Occupational Medicine Advance Access published November 2, 2006

Occupational Medicine
doi:10.1093/occmed/kql126

The impact of educational interventions on primary health care workers' knowledge of occupational exposure to blood or body fluids

Prassana Krishnan, Finlay Dick and Elizabeth Murphy

Aim To assess the impact of educational interventions on primary health care workers' knowledge of management of occupational exposure to blood or body fluids.

Methods Cluster-randomized trial of educational interventions in two National Health Service board areas in Scotland. Medical and dental practices were randomized to four groups; Group A, a control group of practices where staff received no intervention, Group B practices where staff received a flow chart regarding the management of blood and body fluid exposures, Group C received an e-mail alert containing the flow chart and Group D practices received an oral presentation of information in the flow chart. Staff knowledge was assessed on one occasion, following the educational intervention, using an anonymous postal questionnaire.

Results Two hundred and fifteen medical and dental practices were approached and 114 practices participated (response rate 53%). A total of 1120 individual questionnaires were returned. Face to face training was the most effective intervention with four of five outcome measures showing better than expected knowledge. Seventy-seven percent of staff identified themselves as at risk of exposure to blood and body fluids. Twenty-one percent of staff believed they were not at risk of exposure to blood-borne viruses although potentially exposed and 16% of exposed staff had not been immunized against hepatitis B. Of the 856 'at risk' staff, 48% had not received training regarding blood-borne viruses.

Conclusions We found greater knowledge regarding management of exposures to blood and body fluids following face to face training than other educational interventions. There is a need for education of at risk primary health care workers.

Key words Blood-borne viruses; education; health care workers; needlestick injury.

Introduction

Among health care workers, needlestick injuries are common [1,2], under-reported [3,4] and yet pose a small, but not insignificant, risk of exposure to potentially fatal blood-borne viruses [5,6]. To date, most studies of needlestick injuries have been conducted among hospital employees [7]. Few studies have assessed educational interventions to reduce such exposures and those that have, combined education with other interventions [8,9] or assessed specific occupational groups such as nursing students [10].

Historically, primary care staff in Scotland have had limited or no access to occupational health services. The self-employed general practitioners (GPs) and dentists, along with their employees, made up much of the primary care sector in Scotland functioning as independent contractors to the National Health Service (NHS). In common with other small and medium size enterprises, they lacked occupational health and safety resources. In 2001, the Scottish Executive Health Department set priorities for the provision of occupational health services to general medical and dental practitioners and their staff in Scotland. These priorities were minimizing the health and safety risks to staff, reducing accidents and injuries and raising awareness of health and safety issues [11].

The recognition that health care workers in primary care were an under-provided group with respect to education about occupational hazards was not unique to Scotland. In 2003, the UK's National Institute of Clinical Effectiveness published guidelines on the prevention of

Capita Health Solutions, 2 Circus Place, London EC2M5RS, UK.

Correspondence to: Prassana Krishnan, Capita Health Solutions, 2 Circus Place, London EC2M5RS, UK. e-mail: prassana.krishnan@capita.co.uk

health care-related infections in primary care [12]. A key recommendation was that 'Everyone involved in providing care in the community should be educated about standard principles and trained in hand decontamination, the use of protective clothing and the safe disposal of sharps'.

Most studies of needlestick injuries have been conducted among hospital rather than primary care personnel [7]. It is acknowledged that Scottish primary care staff require education on workplace hazards including those arising from exposures to blood or body fluids. Few studies have assessed the impact of educational interventions regarding the management of blood and body fluid exposures among such workers. Therefore, we undertook a study of the impact of three educational interventions on primary health care workers' knowledge of the management of blood and body fluid exposures.

Methods

The study was set in two NHS health board areas in the north-east and south-west of Scotland. The study population was defined as those general medical and general dental practices registered with Practitioner Services or the Primary Care Trust. In all 155 practices in NHS Grampian and 60 practices in NHS Dumfries and Galloway were identified. These 215 practices were cluster randomized into four groups (A, B, C and D). Cluster randomization applies where groups of people, in this case medical or dental practices, are randomized rather than individuals. The group or practice is then considered to be the unit of analysis. Cluster randomization is the most appropriate method for evaluating the impact of educational interventions as it reduces cross-contamination of information, which can occur between people when randomizing individuals in trials of educational interventions [13]. All 215 practices identified in the two NHS health board areas were contacted and invited to participate. Among participating practices, all staff members, including non-clinical staff, were invited to participate to prevent selection bias by practice managers.

The aim of the questionnaire was to assess what individual health care workers would do (following the educational intervention) when faced with potential occupational exposures to blood and body fluids. Questions were chosen to explore key factors in the prevention and management of blood and body fluid exposures based on discussions with colleagues and a literature review. Information was collected on participant's risk perception and their self-reported history of training on the management of blood and body fluid exposures. Questions on exposure to blood and body fluids were closed questions, i.e. yes/no. Respondents were asked to rate their perceived level of knowledge regarding hepatitis B immunization, safe handling of body fluids, safe use of needles, first aid following needlesticks and sources of advice following a contamination incident as 'high', 'moderate' or 'low'. The postal questionnaire was piloted in a GP practice and an occupational health service and subsequently amended: a question on area of work was expanded; examples of the safe handling of body fluids were added and 'sign-posting' within the questionnaire was improved.

The questionnaires were designed to be optically read using Formic™ (version 4) for Windows data capture software system for subsequent analysis using SPSS version 12 for Windows statistical package. Data from completed forms were captured via an electronic scanner, which 'reads' the forms and stores the information in a database.

An information pack containing a letter of introduction and a supply of questionnaires was sent to each practice manager within the four groups (A–D) inviting them to participate in the study. Group A was the comparison group and practices in this group received no intervention but their staff were provided with the questionnaire for immediate completion and return (to maximize response). In Group B, practice managers were asked to distribute the same questionnaires 6 weeks following distribution of the flow charts to those workers who had agreed to participate. Practice managers of practices allocated to Group C were contacted for an e-mail address to which flow charts could be e-mailed. In Group D, questionnaire distribution was limited to those workers who attended the oral presentation. A nurse was recruited in each region to perform a 15-min oral presentation covering information contained in the flow chart. To maximize response rates, questionnaires were completed anonymously and returned by individual workers using pre-paid envelopes. The educational interventions were as follows:

(i) Group A: comparison group receiving no intervention.
(ii) Group B: flow chart showing the management of occupational exposure to blood or body fluids.
(iii) Group C: e-mail alert containing the above flow chart for circulation to workers.
(iv) Group D: visit to practice by occupational health nurse for 15-min presentation of information contained in the flow chart.

Further copies of the questionnaire were sent to practice managers 8 weeks following the intervention, for distribution to any workers yet to return their questionnaire.

The statistical analyses employed were chi-squared tests for the key questions assessing knowledge following the educational intervention. Chi-squared tests assess the strength of association within groups by comparing actual (observed) numbers in each group, following the intervention, with those that would be expected by chance alone. Respondents were asked to self-assess their knowledge as low, moderate or high for the key questions

(Table 2) that assessed knowledge following the educational interventions. The observed and expected count for each cell in the high knowledge level category was calculated.

Results

Figure 1 illustrates the flow of participants through the cluster randomization into the four groups. All 215 practices in the two health board areas were invited to enter the study and 114 practices took part (practice response rate 53%) returning 1120 questionnaires. There were no significant differences in gender or age distribution across the four groups. The occupational composition of the four groups is shown in Table 1.

A chi-squared test was used to test for association between the four groups and their level of knowledge, following the educational interventions, for the five key areas studied (see Table 2). The differences between the observed and expected counts in each cell for the four groups were statistically significant for every question other than needle safety. For all categories in the high knowledge level the observed count exceeded the expected count for group D (face to face training) for the key questions asked. For group B (leaflet), the observed count exceeded the expected count in three categories while for group C (e-mail) no categories exceeded the expected count.

Overall 77% (n = 856) of workers identified themselves as being at risk of exposure to blood and body fluids (Table 3). Of those reporting a risk of exposure to blood and body fluids, 21% (n = 176) believed they were not at risk of exposure to blood-borne viruses and 16% (n = 138) had not been immunized against hepatitis B. Of these 856 'at risk' workers, 48% (n = 410) indicated that they had not received any training regarding blood-borne viruses.

Discussion

Of three educational interventions on primary health care workers' knowledge of the prevention and management of exposures to blood and body fluids, face to face training achieved the greatest proportion of responses in the

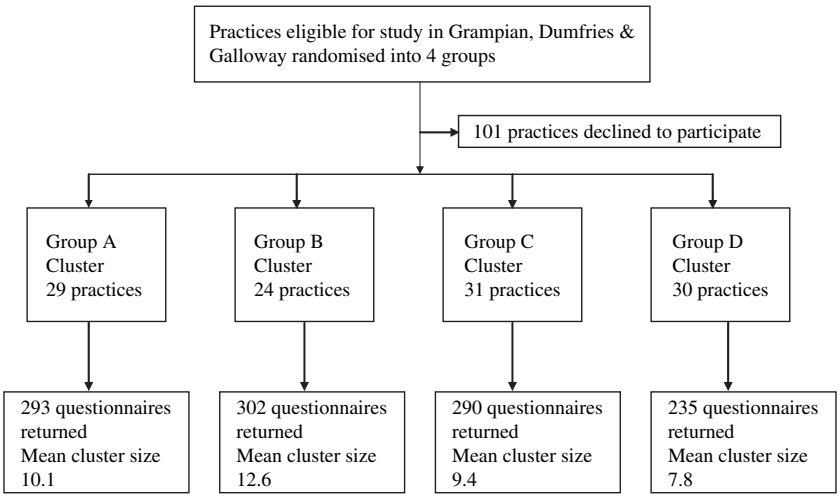

Figure 1. Flow of participants through cluster randomization and recruitment response.

Table 1. Distribution of occupations across the four study groups

	Group A	Group B	Group C	Group D
Total responses	n = 292	n = 300	n = 289	n = 234
Missing responses	n = 1	n = 2	n = 1	n = 1
Occupational group				
Administrative and clerical	n = 89 (31%)	n = 105 (35%)	n = 136 (47%)	n = 91 (39%)
GP	n = 56 (19%)	n = 61 (20%)	n = 55 (19%)	n = 30 (13%)
Nurse/dental nurse	n = 105 (36%)	n = 103 (34%)	n = 76 (26%)	n = 89 (38%)
Dentists	n = 26 (9%)	n = 13 (4%)	n = 11 (4%)	n = 22 (9%)
Others[a]	n = 16 (6%)	n = 18 (6%)	n = 11 (4%)	n = 2 (1%)

[a]Domestic, maintenance, professions allied to medicine and medical students.

high category across all issues. When comparing face to face training with the comparison group (group A), the percentage of high knowledge responses was ~10% higher for questions relating to hepatitis B immunization, first-aid measures and sources of advice. For these particular areas, the impact of face to face training could also be clinically significant. The face to face training group had higher knowledge counts than expected for all categories suggesting that it is effective in raising perceived knowledge by subjective self-assessment. An alternative explanation is that the significant association between face to face training and higher self-rated knowledge of the prevention and management of exposures to blood and body fluids is due to bias, confounding or chance. We minimized the likelihood of recruitment or selection bias by cluster randomization and recruiting all available workers. We cannot rule out the possibility of chance as an explanation for our findings but as other studies [10,14] have shown the effectiveness of educational interventions in reducing needlestick injuries this seems unlikely.

From a practical point of view, practice visits to provide face to face training were time consuming owing to the large geographical area covered, were difficult to organize, had variable attendance and were more costly than the other interventions. If attendance at training sessions were mandatory, a clearer picture of the effectiveness of such training would emerge. Compulsory training is possible, under the employer's legal duty to provide information, instruction and training under Control of Substances Hazardous to Health Regulations [15] (regulation 12). If training sessions were scheduled periodically at various locations, this might facilitate greater attendance. E-mail alerts as a mode of transmitting information was relatively cheap. However, there were difficulties as many dental practices did not have an e-mail address and there was no readily accessible source of e-mail addresses. Due to the large quantity of information health workers receive by e-mail, it would be easy for information on needlestick injury prevention to go unread. The same difficulties that may arise with e-mail as a means of education apply to leaflets. Furthermore, printing and distributing leaflets can be costly and there is no opportunity for the health worker to ask questions, interact with a trainer or raise issues relevant to their practice.

A secondary aim of this study was to explore staff risk perception and previous training on the management of exposures to blood and body fluids. Approximately 80% of workers exposed to blood/body fluids correctly identified that they were at risk of exposure to blood-borne viruses. It is of concern that one in five at risk workers in primary care did not perceive they were at risk from blood-borne viruses.

In a primary health care setting, it may not be possible to eliminate some hazardous procedures and so training (an administrative control) is important in the prevention and management of needlestick injuries. In our study,

Table 2. Chi-squared tests showing observed and expected counts for high knowledge levels regarding management of blood/body fluid exposures following educational intervention in the four study groups

	Groups				*P* value
	A	B	C	D	
Hepatitis B immunization					
Observed count	123	130	92	118	0.001
Expected count	123.2	123.6	119.8	96.4	
Universal precautions					
Observed count	181	178	155	154	0.03
Expected count	175.3	179.6	172.8	140.2	
Needle safety					
Observed count	192	194	181	161	0.21
Expected count	191.1	194.4	189.8	152.6	
First aid after exposure					
Observed count	122	151	113	120	0.003
Expected count	133.4	134.7	131.5	106.4	
Sources of advice					
Observed count	81	93	80	86	0.03
Expected count	89.8	90.4	88.2	71.6	

Table 3. Exposure to blood/body fluids, perceived risk of exposure to blood-borne viruses and hepatitis B immunization status in the four study groups

	Group A, $n = 293$	Group B, $n = 302$	Group C, $n = 290$	Group D, $n = 235$
Does your job involve exposure to blood/body fluids? (Yes)	$n = 245$ (84%)	$n = 233$ (79%)	$n = 195$ (68%)	$n = 183$ (79%)
Missing responses	$n = 1$	$n = 5$	$n = 1$	$n = 3$
If in an exposed job do you believe you are at risk of exposure to blood borne viruses? (Yes)	$n = 200$ (82%)	$n = 180$ (77%)	$n = 151$ (77%)	$n = 149$ (81%)
Missing responses	$n = 9$	$n = 9$	$n = 10$	$n = 6$
Immunised against hepatitis B (Overall)	$n = 216$ (74%)	$n = 211$ (71%)	$n = 182$ (64%)	$n = 169$ (72%)
Missing responses	$n = 0$	$n = 5$	$n = 7$	$n = 1$
Hepatitis B immunisation in those exposed to blood/body fluids	$n = 205$ (84%)	$n = 196$ (84%)	$n = 159$ (82%)	$n = 158$ (86%)
Missing responses	$n = 0$	$n = 5$	$n = 7$	$n = 0$

only 48% of workers exposed to blood and body fluids had received any training regarding protection against blood-borne viruses. This suggests a need for greater targeting of educational interventions to at risk primary health care workers. General medical practitioners (GPs) and dentists, who employ these staff, need to increase compliance with health and safety legislation [15–17]. GPs and dentists may be unaware of their obligations under health and safety legislation [18].

This is the first study to compare the impact of educational interventions on knowledge in the prevention and management of blood and body fluid exposures in a UK primary care setting. This study employed cluster randomization, where groups of people rather than individuals are randomized. This type of randomization minimizes the potential for information contamination among participants. However, the outcome for each respondent cannot be assumed to be independent of others in their group, so the effective sample size is less than the total number of individual participants. All GP and dental practices identified in Grampian and Dumfries and Galloway were invited to participate, so minimizing the potential for selection bias. The questionnaires were designed to be optically scanned and read which meant quick and accurate processing of information. The four groups were similar in gender and age composition.

The overall response rate for this study was disappointing at 53%. Approximately one-quarter of practices wrote back declining participation in the study. The main reason cited by practices for not participating was time constraint. Many GP practices were participating in other studies and were preparing for their new contract. Responder bias may occur where those employees aware of the risks from blood exposures may be more likely to participate. Due to the randomization process, responder bias should have been distributed equally among the four groups allowing a valid comparison between groups. Unfortunately, there is no way of knowing whether practice managers distributed the questionnaires 6 weeks after the interventions (Groups B–D) as requested. It would be useful to know whether knowledge gains were sustained over longer periods as this has implications for the timing of refresher training. One potential weakness of the study design was that the comparison group completed the questionnaires immediately and the intervention groups did so 6 weeks after the educational intervention. An alternative approach would have been to assess pre-intervention knowledge for all groups to assess baseline variation in knowledge. However, this approach might have reduced response rate and increased costs and therefore we relied on randomization to minimize systematic differences between the groups.

For further studies, it would be useful to assess whether combining educational interventions, e.g. practice presentation plus leaflets lead to greater knowledge than single interventions. Training and education should be incorporated in any future community needlestick prevention studies. With limited funds available for training, future studies should also compare the costs of educational and other interventions.

In summary, this study demonstrated a modest but statistically significant improvement in primary health care workers' knowledge of the management of occupational exposures to blood and body fluids following a verbal presentation. This study supports the view that knowledge of health risks is inadequate among at risk primary health care workers. Large numbers of at risk community staff have not received any training regarding protection from blood-borne viruses. GPs and dentists, as employers, need to provide greater information and training for health care workers to comply with health and safety legislation. Employers must raise knowledge and awareness regarding the prevention and management of occupational blood and body fluid exposures.

Conflicts of interest

None declared.

References

1. Ippolioto G, Puro N, Petrosilla G, De Carli and the SIROH group. Surveillance of occupational exposure to blood borne pathogens in health care workers. Surveillance report. The Italian National Programme. *Euro Surveill* 1999;**4**.
2. Perry J, Parker G, Jagger J. EPINet report: 2001 percutaneous injury rates. *Adv Expo Prev* 2003;**6**.
3. Doebbeling BN, Vaugh TE, McCoy KD *et al*. Percutaneous injury, blood exposure and adherence to standard precautions: are hospital based healthcare providers still at risk? *Clin Infect Dis* 2003;**37:**1006–1013.
4. Rodriguez EB, Moruno AJR, Dona JAC, Pujolar AE, Fernandez FJL. Underreporting of percutaneous exposure accidents in a teaching hospital in Spain. *Clin Perform Qual Health Care* 1999;**7:**88–91.
5. Gerbedring JL. Incidence and prevalence of HIV, hepatitis B virus, hepatitis C virus and cytomegalovirus among health care personnel at risk for blood exposure: final report from a longitudinal study. *J Infect Dis* 1994;**170:**1410–1417.
6. Lanphear BP. Trends and patterns in the transmission of blood borne pathogens to health care workers. *Epidemiol Rev* 1994;**16:**437–450.
7. Rogers B, Goodno L. Evaluations of interventions to prevent needlestick injuries in health care occupations. *Am J Prev Med* 2000;**18:**90–98.
8. Richard VS, Kenneth J, Ramaprabha P, Kirupakaran H, Chandy GM. Impact of introduction of sharps containers and of education programs on the pattern of needlestick injuries in a tertiary care centre in India. *J Hosp Infect* 2001;**47:**163–165.

9. Haivduven D, DeMaio T, Stevens D. A five year study of needlestick injuries: significant reduction associated with communication, education, and convenient placement of sharps containers. *Infect Control Hosp Epidemiol* 1992;**13:**265–271.
10. Wang H, Fennie K, He G, Burgess J, Williams AB. A training programme for prevention of occupational exposure to bloodborne pathogens: impact on knowledge, behaviour and incidence of needlestick injuries among student nurses in Changsha, People's Republic of China. *J Adv Nurs* 2003;**41:**187–194.
11. *Report of the Short Life Working Group on Needlestick Injuries in the NHSScotland. Needlestick Injuries: Sharpen Your Awareness*. Scottish Executive, 2001.
12. *Infection Control: Prevention of Healthcare-Associated Infections in Primary and Community Care*. National Institute of Clinical Effectiveness, 2003.
13. Kerry S, Bland M. Analysis of a trial randomised in clusters. *Br Med J* 1998;**316:**54.
14. Gershon R, Pearse L, Grimes M, Flanagan P, Vlahov D. The impact of multi-focused interventions on sharps injury rates at an acute care hospital. *Infect Control Hosp Epidemiol* 1999;**20:**806–811.
15. *The Control of Substances Hazardous to Health Regulations 2002*. Statutory Instrument 2002. No. 2677. Crown Copyright 2002.
16. *Health and Safety at Work etc. Act 1974*. HMSO, 1974.
17. *The Management of Health and Safety at Work Regulations 1999*. Statutory Instrument 2002. No. 2677. Crown Copyright 2002.
18. Sen D, Osborne K. General practitioners' knowledge of notifiable, reportable, and prescribed diseases. *Br Med J* 1995;**310:**12.