Knowledge and Practice of Occupational Infection Control among Healthcare Workers in Jamaica

TM Foster[1], MG Lee[1], CD McGaw[2], MA Frankson[3]

ABSTRACT

Objective: *To assess the knowledge, compliance and practice among healthcare workers of occupational infection control at two hospitals in Jamaica.*

Methods: *Employing a cross-sectional study design, medical personnel (physicians and nurses) at two hospitals in Jamaica, were studied, utilizing a structured questionnaire consisting of 14 items to collect the data.*

Results: *Participants considered the following fluids, not blood stained, high risk for HIV transmission: breast milk (79%), saliva (14%), urine (27%), pleural fluid (53%), CSF (55%), synovial fluid (37%), faeces (27%), peritoneal fluid (53%) and vomitus (21%). The respondents estimated the risk of transmission of infection after a needlestick injury from a patient with: HIV, mean 22.5%, HBV, 34% and HCV, 26%. Needles for drawing blood were identified as having the highest risk for transmission of infections in 63%.*

The following precautions were adhered to all the time: wearing gloves (38%), not re-sheathing needles (22%), not passing needles directly to others (70%), properly disposing of sharps (86%) and regarding patients' blood and other high risk fluid as potentially infected (62%). Post exposure, 43% indicated bleeding\squeezing the NSI site as the initial first-aid procedure, washing with soap and water (29%) and irrigating the area with water (20%)

Conclusions: *Healthcare workers are aware of the risk of transmission of infection, however compliance with universal precautions was inadequate. An improvement in knowledge and practice with clear guidelines are needed and a comprehensive programme to educate HCWs regarding compliance with universal precautions is urgently required.*

Keywords: Infection control, healthcare workers

Conocimientos y Práctica del Control Ocupacional de Infecciones entre los Trabajadores de la Salud en Jamaica

TM Foster[1], MG Lee[1], CD McGaw[2], MA Frankson[3]

RESUMEN

Objetivo: *Evaluar los conocimientos, el cumplimiento de medidas, y la práctica entre los trabajadores de la salud encargados del control ocupacional de infecciones en dos hospitales en Jamaica.*

Métodos: *Empleando un diseño de estudio transversal, se estudió el personal médico (médicos y enfermeras) de dos hospitales en Jamaica. En el estudio se utilizó una encuesta estructurada de 14 puntos, para recoger los datos.*

Resultados: *Los participantes consideraron que los fluidos siguientes, no sanguinolentos, presentan un alto riesgo de transmisión de VIH: leche materna (79%), saliva (14%), orina (27%), fluido pleural (53%), LCR (55%), fluido sinovial (37%), heces (27%), fluido peritoneal (53%) y vómito (21%). Los encuestados estimaron el riesgo de transmisión de infección después de una lesión por punción con aguja de un paciente con: VIH, media 22.5%, VHB, 34% y VHC, 26%. Las agujas para extraer sangre fueron identificadas como el factor de mayor riesgo en la transmisión de infecciones, con 63%.*

Las precauciones siguientes se observaron todo el tiempo: uso de guantes (38%), no recapar agujas

From: Departments of [1]Medicine, [2]Surgery, Radiology, Anaesthesia and Intensive Care, and [3]Dean's office, Faculty of Medical Sciences, The University of the West Indies, Kingston 7, Jamaica, West Indies

Correspondence: Professor MG Lee, Department of Medicine, The University of the West Indies, Kingston 7, Jamaica, West Indies. Email: michael.lee@ uwimona.edu.jm

usadas (22%), no pasar agujas directamente a otros (70%), eliminar adecuadamente los desechos cortopunzantes (86%), y considerar la sangre de los pacientes y otros fluidos de alto riesgo de los pacientes, como potencialmente infectados (62%). En cuanto a la post-exposición, el 43% indicó hacer sangrar/ejercer presión sobre el sitio de la LPA como el procedimiento inicial para los primeros auxilios, lavando con jabón y agua (29%) e irrigando el área con agua (20%)

***Conclusiones**: Los trabajadores de la salud tienen conciencia del riesgo de la transmisión de infecciones. No obstante, el cumplimiento de las medidas universales era inadecuado. Es necesario mejorar los conocimientos y las prácticas con normas claras, y se requiere con urgencia un programa integral para educar a los trabajadores de la salud en relación con el cumplimiento de las medidas universales.*

Palabras claves: Control de infecciones, trabajadores de la salud

West Indian Med J 2010; 59 (2): 148

INTRODUCTION

Exposure to infected blood and body fluids is the main route of transmission of blood-borne pathogens including hepatitis B virus (HBV), hepatitis C virus (HCV) and human immunodeficiency virus [HIV] (1, 2). Infections with these pathogens are serious but may be preventable especially in the healthcare setting (3). Healthcare workers (HCWs) come into frequent contact with blood, body fluids, needles and instruments during patient care and while performing invasive procedures. Therefore, the transmission of blood borne infections constitutes an important occupational hazard to all HCWs.

HIV is a pandemic affecting more than 36 million persons worldwide, and in Jamaica, approximately 1.5% of the adult population are affected (3, 4). About 300 million persons worldwide are carriers of the HBV and about 1 per cent of blood-donors in Jamaica are carriers (3, 5). Healthcare workers who have antibodies to HBV either from vaccination or prior infection are not at risk (6). Hepatitis C virus infection is a common chronic infection and the prevalence among blood donors in Jamaica is 0.4% (7). The majority of HCV infected individuals will develop chronic liver disease including chronic active hepatitis and cirrhosis.

Although high risk exposures to infected blood, body fluids and needlestick injuries (NSIs) are common occupational hazards for HCWs, statistics globally probably underestimate the severity of the problem because many healthcare workers do not report their exposures (8). Regular surveillance is necessary to determine how serious the problem is and how well prevention programmes work. Universal precautions, such as the use of protective barriers, care to avoid injuries with sharps used in procedures and proper sanitization of contaminated surfaces, have been implemented to decrease the risk and prevent exposures of HCWs to blood borne pathogens. However, when these exposures occur, the risk of infection can be significantly reduced by following protocols for post-exposure prophylaxis (PEP) and guidelines issued for the management of occupational exposure to blood borne pathogens. This includes early evaluation of the source and exposed person's status along with the timely administration of hepatitis B immune globulin (HBIG), hepatitis B vaccine and/or HIV PEP where applicable (9–14). Surveys in HCWs have revealed that knowledge about the risks associated with needle-stick injuries and use of preventive measures was inadequate (8, 15).

In Jamaica and the Caribbean, no data is available on the knowledge, compliance and practice among healthcare workers of occupational infection control. This study was conducted among physicians and nurses at two hospitals in Jamaica to assess this important problem.

SUBJECTS AND METHODS

Employing a cross-sectional study design, medical personnel (physicians and nurses) at two hospitals in Jamaica, the St Ann's Bay Hospital (SABH) and Mandeville Regional Hospital (MRH) were studied. Located on the Northern coast, the 259-bed St Ann's Bay Hospital has on staff approximately 138 nurses and 76 physicians. Located in the centre of the island, the 210-bed Mandeville Hospital has a staff of approximately 150 nurses and 70 physicians. The target population was a broad cross-section of practitioners and nurses from various specialty areas including Surgery, Accident and Emergency (A&E), Internal Medicine, Obstetrics and Gynaecology (O&G) and Paediatrics.

A structured questionnaire consisting of fourteen items was used to collect the data. Each department was visited and the staff were given a detailed briefing on the study including its aims and objective. They were advised that their participation was entirely on a voluntary and anonymous basis and an individual's data would be kept confidential. Questionnaires were given either in groups or alone as the opportunity arose. A researcher was present at all time during the collection of the data to answer questions and clarify concerns raised by the respondents.

Data obtained through this survey included personal information on respondents' age group, area of work and occupational status, knowledge about transmission of HIV, Hepatitis B and Hepatitis C, needle stick injury with a contaminated needle or instrument and the recommended guidelines after NSIs. Data were kept confidential throughout the phases of data management and accessible only to the study team.

The entire data was analysed using version 12.0 of the Statistical Package for the Social Sciences (SPSS, Inc., Chicago, IL, USA). Descriptive statistics were produced as frequencies, percentages, means, standard deviations, medians and percentiles. Histograms of scale variables of interest were also created and visually assessed. Cross-tabulations of pairs of qualitative (categorical or ordinal) variables were produced and assessed using the Chi-square test of homogeneity and related tests of the strength of associations. The Kruskal-Wallis test was also used to assess the statistical significance of median differences in ranked data such as age categories by grouping variables such as specialty of respondents. Throughout, statistical significance was assessed at $p = 0.05$ or less.

RESULTS

There were 100 participants in the study, 40 from Mandeville Regional Hospital and 60 from St Ann's Bay Hospital. The study group consisted of 28% males and 72% females, which included 60% physicians and 40% nurses; of the physicians, 28 (47%) were males. There was no male nurse. Distributions were similar in both hospitals studied, with no difference in the male: female distribution or nurse: physician ratio. The majority (83%) were in the 21–39 year age range (Table 1). Nurses were older than physicians and female physicians were younger than male physicians.

Table 1: Characteristics of healthcare workers

Demographics	No (%)
Age (years)	
<20	0 (0%)
21 – 29	40 (40.8%)
30 – 39	42 (42.9%)
40 – 49	12 (12.2%)
>50	4 (4.1%)
Specialty area	
Surgery	19 (19%)
Accident and emergency	13 (15.5%)
Obstetrics and gynaecology	10 (10%)
Internal Medicine	20 (20%)
Paediatrics	14 (14%)
Other	15 (15%)
Status	
Senior Resident	9 (9%)
Junior Resident	32 (32%)
Interns	18 (18%)
Nursing sister	3 (3%)
Midwife	5 (5%)
Registered nurse	24 (24%)
Enrolled nurse	11 (11%)

The specialty areas and status of the participants are shown in Table 1. Males were more likely to work in surgery, 43%, compared with only 7% females. There were a total of 567 person years since graduation, with a mean of 6.2 (ranged 0.5 to 40 years). Nurses had more years since graduation than physicians, mean 7.8 *vs* 5.0 years.

Participants when asked to consider various body fluids not visibly contaminated with blood from a patient infected with HIV, whether or not they are high risk for the transmission of HIV, responded as follows: breast milk was considered infectious by 79%: 85% nurses, 75% physicians. Saliva was considered infectious by 14%: 15% nurses, 13% physicians. Urine was considered infectious by 27%: 40% nurses, 18% physicians. Pleural fluid was considered infectious by 53%: 63% nurses, 47% physicians. Cerebrospinal fluid was considered infectious by 55%: 63% nurses, 50% physicians. Synovial fluid was considered infectious by 37%: 45% nurses, 32% physicians while 53% considered peritoneal fluid to be infectious: 58% nurses, 50% physicians. Faeces was considered infectious by 27%; 48% nurses and 13% physicians. Vomitus was considered to be infectious by 21%: 33% nurses, 13% physicians. Six per cent considered none of the above mentioned bodily fluids to be infectious: 8.3% physicians, 2.5% nurses. For faeces, urine and vomitus, more nurses than physicians indicated that these, when contaminated with blood, were infectious ($p < 0.05$, $p = 0.017$ and $p = 0.022$ respectively). There was no difference between physicians and nurses for the other body fluids.

The respondents estimated the risk of transmission of infection after a NSI from a patient with HIV, mean 22.5%, HBV, 34% and HCV, 26%. Twenty-nine per cent correctly reported transmission of HIV by NSI less than or equal to 0.3%. In this survey, 21% of respondents under-estimated the risk. For HBV, 63% correctly reported the risk but 38% of respondents under-estimated the risk. For HCV, 45% correctly reported the transmission risk. Nurses in general overestimated the risk of transmission compared with physicians. Needles for drawing blood were correctly identified by 56% of participants as having the highest risk among the options given. The next frequent response was needles for obtaining tissue or organic fluid except blood, 11%. More physicians (65%) identified the correct options than nurses (42.5%), female physicians (75%) and male physicians (53.6%). There were no significant difference in selecting the correct answer among age ranges except none of those over 50 years old selected the correct answer.

The supervisor was identified by 54% as the person to be contacted in the event of an occupational injury, 23% indicated the nurse in charge and 20% the head of department. Sixteen per cent selected others, including, pharmacist, senior medical officers, A&E officers and infection control supervisor; 5% did not know who to contact.

Forty-three per cent of respondents indicated bleeding/squeezing the needle stick injury site as the initial first-aid procedure. Others procedures suggested were: washing with soap and water (29%) and irrigating the area with water (20%) [Table 2]. There was no significant difference in response between physicians, nurses and institutions. Two-thirds had a second procedure response of which, 14% suggested flushing with water, 13% wash with soap and water,

Table 2: First aid procedure to needle stick site

Procedure	Nurse	Physician (male)	Physician (female)	Total
Bleed\squeeze area	20	9	14	43
Irrigate area	4	8	8	20
Wash with soap, water	14	9	6	29
Wipe off blood	0	1	2	3
Clean with alcohol	0	1	1	2
Wash with water, and disinfectant	2	0	0	2
Bleach to area	0	0	1	1

11% bleed the area and used unsafe procedures such as cleaning with bleach, 6%.

More than 80% of nurses and physicians agreed that PEP should begin within 24 hours, however, 82.5% of nurses believed that it should be started less than or equal to six hours compared with 65% of physicians.

Instructions regarding PEP had been seen around the hospital less than six months ago by forty-six per cent of participants, 17% within 6–12 months, 14% within 1–5 years and 1% within 5–10 years; 17% did not. There was no statistical difference in the response by gender, age, institution or profession.

Participants wore gloves on an average of 86% of the time and only 38% of participants wore gloves all of the time. Nurses wore gloves more often than physicians (95% *vs* 80%) and 47% of nurses wore gloves all the time compared with 32% of physicians.

Respondents wore eye protection on average 13% of the time, primarily because of unavailability. Only 1.7% of respondents wore eye protection all the time. There was no significant difference in the frequency of wearing eye protection between nurses and physicians (11% *vs* 14%).

Only 22% of participants did not re-sheath needles all the time. Nurses did not re-sheath needles more often than physicians (75% *vs* 42.5%). Participants did not pass needles directly to others 89% of the time and 70% did not pass needles directly to others 100% of the time. There was no significant difference between nurses and physicians. Seventy per cent of physicians and 71.4% of nurses did not pass needles directly to others 100% of the time.

Respondents ensured that sharps were placed in the disposal bin 99.4% of the time and 86% of respondents ensured that sharps were properly disposed of 100% of the time. A similar result was obtained for physicians and nurses, from SABH and MRH.

The participants regarded patient's blood and other high risk fluids as potentially infectious, 94% of the time. There was no significant difference between physicians and nurses. Only 56% of physicians regarded blood and other high risk fluid as potentially infectious all the time compared with 71.4% of nurses.

DISCUSSION

Blood and body fluids containing visible blood are considered potentially infectious. In addition, the following are considered potentially infectious: cerebrospinal fluid, synovial fluid, pleural fluid, peritoneal fluid, pericardial fluid and amniotic fluid. However, the risk of transmission of HBV, HCV and HIV infection from these fluids is unknown and the potential risk to HCWs from occupational exposures has not been assessed by epidemiologic studies in healthcare settings. Participants correctly identified synovial fluid, peritoneal fluid, pleural fluid and cerebrospinal fluid even when not contaminated with blood to be infectious. Faeces, nasal secretions, saliva, sputum, sweat, tears, urine and vomitus are not considered potentially infectious unless they contain blood and the risk of transmission of HBV, HCV and HIV infection is extremely low (11). Interestingly, nurses thought faeces, urine and vomitus had a high risk of HIV transmission.

In this study, 79% of the participants were aware that breast milk is considered as high risk for HIV transmission. However, they were not clear on the risk of transmission of HIV to HCWs, if the body fluid was not contaminated with blood, as reflected by the range of responses. Although human breast milk has been implicated in perinatal transmission of HIV and HBV (11, 13), occupational exposure to human breast milk has not been implicated in the transmission of these infections to HCWs (8).

In the present study, the risk of HIV was over-estimated, as only 8% correctly estimated the 0.3% risk (2) in HCWs post-percutaneous exposure and 71% over-estimated the risk. For HBV and HCV, 40% of respondents over-estimated the risk of transmission. However, a significant number of the study participants under-estimated the risk. The number of non-response indicate that less persons knew about the risk of transmission of HCV compared with HBV and HIV. In a study among nurses, it was found that the best knowledge of principles was about HIV, and the worst knowledge was regarding HCV (16). In other studies in doctors and nurses, overall knowledge of risks of blood-borne virus transmission from an infected patient after NSIs was low (17, 18).

The risk of HIV infection after mucous membrane exposure, is estimated to be approximately 0.09%. Although episodes of HIV transmission after non-intact skin exposure have been documented, the average risk for transmission by this route has not been quantified but is estimated to be less than the risk for mucous membrane exposures. The risk of transmission after exposure to fluids or tissues other than HIV-infected blood also has not been quantified but is probably considerably lower than for blood exposures (11). In this study, 56% of respondents correctly identified needles for drawing blood as having the highest risk of HIV infection among the options. Factors that increased risks of transmission of HIV include a deep wound, visible blood on

the device, a hollow-bore blood-filled needle, use of the device to access an artery or vein, and high-viral-load status of the patient (2).

In the present study, 29% indicated that washing the injured area with soap and water, 20% with water only and 44% bleeding the area as the initial first aid measure. After an exposure, wounds and skin sites that have been in contact with blood or body fluids should be washed liberally with soap and water without scrubbing, alcohol-based hand rubs or solutions can be used. No evidence exists that using antiseptics for wound care or expressing fluid by squeezing the wound further reduces the risk of blood borne pathogen transmission; however, the use of antiseptics is not contraindicated. Free bleeding of puncture wounds should be encouraged gently but wounds should not be sucked. Exposed mucous membranes, including conjunctivae, should be irrigated copiously with water, before and after removing any contact lenses (12). The application of caustic agents (*eg*, bleach) or the injection of antiseptics or disinfectants into the wound is not recommended (11). Other recommendations post-exposure include notifying the supervisor or occupational health and safety office, filling out an accident report and going to the doctor or the hospital emergency department where the exposure can be evaluated, preparation made to evaluate the source, management commenced as it relates to the exposure and possible pathogens, counselling of the HCW and follow-up (11).

Ninety-five per cent of respondents knew that drugs were used as PEP for HIV and 84% knew that this should be commenced within 24 hours of the injury for optimal effectiveness. Healthcare workers exposed to HIV should be evaluated within hours after their exposure and should be tested for HIV at baseline to establish infection status at the time of exposure. When indicated, PEP should be started as soon as possible.

In this study, HCWs were generally aware of universal precautions and there was high compliance with wearing gloves and also a high compliance with disposing of sharps properly. In a previous study of doctors and nurses, 94.9% of physicians and 85.5% of nurses were knowledgeable of universal precautions, but only 47.1% of the doctors and 27.9% of nurses reported that they would take precautions with all patients (19). In another study at three hospitals, compliance for certain universal precautions were high including, glove use, 97%, and disposal of sharps, 95% but were low for others including, wearing protective outer clothing and wearing eye protection. Female workers had higher compliance and overall compliance were highest for nurses and lowest for physicians (20). Globally, needle stick injuries are the most common source of occupational exposures to blood and the primary cause of blood-borne infections of HCWs (9). The two most common causes of NSIs are two-handed recapping and the unsafe collection and disposal of sharps waste (21). It is documented that 10% – 25% of injuries occurred while recapping a used needle (11).

Under the "universal precaution" principle, blood and body fluids from all persons should be considered as infected with blood borne pathogens (10). Universal precautions are intended to supplement rather than replace recommendations for routine infection control, such as hand-washing and using gloves (9). The following are general guidelines: a) use of single-use disposable injection equipment: b) discard contaminated sharps immediately, without recapping, in puncture and liquid proof containers that are closed, sealed and destroyed before completely full, c) document the quality of the sterilization for all medical equipment used for procedures, d) wash hands with soap and water before and after procedures; use of protective barriers such as gloves, gowns, aprons, masks, goggles for direct contact with blood and other body fluids, e) disinfect instruments and other contaminated equipment and f) handle soiled linen properly. Cleaning should occur outside patient areas, using detergent and hot water (10).

The recommendations made by participants in this study were comparable to those generally listed to ensure adherence to universal precautions. These include: a) staff understanding of universal precautions: healthcare workers should be educated about occupational risks and understand the need to use universal precautions with all patients. Regular in-service training should be provided for all medical and non-medical personnel. In addition, pre-service training for all HCWs should address universal precautions, b) reduce unnecessary procedures: it is important for HCWs to avoid unnecessary blood transfusions, injections, suturing and other invasive procedures, c) availability of adequate supplies: adequate supplies should be made available to comply with basic infection control standards, even in resource constrained settings. Attention should also be paid to protective equipment and adequate water supplies, d) adopt locally appropriate policies and guidelines: national healthcare waste management plans should be developed.

In conclusion, HCWs at two hospitals in Jamaica are aware of the risk of transmission of blood borne pathogens, however, compliance with universal precautions was inadequate. An improvement in knowledge and practice with clear guidelines and protocols are needed.

ACKNOWLEDGEMENTS

The authors are thankful for the assistance given by; The Research Resource Unit, Office of the Dean, Faculty of Medical Sciences, Mona. Dr SM Roofe, NERHA and Dr M Coombs, SRHA for their kind permission to conduct the study at the St Ann's Bay and Mandeville Regional Hospitals. Many thanks also to Dr P Wellington and staff of Mandeville Regional Hospital. Dr H Betton and staff of St Ann's Bay Hospital.

REFERENCES

1. Canadian Centre for Occupational Health and Safety (CCOHS). Needle-stick injuries. OSH Answers Needlestick injuries. 2005. www.ccohs.ca/osanswers/diseases/needlestick.
2. Cardo DM, Culver DH, Ciesielski CA, Srivastava PU, Marcus R, Abiteboul D et al. A case-control study of HIV seroconversion in healthcare workers after percutaneous exposure. N Engl J Med 1997; **337:** 1485–90.
3. Newsom DH, Kiwanuka JP. Needle-Stick Injuries. Bandolier Extra: Evidence based Healthcare. July 2003. www.medicine.ox.ac.uk/bandolier.com.
4. Ministry of Health, Jamaica. Jamaica AIDS report 2001. Kingston: MOH; 2002.
5. Figueroa JP, Carpenter H, Hospedales CJ. A Survey of Hepatitis B among healthcare workers in Jamaica. West Indian Med J 1994; **4:** 2–6.
6. National Institute for Occupational Safety and Health. NIOSH Alert: Preventing needle-stick injuries in healthcare setting. Cincinnati: National Institute for Occupation Safety and Health, Nov 1999. (DHHS publication no. (NIOSH) 2000–108)
7. King SD, Dodd RY, Haynes G, Wynter HH, Sullivan MT, Serjeant GR et al. Prevalence of Antibodies to Hepatitis C and other markers in Jamaica. West Indian Med J 1995; **44:** 55–7.
8. Gurubacharya Dl, Mathura KC, Karki DB. Knowledge, attitudes and practices among healthcare workers on needle-stick injuries. Kathmandu Uni Med J (KUMJ). 2003; **1:** 91–4.
9. Perspectives in Disease Prevention and Health Promotion Update. Universal Precautions for Prevention of Transmission of Human Immunodeficiency Virus, Hepatitis B and other Blood-borne Pathogens in Healthcare settings. MMWR 1998; **37:** 377–88.
10. Standard supplies list. Universal Precautions, including Injection Safety: World Health Organization (WHO). 2005 www.WHO.INT/HIV/topics/precautions
11. Updated US Public Health Service Guidelines for the Management of Occupational Exposure to HBV, HCV and HIV and Recommendations for Post Exposure Prophylaxis. MMWR 2001; **50:** 1–42.
12. United Kingdom Health Departments. Guidelines on post-exposure prophylaxis for healthcare workers occupationally exposed to HIV. Department of Health, London, 1997.
13. Department of Health. HIV post-exposure prophylaxis: Guidance from the UK Chief Medical Officers Expert Advisory Group on AIDS. 2nd ed. 2004. www.advisorybodies.doh.gov.uk/eaga/publications.htm.
14. Cullen BL, Genasi F, Symington I, Bagg J, McCreaddie M, Taylor A et al. Potential for reported needle-stick injury prevention among healthcare workers through safety device usage and improvement of guideline adherence: expert panel assessment. J Hosp Infect. 2006; **63:** 445–51.
15. Alam M. Knowledge, attitude and practice among healthcare workers on needle stick injuries. Ann Saudi Med 2002; **22:** 5–6.
16. Bilski B, Wysocki J. The level of knowledge of post-exposure prophylaxis of blood-borne infections at the workplace observed in nurses. Med Pr 2005; **56:** 375–8.
17. Leliopoulou C, Waterman H, Chakrabarty S. Nurses failure to appreciate the risks of infections due to needle stick accidents: a hospital based survey. J Hosp Infect. 1999; **42:** 53–9.
18. Stein AD, Makarawo TP, Ahmad MF. A survey of doctors' and nurses' knowledge, attitudes and compliance with infection control guidelines in Birmingham teaching hospitals. J Hosp Infect. 2005; **54:** 68–73.
19. 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;78 **Suppl 2:** S112–7
20. Gershon RR, Vlahov D, Felknor SA, Vesley D, Johnson PC, Delclos GL et al. Compliance with universal precautions among healthcare workers at three regional hospitals. Amer J Infect control 1995; **23:** 225–36.
21. World Health Organization. Aide-Memoire for a Strategy to Protect Health Workers from Infection with Bloodborne Viruses. Geneva, Switzerland: WHO, November 2003.