALAYSIA
Email: thiruselvi_subramaniam@imu.edu.my

phase. These aims were accomplished by comparing the previous group of medical students (Group A) from the same school who did not receive intervention with the medical students who had intervention (Group B).

Method

Our university practices an outcome based curriculum built on specific domains and students go through a pre-clinical (two and a half years) and clinical phase of learning (another two and a half years). Knowledge on PPE and practice of standard precaution is introduced in the pre-clinical phase (mostly lecture based) but can really be put into practice when they come to the clinical phase and begin rotation in the different disciplines at the teaching hospitals. They are exposed to all types of patients and situations and often get opportunities to participate in the management of patients where the knowledge and awareness on the use of PPE become imperative for their safety as well as the patients'.

This is a cross-sectional study where data was collected until the target numbers (based on previous similar study) were reached. A total of 40 students were enrolled in this study, though the whole batch was exposed to the same interventions made to improve awareness and knowledge beginning from semester 6 (year 3). Over a six month period, students posted to A&E were randomly selected and included in the study.

Interventions were included into the usual teaching learning activities and not as a separate PPE session by itself. During the first week of the clinical phase of medical school, as part of their orientation programme, all students were given lectures on standard precautions with emphasis on the risks of needle stick injuries and the precautions to be taken. Subsequently, the same batch of students were shown a 10 minute video on the techniques of hand washing, gowning and doffing of gown, gloving and doffing of gloves and the correct

way to put on and remove the mask as part their clinical skills training during all their postings (three in total per semester) until they reached second half of year four when they start their A&E posting. This was in addition to their usual timetabled hands-on teaching of clinical skills in the use of PPE which also takes place during the surgical posting.

When they start their emergency ward posting in semester 8 (year 4), we began to observe all their activities in the casualty and their use of the PPE. They were given a questionnaire (identical to the one from the previous study) during the postings which they thought was part of their emergency posting and were unaware that they were being assessed. The data was collected, analysed and compared with the results from the previous study where there was no focussed emphasis in the use of PPE. We looked at the questions from the questionnaire where more than 10% students answered incorrectly in the 2009 and compared them with the performance on the same questions in 2011 after efforts were made to improve awareness and knowledge.

Statistical analysis

We used chi-square test and Fisher's exact test where appropriate to compare student performance in 2009 and 2011. This was because we noted that the sample size was small when comparing the changes between the two years. Statistical significance is set at $p < 0.05$.

Results

The performance with the questionnaire was better in Group B and there was statistically significant improvement in knowledge regarding stethoscopes as vehicles of infection transmission, Q2 ($p=0.01$) and the need for special mask as airborne transmission precaution, Q4 ($p=0.01$) (Table 1).

Table 1: Questions in which more than 10% students answered incorrectly in 2009 compared with the performance in 2011

NO.	QUESTION	% 2009	% 2011	χ^2 VALUE P VALUE
1	Hand washing is the single most important precaution for preventing the spread of infection.	25 (10/40)	10 (4/40)	3.12 0.08
2	Stethoscopes are a vehicle for transmission of infections.	10 (4/40)	5 (2/40)	6.27 0.01
3	If you have an accidental exposure, immediately wash exposed skin with soap and water or flush exposed mucus membranes with water and then report the incident to your supervisor.	15 (6/40)	2.5 (1/40)	0.11*
4	You must wear a special mask when you enter the room of a patient on airborne precautions.	10 (4/40)	5 (2/40)	6.27 0.01
5	The proper way to take off your gloves is to pull at the fingers until the gloves slide off.	17.5 (7/40)	5 (2/40)	0.15*
6	The Facility where you are attached to has a protocol called "hand hygiene".	12.5 (5/40)	12.5 (5/40)	0 1.00

*Note: All analyses are Chi-squared tests, except those marked * where Fisher's Exact test was done.*

Table 2: Performing invasive procedures (venipuncture, setting IV lines, administering drugs, intubation, defibrillation and suctioning)

NO.	PROCEDURE	2009	2011	χ^2 value P value
1	Wash hands before task with alcohol rubs	35 (87.5%)	40 (100%)	P=0.05*
2	Wear plastic apron	14 (35%)	21 (52.5%)	2.49 P=0.11
3	Wear mask	17 (42.5%)	40 (100%)	32.3 P<0.001
4	Wear gloves	40 (100%)	40 (100%)	P=1.00
5	Discard sharps into the sharp bin	37 (92.5%)	40 (100%)	P=0.24*
6	Remove gloves	40 (100%)	40 (100%)	P=1.00
7	Remove mask	17 (42.5%)	40 (100%)	32.3 P<0.001
8	Wash hands with alcohol rubs after the task	40 (100%)	40 (100%)	P=1.00

*Note: All analyses are Chi-squared tests, except those marked * where Fisher's Exact test was done*

There appears to be an improvement in all the tasks, some more than the others. All the 40 students in Group B washed their hands before a task with alcohol rubs, wore masks and removed the masks when performing invasive procedures, discarded sharps into the sharps bin, wore gloves and removed them after procedures and washed hands with alcohol after tasks. There was a statistically significant improvement in the practice of wearing and removing masks among students when performing invasive procedures ($P < 0.001$).

Table 3: Performing Non -Invasive procedures (assisting with patient's personal needs, performing ECG, preparing equipment, placing O2 mask on patients and administering nebulizers)

NO	YEAR	2009	2011	X ² VALUE P VALUE
	Effective Practice	Yes	Yes	
1	Wash hands before task	12 (30%)	32 (80%)	20.20 P<0.001
2	Wash hands after task	10 (25%)	39 (97.5%)	44.29 P<0.001

Discussion

Often times it is an epidemic or outbreak affecting lives that drives a much needed change.¹⁰ Humans generally seem to need something like this to believe and accept a change and this has been so from beginning of time. Updated guidelines for standard precaution practices are made available online for all and a lot of effort has been made by WHO and NIOSH to improve awareness and encourage the use of PPE amongst health care workers.¹¹ Despite this there are indications that adherence to standards is still suboptimal among healthcare workers.^{12,13,14} Medical students are future doctors and the introduction of appropriate PPE use and inculcating the culture of patient safety in this group will be a mechanism by which attitudes can be changed as there appears to be no uniformity in the use of PPE among health care workers.^{13,15} Standard practice and use of the PPE devices is started in the pre-clinical phase and spirals out to more complex integration in the clinical phase and it is in the clinical phase that students get to put to practice most of what they are taught in our university. The teaching of these standard practices and use of PPE is included in the time table as part of clinical skills learning. Prior to this, during semester 6 (year 3), when students began their clinical phase they were taught how to perform selected skills like scrubbing, gowning and gloving besides other skills. There were no sessions focussed mainly on PPE use and standard precautions.

A pilot study done in 2009 found that knowledge on this subject was relatively good though a fair number of students did not apply what they knew.⁷ The results were quite similar to another study where students' knowledge was adequate but adherence to practice was poor.⁶ There are suggestions that medical students are not acquiring the necessary knowledge on standard precautions despite increased teaching.^{16,17} In our study, this group of students (Group B), have shown improvement in knowledge, especially in the responses to some of the questions compared to the previous group (Group A) (Table 1) after educational interventions.

Having noted that there was still a place for improvement, some changes were made in the way standard precautions were taught to students in the clinical phase. This was in the form of short lectures during the orientation programme for entry in to clinical phase, videos on correct techniques of PPE use during all postings, placing posters on hand washing especially at the wash areas and ensuring ready availability of hand wash solutions and gloves wherever required. It has been shown that though increasing knowledge should enhance competence, strategies to improve adherence to recommended use of PPE should focus on ready availability of equipment, training and fit testing and good communication practices.¹² In our study, there was statistically significant improvement in the practice of PPE among students after these changes were made. 80% washed hands before a task compared to only 30% before this exercise and 97.5% washed after a task compared to 75% in the previous group. These findings were similar to studies by Jeffe *et. al.* and Diekema *et. al.* where they noted that there was significant improvement in knowledge, attitude and behavior after students were given training on universal precautions.^{8,9}

Improving practice among students is good but the challenge is to ensure that there is long term effectiveness in terms of knowledge and compliance as compliance and adherence to recommended universal precautions has been documented as lacking.¹⁸ According to Kelly on the online review titled 'Addressing the Challenges

of PPE Non-Compliance' there are many reasons cited for the lack of compliance; lack of time, perception that using PPE interferes with the ability to perform the task, physical discomfort or difficulty communicating when wearing masks and PPE not available when needed. If there is a strong culture of safety in the healthcare setting, it has been shown to result in a higher rate of adherence to standard infection control precautions among employees, a decreased incidence of exposure mishaps in hospitals, and fewer workplace injuries among employees.¹⁹ This is the kind of culture that students should be exposed to during the learning years if transference to practice upon graduation is to occur and persist.

An interesting study was done on fourth year students after they had training on infection control during their second year. It demonstrated that although there was a significant knowledge increase about infection control immediately after participating in the intervention, there was no significant knowledge retention about infection control two years later suggesting that retraining regularly may improve adherence and long term knowledge retention.²⁰ This is a challenge that medical schools need to address and come up with ways to ensure that it becomes so ingrained that it is practised without conscious effort. Education on infection control practices and why this need to be emphasised upon should be continued throughout the course of their study in the medical school.^{10, 14}

Student learning is mostly driven by assessment, thus, perhaps inclusion of PPE and the techniques of use in assessments like OSCE would reinforce the importance to students.²¹ Any assessment tool like objective structured practical skills (OSPE) or multiple choice questions (MCQ) or formative assessment during bedside teaching could be used to emphasise the importance of infection control and use of PPE. Results from a study on beliefs and attitudes of medical students regarding hand hygiene suggested that future educational approaches should include clear presentation of the evidence of effectiveness of hand hygiene, availability of

alcohol-glycerol hand rub at the bedside, better practice by senior doctors (role models), feedback from teachers at the bedside, and inclusion of hygiene marks in all clinical teaching.²¹ The inclusion of standard practice in our OSPE assessment for example, being incorporated in an intravenous line insertion station, is something that is already in practice in our university.

In a busy setting like the A&E it becomes a challenge for the nurse supervisors to keep an eye on all the students and their practices. Thus there is significant dependence on the healthcare workers in the department to monitor the students and provide feedback. Immediate feedback by their supervisors during sessions in the hospital would be more meaningful and students are more likely to comply. Immediate personalised performance feedback has been shown to be effective at improving and maintaining adherence to hand hygiene.²² There is a hidden challenge here which is to have uniformity in practice of PPE by the healthcare workers which has been found to be very varied within departments, hospital, inter-hospital and even among different countries. This can serve to confuse and deter student practice and compliance.²³ Regular training of healthcare workers should be carried out to standardise practice which would then help change the culture of the present inconsistent practices among them.

During clinical postings students follow and observe health personnel who range from nursing aides to doctors whose practices will influence their own practices. Teaching by example (role modelling) is an important method of ensuring that students maintain good practices. One of the objectives of a study done by Michelle *et. al.* was to determine the effect of the mentor's hand hygiene practices on student's hand hygiene rates during clinical rotations. They found that the mentor's practice of hand hygiene was the strongest predictor of the student's rate of hand hygiene.²⁴ Sub-optimal compliance with Universal Precautions among operating room personnel was demonstrated in a study which is an important example of a negative influence to students who are in their operating theatre (OT) rotation.¹³

The *Handwashing Liaison Group* has pointed out that 'The failure of healthcare workers to decontaminate their hands reflects fundamentals of attitudes, beliefs and behaviours'.²⁵ There are studies looking at behavioural interventions to improve infection control practices. None of the behavioural theories appear to predict behaviour but suggest that some of the common constructs in each theory (beliefs, perceived health threats, attitudes, cues, subjective norms, perceived behavioural control, intention and the stages and processes of change) can be integrated into an intervention to improve infection control practices.^{26,27} It has been suggested that attitudes to hand-washing and perception of infection risk are not significantly associated with hand-washing practice, whereas peer behaviour might be a significant influencing factor.¹⁰

There were limitations to the study especially in terms of sample size which is relatively small and the fact that the same group was not reassessed after enhanced teaching. This was a logistic problem as the students moved on to the next semester and there was a need to implement the changes and allow for a period of time to lapse before we assessed again. There was also the possibility of the second group being aware of being observed though remote.

Conclusion

The results of this study showed that there is better awareness and practice when emphasis is made on PPE use in medical school. In summary, strategies to improve students' attitude and compliance would need to include:

1. Culture change in the safety practices in healthcare system where students get their clinical training
2. Infection control and use of PPE be made part of formative or summative assessment
3. Educating the teaching faculty to ensure they become good role models
4. On the spot feedback by faculty and healthcare staff
5. Constant exposure during their postings.

REFERENCES

1. Hunt DCE, Mohammudally A, Stone SP, et al. Hand-hygiene behaviour, attitudes and beliefs in first year clinical medical students. *J Hosp Infect.* 2005; 59: 371-3.
2. Askarian M, Honarvar B, Tabatabaee H-R, Assadian O. Knowledge, practice and attitude towards standard isolation precautions in Iranian medical students. *J Hosp Infect.* 2004 Dec; 58 (4):292-6.
3. Mann CM, Wood A. How much do medical students know about infection control? *J Hosp Infect.* 2006; 64: 366-70.
4. Karolin G, Iris F, Chaberny and Ralf-Peter V. Beliefs about hand hygiene: A survey in medical students in their first clinical year. *Am J Infect Control.* 2011; 39: 885-8.
5. Amin TT, Al Noaim KI, Bu Saad MA, Al Malhm TA, Al Mulhm AA & Al Awas MA. Standard Precautions and Infection Control Medical Students' Knowledge and Behavior at a Saudi University: The Need for Change. *Global Journal of Health Science.* 2013; 5 (4): 114- 25.
6. Verena G. Paul S, Harald HK, and Andreas FH. Knowledge of and Adherence to Hygiene Guidelines among Medical Students in Austria. *Interdiscipl Persp Infect Dis* 2013; Article ID 802930.
7. Subramaniam T, Loo CN, Poovaneswaran S. The practice of PPE amongst fourth year medical students at A&E. Where are we? *IeJSME.* 2013; 7(2): 29-32.
8. Diekema DJ, Schuldt SS, Albanese MA, Doebbeling BN. Universal Precaution Training of Preclinical Students' Impact on Knowledge, Attitude and Compliance. *Prev Med.* 1995 Nov; 24(6): 580-5.
9. Jeffe D B, Mutha S, Kim L E, Evanoff B A, Fraser V J. Evaluation of a preclinical, educational and skills-training program to improve students' use of blood and body fluid precautions: one-year follow-up. *Prev Med.* 1999 Nov; 29 (5):365-73.
10. Wong TW, Tam WS. Hand-washing practice and the use of personal protective equipment among medical students after the SARS epidemic in Hong Kong. *AJIC: Amer J Infect Control* 2005; 33(10): 580-6.
11. Guidelines for protecting the safety and health of health care workers. Online. available at www.cdc.gov/NIOSH/hcworld
12. Nichol K , McGeer A , Bigelow P, O'Brien-Pallas L, Scott J, Linn Holness D. Behind the mask: Determinants of nurse's adherence to facial protective equipment. *Amer J Infect Control* 2013; 41: 8-13.
13. Akduman D, Kim LE, Parks RL, L'Ecuyer PB, et al. Use of Personal Protective Equipment and Operating Room Behaviors in Four Surgical Subspecialties: Personal Protective Equipment and Behaviors in Surgery . *Infect Contr Hospital Epid* 1999; 20 (2):110-4.
14. Cohen DL, Casken J. Protecting healthcare workers in an acute care environment during epidemics: lessons learned from the SARS outbreak. *Int J Caring Sci* 2011; 4 (1): 3-10.
15. Ganczak M, Szych Z. Surgical nurses and compliance with personal protective equipment. *J Hosp Infect* 2007; 66: 346-51.
16. Monsalve Arteaga LC, Martinez Balzano CD & Carvajal de Carvajal AC. Medical students' knowledge and attitudes towards standard precautions. *J Hosp Infect* 2007; 65: 371- 83.
17. Koenig S, Chu J. Senior medical students' knowledge of universal precaution. *Acad Med* 1993; 68 (5): 372-4.
18. Gershon RR, Karkashian C, Felknor S. Universal precautions: an update: *Heart Lung* 1994 23(4): 352-8.

19. Kelly MP. Addressing the Challenges of PPE Non-Compliance Copyright 2014. Available at: <http://www.infectioncontroltoday.com/articles/2011/10/addressing-the-hallenges-of-ppe-non-compliance.aspx>. [accessed Jan 28, 2015].
 20. Calabro K, Bright K, Kouzekanani K. Long term effectiveness of infection control training among fourth year medical students. Med Educ Online (serial online). 2000; 5:1. Available from URL <http://www.med-ed-online.org>. [Accessed 2014].
 21. Feather A, Stone SP, Wessier A, Boursicot KA and Pratt C. 'Now please wash your hands':the Handwashing behaviour of final MBBS candidates. J Hosp Infect 2000; 45: 62– 4.
 22. Luke MM and Alavosius M. Adherence with universal precautions after immediate, personalized performance feedback. Journal of Applied Behavior Analysis. 2011; 44: 967-71.
 23. Beam EL, Gibbs SG, Boulter KC, Beckerdite ME, Smith PW. A method for evaluating health care workers' personal protective equipment technique. Amer J Infect Control 2011; 39 (5): 415-20.
 24. Snow M, White GL, Alder SC, and Stanford JB. Mentor's hand hygiene practices influence student's hand hygiene rates. Am J Infect Control 2006; 34: 18-24.
 25. Handwashing Liaison Group. Hand Washing. A modest measure-with big effects. BMJ 1999; 318: 686.
 26. Whitby M, Pessoa-Silva CL, McLaws ML et al. Behavioural considerations for hand hygiene practices: the basic building blocks. J Hosp Infect 2007; 65, 1- 8.
 27. Kretzer EK, Larson EL. Behavioral interventions to improve infection control practices. Am J Infect Control 1998; 26(3): 245-53.
-