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MISSING THE POINT: A REVIEW OF NEEDLESTICK INJURY AND OCCUPATIONAL RISKS FROM BLOODBORNE VIRUSES

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ABSTRACT

Hundreds of thousands of occupational exposures to the blood and body fluids of patients can occur each year in healthcare settings. Accidental needlestick or "sharps" injuries caused by hollow-bore needles, scalpels or other sharp objects constitute an important occupational health hazard for healthcare professionals and provide the most important route of infection of healthcare workers by human immunodeficiency virus (HIV), hepatitis B virus (HBV), and hepatitis C virus (HCV).

Both anecdotal and survey data suggest that healthcare students and professional staff receive variable and often inadequate education and training in infection control. The purpose of this article is to present an update about occupational infection risks, with details of a new interactive CD-ROM which provides key infection control training materials on bloodborne viruses, for students and staff.

INTRODUCTION

Sharp instruments, particularly disposable hollow-bore hypodermic needles, are used, worldwide on a daily basis throughout healthcare facilities. It has been estimated that about 200 million hypodermic needles were used in the UK alone in 1998 (Ely, 1999). "Sharps" may constitute a low infection risk for the general public when subject to careful storage, transport and destruction. However, for physicians, nurses, laboratory workers, waste handlers and other staff they present a very important risk of infection from bloodborne pathogens, which may greatly outweigh immediate health risks from other constituents of clinical waste. Published reports suggest that health care students, professional staff and ancillary staff receive variable and often inadequate education and training in infection control and the processing of clinical waste.

BLOODBORNE VIRUSES

Although more that 20 pathogenic organisms may be transmitted in blood (Collins and Kennedy, 1987), three bloodborne viruses, Human immunodeficiency virus (HIV), hepatitis B virus (HBV) and hepatitis C virus (HCV) present particular risks. Each of these viruses can be spread by sexual contact, but blood to blood contact is the most efficient transmission route, and infection can occur following an injury with a contaminated sharp instrument.

Hepatitis B virus has been identified as a potential hazard since 1949, when a blood-bank technician, whose jobs included sharpening needles from reusable transfusion-giving sets, developed acute hepatitis following injury. However, despite the fact that HBV is significantly more infectious than HIV, concern about preventing bloodborne infections did not reawaken until the risk for occupational HIV infection by exposure to blood was identified in the early 1980s. With the availability of an accurate test for HCV, it is now clear that infection with this virus is widespread in certain populations, especially intravenous drug users, and infection may lead to serious long-term illness. The presence of these infections in patients will provide a risk of infection for those undertaking venepuncture, laboratory or invasive clinical techniques, and where percutaneous injury with contaminated sharps or mucous membrane exposure by blood may occur.

Hepatitis B (HBV)

Hepatitis B virus may circulate in the blood of infected patients in titres greater than 10^{13} infectious units per millilitre (CDC, 1985). It can remain viable on hard surfaces within dried blood or in liquid blood in syringes at room temperature for at least seven days, and possibly much longer. Thus, even a tiny amount (0.04 microlitre) of blood or serum may infect a health worker if percutaneously injected, or splashed onto the eyes or mucous membranes. Blood on the hands of healthcare workers may lead to inadvertent exposure through

pre-existing cuts, lesions or broken skin, or be rubbed into the eye subsequent to the exposure (Breuer and Jeffries, 1992). There is no evidence of transmission of HBV by inhalation of droplets or aerosols. The hepatitis B virus is very stable; it is resistant to common antiseptics, such as chlorhexadine and is not destroyed by boiling for less than five minutes. Use of hypochlorite, glutaraldehyde, chlorine and autoclaving at 134°C for a minimum of three minutes are methods/techniques known to destroy the virus.

Hepatitis C (HCV)

Hepatitis C virus may be present in body fluids other than blood and has been detected in ascitic fluid, seminal fluid and urine from patients with chronic liver disease who are serum HCV RNA positive. Hepatitis C virus antigens have been demonstrated in liver biopsy sections and HCV-positive hepatocytes were found to be scattered in the lobules. It is likely that the infection can be transmitted via transplanted organs and bone grafts, and HCV is thought to be the chief cause of post blood transfusion hepatitis; up to 90% of blood donors with antibody to HCV have infectious virus particles in their blood (Esteban, 1990).

The amount of circulating HCV RNA in samples studied thus far appears to be lower than for HBV but may be higher than in HIV infected individuals. Kiyosawa, et al, (1991) followed up 110 Japanese healthcare workers after percutaneous exposures to infected patients. Four developed clinical hepatitis and three became anti-HCV positive, representing a transmission rate of 2.7%. In a second study, 5 out of 68 anti-HCV negative healthcare workers who sustained percutaneous exposures to infected blood subsequently developed elevated serum transaminases after exposure. Anti-HCV and HCV RNA were detectable in three subjects and HCV RNA alone was detectable in the other two, for an overall transmission rate reported of 7 of 68 (10%). Decontamination processes used for HBV should also inactivate HCV.

Human Immunodeficiency Virus (HIV)

Early on in the HIV/AIDS epidemic occurring in the United States it was felt that HIV did not pose a major risk for occupational infection in healthcare workers. Concern began to be shown in 1984 after the first case of documented sero-conversion following percutaneous exposure to blood was reported. Today, there are few countries that do not report significant prevalence rates for this virus (Table 1). About 16,000 new HIV transmissions occur each day and the virus is spreading most rapidly in developing countries (90% of cases). HIV has been isolated from peripheral blood mononuclear cells in 97% of persons who were HIV antibody-positive, confirming that all HIV-antibody-positive patients are potentially infectious and that cell free body fluids such as plasma should also be considered to be infectious, whether patients are asymptomatic or symptomatic. Although the plasma HIV titres may be considerably lower than for HBV, small quantities of blood may still be able to effect transmission (Table 2).

The virus has been reported to be inactivated by treating at 56°C for 30 minutes but can survive under laboratory conditions for 7 days at room temperature (20-22°C), either in dry or liquid media and viable virus has been recovered from a cadaver up to 16 days after death. Studies have shown that HIV is inactivated rapidly by commonly-used chemical disinfectants such as sodium hypochlorite solution, at a concentration of 10,000 ppm (1%).

RISK ASSESSMENT

Hundreds of thousands of occupational exposures to blood and body fluids of patients occur each year in health care settings and blood has been implicated as the source of the exposure in nearly all occupationally acquired infections. The actual risk to an individual health care worker or waste handler of contracting a blood-borne virus depends on a number of variables, including:

- seroprevalence of the virus in the source (patient) population;
- known or suspected infectious status of the individual patient;
- infectivity of the virus;
- risk category of the clinical procedure;
- degree of exposure to blood at the time of the incident; and
- the provision of post exposure prophylaxis.

Freshly drawn blood, taken from a highly viraemic HBV infected patient which enters the body of a healthcare worker via a deep needlestick injury, is most likely going to lead to infection (1 in 3 risk). In comparison, HIV transmission following a single sharps injury presents about 1 in 300 risk, derived from a review of 25 follow-up studies carried out worldwide. This contrasts with the results of 21

studies of mucocutaneous HIV exposures, which indicate a risk of 1 in 2,910 per high risk event. Approximate transmission risks for the three agents following needlestick injury can be compared using the "rule of threes" (Table 3).

SURVEILLANCE OF STAFF WITH OCCUPATIONAL EXPOSURE TO BLOODBORNE VIRUSES

It has been estimated that in Europe, up to 6.8 million workers and students are potentially exposed to the hazards of blood contact, although the United States has the largest number of recognised cases of occupationally-acquired HIV infections in the world. By December 1997, 286 staff were reported, worldwide, to have acquired HIV occupationally, an increase of 104 over the three-year period 1994-7. Evans noted in 1999 that the majority of cases (58%) were reported from the US, followed by mainland Europe (33.5%; Table 4).

In the US, estimates indicated that between 252,000-756,000 sharps injuries occurred in 1990.

TABLE 1
Estimated worldwide prevalence of HIV and Hepatitis B and C Viruses.

Virus World Prevalence
HBV: 350 million individuals
HCV: 500 million individuals
HIV: 30 million individuals

TABLE 2
Approximate number of infectious units of virus per millilitre of patient blood. (Source: Bennett and Howard, 1994)

Virus	Number of particles/ml of infected blood
HBV	10^6 - 10^{13}
HCV	10^6
HIV	10 - 10^3

TABLE 3
Approximate occupational transmission risks for HBV, HCV, and HIV, following injury with a sharp with infected blood.

Virus Transmission Risk (highest)	
HBV:	1 in 3
HCV:	1 in 30
HIV:	1 in 300

TABLE 4
Worldwide distribution of reported occupationally acquired HIV infection.

Region	Occupationally acquired HIV infections	Number of AIDS cases (Alive Dec '97)
Europe	40	417,000
USA	160	820,000
Africa	6	21.2 million

Fifteen occupational health departments from Wessex and Oxford regions in the UK found that 1102 incidents were reported over a nine-month period (Smedley, 1995). Such studies however, cannot give an accurate picture of the problem as many incidents go unreported. Jagger and colleagues in the US have reported categories of staff that are at the highest risk of sustaining sharps-injury associated HIV infection. Fifty-eight hospitals in the US provided sharps injury data over one year in which there were a total of nearly 4000 high risk injuries during blood taking. Nurses and phlebotomists ranked first as highest risk, followed by physicians.

A review of all incidents involving blood/body fluid exposure of staff reported to the Royal Free Hospital occupational health unit in London in 1996 also showed that nurses experienced the most reported incidents (41%), followed by physicians (15%). In contrast, porters or housekeeping staff suffered only 1% of reported exposures.

Accidental injuries can occur in various ways to the person using the sharp instrument, but the most significant cause is a result of resheathing contaminated needles. Up to 40% of injuries may be due to this single procedure which is discouraged by many organisations including the British Medical Association (BMA, 1990), US Centers for Disease Control and Prevention and the World Health Organisation.

A BMA postal survey (Morgan, 1997) of nearly 2000 UK medical students in 1992 revealed that many were at risk of infection due to unsafe practices, with high rates of resheathing reported and 25% recalling one or more injuries over the previous year. Only 42% of students (816/1950) stated that they would definitely report a future needlestick injury.

A review of recently published literature confirms that reporting rates of needlestick injuries are still low (Luthi, 1998; Hettiaratchy, 1998; Haiduven, 1999). The reasons given by staff include little or no perception of risk, being too busy, and dissatisfaction with follow-up procedure. Surgeons may underestimate the risk of bloodborne pathogens and as a result use gloves selectively and/or not use double gloving techniques, even though gloves may provide significant benefits by reducing the volume of blood transferred during a sharps injury (Mast, 1993; Bennett, 1994).

HEALTH AND SAFETY LEGISLATION

In the UK, the emotional and financial costs of sharps injuries to the National Health Service are significant. In October 1998, UK newspapers reported an out-of-court settlement for £465,000 (approximately $765,000 US) damages between a junior hospital doctor and the employing health authority. The doctor had developed a "needle phobia" following an accidental injury and was unable to continue practising medicine. She had been qualified for less than a year when she pricked herself on a needle left on a drugs trolley at a London hospital. The doctor struggled to cope with her growing anxieties about sharps, blood and AIDS for two years before going on sick leave in 1994; she is unlikely to work again as a physician.

The BMA has emphasised the responsibility of employers for providing full sharps training and hepatitis B vaccine for all those at the "sharp end," with post-exposure counselling, assessment and occupational support. Post exposure treatment using AZT in combination with other drugs should be considered for staff following a high risk HIV exposure. It is likely that many health authorities and trust hospitals have yet to get the situation fully under control.

The UK Department of Health has confirmed that all employers have a legal obligation "to ensure that their employees are appropriately trained and proficient in the procedures necessary for working safely." In the US, needlestick injuries have long provided the basis for litigation in a variety of settings and the award of nearly half a million pounds to one UK physician is likely to be just the tip of the financial iceberg. New laws requiring syringes to be fitted with retractable needles or plastic sheaths, which are now required in California, have not yet been proposed for the UK.

INFECTION CONTROL MANAGEMENT AND TRAINING

Health authorities have been reminded by the UK Departments of Health (DOH, 1998) of their responsibility to draw up local guidelines and to establish an infection control team to liaise with the occupational health service, which should advise managers and employees on all aspects of immunization and infection control. Ultimate responsibility lies with the chief executive of each health authority, health board or National Health Service

trust. UK medical students undertaking "electives" in developing countries may be at particular risk, as will inexperienced hospital porters handling sharps containers on a regular basis.

To assist in this important process, the BMA Board of Science and Education has produced an interactive CD-ROM that covers all the major issues, concerned with bloodborne viruses/ infection control and is suitable for universities and colleges, hospitals and general practices (Morgan, 1999). This CD-ROM will supplement locally produced guidelines and provide users with:

- a basic introduction to HIV, HBV, and HCV;
- information on protective clothing and safe use and disposal of sharps;
- emergency advice following sharps injury and post-exposure treatments;
- comprehensive information on instrument sterilisation, disinfection and clinical waste in primary care;
- case studies from leading journals and a searchable bibliographical database; and
- technical information from the UK Health and Safety Executive and Medical Devices Agency and the full searchable text of the recent guidelines from the Department of Health.

The CD-ROM contains numerous graphics and video clips, is easy to use and navigate and can be used on stand-alone personal computers or run on networked systems, perhaps as part of an hospital health and safety database resource. Injured staff should be able to access the system on a 24 hour basis to obtain immediate guidance following an exposure.

DISCUSSION

Prior to the introduction of HBV vaccine and improved health and safety legislation, thousands of hospital staff became infected worldwide each year with this virus. With the emergence of new strains of viral hepatitis, and the absence of vaccines for HIV and HCV, the risk of infection to healthcare staff will persist. The routine use of needles and other sharps will continue to pose hazards and improved reporting and audit shows that staff still experience high rates of sharps injuries.

Concern about HIV has not led to a substantial reduction in sharps injuries. In contrast, the reductions reported in the literature are correlated with changes in staff education and procedures (Dale, 1998), including:

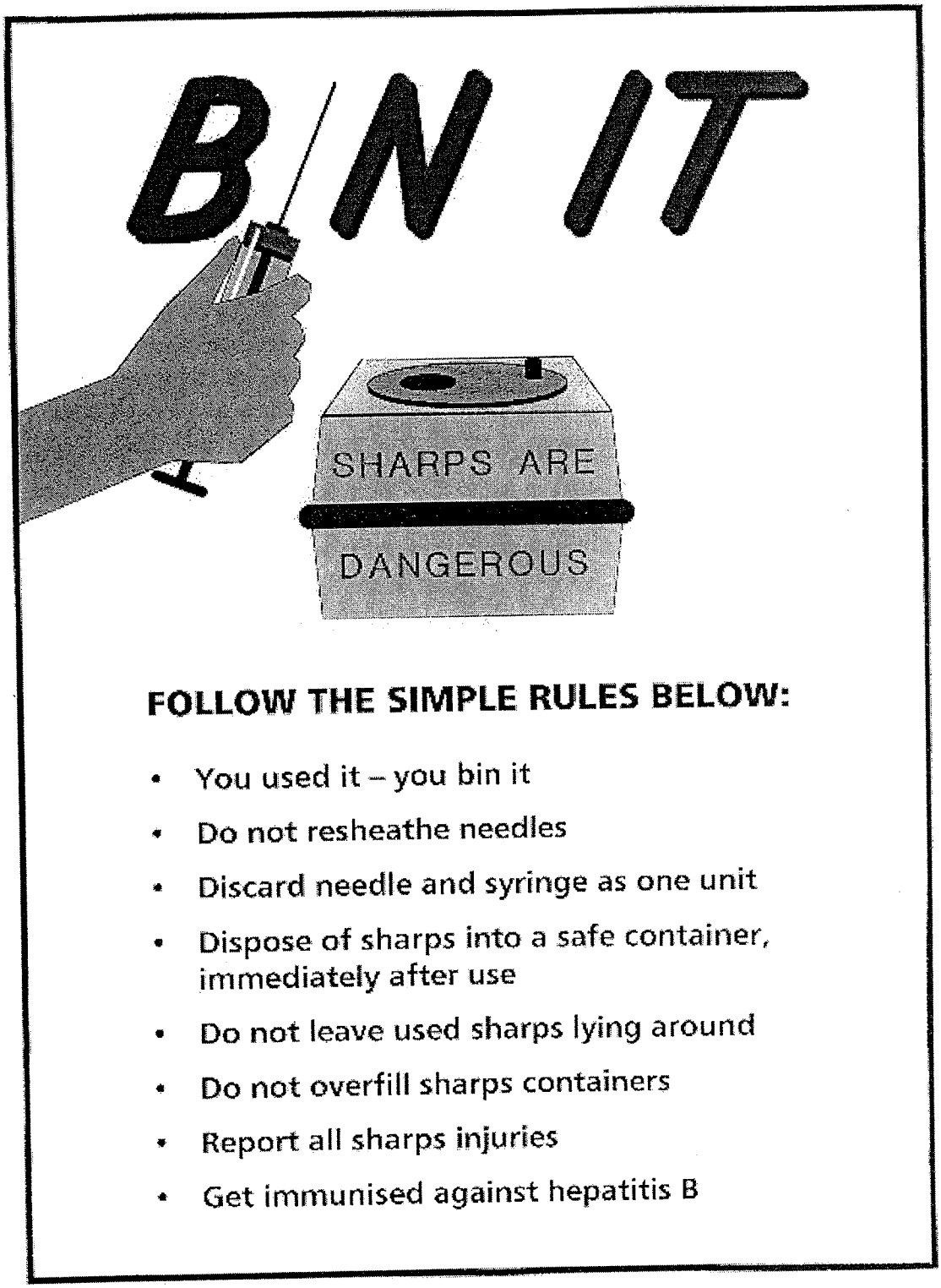
- All "at risk" staff must receive appropriate training, as part of an induction before they are routinely in contact with sharps;
- Staff "at risk" must be provided with suitable protective clothing, hepatitis B immunisation and access to occupational health services;
- All medical schools and hospitals should actively discourage staff and students from resheathing contaminated needles and recommend that syringes/needles be disposed of intact, directly after use, into an approved container;
- A plentiful supply of approved sharps containers must be provided in all theatres, clinical departments, accident and emergency areas, hospital wards, etc. and emptied regularly;
- Reporting of all sharps injuries must be actively encouraged, regular audits carried out and staff provided with "refresher training"; and
- Injured staff should receive medical advice, counselling and in the case of high risk exposure for HIV, Post Exposure Prophylaxsis should be considered. All healthcare facilities should have policies to deal with any member of staff who may become infected in the course of their work.

The style of staff training and support should be tailored according to its objectives. Large meetings provide a useful format for conveying information about bloodborne pathogens and infection control principles but do not encourage discussion of attitudes and anxieties, especially with multidisciplinary groups. Small meetings, particularly of people working together, should provide a more suitable environment for expressions of uncertainty. Discussions could cover techniques, practices, or previously unspoken concerns about lack of an adequate infection control policy or resources. Posters, such as that in Figure 1, can be effective.

The outcome of staff training and communication needs to be evaluated in terms of the effect on staff knowledge and attitudes but especially on staff behaviour in infection control practices. A hospital "culture" may exist in which reporting of a sharps injury or blood exposure is not encouraged as this would reflect badly both on the individual, who could be seen to be incompetent or making a fuss, and also on the supervisor. This could become particularly noticeable if assessment of a student after an exposure is badly managed, or if a blood sample is required to be taken from a pa-

FIGURE 1

Model principles for handling sharps—a poster for use in all health care settings. (Source: BMA)



tient who may not be agreeable. Reporting of exposures must be encouraged and an effective system of follow-up must be established.

Over the years we have seen that education and guidelines will not in themselves bring about changes in healthcare worker behaviour, but new methods to impart information such as interactive CD-ROM systems or the use of role playing and problem-solving educational techniques should be fully examined. Improved clinical safety and infection control will be dependent on the necessary physical environment and the attitudes of senior staff, who must provide the resources and motivation to manage the use and disposal of sharps more safely in all clinical environments.

The CD-ROM described in this report requires a 486 PC with 12 Mb RAM, Microsoft Windows 3.1 or later (Windows 95 or later and 4XCD drive recommended) and SVGA graphics, minimum 65K colors, with sound card and speakers.

To order, please contact the BMJ Bookshop at BMA House, Tavistock Square, London, UK, WC1H 9JR (Fax: (0)-207-383-6455 or by e-mail at orders@bmjbooks.com). Single user price = £42 or site licence with three CDs at £195 (both require payment of VAT of 17.5%). In addition, one must add 30% to the total cost for postage and handling fees.

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