# CHAPTER 5
# Percutaneous blood exposure data: 58 hospitals in the USA

J. Jagger and M. Bentley

## INTRODUCTION

The United States has the largest number of recognized cases of occupationally-acquired human immunodeficiency virus (HIV) infections in the world. Although no surveillance system in the US or elsewhere identifies all, or even most, occupationally-infected health-care workers, the number of recognized cases alone is cause for serious concern. A review of international literature up until June 1993 identified 176 documented or probable cases of occupationally-acquired HIV infection worldwide (Ippolito *et al.*, 1993a,b); two-thirds of those were in the United States. One use that can be made of these unfortunately large and growing numbers is to identify transmission patterns, which can lead in turn to focused and effective prevention measures.

The US Center for Disease Control and Prevention (CDC) identified 163 documented or possible cases of occupationally-acquired HIV in the United States until December 1996 (CDC, 1996). Two professional categories, nurses and clinical laboratory workers – primarily phlebotomists – ranked first among HIV-infected health-care workers, accounting for 24% each of the 123 reported cases. Physicians ranked next, accounting for 12% of cases. The high number of cases among nurses is consistent with the fact that they comprise the largest group of health-care workers in the US, numbering 2.2 million (source: American Nurses Association). Similarly, the number of HIV-infected physicians is consistent with the smaller number of physicians – approximately 670,000 in the US workforce (source: American Medical Association). The number of infected phlebotomists, however, is disproportionate to their numbers in the workforce: less than 100,000 phlebotomists are employed in the US according to the National Phlebotomy Association and the American Society of Phlebotomy Technicians, less than 1/20th the number of nurses.

A notable difference between nurses and phlebotomists is that the latter consistently perform blood-drawing procedures, while nurses perform a wider variety of procedures. When a phlebotomist sustains a needlestick injury the device causing injury is most likely to be a blood-filled needle. In contrast, a nurse may be injured by a needle used for an intramuscular injection or


*Occupational Blood-borne Infections* (eds C.H. Collins and D.A. Kennedy)

intravenous infusion, which would not be blood-filled, and less often by a needle used for blood drawing.

Needles used for different purposes appear to carry different risks for transmitting HIV (Berry, 1993). The same may be true for other blood-borne pathogens, such as hepatitis B and hepatitis C, but there are insufficient surveillance data to confirm this. In a report by the CDC on the exposure circumstances of workers with occupationally-acquired HIV infection, those who were exposed by needlestick had all been stuck by hollow bore, blood-filled needles. Furthermore, phlebotomy was the procedure most frequently associated with HIV exposures (Metler *et al.*, 1992). Similar conclusions have been drawn from data reported in other countries (Ippolito *et al.* 1993a,b).

This evidence suggests that blood drawing presents a high risk of exposure to blood-borne pathogens and that the risk profiles of different professional groups are in part linked to the frequency with which they perform blood drawing procedures. These are compelling reasons for focusing prevention efforts on the devices, procedures, and professional groups involved in blood drawing.

The data presented here describe the patterns of percutaneous injuries associated with blood-drawing procedures in a network of hospitals in the US.

## METHODS

Fifty-eight hospitals which voluntarily participated in three data-sharing networks contributed one year of data for this report. All the hospitals use the standardized Exposure Prevention Information Network (EPINet) system for tracking percutaneous injuries in their institutions (Jagger *et al.*, 1994). Network A includes nine hospitals located in six states in the eastern half of the US; they report their data to the University of Virginia. Network B consists of 50 hospitals in South Carolina that report their data to the Palmetto Hospital Trust Needlestick Prevention Demonstration Project in Columbia, South Carolina. Network C includes 11 Sisters of Providence hospitals in the Pacific Northwest that report their data to Johnson & Higgins of Washington, Inc., in Seattle. The hospitals represent a cross-section of institutions in diverse geographic locations; of the hospitals included in this report, 26 had an average daily census of less than 100 beds, 16 had from 100 to 299 occupied beds, and 16 had 300 or more occupied beds. Seventeen were teaching hospitals.

Data included all percutaneous injuries reported by health-care workers to the employee health departments or similar designated authorities in their institutions. Data collection began in September 1992. Each participating facility provided one year of data on disk to investigators; of the 70 hospitals in the three networks, 58 with complete data at the time of this report were included.

## RESULTS

There was an overall total of 3,829 percutaneous injuries in the merged database, and a cumulative total of 11,978 occupied beds in the 58 hospitals. Needlestick incidents were selected in which the device associated with the injury was: (i) a syringe used for drawing venous or arterial blood; (ii) a winged steel needle (butterfly) used for blood drawing; or (iii) a vacuum tube phlebotomy needle. Four hundred and seventy-one cases met these criteria – 12.3% of all injuries from the 58 hospitals. Table 5.1 shows the job categories of workers reporting needlestick injuries from blood drawing needles. Nurses and phlebotomists together accounted for two-thirds of cases. The remaining cases were reported primarily by respiratory therapists (a job category that does not exist in many countries outside the US), who often draw blood for arterial blood gas analysis, and by clinical laboratory technicians and physicians (mainly medical residents).

Table 5.2 shows the location of these incidents. Most injuries occurred in patient rooms; the next most frequent locations were emergency departments and intensive or critical care units. Less frequent locations were out-patient clinics, operating rooms, and clinical laboratories.

Figures 5.1–5.4 compare the mechanisms of needlestick injuries for four major needle devices used for blood drawing. This breakdown of injuries shows a profile of when the injuries occurred during the use/disposal cycle; each device has a unique profile, reflecting the design characteristics of the device and the handling requirements for performing specific procedures. For instance, recapping injuries are more frequently associated with syringes used for drawing arterial blood (Fig. 5.1) than for similar syringes used for drawing venous blood (Fig. 5.2). This may be due to the requirement for removing needles from arterial blood gas syringes before delivering the filled syringes to the laboratory. On the other hand, injuries that occur when withdrawing a needle from the stopper of a tube are more frequent with syringes used for drawing venous

**Table 5.1.** Job classification of health workers reporting needlestick injuries associated with blood drawing (58 hospitals, one year).

| Job | Number | Percentage |
|---|---|---|
| Nurse | 157 | 33.3 |
| Phlebotomist | 150 | 31.8 |
| Respiratory therapist | 43 | 9.1 |
| Clinical laboratory worker | 40 | 8.5 |
| Physician* | 39 | 8.3 |
| Attendant (non-surgical) | 14 | 3.0 |
| Other | 28 | 5.9 |
| Total | 471 | 100 |

*30/39 reported needlestick injuries were to residents.

**Table 5.2.** Place of occurrence of needlestick injuries associated with blood drawing (58 hospitals, one year).

| Job | Number | Percentage |
|---|---|---|
| Patient room | 251 | 53.3 |
| Emergency department | 66 | 14.0 |
| Intensive/critical care unit | 39 | 8.3 |
| Out-patient department | 24 | 5.1 |
| Clinical laboratory | 21 | 4.5 |
| Operating theatre | 13 | 2.8 |
| Venepuncture | 12 | 2.5 |
| Treatment room | 9 | 1.9 |
| Other | 36 | 7.6 |
| Total | 471 | 100 |

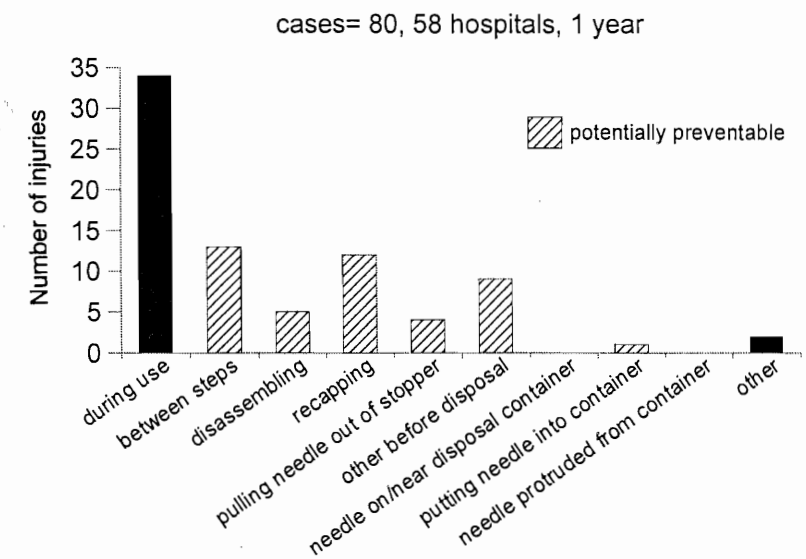



**Fig. 5.1.** Mechanism of injury from syringes used for drawing arterial blood. (Courtesy of the International Health Care Worker Safety Center, University of Virginia.)

blood because the blood is often injected into tubes before delivery to the laboratory.

The risks associated with winged steel needles (butterflies) are largely related to problems in transporting the devices safely to the disposal containers and difficulties in pushing the needles through the openings of containers (Fig. 5.3). The coiled tubing attached to the needles makes the devices awkward to handle.

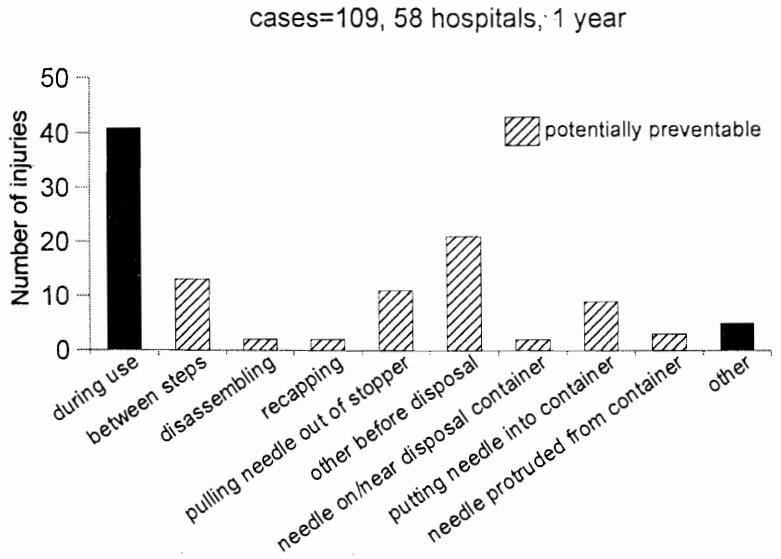



**Fig. 5.2.** Mechanism of injury from syringes used for drawing venous blood. (Courtesy of the International Health Care Worker Safety Center, University of Virginia.)

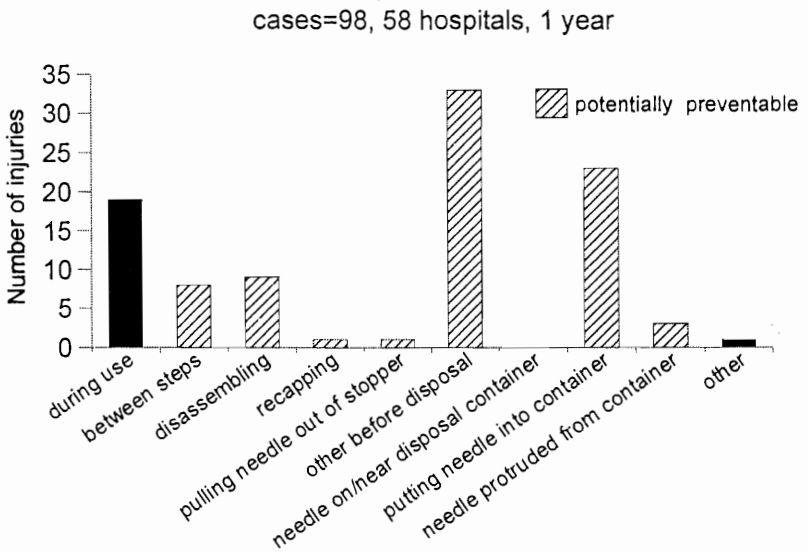



**Fig. 5.3.** Mechanism of injury from winged steel needles used for drawing blood.

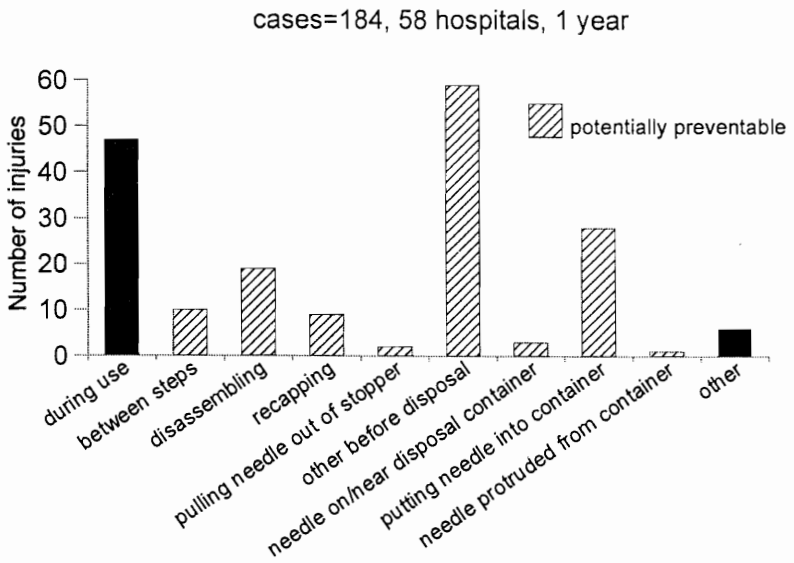



**Fig. 5.4.** Mechanism of injury from vacuum tube phlebotomy needles.

There were 184 injuries from vacuum tube phlebotomy needles (Fig. 5.4). The circumstances of the injuries were similar to those for winged steel needles: that is, they were caused by problems in transporting needles to disposal containers and in introducing needles into the containers.

Hollow-bore needles were not the only devices associated with injuries incurred during blood drawing procedures. Lancets used for fingersticks and heelsticks, glass capillary tubes, and glass vacuum tubes containing blood samples also caused injuries. Most numerous among these were 108 injuries caused by fingerstick and heelstick lancets that lacked an automatic retracting safety feature. Fifty-four per cent of the injuries occurred when disengaging a disposable lancet from a reusable holder or when handling the used lancet prior to disposal. These injuries reflect the difficulty of handling such small devices which, if no protective shield is provided, require the fingers to remain close to the exposed point as the device is disassembled and discarded.

Eighteen injuries were caused by glass capillary tubes used to contain small-volume blood samples following fingerstick or heelsticks. Injuries occurred during all phases of handling. Force must be applied when pushing the tubes into putty to close off one end, and again the tubes are subject to significant force when they are centrifuged for haematocrit determination. Under such stresses the fragile glass easily fractures. The devices are blood-filled and have the potential to produce sizable lacerations with significant inoculation of blood.

Nine injuries were caused by broken glass vacuum tubes. Although there were relatively few such injuries when compared with the 184 from phlebotomy needles used to draw blood into the tubes, vacuum tube injuries are

particularly serious because of the large amounts of blood that can be introduced into the lacerations. Breakage often occurred at the top of the tubes, when the tight-fitting stoppers were removed either to introduce or withdraw blood samples.

## PREVENTABLE INJURIES

The EPINet system is designed to identify the proportion of injuries that are potentially preventable through improvements in the design of sharp medical devices. Injuries are considered preventable if an alternative already exists that can eliminate the sharp device or unsafe feature. For instance, all injuries from needles used to inject fluid into or withdraw fluid from intravenous access ports are preventable, because needleless equipment can be used. All injuries caused by the breakage of glass devices for which non-breakable alternatives are available can also be prevented.

Some, but not all, needles can be eliminated. Many devices have needles that are used to pierce skin or tissue; these are necessary needles. Needlestick injuries that occur after use or between uses of a necessary needle, however, are potentially preventable, when a safety feature that shields the hand from the needle can be put into place. The percentage of needlestick injuries that occur during the performance of the procedure, when the needle must be exposed for use, is not included in the preventable fraction for that device.

The concept of the 'preventable fraction' is intended to project a target that may be achieved by the implementation of feasible measures. It is not intended to imply that there is a limit to the potential reductions that can be achieved. It is possible that some safety devices on the market may already exceed the estimated preventable fraction in a given device category. It is also possible that in the future additional prevention strategies, such as procedure changes or new technology, may increase the preventable fraction or even eliminate injuries in a specific device category altogether.

Figures 5.1–5.4 highlight the preventable fraction of needlestick injuries for each device. They were: (i) 58% for syringes used for drawing venous blood; (ii) 55% for syringes used for drawing arterial blood; (iii) 80% for winged steel needles (butterflies); and (iv) 71% for vacuum tube phlebotomy needles. Across all four devices, 67% (316/471) of injuries fell into the potentially preventable fraction.

Seventy-four per cent of injuries from fingerstick or heelstick lancets fell into the preventable fraction. Nearly all injuries, however, caused by such lancets are preventable, because there are safety lancets presently on the market with a built-in spring action that automatically withdraws the sharp point into a shielded position immediately after being discharged. The sharp lancet retracts so quickly that it is highly improbable that a health-care worker could sustain a puncture injury after performing a fingerstick or heelstick procedure. The percentage of preventable injuries, therefore, is likely to be significantly greater

than 74%. The safest retracting lancets are those that do not permit a contaminated lancet to be inadvertently discharged a second time.

An additional advantage of the safety lancets is that they reduce the potential for patient-to-patient cross-contamination, because when the used lancet is disposed of, all parts of the device that have come into contact with the patient are automatically discarded with the lancet. The problem of cross contamination from spring-loaded lancets was linked to an outbreak of hepatitis B and was subsequently the subject of a 1990 FDA Safety Alert (Food and Drugs Administration, 1990; Douvin *et al.*, 1990).

All injuries (100%) from glass capillary tubes used for haematocrit determination are preventable, because it is not necessary to use these devices – unbreakable plastic capillary tubes are available, as well as a system for haematocrit determination that does not require the use of capillary tubes at all. These injuries could be eliminated tomorrow with the appropriate selection of products.

It is difficult to estimate the proportion of preventable injuries from broken vacuum tubes. Plastic vacuum tubes are available as an alternative to glass; however, vacuum tubes are used for many different applications and the proportion of glass tubes that could be eliminated by the plastic ones is not certain. There is also a redesigned vacuum tube stopper for glass vacuum tubes that is intended to reduce stresses on the top edge of the tube and thereby lower the risk of breakage if the stopper is removed.

As a final point, the handling requirements of blood drawing equipment must be taken into consideration when implementing prevention programmes or evaluating safer devices. After withdrawing a phlebotomy needle from a patient, the health-care worker must apply pressure to stem bleeding at the puncture site. This leaves only one hand free to handle the exposed needle. The health-care worker must either dispose of the needle with one hand or leave it on a nearby surface until he or she is free to move away from the patient. This situation points to the need for an appropriate disposal container within arm's reach of the patient. It also emphasizes the advantage of having a safety blood drawing device that requires only one hand for activation. If two hands are needed to activate a safety feature after the needle has been removed from the patient, the health-care worker is in the same situation as with a conventional device, and cannot activate the needle protection feature until both hands are free.

Figure 5.5 illustrates six hazardous practices that should be avoided when blood is drawn.

We have compiled a selection of devices that are currently on the market and which are designed to prevent percutaneous injuries associated with blood-drawing procedures. These devices are illustrated in Fig. 5.6. Inclusion in this selection does not imply an endorsement of any specific product. Nor is it inclusive (see also Bouvet, Chapter 7 this volume). Safety devices are likely to vary in their effectiveness in preventing injuries. Institutions that purchase them must evaluate them thoroughly for: (i) health-care worker safety; (ii) patient safety; and (iii) their impact on the reliability of laboratory tests.

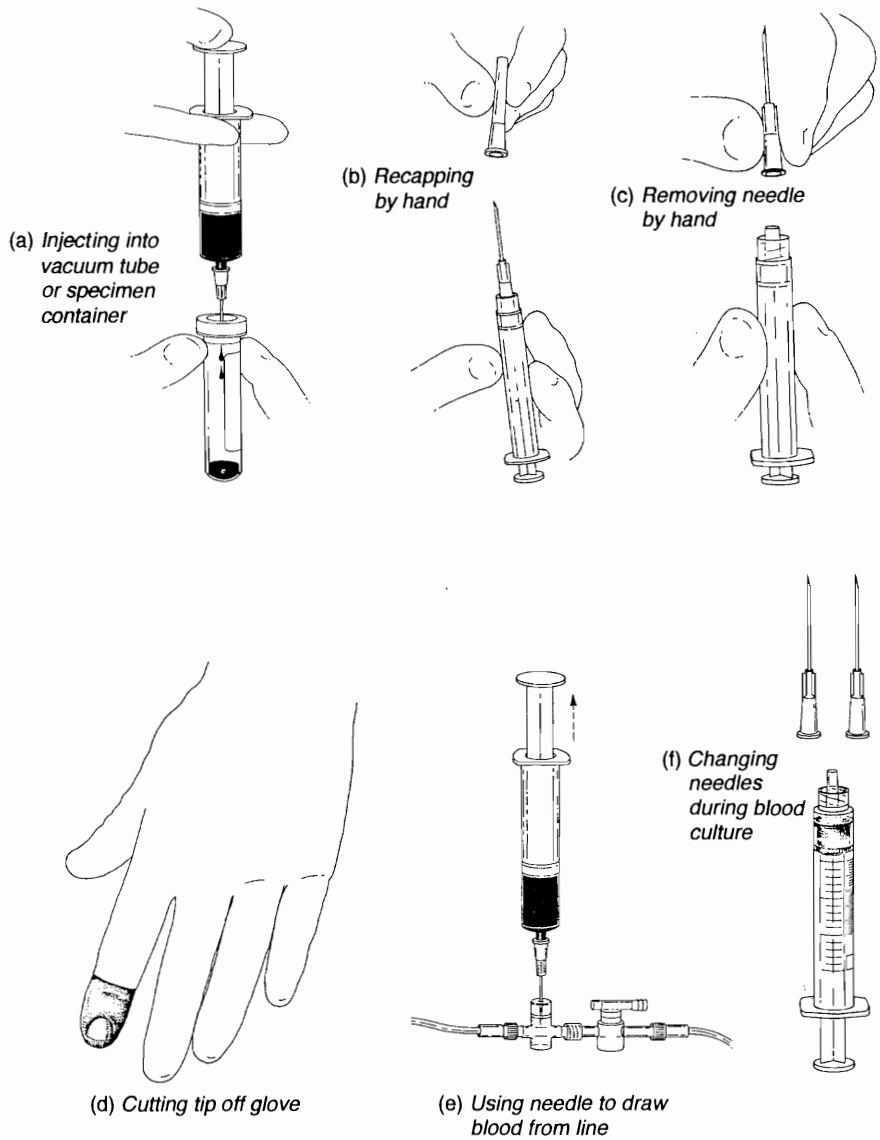
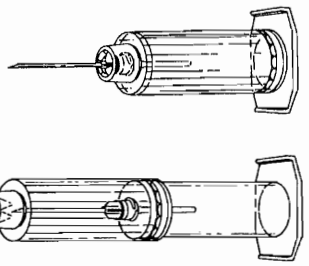



Fig. 5.5. Six hazardous practices to avoid.

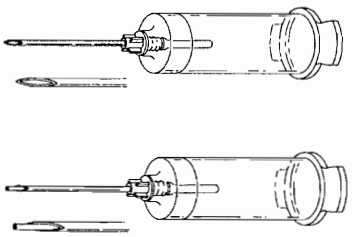
(a)



*protected position*

VACUTAINER® Brand Safety-Lok™
■ Becton Dickinson
*Single use vacuum tube/needle holder with protective sliding sleeve that pushes forward after use and locks in place*

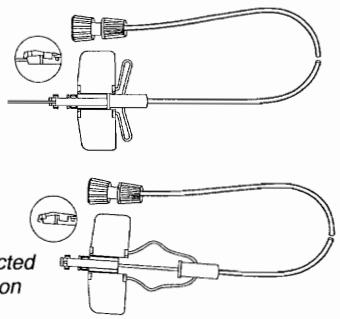
(b)



*protected position*

Punctur-Guard™ ■ Bio-Plexus
*After final tube of blood is drawn, blunt internal needle is activated by forward pressure of vacuum tube. Needle point is blunted before it is removed from patient*

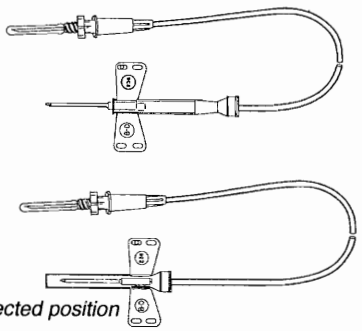
(c)



*protected position*

Angel Wing™ Safety Needle
■ Sherwood Medical
*Stainless steel barrier tip is advanced forward to end of needle, locking over point as needle is withdrawn from patient; one-handed activation*

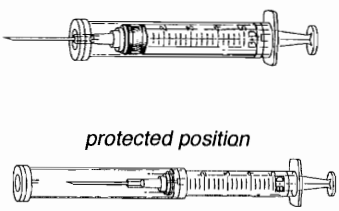
(d)



*protected position*

VACUTAINER® Brand Safety-Loc™
Winged Needle ■ Becton Dickinson
*After removal from patient, safety shield is advanced forward and locks in place beyond needle tip*

(e)

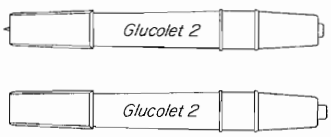


*protected position*

B-D Safety-Lock™ ■ Becton Dickinson
*Needle guard has protective sliding sleeve that pushes forward after use and locks in place. Note: the 10cc syringe with the shield locked in place can accept a 3cc to 10cc vacuum tube, allowing injection of blood into tube with shielded needle*

(f)

*In use*





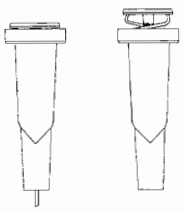


*After use*

Glucolet 2™ Retracting Lancet ■ Miles, Inc./Diagnostic Division
*Disposable lancet is fitted to reusable spring-loaded holder. When activated, lancet instantly protracts and retracts; retracted lancet is removed from holder for disposal*

**Fig. 5.6.** Safety products related to blood drawing.

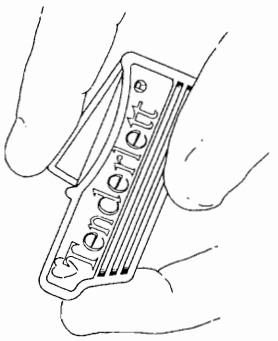
(g)



*In use* *After use*

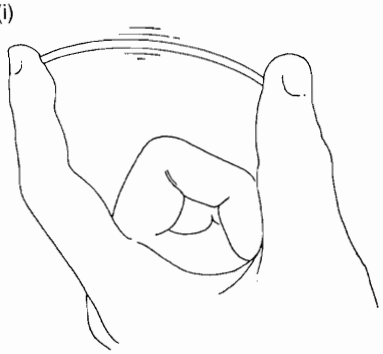
MICROTAINER™ Brand Safety Flow Lancet ■ Becton Dickinson
*Self-contained lancet is manually activated and automatically retracts when activating lever is released*

(h)



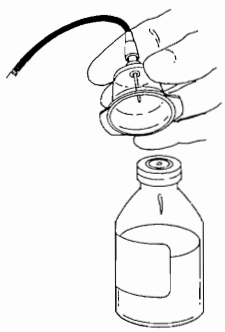

Tenderlett® Automated Skin Incision Device ■ International Technidyne Corporation
*When device is triggered, surgical steel blade swiftly protracts and then automatically retracts. Design precludes inadvertent reuse*

(i)



SafeCrit™ Plastic Microhematocrit Tube ■ Norfolk Scientific
*Capillary tube made of plastic avoids hazard of glass breakage*

(j)



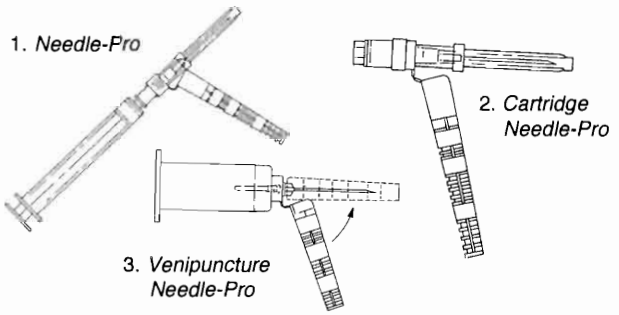
BACTEC® Direct Draw Adapter ■ Becton Dickinson
*Designed for blood culture procedures. Vacuum vial and covered needle safety adapter allow blood to be drawn directly into culture medium, avoiding need to inject into specimen container*

(k)

HEMOGARD VACUTAINER® Brand Vacuum Tube Stopper ■ Becton Dickinson
*Rigid stopper grips outside of tube; intended to reduce risk of tube breakage and blood splash when removing stoppers*

**Fig. 5.6.** *Continued.*

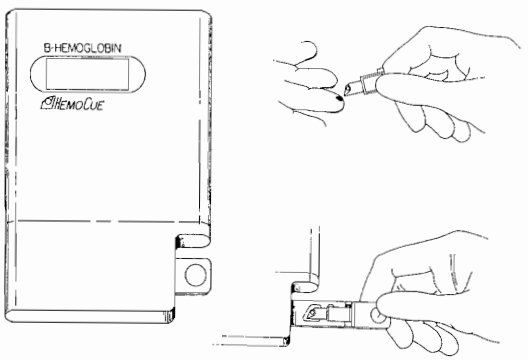
(l)




Needle-Pro™ Needle Protection Devices ■ SIMS: Smiths Industries Medical Systems

*Hinged sheath engages over needle; used needle is pressed into Needle-Pro device using one hand. Comes in 3 configurations. (1) Needle-Pro: Basic needle protection device; can be used for arterial blood drawing. (2) Cartridge Needle-Pro: Combines hypodermic needle cartridge with Needle-Pro sheath. (3) Venipuncture Needle-Pro: Disposable blood collection tube holder and integral needle protection device*

(m)




HemoCue® Hematocrit Reader ■ HemoCue, Inc.

*Uses flat plastic cuvette to contain blood sample for hematocrit determination. Cuvette is inserted directly into reader, avoiding need for centrifugation*

**Fig. 5.6.** *Continued.*

## ACKNOWLEDGEMENTS

***International Health Care Worker Safety Center, University of Virginia***

*Network Coordinators: Janine Jagger, Beth Blackwell, Melanie Balon*

*Florida Hospital (Orlando, FL), Dianne Ross, Carol Griffin; Martha Jefferson Hospital (Charlottesville, VA), Pam Jones, Edwina Juillet; North Broward Hospital (Ft. Lauderdale, FL), Marc Gomez, Janet Narushko; Saint Joseph Hospital (Omaha, NE), Ann Lorenzen; Saint Vincent Hospital (Indianapolis, IN), Dianne Spiller; Saint Vincent Hospital (Erie, PA), Mary Jo Dolecki, Diane Dougan; Shands Hospital (Gainesville, FL), Deborah Boeff, Suzanne Hench;*

*University Hospitals of Cleveland (Cleveland, OH), Pamela Parker; University of Virginia Hospitals (Charlottesville, VA), Betty Joe Coyner, Vickie Pugh*

**Sisters of Providence, Johnson & Higgins of Washington, Inc., Seattle**

Network Coordinators: Eileen Bradshaw, Janet Swapp

*Providence General Hospital and Medical Center (Everett, WA), Catherine Murray; Providence Hospital (Anchorae, AK), Veronica Allarmas; Providence Hospital (Centralia, WA), Joan McKenzie, RN, MN; Providence Hospital (Medford, WA), Ruth DeVee; Providence Hospital (Toppenish, WA), Leslie Simmons, RN; Providence Medical Center (Portland, OR), Joanne Henkel, RN; Providence Medical Center (Seattle, WA), Catherine Elliott-Rostykus, RN, Betsy Blessing-Hubbard, RN, Barb Schubert; Providence Milwaukie Hospital (Milwaukie, OR), Debbie Marshall, RN; Providence Seaside Hospital (Seaside, OR), Leonard Naidoff, RN; St. Elizabeth Medical Center (Yakima, WA), Judy Hanratty, RN; St. Joseph Medical Center (Burbank, CA), Cathy McDonald; St. Peter Hospital (Olympia, WA), Bev Masini, RN, Barbara Soule, RN, CIC; St. Vincent Hospital and Medical Center (Porland, OR), Becky Fuller, RN, COHN*

***Palmetto Hospital Trust Needlestick Prevention Demonstration Project, South Carolina***

Network Coordinators: Marshall Fowler, Susan Austin, Kim Carter

*Abbeville County Hospital (Abbeville, SC), Nancy Brock, RN; Allen Bennet Memorial Hospital (Greer, SC), LouAnne Weber, RN-CSMSN; Anderson Memorial Hospital (Anderson, SC), Rhonda Chalfant; Baptist Medical Center Columbia (Columbia, SC), Gwen Floyd; Baptist Medical Center Easley (Easley, SC), Lois McCready, RN; Barnwell County Hospital (Barnwell, SC), Allene Townes; Beaufort Memorial Hospital (Beaufort, SC), Helena Gregg, RN; Bruce Hospital System (Florence, SC), Laurie Horton, RN; The Byerly Hospital (Hartsville, SC), Susan Nash, RN; Cannon Memorial Hospital (Pickens, SC), Linda Masters; Charleston Memorial Hospital (Charleston, SC), Robin Smith; Chester County Hospital (Chester, SC), Marian Bagley, RN; Clarendon Memorial Hospital (Manning, SC), Lynne Bowen, RN; Conway Hospital (Conway, SC), Lenora Thompson, RH; Edgefield County Hospital (Edgefield, SC), Pat Robinson, RN; Elliott White Springs Memorial Hospital (Lancaster, SC), Julie Bowers, RN; Fairfield Memorial Hospital (Winnsboro, SC), Debra Gudenas, RN; Florence General Hospital (Florence, SC), Debby Rapp, RN; Georgetown Memorial Hospital (Georgetown, SC), Emma Miller, RN; Greenville Memorial Medical Center (Greenville, SC), LouAnne Weber, RN; Greenwood Methodist Home (Greenwood, SC), Juanita J. Butler; Hillcrest Hospital (Simpsonville, SC), LouAnne Weber; Hilton Head Hospital (Hilton Head Island, SC), jane Binns, RN, CDE; Kershaw County Memorial Hospital (Camden, SC), Margaret Perry; Laurens County Hospital (Clinton, SC), Linda Casey, RN; Lexington Medical Center and Drug Abuse Program (Lexington, SC), Cathy Blanks, RN; The Loman Home (White Rock, SC), Sheila Bantz, RN; Loris Community Hospital (Loris, SC), Linda Mills, RN; Lower Florence County Hospital (Lake City, SC), Martha Lyerly, RN; Marion Memorial Hospital (Marion, SC),*