Journal of Hospital Infection (2003) 54, 232–238

Available online at www.sciencedirect.com

www.elsevierhealth.com/journals/jhin

Sharps injury reduction using Sharpsmart™—a reusable sharps management system

T. Grimmond[a,*], T. Rings[b], C. Taylor[c], R. Creech[d], R. Kampen[e], W. Kable[f], P. Mead[g], P. Mackie[h], R. Pandur[i]

[a]The Daniels Corporation International Ltd, Dandenong, Australia 3175
[b]Infection Control and Prevention, South Auckland Health, Auckland, New Zealand
[c]Staff Occupational Health, Royal Prince Alfred Hospital, Sydney, Australia
[d]Formerly Occupational Medicine, Canberra Hospital, Canberra, Australia
[e]Infection Control and Staff Health, Calvary Hospital, Canberra, Australia
[f]Infection Control, Canterbury Hospital, Sydney, Australia
[g]Formerly Infection Control Consultant, Mercy Hospital, Auckland, New Zealand
[h]Health and Safety Office, Lothian Trust, St Johns Hospital, Livingstone, Edinburgh, UK
[i]Infection Control, Maroondah Hospital, Victoria, Australia

Received 22 May 2002; accepted 24 March 2003

KEYWORDS
Sharps injury; Needlestick injury; Percutaneous injury; Sharps containers; Sharpsmart safety devices; Engineered controls

Summary Sharps containers are associated with 11–13% of total sharps injuries (SI) yet have received little attention as a means of SI reduction. A newly developed reusable sharps containment system (Sharpsmart™) was trialed in eight hospitals in three countries. The system was associated with an 86.8% reduction of container-related SI (CRSI) ($P = 0.012$), a 25.7% reduction in non-CRSI ($P = 0.003$), and a 32.6% reduction in total SI ($P = 0.002$) compared with historical data. The study concludes that the Sharpsmart system is an effective engineered control in reducing SI.

Introduction

Sharps injury (SI) among healthcare workers (HCWs) remains a serious issue. Preliminary results from the first multi-centre study in the UK[1] give an SI rate of 17 per 100 occupied beds (OB)/year and this, assuming an equal number of HCWs work outside hospitals,[2] equates to 154 000 SI annually in UK. A recent USA Exposure Prevention Information Network (EPINet) study[3] found the SI rate among participating hospitals to be 22 per 100 OB/year which, using the above parameters, equates to 563 000 SI annually in the USA. In Australia the rate of reported SI is 20 per 100 OB/year,[4] equating to an annual SI incidence of 47 000. Preliminary data from 12 pilot sites in Canada reported an SI reporting rate of 18.8 per 100 OB/year,[5] which using the above parameters, may suggest an annual incidence of 84 000 SI.

The seriousness of SI lies in the risk of acquisition of bloodborne pathogens. Worldwide, more than 100 HCWs have contracted human immunodeficiency virus (HIV) from work-related SI and many thousands have contracted hepatitis B (HBV) or hepatitis C virus (HCV). Notwithstanding the emotional costs to injured HCWs and their families,

*Corresponding author: T. Grimmond, 3 Tarbett Rd Hillcrest, Hamilton 2001, New Zealand.
E-mail address: terry@daniels.com.au

0195-6701/03/$ - see front matter
doi:10.1016/S0195-6701(03)00141-5

the financial cost of each SI follow-up is between US$500–2500[6] and the annual costs associated with treatment of infection can be tens of thousands per infected HCW and the ultimate cost up to US$1 million.[7] A recent Scottish report estimates that SI costs NHS Scotland £260 000 annually, not including the value of lost output for an infected HCW or the cost of replacing staff.[8] The Scottish report warns that this cost could rise significantly with a successful high cost claim—such a lawsuit for US$12 million which was recently awarded to a US intern who contracted HIV.[9]

Such consequences have elicited much research into SI reduction—the three most effective means cited being engineered controls (EC) such as needleless systems and safety syringes, education, and modification of hazardous work practices. Studies have shown that using all three in a multi-intervention approach coupled with continued and focused efforts is necessary to reduce overall SI.[10–12] Of particular note is the multi-intervention success of the large CCLIN-GERES study in Northern France.[13] Modification of work practices alone is not sufficient as it is hampered by the difficulty in changing staff behaviour.[14] Education is essential for every intervention, and can be effective on its own,[15] but requires large resources.[10,11,16] The large SIROH study in Italy, where EC are seldom used, has shown that reliance on education and behaviour modification alone has not brought about a significant reduction in overall SI.[17] EC are the most effective of the three interventions—reducing SI by up to 84% within their device-specific procedures.[18] Ironically, however, USA hospitals have the largest choice of EC yet EPINet studies have only shown a decrease in overall SI rate in the last two surveys.[3,19] It is apparent that widespread adoption of EC is hampered by their cost.[6,20,21] With the recent passing of the USA federal Needlestick Safety and Prevention Act, EC costs will decrease markedly over the next four to five years, and hopefully, enable their universal adoption. There remains, however, an immediate need for effective systems in the reduction of total SI, particularly systems that have minimal impact on hospital resources.

Sharps containers are an example of EC yet have received little attention in the last decade, being somewhat overshadowed as a "safety device" by their patient-related counterparts. However, sharps containers play an important role in sharps management and little has been said of the fact that container-related SI (CRSI) account for a remarkably consistent 11–13% of total SI.[1,3,5,22,23] Compared with other EC, a sharps containment system designed with effective passive safety might be a simple, cost-effective investment in overall SI reduction.

This paper outlines a collaborative study to determine the impact on SI of a new reusable sharps containment system developed to eliminate CRSI (Sharpsmart™, The Daniels Corporation International Ltd, Melbourne).

Methods

The Sharpsmart System comprises: a pre-assembled, reusable sharps container range based on three container sizes of 6.5, 14.5 and 23.5 fill-line litres, manufactured from a highly puncture-resistant plastic polymer and possessing a large opening, passive overfill protection and hand-entry prevention; multiple bracketry options for ergonomic and safe siting of containers; site inspections to advise on optimal siting of containers; multi-media education and training of staff in correct use of the containers. The system is coupled to a factory-based, fully automated, robotic decanting and sanitization process (WashSmart™).

The containers are delivered to the hospital in dedicated transport enclosures and are distributed to wards by hospital staff. When full the containers are sealed by hospital staff and transported to the loading dock where they are placed in the dedicated transport enclosures, which are collected by the servicing company and returned to the factory. At the factory the containers are decanted and sanitized using the automated WashSmart™ process before redistribution to hospitals. Decanted sharps waste is destroyed at the factory under appropriate local regulations.

In November 2000, invitations to participate in the SI study were forwarded to the seven hospitals in Australia and New Zealand that had converted fully to the new Sharpsmart system and to four hospitals in the UK that had recently completed trials. In participating hospitals, retrospective SI data were retrieved from written or electronic SI records in 1999–2000 before adoption of Sharpsmart and in 2000–2001 during their use. During the period of fitting the system (several days to weeks) no SI data were utilized.

Categorization of SI was based primarily on the International Health Care Worker Safety Center's (IHCWSC) EPINet criteria.

Data received

All SI reports in both study periods were examined and the following data retrieved:

1. Total number of reported SI (from all sharp items, e.g. needles, scalpels, scissors)
2. How the injury occurred—using seven standard, post-patient EPINet categories (E) and seven additional categories:
   - 2.1. Recapping (E)
   - 2.2. Other after use, before disposal (E)
   - 2.3. Item left on disposal container (E)
   - 2.4. Putting item into disposal container (E)
     - Due to overfilled container
     - Due to container opening/nature of sharp item
     - Due to other reasons
   - 2.5. Protruded from disposal container (E)
   - 2.6. Pierced side of disposal container (E)
   - 2.7. Picking up from floor after bouncing out of container
   - 2.8. Picking up from floor after spillage/rupture of container
   - 2.9. Pierced side of inappropriate disposal container (E)
   - 2.10. While collecting rubbish from waste bin
   - 2.11. All other (predominantly during patient procedure)

Of the above categories, 2.3 to 2.8 were grouped as CRSI. When records were insufficient to categorize SI per the above scheme, the staff member suffering the injury was contacted and further details obtained. In addition to SI data the average daily OB and average daily total full-time equivalent staff (FTE) for both study periods were sought from each hospital.

Three major parameters, CRSI, non-CRSI and total SI per 100 OB/year and per 100 FTE/year, were compared for the two study periods. In addition all 14 SI categories were calculated per 100 FTE/year and compared. All data were assessed statistically using a paired *t*-test and significance was set at $P < 0.05$. The study did not receive industry or grant funding.

Results

All seven fully converted hospitals and one trial hospital participated in the study. In the trial hospital the study was confined to four clinical areas of exclusive Sharpsmart use. The eight acute-care hospitals (Australia: five; New Zealand: two; Scotland: one) ranged in size from 86 to 990 available beds. Apart from SI education for orientation of new staff, and the education of staff in the Sharpsmart system, no other EC or SI reduction protocols were introduced or trialed by the hospitals during the two study periods. Among the eight hospitals, the pre-Sharpsmart period ranged from 7.7 to 16 months; mean: 12 months; median: 12 months. The Sharpsmart study period ranged from one to 12 months; mean: 7.4 months; median: seven months. All hospitals supplied OB and FTE data excepting hospital H where FTE was not available for the four clinical areas.

Before adopting the system, nine brands of disposable containers and one brand of reusable container (not Sharpsmart) were used by the eight hospitals. In all hospitals sharps containers in both study periods were sited as close as practical to the point of sharps generation.

Tables I and II depict the SI parameters for each hospital for the two study periods. With Sharpsmart use, all hospitals had decreases in total SI and non-CRSI rates and seven had decreases in CRSI (Hospital G had no reported CRSI in both periods; Tables I and II). For the eight hospitals, the total SI rate per 100 OB/year decreased from 20.3 to 13.6 (32.7% reduction, $P = 0.002$) and total SI/100 FTE/year decreased from 4.3 to 3.0 (32.1% reduction, $P = 0.002$; Table I). The CRSI rate per 100 OB/year decreased from 2.3 to 0.3 (86.8% reduction, $P = 0.012$) and the CRSI/100 FTE/year decreased from 0.5 to 0.07 (86.6% reduction, $P = 0.011$; Table II). Non-CRSI/100 OB/year decreased from 18.0 to 13.3 (25.7% reduction, $P = 0.003$) and non-CRSI/100 FTE/year decreased from 3.9 to 2.9 (25.0% reduction, $P = 0.006$; Table II).

Table III depicts how the SI occurred in both study periods. The percentage of total SI categorized as CRSI was 11.6% (60/516) before using Sharpsmart and 1.1% (3/271) with Sharpsmart. Of the three CRSI in the Sharpsmart period one occurred while placing a butterfly-needle into the Sharpsmart. The second occurred when the HCWs found the nearest Sharpsmart full and incurred an SI while walking to another container (although not falling within agreed categories for CRSI, the SI coordinator for the hospital elected to classify it as CRSI). The third was classified as CRSI by default—a staff member had stated 'during disposal' in her report but when sought for clarification was no longer an employee. In the absence of firm data the SI coordinator for the hospital classified it as CRSI. At the same hospital, six other HCWs who had stated 'during disposal' were contacted and stated that the SI occurred while transporting the sharp for disposal (non-CRSI).

Discussion

Our data indicate that a significant decrease in SI was associated with use of the Sharpsmart system.

Table I Descriptive characteristics and sharps injury rates per 100 OB/year and 100 FTE/year before and during Sharpsmart use in eight participating hospitals

Hospital	Before Sharpsmart use				During Sharpsmart use			
	Aver. FTE	Aver. OB	SI per 100 OB/year	SI per 100 FTE/year	Aver. FTE	Aver. OB	SI per 100 OB/year	SI per 100 FTE/year
A	265	122	17.9	8.2	295	139	15.0	7.1
B	550	185	24.5	7.1	648	189	21.9	6.4
C	2098	608	21.7	6.3	1985	595	17.5	5.2
D	2281	450	21.3	4.2	2295	456	8.0	1.6
E	5323	790	20.9	3.1	5455	790	15.0	2.2
F	849	203	18.2	4.4	882	238	11.8	3.2
G	634	154	13.6	3.3	605	144	6.9	1.7
H	-	77	9.1	-	-	80	0.0	-
Total	12 085	2589	20.3	4.3	12 165	2631	13.6[a]	3.0[b]

OB, occupied beds; FTE, full-time equivalent staff.
[a] 32.7% decrease, $P = 0.002$.
[b] 32.1% decrease, $P = 0.002$.

The reduction in CRSI alone would equate to a reduction in total SI of 10.1% (87% of 11.6%), however, when coupled with the non-CRSI reduction there was a reduction in total SI of 33%. This compares favourably with other EC such as needleless intravenous systems and safety syringes, which individually, may bring about reductions in total SI of up to 30–35%.

Rigid sharps containers and their use in patient rooms was first adopted in the early 1980s and gained impetus with the acquired immunodeficiency syndrome (AIDS) epidemic. Their adoption was primarily designed to allow disposal of needles without recapping. Interestingly, all five early studies on sharps containers found that their introduction changed the nature of the SI but made no significant impact on total SI.[24–28] Their use initiated a new type of SI, 'container-related', which is a subset of 'disposal related' SI (DRSI).

CRSI are due to many causes including: too small a container opening; necessity for two-handed insertion; ability to overfill; ability to insert hands; needles protruding through gaps in incorrectly assembled containers; unsafe closure mechanism; sharps jamming in the opening; protrusion through incorrectly closed containers; penetration through container walls; incorrect height of container; sharps spillages when moving container; picking up sharps from floor after they have bounced out or spilled from containers that have come apart or toppled over; inability to safely receive sharps attached to tubing; and staff walking with sharps or leaving them on surfaces because patient-room containers were not noticed. These causes have been frequently mentioned in studies on SI and sharps containers.[27,29–32] Other studies have proposed that safe containers conveniently placed should reduce DRSI.[29,30]

This study demonstrates that the design of the Sharpsmart container effectively addressed CRSI issues (87% reduction) and was inherently safer to use through a combination of the container's overfill prevention, no hand entry, wide opening, high puncture resistance, and pre-assembly (protrusion prevention). However, the system was also associated with a change in staff behaviour in disposing of sharps (26% reduction in non-CRSI). It is postulated that this modification in behaviour was due to staff being influenced by nearby siting of containers (less walking with sharps), large size (less likely to be full), bright colour (more noticeable), ergonomic height (no stooping or unsighted opening), and institution-wide pre-implementation training (raised sharps awareness).

Jagger[18] states that the lower the SI rate the more difficult it becomes to demonstrate the

Table II Container-related sharps injuries (CRSI) and non-CRSI per 100 OB/year and per 100 FTE/year before and during Sharpsmart use in eight participating hospitals

Hospital	Before Sharpsmart use				During Sharpsmart use			
	CRSI per 100		Non-CRSI per 100		CRSI per 100		Non-CRSI per 100	
	OB/year	FTE/year	OB/year	FTE/year	OB/year	FTE/year	OB/year	FTE/year
A	0.6	0.28	17.3	7.9	0	0	15.0	7.1
B	0.8	0.25	23.6	6.9	0	0	21.9	6.4
C	2.5	0.71	19.2	5.6	0.3	0.10	17.1	5.1
D	4.4	0.88	16.9	3.3	1.3	0.27	6.7	1.3
E	2.4	0.36	18.5	2.7	0	0	15.0	2.2
F	0.5	0.12	17.7	4.2	0	0	11.8	3.2
G	0.0	0	13.6	3.3	0	0	6.9	1.7
H	3.9	–	5.2	–	0	–	0	–
Mean	2.3	0.50	18.0	3.9	0.3[a]	0.07[b]	13.3[c]	2.9[d]

[a] 86.8% decrease, $P = 0.012$.
[b] 86.6% decrease, $P = 0.011$.
[c] 25.7% decrease, $P = 0.003$.
[d] 25.0% reduction, $P = 0.006$.

efficacy of safety devices, therefore the significant SI reductions with the system, given the low pre-study rate (4.3/100 FTE) when compared with other studies,[33] is of particular note. Given that safety devices can themselves be a source of SI,[18] it is also noteworthy that the system had significant reductions in all three SI parameters yet was associated directly with only one SI.

Examination of the SI category data (Table III) indicates that each category was associated with SI reduction in the Sharpsmart period, however the low numbers precluded statistical significance in all but 'putting items into disposal container'. Two other categories, 'due to overfilled containers', and 'protruded from disposal container' approached significance ($P = 0.06$).

The introduction of an effective sharps containment system should reduce CRSI, and therefore DRSI and total SI. However it is difficult to find studies where sharps containers have been introduced as a sole intervention with product training only, as distinct from continued sharps education, and have achieved a significant SI reduction. McCormick *et al.*[31] demonstrated a 56% decrease in CRSI with new patient room sharps containers but an increase in total SI. Haiduven *et al.*[34] introduced

Table III Number, rate/100 FTE and significance of specific category of sharps injuries before and during Sharpsmart use in eight participating hospitals

How injury occurred	Before Sharpsmart		During Sharpsmart		*P*-value (FTE)
	No.	SI/100 FTE	No.	SI/100 FTE	
CRSI					
Item left on disposal container	0	0	0	0	–
Putting item into disposal container	44	0.37	3	0.07	0.01
Due to overfilled container	22	0.19	0	0	0.06
Due to container opening or nature of sharp item	13	0.11	1	0.05	NS
Due to other reasons	9	0.07	2	0.02	NS
Pierced side of disposal container	0	0	0	0	NS
Picking up from floor after bouncing out of container	4	0.03	0	0	NS
Picking up from floor after spillage/rupture of container	4	0.03	0	0	NS
Protruded from disposal container	8	0.07	0	0	0.06
Non-CRSI					
Recapping	18	0.15	12	0.10	NS
Other after use, before disposal	175	1.44	97	0.99	NS
Pierced side of inappropriate disposal container	1	0.01	0	0	NS
While collecting rubbish from waste bin	56	0.46	14	0.14	NS
Other (predominantly during patient use)	206	1.78	145	1.68	NS
Total (CRSI + Non-CRSI)	516		271		

patient room containers which resulted in no change in DRSI and an increased CRSI. Only the study by Richard *et al*.[35] has noted DRSI and total SI reductions attributable primarily to a change to patient room containers. Our study is the first to report significant decreases in CRSI, DRSI and total SI with a sharps containment system as the sole intervention. Factors that contributed to the success of the system were its approval by clinical staff, inbuilt passive safety, and little training being required—features that are pre-requisites for successful EC.[34,36,37]

A limiting factor to the study was the voluntary nature of self-reporting by HCWs. It was assumed that SI reporting rates were similar in all eight hospitals, that reporting trends were similar over the two study periods, and that reported SI were a true reflection of actual exposures. Concomitant studies (two regimens studied simultaneously within each hospital) would have reduced time-trend changes but finding 'identical' clinical units, and logistic and infrastructure difficulties, make such studies of sharps containers impractical in hospital environments. The retrospective nature of the study and reliance on reports may have been a further limiting factor although in only one instance in 787 was the SI categorized by default. Another limitation may have been the Hawthorne Effect,and although unlikely to have been a significant effect across all eight hospitals, further studies will be needed to eliminate this as a possible contributing factor. The statistical significance of each major SI parameter indicates that the difference in length of the two study periods was not a limiting factor.

In the UK, one of the Royal College of Nurses' Safe Environment objectives is to introduce safe systems to minimize the risk of sharps injury.[38] In the USA, The Centers for Disease Control and Prevention aim to eliminate occupational needlesticks by 2006.[39] This study has shown that the Sharpsmart system could be a useful additional safety device in helping to meet such objectives.

References

1. May D. Royal College of Nursing Sharps Injury Campaign. *2000/2001 Surveillance Results*. London: Royal College of Nursing; 2001.
2. Estimated Annual Number of U.S. Occupational percutaneous injuries and mucocutaneous exposures to blood or at-risk biological substances. International Health Care Worker Safety Centre, University of Virginia Health Sciences Center. *Adv Expo Prev* 1998; 4: 3.
3. Perry J, Parker G, Jagger J. EPINet Report: 2001 percutaneous injury rates. *Adv Expo Prev* 2003;**6**:32–36.
4. Perry J. Exposure prevention and surveillance in Australia. *Adv Expo Prev* 1998;**3**:53–56,60.
5. Canadian Needlestick Surveillance Network. Summary Report on Health Care Workers exposed to blood/body fluids: results from April 2000 to March 2001. The Health Care Acquired Infections Division, Health Canada; Ottawa.
6. Occupational Safety: selected cost and benefit implications of needlestick prevention devices for hospitals. GAO-01-60R. Reply to Request from Senator Pete Stark. US General Accounting Office, Nov 2000; Washington.
7. Kent K. What does it cost to live with HIV? *Can Med Assoc J* 1998;**158**:14.
8. Needlestick Injuries: Sharpen Your Awareness. Report of the Short Life Working Group on needlestick injuries in the NHS Scotland; 2001. NHS Scotland. The Stationery Office Bookshop, Edinburgh.
9. Perry J. Yale to pay $12.2 million in largest ever award in needlestick case. *Adv Expo Prev* 1998;**3**:26.
10. Gershon RRM, Pearse L, Grimes M, Flanagan PA, Vlahov D. The impact of multifocused interventions on sharps injury rates at an acute care hospital. *Infect Control Hosp Epidemiol* 1999;**20**:806–811.
11. Haiduven DJ, DeMaio TM, Stevens DA. 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.
12. Preventing needlestick injuries in health care settings. NIOSH, Centers for Disease Control, US Department of Health and Human Services Publication No. 2000-108, November 1999. Centers for Disease Control, Atlanta.
13. Tarantola A. Accidental blood exposure surveillance data in France: an update. CCLIN Paris-Nord ABE Network and the GERES. Frontline Conference, 2001; London.
14. Hanrahan A, Reutter L. A critical review of the literature on sharps injuries: epidemiology, management of exposures and prevention. *J Adv Nursing* 1997;**25**:144–154.
15. Beekmann SE, Vlahov D, Koziol DE, McShalley ED, Schmitt JM, Henderson DK. Temporal association between implementation of universal precautions and a sustained, progressive decrease in percutaneous exposures to blood. *Clin Infect Dis* 1994;**18**:562–569.
16. Bryce EA, Ford J, Chase L, Taylor C, Scharf S. Sharps injuries: defining prevention priorities. *Am J Infect Control* 1999;**27**: 447–452.
17. Puro V. Prevention of occupational blood borne virus transmission in Europe—surveillance in Europe. Studio Italiano Rischio Occupazionale da HIV (SIROH). National Institute for Infectious Diseases, Rome. Frontline Conference, 2001; London.
18. Jagger J. Reducing occupational exposure to bloodborne pathogens: where do we stand a decade later? *Infect Control Hosp Epidemiol* 1996;**17**:573–575.
19. Occupational exposures to bloodborne pathogens. Uniform Needlestick and Sharp Object Injury Report 1996, 65 Hospitals. *Adv Expo Prev* 1997; 3: 15.
20. Skolnick R, LaRocca J, Barba D, Paicius L. Evaluation and implementation of a needless intravenous system: making needlesticks a needless problem. *Am J Infect Control* 1993; **21**:39–41.
21. Owens-Schwab E, Fraser VJ. Needleless and needle protection devices: a second look at efficacy and selection. *Infect Control Hosp Epidemiol* 1993;**14**:657–660.
22. Pournaras S, Tsakris A, Mandraveli K, Faitatzidou A, Douboyas J, Tourkantonis A. Reported needlestick and sharp injuries among health care workers in a Greek general hospital. *Occup Med* 1999;**49**:423–426.

23. Sharps injury control program, Jan 2002. Department of Health Services, California.
24. Edmond M, Khakoo R, McTaggart B, Solomon R. Effect of bedside needle disposal units on needle recapping frequency and needlestick injury. *Infect Control Hosp Epidemiol* 1988; **9**:114–116.
25. Krasinski K, LaCouture R, Holzman RS. Effect of changing needles disposal systems on needle puncture injuries. *Infect Control* 1987;**8**:59–62.
26. Ribner BS, Landry MN, Gholson GL, Linden LA. Impact of a rigid, puncture resistant container system upon needlestick injuries. *Infect Control* 1987;**8**:63–66.
27. Linnemann CC, Cannon C, DeRonde M, Lamphear B. Effect of educational programs, rigid sharps containers, and universal precautions on reported needlestick injuries in healthcare workers. *Infect Control Hosp Epidemiol* 1991;**12**:214–219.
28. Sellick JA, Hazamy PA, Mylotte JM. Influence of an educational program and mechanical opening needles disposal boxes on occupational needlestick injuries. *Infect Control Hosp Epidemiol* 1991;**12**:725–731.
29. Jagger J, Bentley MB. EPINet Report: disposal-related sharp object injuries. *Adv Expo Prev* 1995;**1**:1–2,6,7,11.
30. Weltman AC, Short LJ, Mendelson MH, Lilienfeld DE, Rodriguez M. Disposal-related sharps injuries at a New York City teaching hospital. *Infect Control Hosp Epidemiol* 1995; **16**:268–274.
31. McCormick RD, Meisch MG, Ircink FG, Maki DG. Epidemiology of hospital sharps injuries: a 14 year prospective study in the Pre-AIDS and AIDS Eras. *Am J Med* 1991;**91**:301S–307S.
32. NIOSH. Selecting, evaluating, and using sharps disposal containers. Cincinnati, OH: US Department of Health and Human Services, Public Health Service, Centers for Diseases Control and Prevention, National Institutes for occupational Safety and Health, DHHS (NIOSH) Publication No. 97-111.
33. Beekmann SE, Vaughn TE, McCoy KD, et al. Hospital bloodborne pathogens programs: program characteristics and blood and body fluid exposure rates. *Infect Control Hosp Epidemiol* 2001;**22**:73–82.
34. Haiduven DJ, Phillips ES, Clemons KV, Stevens DA. Percutaneous injury analysis: consistent categorization, effective reduction methods, future strategies. *Infect Control Hosp Epidemiol* 1995;**16**:582–589.
35. Richard VS, Kenneth J, Ramaprabha P, Kirupakaran H, Chandry GM. Impact of introduction of sharps containers and of education programmes on the pattern of needle stick injuries in a tertiary care centre in India. *J Hosp Infect* 2001; **47**:163–165.
36. Jagger J, Hunt EH, Brand-Elnaggar J, Pearson R. Rates of needle-stick injury caused by various devices in a university hospital. *N Eng J Med* 1988;**319**:284–288.
37. Wugofski L. Needlestick prevention devices: a pointed discussion. *Infect Control Hosp Epidemiol* 1992;**13**: 295–298.
38. Working Well: A Call to Employers. A summary of the *RCN Working well Survey* into the wellbeing and working lives of nurses, 2002. Publication No. 001 595. Royal College of Nursing, London.
39. CDC's Seven Healthcare Safety Challenges. Issues in Healthcare Settings. Division of Healthcare Quality Promotion. Centers for Disease Control, Atlanta.