



Risk Groups for Needlestick Injury Among Healthcare Workers in Children's Hospital: A Cross-sectional Study

Çocuk Hastanesinde Sağlık Çalışanlarında İğne Yaralanması Risk Grupları: Kesitsel Bir Çalışma

Mine Düzgöl¹(iD), Ahu Kara Aksay¹(iD), Ersin Durgun²(iD), Yeliz Yaman¹(iD), Nevbahar Demiray¹(iD), Gamze Gülfidan³(iD), Yüce Ayhan³(iD), Süleyman Nuri Bayram¹(iD), İlker Devrim¹(iD)

¹Clinic of Pediatric Infectious Diseases, Dr. Behçet Uz Child Diseases and Pediatric Surgery Training and Research Hospital, İzmir, Turkey

²Clinic of Pediatrics, Dr. Behçet Uz Child Diseases and Pediatric Surgery Training and Research Hospital, İzmir, Turkey

³Clinic of Microbiology, Dr. Behçet Uz Child Diseases and Pediatric Surgery Training and Research Hospital, İzmir, Turkey

Cite this article as: Düzgöl M, Kara Aksay A, Durgun E, Yaman Y, Demiray N, Gülfidan G, et al. Risk groups for needlestick injury among healthcare workers in children's hospital: a cross-sectional study J Pediatr Inf 2020;14(4):e212-e217.

Abstract

Objective: Needlestick injuries are important for healthcare workers due to their morbidity and mortality. The aim of this study was to determine the risk group of needlestick injuries (NSIs) among healthcare workers, and possible risk groups, actions, and prevention practices of the healthcare workers.

Material and Methods: This cross-sectional study included 249 healthcare workers (doctors, nursing staff, laboratory technicians and the cleaning personnel) in a tertiary care pediatric hospital in Turkey.

Results: Among the 249 healthcare workers, there were 35 physicians, 124 nursing staff, 11 laboratory technicians and 79 cleaning personnel. Seventy (28.1%) were males, 179 (71.9%) were females. The most common equipment associated with needlestick injury were syringe needles (54.6%), followed by intravenous cannula (peripheral catheter) (17.2%). In 103 (41.2%) cases, the injury occurred during use of the needle, with the greater part of injuries (24%) while establishing a venous access. Most healthcare workers experienced hand injuries (%82.7).

Conclusion: This study revealed that the high risk group for needlestick injury was nurses followed by the cleaning personnel. Healthcare workers did not take the necessary measures for themselves. Needlestick injuries could be prevented easily by increasing the use of needles when needed, increasing awareness for using devices with safety features, promoting education and safe work practices for needles and related systems.

Keywords: Needlestick injuries, healthcare workers, safety devices

Öz

Giriş: İğne batması yaralanmaları sağlık sektöründe çalışanlar için morbidite ve mortalite nedeni olduğundan önemlidir. Bu çalışmanın amacı, sağlık çalışanları arasındaki iğne batması yaralanmalarının (İBY) risk grubunu ve sağlık çalışanlarının olası risk gruplarını, davranışlarını ve yaralanma önleme uygulamalarını belirlemektir.

Gereç ve Yöntemler: Bu kesitsel çalışma, Türkiye'deki üçüncü basamak bir çocuk hastanesinde 249 sağlık çalışanını (doktorlar, hemşireler, laboratuvar teknisyenleri ve temizlikçiler) içermiştir.

Bulgular: 249 sağlık çalışanından 35'i hekim, 124'ü hemşire, 11'i laboratuvar teknisyeni ve 79'u temizlik personeliydi. 70'i (%28.1) erkek, 179'u (%71.9) kadındı. İğne batması yaralanması ile ilişkili en yaygın ekipmanın şırınga iğneler (%54.6) kaynaklı olduğu görülmüş olup, ardından venöz damar içi yerleştirilen kanül (periferik kateter) (%17.2) idi. 103 (%41.2) hastada en sık oluşan yaralanmalar venöz girişim sonucu oluşan yaralanmalardır (%24). Sağlık çalışanlarında en sık görülen yaralanma el yaralanmasıdır (%82.7).

Sonuç: Bu çalışma, iğne batması nedeniyle oluşan yaralanmalarda yüksek risk grubunun hemşireler tarafından oluşturulduğu ve bunu temizlik personelinin izlediğini göstermiştir. Sağlık çalışanlarının kendileri için gerekli önlemleri almadıkları görüldü. İğne batması yaralanmaları, gerektiğinde iğnelerin kullanımını artırarak, güvenlik özelliklerine sahip cihazların kullanımıyla ilgili farkındalığı artırarak, iğnelerin ve ilgili sistemlerin eğitimini ve güvenli çalışma uygulamalarını teşvik ederek kolayca önlenabilir.

Anahtar Kelimeler: İğne batması yaralanmaları, sağlık çalışanları, güvenlik cihazları

Correspondence Address/Yazışma Adresi

Mine Düzgöl

Dr. Behçet Uz Çocuk Hastalıkları ve Cerrahisi Eğitim ve Araştırma Hastanesi, Çocuk Enfeksiyon Hastalıkları Kliniği, İzmir-Türkiye

E-mail: mineduzgol@gmail.com

Received: 22.07.2020

Accepted: 12.09.2020

Available Online Date: 18.12.2020

©Copyright 2020 by Pediatric Infectious Diseases and Immunization Society. Available online at www.cocukenfeksiyon.org

Introduction

Centers for Disease Control and Prevention (CDC) and the National Surveillance System for Healthcare Workers (NaSH) have well-defined needlestick injury (NSI) and it includes skin penetration resulting from a needle or other sharp object, exposed to blood, tissue, or other body fluid before the penetration (1).

For centuries, health workers, performing their own professional responsibilities, have faced contamination risk of bloodborne diseases. These professions are in the high risk group for infection with bloodborne pathogens because of exposure to blood and other body fluids (2). Most exposures among healthcare workers have been reported to be caused by percutaneous injuries with sharp objects contaminated with blood or body fluids (3-7). These sharp objects include needles, scalpels, lancets and even broken glass. The pathogens most commonly transmitted to healthcare workers are bloodborne pathogens included hepatitis B and C viruses (HBV, HCV) and the human immunodeficiency virus (HIV) (8). Among healthcare workers (HCW) and laboratory personnel worldwide, more than 25 blood-borne viruses have been reported associated with NSI suggesting the importance of these needlestick injuries and their possible consequences (9).

The purpose of this study was to determine the high risk group for needlestick injuries (NSIs) among healthcare workers, high risky actions and practices regarding the use of protective strategies against exposure to blood-borne pathogens.

Materials and Methods

This cross-sectional study was designed to evaluate the distribution and risk factors for needle stick injury among healthcare workers in Dr. Behcet Uz Children Research and Training Hospital between the period of January 2014 and

October 2015. The study population included doctors, nursing staff, laboratory technologists and the cleaning personnel. Data collection involved the medical files and records of the same hospital.

In the study, all needlestick injuries were recorded and required precautions were done by the infection control committee.

Needlestick injury was defined as “any cut or prick to the respondents by a needle previously used on a patient is work related and sustained within the hospital premises.” Data collected were entered into a computer-based forms.

Statistical analysis was performed by using the Statistical Package for the Social Science (SPSS) software. Distribution of numeric variables was tested by both graphical methods and Shapiro–Wilk test. The difference between means of numeric variables was tested by Student’s t test or Mann–Whitney U test, where appropriate. The difference between proportions was tested by Chi-Square or Fisher’s exact test. $p < 0.05$ was considered statistically significant.

Results

During the study, 249 healthcare workers with needlestick injuries were recorded including 35 (14.10%) physician, 124 (49.7%) nursing staff, 11 (4.4%) laboratory technicians and 79 (31.7%) cleaning personnel. Seventy (28.1%) were males, 179 (71.9%) were females. When comparing NSI rates in different departments, major source of reporting incidental departments were the surgical intensive care unit (61 incidents, 24.5%) and neonatal intensive care unit (62 incidents, %24) (Figure 1).

Among the HCW, 206 HCW (82.7%) had experienced hand injuries, and the most common pieces of equipment involved in NSIs were syringe needles (136 incidents; 54.6%), followed

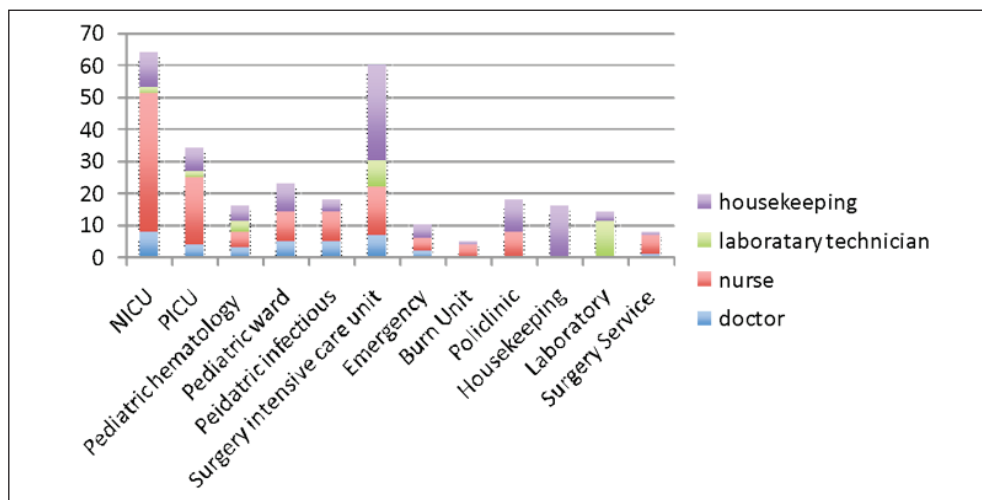


Figure 1. Basic characteristics and working environment of study participants by hospital. NICU: Neonatal Intensive care unit, PICU: Pediatric Intensive care unit.

Table 1. The most common pieces of equipment involved in needlestick injury, circumstances associated with needle stick injury, protective measure against needlestick injuries among healthcare workers

Common pieces of equipment involved in needlestick injuries		
Injector	136	54.60%
Catheter	43	17.20%
Suture	11	4.40%
Scalpel	4	1.60%
Ampoule	1	0.40%
Lam	1	0.40%
Broken Glass	2	0.80%
Nail	10	4%
Others	41	16.40%
Circumstances associated with needlestick injuries		
Draw blood sample	60	24%
Peripheral iv catheter	43	17.20%
Recapping	35	14%
Breaking ampoule	1	0.40%
Assist others	13	5%
Exchanging material	10	4.00%
Suturing	11	4.40%
Housekeeping	31	12%
Garbage collection	15	6%
Others	30	12%
Protective measure against needlestick injuries among healthcare workers		
No protection	79	31.70%
Surgery gloves	143	57.40%
Gauntlet	10	4%
Double gloves	2	0.80%
Protective gloves	2	0.80%
Box gown	1	0.40%
Mask	1	0.40%
Others	11	4.40%

by 43 reports of intravenous cannula or peripheral catheter (17.2%). In 103 (41.2%) cases, the injury occurred during the use of the needle and 60 injuries (24%) occurred while establishing a venous access (Table 1). Among the 249 HCW; 92 (36.9%) had not been wearing gloves at the time of the incident (Table 1).

All healthcare workers were informed about the contents of the exposure and control plan and were provided with adequate education and training to work safely with biohazardous material. Thirteen percent of the injured staff had Hepatitis B immunization and nine percent had Tetanus immunization after NSI.

Discussion

Most of the NSI during the study period had occurred in the departments of surgery, pediatric and neonatal intensive care unit, consistent with previous studies (10). This finding may support that departments such as the ICU in which invasive interventions such as injections, intravenous infusions, and drug preparation are more intensively performed have the higher risks (11). In contrast, a study about NSI among the hospital healthcare workers from Saudi Arabia has demonstrated no difference between medical and surgical departments regarding NSI risk (12). However, intensive care units have higher rates of NSIs as compared to medical wards and surgical ward (13,14). These results suggest that prevalence rates of

NSIs across departments are not consistent in different countries, which most likely change with culture, governmental and hospital regulations despite universal recommendations.

In this study, nurses were reported as the major occupational group, followed by the cleaning personnel, which was consistent with the findings of Martins et al. Study (15). After nurses, the cleaning personnel were the second dominant occupation group with 31.7% of total NSIs in this study, which was higher than 21.6% needlestick injuries reported among the cleaning staff from India (16). This high incidence was thought to be due to inappropriate disposal at upstream, and inadequacy of the resources places these workers at risk as documented in Saudi Arabia (13) and the USA (17). Nurses have been found to be the most occupational health group to have NSIs (18-21). This can be explained by the facts that the nurses are responsible from most of the injections and intravenous fluid administration, basically nurses are healthcare group dealing with injections and sharp objects the most and the numbers of nurses are usually higher than any other occupational group inside hospitals.

Most of the incidents occur during using the needle (41.2%), with the greater part of injuries (24%) while establishing a venous access. The most common equipment involved in NSIs were syringe needles (136 or 54.6%), followed by intravenous cannula (43 or 17.2%) which was consistent with the same findings of previous studies (15,22,23). In this study, NSIs that occurred during recapping accounted for 11% of all NSIs, with a lower incidence than Iran (24) but higher than 2006/07 data from the United States (about 4%) (25). This could be due to the different levels of safety regulations held by hospitals.

In this study, most HCWs experienced hand injuries like the previous studies (13). This may be either due to inadequate training of HCWs or different experience levels about the optimal procedures or lack of access to safety needle devices in the institution to avoid recapping. NSIs during recapping might be prevented by the placement of sharps containers in convenient places to help facilitate effective and safe disposal plus increasing the awareness of NSIs and importance of blood-borne pathogens (26). Replacement of traditional needles with safety needle devices such as needleless sets, safety cannula, self-capping intravenous catheters, self retracting lancets, and auto-disposable syringes will reduce these injuries among the healthcare workers. Continuous training is the main strategy to decrease the rate of NSIs. The number of NSI has been shown to decrease by 74–83% after the introduction of such safety-engineered alternatives (27,28). Especially in pediatric clinics in which younger children and toddlers can move rapidly and unexpectedly during injection, the safety devices should be used regularly.

Among the 249 respondents who had never received a NSI, 92 (36.9%) were wearing gloves at the time of the inci-

dent. O'Sullivan et al. have reported in two teaching hospitals among Irish intern doctors that only 26% of the interns reported wearing gloves while performing intravenous cannulation, but this percentage was up to 94% in patients with high risk (29). This emphasizes the importance of taking perceived benefits and threats into consideration when planning to reduce NSSIs among HCWs, as it is suggested in some theories like the Health Belief Model (6). When the interns perceived higher risk of acquiring a disease and potential benefit of wearing gloves, they were reported to be more likely to comply with the standard precautions (29). Moreover, relatively low incidence of NSIs at HCWs working in the pediatric infectious disease ward suggests that HCW working in this service are more alert and concentrated than the other services since more contagious patients are treated in these departments. However, it should be kept in mind that in other services such as the NICU, PICU and Surgery wards, the status of the patients for blood-borne diseases are not known, and there is still great risk of infections for HCWs.

In 2007, the World Health Organization estimated the number of injuries as 2 million per year globally (30). Moreover, the European Biosafety Network estimated 1 million needlestick injuries annually (30). Another project estimated the rates of injuries on a global level to affect about 3.5 million individuals (1). The US Occupational Safety and Health Administration (OSHA) estimated that 5.6 million workers in the healthcare industry were at risk of occupational exposure to blood-borne diseases via percutaneous injury (31). 600,000 NSIs were estimated to happen among HCW in the US annually. The risk for blood or body fluid infection transmission among healthcare workers was reported to be two to nineteen times greater than general population (32). This study revealed that Turkish nurses, especially those working in the surgery department and intensive care units, are at high risk of blood or body fluid pathogen transmission from using of contaminated needles.

Several reports on needlestick prevention published between 1987 and 1992 focused on the appropriate design and convenient placement of puncture-resistant sharps disposal containers and the training of healthcare personnel (33-39). Most of these studies documented only limited success for the prevention of disposal-related injuries and especially recapping. Universal (defined as standard now) precautions are important approaches that demonstrated preventing blood exposures to skin and mucous membranes effectively (40, 41). However, these precautions mainly focused on the use of barrier precautions (i.e., personal protective practices) and work-practice controls (e.g., care in handling sharp devices) while precautions for sharps injuries should be much more detailed than standard precautions.

This study had limitations due to its retrospective design. Our findings represent only one children training and research

hospital in Turkey. However, this study has mainly focused on a special group of HCWs who were dealing with children which was different from previous studies focusing on adult studies.

In conclusion, effective training and awareness to NSIs and associated bloodborne pathogens, organizational safety regulations for exposure prevention (protection devices such as handling sharp devices, personal protective barrier methods) are essential to reduce the risk of such injuries. Regarding children's hospitals, safety devices such as safety needle systems might be a good strategy to reduce NSIs among HCW.

Informed Consent: This study does not include any patients because of being a sectional study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - İD; Design - MD, İD; Supervision - İD; Resource - MD; Data Collection and/or Processing - MD, ED, YY, SNB; Analysis and/or Interpretation - MD, İD, GG, YA; Literature Search - MD, AKA; Writing - MD; Critical Review - İD, ND.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study has received no financial support.

References

1. The National Surveillance System for Healthcare Workers (NaSH) Summary Report for Blood and Body Fluid Exposure 2015;1-27. [\[CrossRef\]](#)
2. Gerberding JL. Current epidemiologic evidence and case reports of occupationally acquired HIV and other bloodborne diseases. *Infect Control Hosp Epidemiol* 1990;11(10 Suppl):558-60. [\[CrossRef\]](#)
3. Romea S, Alkiza ME, Ramon JM, Oromi J. Risk of occupational transmission of HIV infection among health-care workers. Study in a Spanish hospital. *Eur J Epidemiol* 1995;11:225-9. [\[CrossRef\]](#)
4. University of Virginia. Uniform needlestick and sharp object injury report. International Health-care worker Safety Center, Exposure Prevention Information Network, EPINet. Virginia: USA, 1998. [\[CrossRef\]](#)
5. Summary report for data collected from June 1995 through July 1999. Centers for Disease Control and Prevention, The National Surveillance System for Hospital Care Workers. Atlanta: GA, USA, 2001. [\[CrossRef\]](#)
6. Needlestick injuries. Canadian Center for Occupational Health and Safety CCOH. Hamilton: Ontario, Canada, 2000. [\[CrossRef\]](#)
7. Puro V Govoni A, Mattioli F, De Carli G. Antiretroviral post-exposure prophylaxis in Italy. In: XIII International AIDS Conference; 2000; Durban, South Africa. [\[CrossRef\]](#)
8. Sepkowitz KA. Occupationally acquired infections in health-care workers: Part 1. *Annals of Internal Medicine* 1996;125:826-34. [\[CrossRef\]](#)
9. Tarigan LH, Cifuentes M, Quinn M, Kriebel D. Prevention of needle-stick injuries in healthcare facilities: a meta-analysis. *Infect Control Hosp Epidemiol*; 2015;36:823-6. [\[CrossRef\]](#)
10. Ghamdi SA, Al-Azraqi T, Bello C, Gutierrez H, Hyde M, Abdullah M. Needlestick and sharps injuries at Asir Central Hospital, Abha, Saudi Arabia. *Ann Saudi Med* 2003;23:404-7. [\[CrossRef\]](#)
11. İlhan MN, Durukan E, Aras E, Türkçüoğlu S, Aygün R. Long working hours increase the risk of sharp and needlestick injury in nurses: the need for new policy implication. *J Adv Nurs* 2006;56:563-8. [\[CrossRef\]](#)
12. Abu-Gad HA, Al-Turki KA. Some epidemiological aspects of needle stick injuries among the hospital health care workers: Eastern Province, Saudi Arabia. *Eur J Epidemiol* 2001;17:401-7. [\[CrossRef\]](#)
13. Memish ZA, Assiri AM, Eldalatomy M, Hathout HM, Alzoman H, Undaya M. Risk analysis of needle stick and sharp object injuries among health care workers in a tertiary care hospital (Saudi Arabia). *J Epidemiol Glob Health* 2013;3:123-9. [\[CrossRef\]](#)
14. Mohammad A. Needlestick and sharps injuries among resident physicians: an institutional review. *Conn Med* 2014;78:9-15. [\[CrossRef\]](#)
15. Martins A, Coelho AC, Vieira M, Matos M, Pinto ML. Age and years in practice as factors associated with needlestick and sharps injuries among health care workers in a Portuguese hospital. *Accid Anal Prev* 2012;47:11-5. [\[CrossRef\]](#)
16. Jayanth ST, Kirupakaran H, Brahmadathan KN, Gnanaraj L, Kang G. Needle stick injuries in a tertiary care hospital. *Indian J Med Microbiol* 2009;27:44-7. [\[CrossRef\]](#)
17. Shah SM, Bonauto D, Silverstein B, Foley M. Workers compensation claims for needlestick injuries among healthcare workers in Washington State, 1996-2000. *Infect Control Hosp Epidemiol* 2005;26:775-81. [\[CrossRef\]](#)
18. Kebede G, Molla M, Sharma HR. Needle stick and sharps injuries among health care workers in Gondar city, Ethiopia. *Safety Science* 2002;50:1093-7. [\[CrossRef\]](#)
19. Yoshikawa T, Wada K, Lee JJ, Mitsuda T, Kidouchi K, Kurosu H, et al. Incidence rate of needlestick and sharps injuries in 67 Japanese hospitals: a national surveillance study. *PLoS One* 2013;8:1093-7. [\[CrossRef\]](#)
20. Hoffmann C, Buchholz L, Schnitzler P. Reduction of needlestick injuries in healthcare personnel at a university hospital using safety devices. *J Occup Med Toxicol* 2013;8:20. [\[CrossRef\]](#)
21. Voide C, Darling KEA, Kenfak-Foguena A, Erard V, Cavassini M, Lazor-Blanchet C. Underreporting of needlestick and sharps injuries among healthcare workers in a Swiss University Hospital. *Swiss Med Wkly* 2012;142:w13523. [\[CrossRef\]](#)
22. Phipps W, Honghong W, Min Y, Burgess J, Pellico L, Watkins CW, et al. Risk of medical sharps injuries among Chinese nurses. *Am J Infect Control* 2002;30:277-82. [\[CrossRef\]](#)
23. Irmak Z. Needlestick and sharps injury among nurses at a state hospital in Turkey. *Australian Journal of Advanced Nursing* 2012;30:48-55. [\[CrossRef\]](#)
24. Azadi A, Anoosheh M, Delpisheh A. Frequency and barriers of under reported needlestick injuries amongst Iranian nurses, a questionnaire survey. *Journal of Clinical Nursing* 2011;20(3):488-93. [\[CrossRef\]](#)
25. Perry J, Jagger J, Parker G, Phillips KE, Goma A. Disposal of sharps medical waste in the United States: impact of recommendations and regulations, 1987-2007. *Am J Infect Control* 2012;40:354-8. [\[CrossRef\]](#)
26. 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;265-71. [\[CrossRef\]](#)
27. Jagger J, Bentley MB. Injuries from vascular access devices: high risk and preventable. Collaborative EPINet Surveillance Group. *J Intraven Nurs* 1997;20:33-9. [\[CrossRef\]](#)
28. Lamontagne F, Abiteboul D, Lolom I, Pellisier G, Tarantola A, Descamps JM, et al. Role of safety-engineered devices in preventing needle stick injuries in 32 French hospitals. *Infect Control Hosp Epidemiol* 2007;28:18-23. [\[CrossRef\]](#)
29. O'Sullivan P, Seoighe DM, Baker JF, O'Dally BJ, McCarthy T, Morris S. Hospital-based needlestick use and injuries by Dublin interns in 2010. *Irish J Med Sci* 2011;180:545-7. [\[CrossRef\]](#)

30. Patterson JM, Novak CB, Mackinnon SE, Patterson GA. Surgeons concern and practices of protection against bloodborne pathogens. *Ann Surg* 1998;228:266-72. [\[CrossRef\]](#)
31. Kirchner B. Safety in ambulatory surgery centers: occupational safety and health administration surveys. *AORN J* 2012;96:540-5. [\[CrossRef\]](#)
32. Zafar A, Habib F, Hadwani R, Ejaz M, Khowaja K, Khowaja R. Impact of infection control activities on the rate of needle stick injuries at a tertiary care hospital of Pakistan over a period of six years: An observational study. *BMC Infect Dis* 2009;29:78. [\[CrossRef\]](#)
33. Ribner BS. An effective educational program to reduce the frequency of needle recapping. *Infect Control Hosp Epidemiol* 1990;11:635-8. [\[CrossRef\]](#)
34. Ribner BS, Landry MN, Gholson GL, Ganguli LA. Impact of a rigid, puncture resistant container system upon needlestick injuries. *Infect Control* 1987;8:63-6. [\[CrossRef\]](#)
35. Linnemann CC Jr, Cannon C, DeRon0de M, Lanphear B. Effect of educational programs, rigid sharps containers, and universal precautions on reported needlestick injuries in healthcare workers. *Infect Control Hosp Epidemiol* 1991;12:214-9. [\[CrossRef\]](#)
36. Sellick JA Jr, Hazamy PA, Mylotte JM. Influence of an educational program and mechanical opening needle disposal boxes on occupational needlestick injuries. *Infect Control Hosp Epidemiol* 1991;12:725-31. [\[CrossRef\]](#)
37. 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;9:114-6. [\[CrossRef\]](#)
38. Smith DA, Eisenstein HC, Esrig C, Godbold J. Constant incidence rates of needle-stick injury paradoxically suggest modest preventive effect of sharps disposal system. *J Occup Med* 1992;34:546-51. [\[CrossRef\]](#)
39. 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;13:265-71. [\[CrossRef\]](#)
40. Wong ES, Stotka JL, Chinchilli VM, Williams DS, Stuart G, Markowitz SM. Are universal precautions effective in reducing the number of occupational exposures among health care workers? *JAMA* 1991;265:1123-8. [\[CrossRef\]](#)
41. Fahey BJ, Koziol DE, Banks SM, Henderson DK. Frequency of nonparenteral occupational exposure to blood and body fluids before and after universal precautions training. *Am J Med* 1991;90:145-53. [\[CrossRef\]](#)