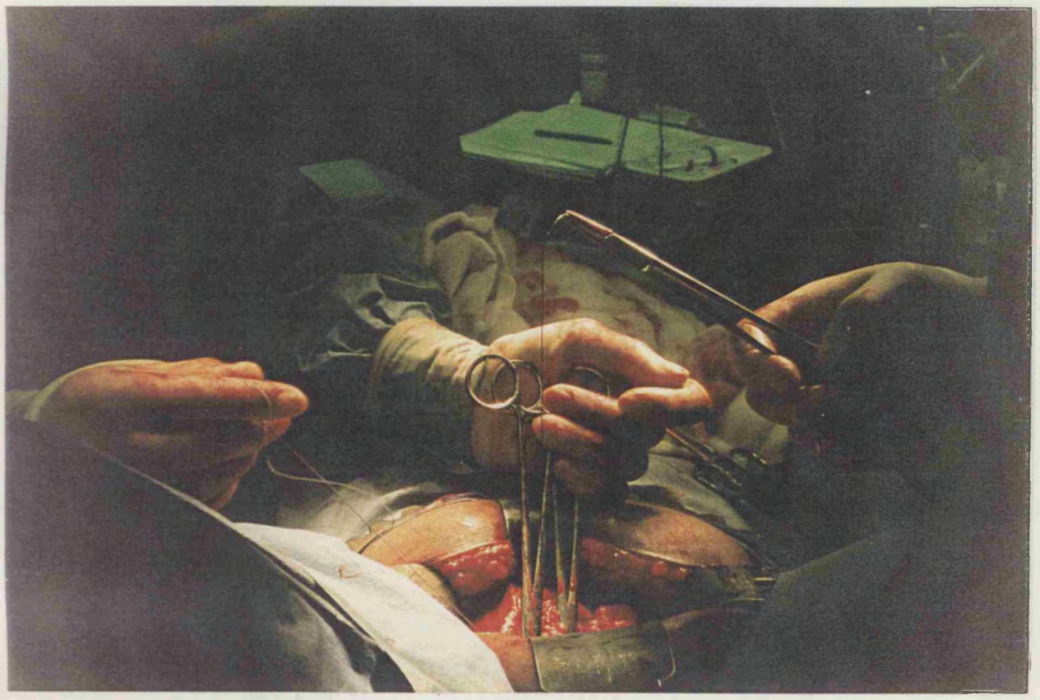

BLOOD EXPOSURES IN SURGICAL PRACTICE: INCIDENCE, REPORTING RATES, CAUSATION AND PREVENTION

A thesis submitted to the University of London for the degree of Doctor of Medicine

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ABSTRACT

Little is known about the detailed circumstances of blood exposure incidents during surgery, but blood borne viruses can be transmitted via this route.

This thesis describes a prospective study of 6096 consecutive surgical operations in a London teaching hospital. The incidence of blood exposures was measured and associated variables were identified.

Blood exposures occurred in 2.4% of operations. The risk was increased with major operations, long operations, and operations in which blood loss was greater than 500mls, the Renal team was operating or a qualified nurse was acting as 'scrub'. New findings were an increased risk when the main surgeon wore prescription glasses and when the wound was closed with staples.

An additional study compared the main study data with two other methods of collecting blood exposure information, and estimated the rate of incident reporting by staff to the occupational health unit. Staff acknowledged the greatest number of blood exposure incidents when reporting retrospectively by confidential postal questionnaire. Only 15% of the sharps exposures recorded on the postal questionnaire had been reported to the occupational health unit using the hospital routine reporting scheme.

The final study compared Public Health Laboratory Service (PHLS) data on operations involved in transmission of hepatitis B virus from surgeon to patients with main study data. Operations in which hepatitis B transmission has been demonstrated were commonly performed operations in the hospital studied, but they did not have a high rate of blood exposure incidents.

This thesis provides data that could be useful to guide efforts to reduce blood exposures during surgery. Several procedures at the study hospital have been revised in light of the findings. Areas that need further investigation include the circumstances in which staples are used, and the issue of performance of older surgeons, which has been debated recently. The results here suggest the possibility that a reduction of visual acuity may be associated with an increase in blood exposure incidents.

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CHAPTER 1 - INTRODUCTION AND LITERATURE REVIEW

Many studies have shown that surgeons and other operating room staff are at high risk of accidental blood exposure. This may be by inoculation injury or by contamination of broken skin or mucous membranes. Other studies have shown that theatre staff are at increased risk of infection from Hepatitis B. There is a need for information on factors that influence the risk of blood exposures so that attempts can be made to reduce it. Several studies have obtained data on factors associated with blood exposure incidents, such as blood loss and duration of operation. But few have looked in detail at the circumstances and mechanism of such incidents.

This study was designed to collect detailed information so that variables related to an increased risk of blood exposures could be identified. As a result of the information collected during the study period, two additional pieces of work have been carried out. Chapter 5 reviews the literature on underreporting of blood exposure incidents and compares three methods for collection of data on exposure incidents. In chapter 6 information from the main study is compared with data from PHLS on operation types in which hepatitis B is known to have been transmitted.

LITERATURE REVIEW

Background

Injury to health care workers by contaminated sharp instruments as a means for transmitting blood borne viruses was first recognised in 1949, when blood bank technicians who sharpened needles from reusable transfusion giving sets developed acute hepatitis (Leibowitz et al. 1949). By 1951 there were 44 cases of serum jaundice in health care workers recorded in the literature (Trumbell and Greiner 1951). In 1973 Rosenberg published the first report convincingly linking an outbreak of serum jaundice amongst surgeons to an infected patient whom they had all operated on (Rosenberg et al. 1973).

Seroprevalence studies

In the 1970s seroprevalence studies in the USA revealed that markers of hepatitis B were higher in health care workers than a population of first time blood donors (Smith et al. 1976, Denes et al. 1978). Further studies in the USA and worldwide throughout the next 3 decades continued to show a high seroprevalence of hepatitis B markers in health care workers, especially surgeons (Carstens et al. 1977, Reingold et al. 1988, Tokars et al. 1992, Thomas et al. 1993, Gerberding 1994, Panlilio et al. 1994, Tait and Tuttle 1994) (table 1.1).

Polakoff used the English national figures of reported cases of hepatitis during 1980 - '84 to estimate the annual incidence of hepatitis B (Polakoff 1986). She compared the annual incidence in the general population of working age (6 per 100,000 men and 2 per 100,000 women) with various groups of health care workers. Again, health care workers had a greater risk than the general population, and surgeons had a very high estimated incidence (25 per 100,000) per year, second only to the laboratory scientific officers (37 per 100,000).

With the advent of an effective vaccine against Hepatitis B and the emergence of HIV and hepatitis C virus as occupational risks, recent seroprevalence studies of health care workers have concentrated on the latter two viruses. In 1992 Tokars surveyed American Orthopaedic surgeons attending an annual conference (Tokars et al. 1992). Among participants, 3420 (47.9%) agreed to be tested anonymously for markers of blood borne virus infections; no cases of HIV infection were found among the 3267 surgeons without non-occupational risk factors. This same study gave information about hepatitis C seroprevalence (Tokars et al. 1992). Anti-HCV was detected in 0.8%. Many more (12%) had serological evidence of hepatitis B infection. In the same year Klein looked at the seroprevalence of hepatitis C among New York City dentists (Klein et al. 1991) and reported it to be 1.75% compared with 0.14% in control volunteer blood donors. The small group of oral surgeons in Klein's study had a seroprevalence of HCV of 9.3% compared with 0.97% for all other dentists. In 13 Hepatitis C antibody seroprevalence studies reviewed, seroprevalence for health care workers ranged from zero in 94 Welsh dentists (Herbert et al. 1992) to 9.3% in the 43 New York oral surgeons (Klein et al. 1991). Where a comparison has been made with the local or national population of blood donors, all but one of the studies show a raised seroprevalence among the health care workers (Thomas et al. 1993, Gerberding 1994, Panlilio et al.1994, Polish et al. 1993, Hofmann and Kunz 1990, Libanore et al. 1992, De Luca et al. 1992, Jochen 1992, Petrarulo et al. 1992, Jadoul 1994, Zuckerman et al. 1994). (Table 1.2).

Transmission after blood exposures

In 1990 Vaglia published the first case of HCV infection after needlestick injury in a surgeon (Vaglia et al. 1990). Since then further cases of HCV seroconversion have been documented (Cariani et al. 1991, Suzuki et al. 1994), including via a blood splash into the conjunctiva (Sartori et al. 1993) and from a human bite (Dusheiko et al. 1990).

Studies have looked at the seroconversion rate following a single percutaneous exposure to HBV, HIV and HCV. The seroconversion rate for a hepatitis B 'e' antigen positive percutaneous exposure without prophylactic hyperimmune globulin is about 20-30% (Grady et al. 1978, Werner and Grady 1982) among non-immune recipients.

The UK (PHLS October 1993) and USA (Tokars et al. 1993) have well established national surveillance schemes for significant workplace exposure to HIV. And several countries worldwide have reported results from local (Cavalcante et al. 1991, Bowden et al. 1993, Mallon et al. 1992) and multicentre (Ippolito et al. 1993) prospective surveillance studies. Heptonstall summarised published reports of long term follow-up of HIV positive exposures (Heptonstall et al. 1995). The estimated HIV transmission rate after a single percutaneous exposure is 21 in 6498 (0.32%, 95% CI 0.18%-0.46%) compared with 1 in 2885 (0.03%, 95% CI 0.006%-0.18%) after a single mucocutaneous exposure.

There are 3 prospective studies of recipients of Hepatitis C positive percutaneous injuries in the literature. In 1991 Kiyosawa followed up 110 Japanese health care workers and 3 (3%) seroconverted to anti-HCV (Kiyosawa et al. 1991). In 1992 Hernandez followed up 81 Spanish Health care workers, none of whom seroconverted (Hernandez et al. 1992). In 1992 Mitsui reported 7 (10%) seroconversions from 68 percutaneous injuries (Mitsui et al. 1992). Unlike the 2 previous studies recipient blood was tested for HCV RNA as well as anti-HCV. This higher figure may be a more accurate estimate of the true seroconversion rate since HCV RNA is a more sensitive indicator of HCV infection than anti-HCV.

Transmission of blood borne viruses from infected health care workers to patients

There is also concern about the risk of transmission of blood borne viruses in the opposite direction, from health care worker to patient. For transmission to occur in the operating theatre, the likely route would be via a sharp instrument which had injured the health care worker and was then reintroduced into the patient's open tissues. Circumstances may also occur where the health care worker bleeds directly from their injury into the open wound. There have been several epidemics of hepatitis B among patients of hepatitis B 'e' antigen positive surgeons and these are discussed in chapter 6. To date, there is only one HIV positive health care worker known to have transmitted the virus to patients in the occupational setting. In 1990 the USA Centers for Disease Control (CDC) reported a case of HIV in a patient of a Florida dentist (CDC 1990). Subsequent investigations showed that 5 other patients had been infected and this was confirmed by DNA sequencing (CDC January 1991, CDC ? month 1991, CDC 1993). In 1992 the CDC set up a database collecting information from investigations of patients treated by HIV infected health care workers (Robert et al. 1995). The first investigations began in 1987. By January 1995, 22171 patients of 51 HIV positive health care workers had been tested. 113 HIV positive patients were identified however there was no evidence of transmission based on epidemiological investigations and genetic sequence analysis.

Several authors have attempted to produce models of transmission risk. Lowenfels estimated that for an HIV positive surgeon there would be one chance of transmitting to a patient in 83000 hours of operating (Lowenfels and Wormser 1991). Bell estimated that the probability of transmission to at least one patient during 3500 procedures was 0.81-8.1 (Bell et al. 1992). Owens looked at the cost-effectiveness of a policy to screen surgeons for HIV in the USA (Owens et al. 1995). He concluded that the cost per year of life saved would be considerably in excess of those of most accepted health interventions. In the UK we now have a screening programme for hepatitis B, with 'e' antigen positive surgeons banned from performing invasive surgical procedures (UK Health Departments August 1993, NHS Management Executive August 1993). In the UK, surgeons are not required to be screened for HIV. But surgeons who believe they may be infected with HIV must seek expert medical advice and testing, and if confirmed HIV positive they must cease undertaking exposure prone procedures (UK Health Departments March 1994, GMC October 1995).

The first case of transmission of hepatitis C from a surgeon to a patient was reported in 1995 (PHLS June 1995). We do not yet have the results of the lookback exercise, and there are as yet no published guidelines for the management of hepatitis C positive surgeons.

Blood exposure incident rates

The AIDS era has seen an increasing interest in blood exposure rates in different occupational groups within the health care setting. Several prospective studies show that risk of injury is highest in surgeons. This is supported by the earlier findings of HBV seroprevalence studies. The next step is to identify variables related to risk of exposure in the operating room. Several prospective studies have attempted to address this question but few have reported on whether the information has been used to advise on methods of reducing exposure.

Studies of incidence of accidental blood exposures

There are several large, prospective studies in the literature that have attempted to measure the incidence of accidental blood exposures in surgical practice (Tokars et al. 1992, Quebbeman et al. 1991, Panlilio et al. 1991, Gerberding et al. 1990, Popejoy and Fry 1991, Hussain et al. 1988, McNicholas et al. 1989. Camilleri et al. 1991, Leentvaar-Kuijpers et al.1990, White and Lynch 1993, Wright et al. 1993, Wright et al. 1991, Antona et al. 1994) (table 1.3). They vary in design, definitions of exposure and method of data collection. For sharps exposure, reported rates varied from 1.3% (Gerberding et al. 1990 through 6.9% (Tokars et al. 1992) to 15.0% (Quebbeman et al. 1991). In this final study the operations included were not selected randomly and could have been biased towards the more exposure-prone procedures.

Tokars (Tokars et al. 1992), Quebbeman (Quebbeman et al. 1991) and Panlilio (Panlilio et al. 1991) used trained, dedicated observers (infection control practitioners, operating room nurses, and nurses/operating room technicians respectively). Gerberding (Gerberding et al. 1990) and Popejoy (Popejoy and Fry 1991) used the circulating nurses who also had responsibility for the non-sterile peri-operative care of the patient. Hussain (Hussain et al. 1988) and McNicholas (McNicholas et al. 1989) used the surgeons participating in their study to record exposures both of themselves and their assistants. Camilleri (Camilleri et al. 1991) and Leentvaar-Kuijpers (Leentvaar-Kuijpers et al. 1990) relied on the individual injured staff member to record the incident.

The sample of operations studied varied in size but also in population of operations identified for study. Gerberding (Gerberding et al. 1990), Popejoy (Popejoy and Fry 1991), McNicholas (McNicholas et al. 1989) and Leentvaar-Kuijpers (Leentvaar-Kuijpers et al. 1990) included all operations carried out at their respective hospitals over a fixed period. Hussain (Hussain et al. 1988) included consecutive operations by participating surgeons over a fixed period, and Camilleri (Camilleri et al. 1991) included all operations performed in one operating room. Tokars (Tokars et al. 1992) chose 5 surgical specialties, and designated a different specialty for observation each day. In Panlilio's study (Panlilio et al. 1991), each observer monitored complete procedures from 8am until 4pm, Monday to Friday, in six surgical specialties. Monitoring of weekend, evening and nightshifts depended on availability of observers. In Quebbeman's study (Quebbeman et al. 1991) the observers chose the operations to be observed. Minor procedures such as endoscopy, CVP line insertion and dressing changes were not included.

The studies varied in the surgical specialties and personnel included (table 1.4). Gerberding (Gerberding et al. 1990) included all specialties and all operating room personnel whereas Hussain (Hussain et al. 1988) restricted the study to 3 specialties and surgeons only. There was also variation in the definition of blood exposure incidents. In Quebbeman's study (Quebbeman et al. 1991) the observers documented needlesticks, blood splashes and glove tears during the operation, and then assisted each person in removing their gown and gloves. These were closely inspected for contamination as were the underlying non-sterile theatre suits, foot and ankle wear and all exposed areas of skin. This contrasts with Panlilio's study (Panlilio et al. 1991) where intraoperative soakage was recorded if skin contact was 'deemed likely' by the observer. There was no subsequent detailed examination of operators and their clothing. The definition of 'percutaneous events' ranged from 'accidental injury' with no further explanation (Hussain et al. 1988) to 'sufferer able to express own blood' (Camilleri et al. 1991).

Some investigators have used glove perforations as a more objective measure of blood contact, and some have looked at the protective effect of double gloving (Chiu et al. 1993, Wong and Magee 1992, Rose et al. 1994, Fell et al. 1989, Camilleri et al. 1991, Brough et al. 1988, Greco et al. 1993, Dodds et al. 1988, Wilson et al. 1996, Quebbeman et al. 1992, Doyle et al. 1991, Matta et al. 1988). In the 7 studies reviewed in table 1.5, the percentage of single glove sets or outer glove of double sets with one or more perforations varies between 21% (Matta et al. 1988) and 51% (Quebbeman et al. 1992). Where 2 sets were worn only 4% (Doyle et al. 1991, Matta et al. 1988) to 7% (Quebbeman et al. 1992) of the inner glove sets were perforated. It is unlikely that all the perforations caused by a sharp instrument went on to penetrate the skin. However wearing 2 sets of gloves does appear to reduce direct contact of blood with skin. Interestingly, in the 3 studies which asked surgeons about their experience of glove perforations during the operations studied, only 27% (Brough et al. 1988), 47% (Greco et al. 1993) and 51% (Matta et al. 1988) were detected by the wearer.

3 studies have looked at the incidence of blood splashes on the spectacles of surgeons. In orthopaedic (Porteous 1990), otolaryngological (Hinton et al. 1991) and general

surgery (Brearley and Buist 1989) the incidence was 29%, 32% and 25% respectively. The surgeon was aware of the splash incident in only 5% of the general surgical operations and 3% of the otolaryngological cases.

Some retrospective studies of incidence have been reported (Tokars et al. 1992, Williams et al. 1993, Lowenfels et al. 1989, Vergilio et al. 1993, Adegboye et al. 1994, Jagger et al. 1994, Kaspar and Wagner 1991). These rely on recall and are less easy to compare because the studies vary in the number of months for which the individual is asked to recall incidents. In the 4 studies shown in table 1.6, (Tokars et al. 1992, Williams et al. 1993, Lowenfels et al. 1989, Vergilio et al. 1993) recall time varied from 1 (Tokars et al. 1992, Williams et al. 1993) to 12 months (Lowenfels et al. 1989). 15% (Williams et al. 1983) and 39% (Tokars et al. 1992) of surgeons recalled at least one percutaneous injury during the previous month compared with 86% (Lowenfels et al. 1989) during the preceding 12 months.

It is difficult to establish the true incidence of blood exposures in operating theatres. Health care workers in general have been shown to under-report (Astbury and Baxter 1990, Mangione et al. 1991). In a UK survey of theatre staff only 15% of sharps exposures recalled had been reported to the occupational health unit, and none of 240 non-sharps exposures (Williams et al. 1993) (see chapter 5). In prospective observational studies of surgical staff, exposures may go unrecognised by the observer or the surgeon (Brough et al. 1988, Brearley and Buist 1989). There may a reluctance to acknowledge or report an exposure and, in retrospective studies, recall may be poor or biased towards certain types of incidents. It is likely that most retrospective studies and some prospective studies underestimate the true blood exposure rate.

Variables associated with accidental blood exposures

In the last 5 years approximately 20 studies worldwide have attempted to identify variables associated with blood exposure incidents. Over half of these studies have come from the USA. The variables examined differ between studies. There is great disparity in surgical specialties included for study. Also, as with the studies of incidence mentioned previously, the methods of data collection and definitions differ, making direct comparison between the studies difficult.

The majority of studies have carried out some form of univariate statistical analysis of their data, but only 4 authors have gone on to a multivariate analysis (Tokars et al. 1992, Quebbeman et al. 1991, Panlilio et al. 1991, Gerberding et al. 1990, Quebbeman et al. 1992) (Table 1.7). The 2 significant associations with accidental blood exposures most frequently reported after multivariate analysis are long duration of operation (Tokars et al. 1992, Quebbeman et al. 1991, Panlilio et al. 1991, Gerberding et al. 1990, Quebbeman et al. 1992) and high blood loss (Quebbeman et al. 1991, Panlilio et al. 1991, Gerberding et al. 1990).

Univariate analysis from a number of studies has identified certain specialties or operation types such as general surgery and gynaecology, cardiothoracic, vascular, trauma, burns and orthopaedic surgery, vaginal hysterectomy and Caesarean section as having a high rate of blood exposures. However, the studies that carried out multivariate analysis reported only vascular and intra-abdominal gynaecological surgery (Gerberding et al. 1990) and vaginal hysterectomy (Tokars et al. 1992) as having significant association with blood exposures. Gerberding (Gerberding et al. 1990) reclassified operations into major and minor; major operations carried a significantly higher risk for a sharps injury in multivariate analysis.

Some studies looked at job rank or years of experience as a variable affecting a person's risk of injury (Tokars et al. 1992, Quebbeman et al. 1991, Popejoy and Fry 1991, Hussain et al. 1988, Camilleri et al. 1991, Brough et al. 1988, Greco et al. 1993, Dodds et al. 1988, Doyle et al. 1991, Chapman and Duff 1993). While some ranked surgical personnel by professional seniority or years of training, others used position at the operating table, i.e. main surgeon or first/second assistant. Of the studies that looked for a difference by univariate analysis, the majority identified the main surgeon as having significantly more incidents than their assistant and the scrub nurse. Some of these found no difference in rates between assistants and scrub nurse for sharps. Only two authors entered this data into multivariate analysis as the majority based their calculations on surgeons' exposures alone. One found resident surgeons with at least 4 years training to be at significantly greater risk (Tokars et al. 1992). One author looked at the number of operating personnel present and found an increasing number to be significantly associated with increased risk of blood exposure (Quebbeman et al. 1991) (table 1.7).

Area of body contaminated.

Several authors documented the area of the body injured by a sharps (Tokars et al. 1992, Quebbeman et al. 1991, Hussain et al. 1988, Greco et al. 1993, Dodds et al.

1988, Chapman and Duff 1993, Richmond et al. 1992, Robert et al. 1994, Kjaergard et al. 1992). All recorded more injuries to the non-dominant hand and, where more detail was collected, to the index finger of that hand.

Instrument responsible for contamination

Six prospective studies collected information on the surgical instrument responsible for sharps exposures (Tokars et al.1992, Quebbeman et al. 1991, Panlilio et al. 1991, Gerberding et al. 1990, Hussain et al. 1988, McNicholas et al. 1989) (table 1.8), and 2 documented the activity being carried out when the exposure occurred (Tokars et al. 1992, Quebbeman et al. 1991) (Table 1.9). No denominator information is available for these variables so absolute numbers and percentages of total sharps exposures, rather than rates, are discussed.

Not surprisingly the suture needle was responsible for most sharps exposures in all 6 studies, accounting for between 50% (Panlilio et al. 1991) and 95% (Hussain et al. 1988). Scalpel blades made up the next largest group with a range from 3% (Tokars et al. 1992) to 10% (Panlilio et al. 1991). Five of the six studies each reported one exposure involving a spicule of bone. This accounted for 1% (Tokars et al.1992) to 10% (Panlilio et al. 1991) of exposures. Two studies reported that diathermy burns accounted for 1% (Hussain et al. 1988) and 20% (McNicholas et al. 1989) of exposures. The remaining exposures resulted from a wide variety of instruments that were responsible for very low numbers of exposures in only one or two studies.

The two studies that documented the activity during which exposure occurred were difficult to compare because of differences in descriptive categories of activity (Tokars et al. 1992, Quebbeman et al. 1991). By combining certain activities it has been possible to produce five categories for comparison. Table 1.9 shows that manipulation of the suture needle was the activity most commonly associated with sharps injuries.

Exposure reduction

Universal Precautions

In 1987, the USA Centers for Disease Control established guidelines known as universal blood and body fluid precautions (UPs) (CDC 1987). These recommend precautions for blood and body fluids which assume that all patients could be infectious. So rather than making judgements about a patient's risk, the practice of UPs means making an assessment of the procedure to be carried out on that patient. The precautions taken depend on the likelihood of blood exposure during the particular procedure to be undertaken. The arguments for and against Universal Precautions are well rehearsed (CDC 1991, Kelen et al. 1988, Kristensen et al. 1990, Klein 1990, Johnson et al. 1989, Sim 1991, Closs and Tierney 1991, Shanson and Cockcroft 1991). Certainly Universal Precautions can go some way towards reducing blood exposures. But they are not enough on their own. There is evidence that intensive and on-going training of staff is necessary to ensure that they comply with the practice of Universal Precautions (Fahey et al. 1991, Haiduven et al. 1992, Courington et al. 1991, Sellick et al. 1991, Naccache et al. 1993). Some authors have argued a case for pre-operative testing to identify patients infected with blood borne viruses such as HIV (Hughes and Bailey 1993, Joint Working Party of the hospital infection society and the surgical infection study group 1992). And some surgeons have been shown to favour this approach (Roxburgh et al. 1992, Shelley and Howard 1992). But there is evidence that identification of virus carriers is more costly than UPs (Lawrence et al. 1993), and does not help prevent blood exposures. Gerberding (Gerberding et al. 1990) showed that a surgeon's knowledge or assumption of a patient's HIV or HBV status did not affect the surgeons' incidence of blood exposures in a hospital where universal precautions were being practised. This applied to all exposures and to sharps exposures specifically. This is a powerful argument for universal precautions rather than universal testing. But it is important to recognise that the situation in San Francisco where Gerberding carried out her study is likely to be different from many other hospitals; the hospital population in San Francisco has a high prevalence of HIV, and great attention has been paid to safe surgical practices for many years. This includes a policy of UPs. In hospitals with a low prevalence of HIV among patients and where UPs are not practised, it may be that less care is taken to protect the operating team against blood exposures. In these situations there may be more blood exposure incidents, reduced when extra care is taken with known HIV positive patients. Conversely, by attempting to take extra care, the surgeon may choose less familiar practices which could actually lead to an increase in blood exposures. In 1990 the Royal College of Surgeons of England published a statement in which they were against routine patient testing although they did not actually support a policy of Universal Precautions (The Royal College of Surgeons of England 1990).

Equipment and procedures

While universal precautions may reduce blood exposures, they do not eliminate the risk entirely. Other areas that need to be looked at are the design and use of operating instruments and protective equipment. Manufacturers are looking at the whole question of protective clothing. Several have developed gloves from cut resistant synthetic materials. There are some problems with these. They do not prevent needle punctures and most are cumbersome to wear (Fisher 1992). Others have developed a system of double gloving with a green coloured inner glove (Wigmore 1994). When the outer glove is punctured it adheres to the inner glove by the capillary action of the fluid introduced and becomes dark green. The surgeon on noticing this can then change the outer glove. Most of the studies on double gloving indicate that two pairs of gloves provide protection against inner glove puncture (Wilson et al. 1996, Quebbeman et al. 1992, Doyle et al. 1991, Matta et al. 1988). Resistance to double gloving is mainly based on concerns about impaired comfort, sensitivity and manual dexterity (Wilson et al. 1996). Interestingly Quebbeman (Quebbeman et al. 1992) showed that there was a significant difference in the contamination rates between surgeons who cooperated with his study and those who did not. Surgeons who insisted on wearing single gloves when randomised to double gloves had significantly higher contamination rates than surgeons who were randomised to wear single gloves. One possible explanation is that the unco-operative surgeons may be less likely to co-operate with other practices designed to increase intra-operative safety. Another explanation could be that the operations in which the surgeons are unhappy to wear double gloves require a high level of manual dexterity for instrument manipulation and so sharps exposures are more likely. Or it may be that these particular surgeons use their fingers more often for dissection and needle manipulation, so that they tolerate double gloves less well, and have an increased risk of sharps injury.

There are also several different types of surgical gown on the market. In laboratory testing they were shown to have varying resistance to blood strike-through with only impervious plastic reinforcement offering complete protection (Smith and Nichols 1991). The problem with impervious gowns is that they can be uncomfortable to wear for long periods because they make the wearer feel hot and perspire.

The need for surgical face masks to protect patients has been questioned (Tunevall 1991, Leyland and McCloy 1993), since Tunevall showed no significant difference in post-operative wound infection between procedures where the surgeon wore a mask compared with those where s/he did not. However the mask protects the mucous membranes of the nose and mouth of the surgeon against blood splashes and so acts as barrier protection against transmission of infection from patient to surgeon.

Visors have been designed to protect the mucous membranes of the eyes as well as the nose and mouth. Because of problems with restricted view and condensation these are still often reserved for perceived "high risk" patients (Caruana-Dingli et al. 1994). This, of course, is illogical as the restricted view and condensation may increase the risk of sharps injuries.

Urologists have been shown to be at risk of splashes and soaks from contaminated irrigation fluid during endoscopic examination of the urinary tract. McNicholas and Kapoor suggest the use of video equipment during endoscopic surgery so that the surgeon can distance himself from the perineum (McNicholas et al. 1989, Kapoor et al. 1993).

Suture needles are the most frequent instrument involved in sharps injuries (table 1.8).

Several authors have looked at their design and the way in which they are handled. In a randomised study of blunt tipped versus sharp tipped needles Stafford found a significant reduction in glove puncture rate with blunt tipped needles (Stafford et al. 1994). And both Montz and Davis found that blunt tipped needles were on the whole acceptable to surgeons (Montz et al. 1991, Davis 1994). Several authors have called for the development of safer needle devices (Davis 1994, Haiduven and Allo 1994). Kranendonk evaluated a one-handed suturing device and found a significant reduction in both glove perforations and percutaneous injuries (Kranendonk 1994). Ho (Ho 1992) advocates clamping the suture not the needle, so that the needle does not form part of a solid resistance, and Porteous (Porteous 1990) advocates the 'no touch technique'. Other suggestions include a protector for the most vulnerable site for surgical sharps injuries - the non-dominant index finger (Beck 1992).

To summarise, it is well documented that surgeons have a high risk of blood exposure, a relatively high seroprevalence for markers of previous hepatitis B infection, and from time to time surgeons who are carriers of hepatitis B transmit to their patients. Studies of blood exposure in operating theatres vary widely in their design, methods of data collection, definitions of exposures, and specialties and personnel included. Yet exposure incidence reported by various authors is roughly similar. This suggests that these results reflect the correct order of magnitude for proportion of operations with any blood exposure incident and the subpopulation of operations with a sharps exposure. Perhaps Gerberding's study from San Francisco is of greatest interest (Gerberding et a. 1990). This hospital has many HIV patients so surgeons were aware of the importance of extreme care when operating, and universal precautions were instituted and practised. Yet despite these features the circulating nurses recorded a percutaneous injury rate of 1.3%. This was lower than in many studies. But the rate was no lower for patients known to be 'high risk' for HIV or HBV. There remains a need to identify circumstances related to individual exposures so that surgeons can be helped to reduce injury rates further. Factors such as duration and complexity of operation have been linked to an increased risk of blood exposure. Protective clothing and operative procedures are being reassessed with the operator as well as the patient in mind. And in some operating theatres Universal Precautions are being introduced. This study looks more closely at intraoperative factors that may be linked to an increased risk of blood exposure, with the aim of identifying factors that may be amenable to change.

Table 1.1 Hepatitis B seroprevalence studies

AUTHOR		OCCUPATIONAL GROUP	NUMBER TESTED	% STAFF Anti-HBc or Anti-HBsAg +ve	% BLOOD DONORS Anti-HBc +ve	COUNTRY OF ORIGIN OF STUDY PARTICIPANTS AND BLOOD DONORS
Smith	1976	Surgeons Physicians	49 250	22.4 13.6	4.4	USA
Carstens	1977	Anaesthetists (87% white)	95	17.9	5.3 (Whites)	South Africa
Denes	1978	Surgeons All medical staff	 1192	28.0 18.5	3.5	USA
Reingold	1988	Oral Surgeons	434	26.0	Not stated	USA
Tokars	1992	Orthopaedic Surgeons	3420	12.0	Not stated	USA
Thomas	1993	HCWs	943	6.2	1.8	USA
Gerberding	1994	HCW Surgeons only	460 25	21.7 28.0	Not stated	USA *
Panlilio	1994	Surgeons	770	17.0	Not stated	USA
Tait	1994	Anaesthetists	61	16.7	Not stated	USA **

* Dynamic cohort study 1984-1992. Only non-vaccinated staff included in serum survey
** Postal questionnaire asked for hepatitis B status prior to Immunisation

Table 1.2 Hepatitis C seroprevalence studies

AUTHOR	OCCUPATIONAL GROUP	NUMBER TESTED	% STAFF HCV Antibody +ve	% BLOOD DONORS HCV Antibody +ve	COUNTRY OF ORIGIN OF STUDY PARTICIPANTS AND BLOOD DONORS
Polish 1993*	HCWs	1677	1.4	Not stated	USA
Hofman 1990	HCWs	294	2.0	0.7	Austria
Klein 1991	All Dentists Oral Surgeons	456	1.75 9.3	0.14	USA
Libanore 1992	HCWs	1008	4.1	0.95	Italy
De Luca 1992	HCWs	945	4.8	1.1**	Italy
Jochen 1992	HCWs	1033	0.58	0.24	Germany
Petrarulo 1992	HCWs (Renal dialysis)	122	2.45	Not stated	Italy
Herbert 1992	Dentists	94	0.0	0.3	Wales
Thomas 1993	HCWs	943	6.2	0.4	USA
Gerberding 1994	HCWs	851	1.4	0.5	USA
Panlilio 1994	Surgeons	770	0.9	Not stated	USA
Jadoul 1994	Nurses, Haemodialysis	120	4.1	0.6	Belgium
Zuckerman 1994	HCWs	1053	0.28	0.07	UK

* Retrospective testing of serum samples obtained during a pre-hepatitis B vaccination programme in 1983
** HCV seroprevalence in a control population of 576 factory workers was 10%

Table 1.3 Summary of prospective studies of blood exposure incidence in operating theatres.

FIRST AUTHOR & DATE OF PUBLICATION	ARRANGEMENTS FOR DATA COLLECTION	NUMBER OF OPERATIONS STUDIED	% OF OPERATIONS WITH ANY BLOOD EXPOSURE	% OF OPERATIONS WITH A SHARPS EXPOSURE
TOKARS 1992	Trained observers	1382	-	6.9%
QUEBBEMAN 1991	Trained observers	234	50%	15.0%
PANLILIO 1991	Trained observers	206	30.1%	4.9%*
GERBERDING 1990	Circulating nurses	1307	6.4%	1.3%
POPEJOY 1991	Circulating nurses	684	28%	3.0%
HUSSAIN 1988	Surgeon	2016	-	5.6%
McNICHOLAS 1989	Surgeon	427	32%	3.5%* (12.1%#)
CAMILLERI 1991	Injured individual	?	-	4.6%
LEENTVAAR-KUIJPERS 1990	Injured individual	3101	-	1.4%*

* Assumption made that each incident occurred in separate procedure
# Percentage when 304 endoscopic procedures are excluded.

TABLE 1.4 Prospective studies of blood exposure in operating theatres; Specialties and personnel included.

FIRST AUTHOR & DATE OF PUBLICATION	SPECIALTIES	OPERATING ROOM PERSONNEL
TOKARS 1992	General surgery (abdominal), Orthopaedics, Trauma, Gynae, Burns, Plastics.	All operating room personnel
QUEBBEMAN 1992	General surgery, Orthopaedics, Trauma, Gynae, Cardiothoracic, Neuro, Transplant, Vascular.	All operating room personnel
PANLILIO 1991	General surgery, Orthopaedics, Trauma, Gynae, Burns, Plastics.	All operating room personnel
GERBERDING 1990	All specialties.	All operating room personnel
POPEJOY 1991	All specialties	All operating room personnel
HUSSAIN 1988	General surgery, Orthopaedics, Urology.	Surgeon and assistant
McNICHOLAS 1989	Urology.	Surgeon and assistant
CAMILLERI 1991	General surgery.	Surgeons and scrub nurse
LEENTVAAR-KUIJPERS 1990	All specialties.	All operating room personnel

Table 1.5 Prospective studies of surgical glove perforation

FIRST AUTHOR & DATE OF PUBLICATION	SETS OF GLOVES EXAMINED	NUMBER (%) OF SETS WITH PERFORATION	NUMBER (%) OF PERFORATIONS DETECTED BY WEARER
CAMILLERI 1991	581 single sets	134 (23%)	-
BROUGH 1988	339 single sets	127 (38%)	34 (27%)
GRECO 1993	100 single sets	32 (32%)	15 (47%)
DODDS 1988*	291 single sets	74 (25%)	-
QUEBBEMAN 1992	154 single sets 130 double sets	78 (51%) 9 (7% inner set)	-
DOYLE 1992	68 single sets 79 double sets	24 (35%) 3 (4% inner set)	-
MATTA 1988	364 double sets	77 (21% outer set) 15 (4% inner set)	38 (51%)

* Assumption made that 582 gloves represent 291 sets, and that no set had more than one perforation.

Table 1.6 Summary of retrospective studies of sharps injury in surgical staff.

FIRST AUTHOR & DATE OF PUBLICATION	POPULATION OF RESPONDENTS	RECALL PERIOD	% RECALLING ONE OR MORE SHARPS INJURIES
LOWENFELS 1991	202 New York surgeons	12 months	86%
TOKARS 1992	3420 US Orthopaedic surgeons	1 month	39%
VERGILIO 1993	97 US students completing surgical clerkship	3 months	33%
WILLIAMS 1993	UK operating dept. staff All staff (119) Surgeons (55)*	1 month	 12% 15%*

* Calculated from original data

Table 1.7 Studies which have identified variables independently associated with an increase in blood exposure incidents by multivariate logistic regression (significance level 0.05).

FIRST AUTHOR & DATE OF PUBLICATION	SPECIALTY OR OPERATION TYPE	LENGTH OF OP.	BLOOD LOSS	PERSONNEL	OTHER VARIABLES
TOKARS 1992 (sharps only)	√ (Vaginal hysterectomy)	√	ni	√ (Resident surgeon with at least 4 years training)	√ (Day shift) √ (Medium and high risk operations) √ (Fingers holding tissue to be sutured for more than 33% of suturing)
GERBERDING 1990	√ (Vascular and Intra-abdominal Gynae)	√	√	ni	ni
(sharps only)	√ (Major and vasc. surgery)	ni	ni	ni	ni
PANLILIO 1991	ni	√	√	ni	√ (Emergency in service with higher risk of blood contact ie. trauma, burns, ortho)
QUEBBEMAN 1991 (glove punctures only)	ni	√	√	√ (Number of personnel)	ni
QUEBBEMAN 1992	✷	√	✷	ni	ni

√ = Variable significant
✷ = Variable included in regression model but not significant at the 5% level.
ni =Variable not included in regression model

Table 1.8 Studies which have identified instruments responsible for sharps injuries.

INSTRUMENT	TOKARS	GERBERDING	PANLILIO	QUEBBEMAN	HUSSAIN	McNICHOLAS
SUTURE NEEDLE	76 (77)	10 (58)	5 (50)	29 (81)	107 (95)	10 (67)
HOLLOW NEEDLE	-	1 (6)	-	2 (6)	*	*
SCALPEL	3 (3)	1 (6)	1 (10)	1 (3)	4 (4)	-
DIATHERMY	-	-	-	-	1 (1)	3 (20)
BONE SPICULE	1 (1)	1 (6)	1 (10)	1 (3)	-	1 (7)
RETRACTOR	1 (1)	-	-	-	-	1 (7)
GLASS AMPOULE	_	-	-	1 (3)	-	-
WIRE	3 (3)	-	-	1 (3)	-	-
BOVIE INSTRUMENT	3 (3)	-	1 (10)	-	-	-
SUTURE THREAD	2 (2)	-	-	-	-	-
BONE HOOK, ORTHOPAEDIC PIN, CANULA, STAPLE GUN, TROCAR, SCISSORS	6 (6) (1 of each)	-	-	-	-	
UNKNOWN	4 (4)	4 (24)	2 (20)	1 (3)	-	-
TOTAL	99 (100)	17 (100)	10 (100)	36 (100)	112 (100)	15 (100)

* Hollow needles were not identified separately from suture needles.

TABLE 1.9 Comparison of studies where activities being carried out at the time of a sharps incident were recorded in detail.

ACTIVITY	QUEBBERMAN 1991	TOKARS 1992	STUDY
Suturing	15 (41)	26 (26)	22 (21)#
Loading/unloading needle holder	5 (14)	5 (5)	1 (1)
Passing suture/sharp instrument	6 (16)	6 (6)	17 (16)
Dissecting tissues	1 (3)	5 (5)	16 (15)
Holding tissue being sutured*	-	35 (35)	-
Miscellaneous or missing	10 (27)	22 (22)	51 (48)
TOTAL	37 (100)	99 (100)	107 (100)

* This activity was not identified by the other 2 authors.

\# Combines three activities from table 11; suturing, closing muscle and subcutaneous layer and closing skin.

CHAPTER 2 - MAIN STUDY METHODS

Study design

This was a prospective observational study of all procedures carried out over a 6 month period in a London teaching hospital.

Study area

The study area comprised all 12 theatres within the main operating department of the hospital. All major surgical specialties were represented plus renal and liver transplantation. Cardiac surgery was not performed. For each operative procedure during the study period, blood exposures were recorded from when the patient entered the anaesthetic induction room until the patient left the operating theatre. The operating department averaged 1000 operations per month. Universal precautions were under discussion but had not been introduced into the operating department at the time of data collection.

Data collection

Information was collected prospectively on 6096 consecutive operations occurring during the 6 month period from June to November 1991. On the basis of published work, combined with the results of the pilot study, an initial study period of 3 months was chosen. This was expected to produce information on approximately 360 blood exposure incidents. In practice only 90 incidents were recorded during the first 3 months so the data collection was continued for a further 3 months. The study was not extended beyond 6 months. There were two reasons for this. The theatre nurses were reluctant to continue with the data collection. Secondly the monthly incident rate was dropping off which was interpreted as a reflection of their decreased enthusiasm.

The data collection instrument was a questionnaire in two parts. The top sheet recorded denominator information on every operation performed (annex 1). This included whether the operation was routine or emergency; the duration of the operation and the time the list started; the name of the operation and the surgical specialty of the operating team; the seniority of the main operator, anaesthetist and scrub nurse; types of protective equipment worn; amount of blood loss; and whether blunt needles were used to close fat, or staples to close the wound. The final question asked whether a blood exposure incident had occurred. Where this was the case, further details were recorded on the second sheet (annex 2). These included the type of incident (eg. glove perforation with or without skin penetration), exposed person, type of sharp instrument involved, part of body contaminated, whether the contaminated areas had pre-existing intact skin, the time of the incident and the activity during which the exposure occurred.

For operations between 8am and 6pm the theatre receptionist was responsible for attaching the proforma to the patient's notes as they entered the operating department. Between 6pm and 8am the staff of the individual operating theatre were responsible for attaching the proforma. After each procedure the scrub nurse was responsible for ensuring that the proforma was completed.

Pilot study

This took place over a one week period in May 1991. The total incident rate was 6% with one third of these due to sharps. Feedback from operating department staff resulted in modifications to the questionnaire.

Recruitment and encouragement

The study design was presented to the hospital Surgical Specialty group, and discussed with the theatre manager. A training session on proforma completion was held for the theatre nurses. An explanatory letter was sent to all members of the operating teams (annex 3). A similar letter was sent to all new surgical staff on the 1st of August (annex 4). Preliminary analysis during the third month of the study suggested that the reporting rate of incidents had halved when compared with the pilot study. The theatre nurses were canvassed on an extension of three months. They agreed, so the study period was extended to 6 months. A further letter was sent to all involved just before completion of the first 3 month data collection period (annex 5). This gave preliminary results on incidence, and explained that the study would be extended for a further 3 months. Posters and relevant newspaper cuttings were displayed throughout the operating department at regular intervals during the study (annex 6). The investigator visited the operating department every weekday morning to collect the previous days' proformas and to discuss any problems.

Incomplete data

In general the proformas were well completed. The researcher retrieved some missing data from the computer return that accompanied every patient into the operating room. This duplicated some of the proforma information (date and name of operation, time in and out of theatre, routine or emergency). The computer return also contained the names of the main operator, main anaesthetist and scrub nurse. From this information their grade could be recorded. The most incomplete category was 'blood loss' where data was missing for 20% of operations. To carry out multivariate analysis the proportion with data on blood loss needed to be increased. A blood loss figure was derived for operations where this was not recorded, by using the value from other cases of the same operation where blood loss *was* recorded. For intermediate and major operations where all recorded blood loss was in one category, and at least 10 operations were coded, this category was used to replace the missing data. As no minor operations had a recorded blood loss greater than 500mls, all minor operations with missing blood loss data were categorised as 'less than 500 mls'. This increased the completed data by only 2.5%. In the multivariate analysis, in order to retain the remaining cases with missing blood loss data which would otherwise be excluded, covariate adjustment was used.

Denominator data (annex 1)

Operation codes

Each named operation was coded by a member of the hospital coding department, using the OPCS system (OPCS Classification of Operations and Surgical

Procedures 1990). Where multiple procedures were carried out simultaneously, the 'main' operation was coded. This decision was made by the coder and/or author. Where doubt arose the relevant surgical specialty was consulted by the author. Two variables were then derived. The first is an 'operation group' based on the first letter of the code. Each letter relates to a system (eg. nervous system) or part of the body (eg. heart). The second derived variable classified the operations into major, intermediate or minor using the BUPA Schedule of Procedures 1993. This system is based on the OPCS codes and considers skill, complexity and duration of operation (BUPA head office, personal communication). Not all OPCS codes have been given a BUPA classification. In these cases the author used the classification of a similar procedure.

Incident data (annex 2)

Type of incident

To allow comparison of sharps exposures with non-sharps exposures a new variable was created from the 'type of incident' variable (annex 2). Categories 1 to 3 were combined into 'sharps' and category 4 produced 'non-sharps'. Category 5 was designated into either sharps or non-sharps depending on the description on the original proforma.

The 'Activity when injury occurred' variable was given 13 categories on the proforma. Frequency tables revealed that 38 activities had been coded as 'other'. These were retrieved from the original proformas and where an activity occurred more than once a new category was created. 23 activities made up a further six categories.

Statistical analysis

The unit of analysis is a single operation within the study area. The primary outcome looked for is a blood exposure incident. Two sets of analyses were conducted. The first examined variables associated with the incidents, i.e. the categories of denominator information listed above. Univariate analysis was used initially, to examine the association between suitably dichotomised independent variables and the occurrence of blood exposures. Proportions with and without blood exposures and their confidence intervals were calculated for each variable in turn. Continuous variables such as those measuring time (eg. duration of operation) were dichotomised about the median. Multiple linear logistic regression was used to assess the simultaneous effects of variables on the risk of incidents. Because of the small number of incidents, it was not possible to look at all variables simultaneously. Logistic regression was used to examine each segment of data in turn where several items were present or absent; eg. the various grades of operating surgeon within the surgeon status group (annex 2). It was then used to examine the individual categories that showed a level of significance within those groups. An example is vascular surgery when compared with all other types of surgery. This allowed the effect on risk of each individual variable to be assessed while controlling for other variables significantly associated with blood exposures. Finally the best subset of explanatory variables was used to refit the logistic regression model in which the response variable was redefined as 'sharps incident versus no sharps incident'. The latter category included non-sharps exposure incidents together with non-incidents.

The second set of analyses examined details of incidents in the sub-population of operations in which blood exposure occurred. Variables examined included type of exposure, details of the exposed individual's role and the activity being carried out when the incident occurred.

CHAPTER 3 - RESULTS

A proforma was completed for 6096 operative procedures. These represent 92.8% of all operations performed during the 6 month study period as documented by the Hospital Statistics and Medical Coding Unit. there was one or more blood exposure incident in 146 (2.4%) of these procedures.

Descriptive data

The numbers of operations performed by each specialty are shown in table 3.10. General, Obstetric & Gynaecology and Orthopaedic surgery accounted for over 50% of the total number of operations. 81.6% of operations were performed routinely and 18.4% in an emergency.

The Consultant was the main operator in 2389 (40%) operations, the Senior Registrar in 1934 (32%), the Registrar in 1424 (23%) and SHO in 292 (4.8%). A variety of other grades operated in 15 (0.2%). Information was missing for 42 operations. Anaesthetists showed a similar reduction in numbers of operations as their grades dropped. A qualified nurse scrubbed for the majority of operations, 3741 (62%); a student nurse scrubbed for 1063 (18%), an operating department assistant (ODA) for 105 (1.7%), a trainee ODA for 169 (2.8%), and a variety of others for 49 (0.8%). There was no scrub nurse present for 923 (15.3%) operations.

For 1456 (36%) operations there was no surgical assistant. 2044 (51%) of operations had one assistant, 446 (11%) had two, 95 (2%) had three and five

(0.1%) had four.

Various types of personal protective equipment (PPE) were worn by the main operator and these are shown in table 3.11. Corrective spectacles are included although these reflect personal eyesight requirements rather than specifically protective equipment. Protective eyewear was used most frequently by the orthopaedic surgeons and the oral surgeons. Full face visors were used almost exclusively by the orthopaedic surgeons. Plasticised gowns were worn to a variable extent by all specialties, ranging from 10.6% for the neurosurgeons to 75.9% for the ophthalmologists. According to the theatre manager, this reflected availability rather than personal preference. Double gloving was carried out mainly by the Orthopaedic surgeons for whom this procedure is standard practice in this hospital. The majority of the 'other safety equipment' category were plastic aprons worn by the urologists during endoscopic procedures.

Where the information was provided, blood loss was estimated to be less than 500mls for 4420 (90.7%) operations and greater than 500mls for 455 (9.3%). This information was missing for 1221 (20%) operations.

A blunt needle was used in 392 (6.4%) wound closures and staples in 637 (10.5%).

Blood exposures

156 blood exposure incidents were recorded during 146 (2.4%) operations. Six

operations had more than one exposure. In five operations a single exposure incident affected more than one person.

107 sharps exposures occurred in 99 (1.6%) procedures and 47 non-sharps exposures in 43 (0.7%) procedures. Two exposure could not be categorised because of incomplete data.

The 156 blood exposure incidents were dichotomised by combining various exposure categories from the original data collection instrument (annex 2). This created the derived variable 'sharps exposure' and 'non-sharps exposure'. The sharps exposure category included; 40 incidents where the staff member was aware of skin perforation at the time it occurred; 13 episodes where the staff member discovered blood on their hand on removing gloves after the operation (this was taken as evidence suggestive of a skin perforation); and 50 incidents where a glove was perforated but the underlying skin remained intact. A splash or soak occurred on 47 occasions and these were reclassified as non-sharps exposures. The remaining four exposures consisted of three diathermy burns and a stab with a redivac introducer; these four were reclassified as sharps exposures.

162 operating personnel were exposed during the 156 incidents. The surgeon was most frequently exposed, sustaining 54 (51%) of all sharps exposures and 25 (44%) of non-sharps exposures. The scrub nurse sustained 32 (30%) of the sharps exposures followed by the assistant surgeons who sustained 14 (13%). The situation was reversed for non-sharps exposures with the assistant sustaining 13

(23%) and the scrub nurse 7 (12%). The anaesthetists sustained 2 (2%) of the sharps exposures and 5 (9%) of the non-sharps exposures. The remaining 3 (3%) sharps and 7 (12%) non-sharps exposures were sustained by other theatre personnel such as circulating nurses and operating department assistants.

The percentage of operations with incidents fell significantly after the first 2 months of data collection from 4.2% and 3%, to 1.9% in the third and fourth months then 1.7% in the fifth and 1.8% in the last.

45 (53%) sharps exposures were caused by suture needles, 10 (12%) by knives and 10 (12%) by diathermy. The remaining exposures were caused by a wide variety of other surgical instruments (Table 3.12).

The distribution of the 47 non-sharps exposures was as follows; Eyes 17 (36%), face (excluding mucous membranes) 14 (29%), neck 2 (4%), arm 3 (6%), hand 7 (15%), trunk 2 (4%) and foot 2 (4%). Of the 107 sharps exposures, 97 affected the hand and one the arm; information was missing for 9 sharps exposures.

The activities during which the exposures occurred are shown in table 3.13.
17 (20%) of sharps exposures occurred while instruments were being passed between the scrub nurse and surgeon, and 16 (18.8%) while closing muscle and subcutaneous layers. Dissecting of tissues was the most common activity related to non-sharps exposures (13, 31%) and this also accounted for 13 (15.3%) of the sharps exposures. Only sharps exposures occurred while closing the muscle,

subcutaneous tissue and skin. 11 (20%) of the main operators' sharps exposures and five (36%) of the assistants' sharps exposures were sustained during these activities. The difference in rates between main operators and assistants could easily have occurred by chance ($\chi^2 = 1.45$; $p > 0.1$).

Exposed individuals were asked whether the affected area of skin had been broken or intact before the incident. The skin was broken before one (2.1%) non-sharps exposure and eight (7.5%) sharps exposures.

The 6096 procedures recorded during the 6 month study period were classified with 516 OPCS codes. For 74 of these codes, at least one operation within that code had a blood exposure incident. And for 7 OPCS codes at least one operation had more than one blood exposure incident. Annex 7 lists the 74 OPCS codes with at least one sharps exposure per code. For these codes, the number of sharps ranges from one for the majority of codes, to 5 for liver transplantation and abdominal hysterectomy. The proportion of procedures with a sharps exposure, for each code, ranges from 0.3% (a sharps exposure in 1 of 328 extracapsular lens extractions) to 100% where there was a sharps exposure in the only procedure performed under that code (eg. one sharps exposure in one aortic aneurysm repair, one repair of anus and one intra-abdominal manipulation of ileum). There were no sharps exposures recorded during the 28 vaginal hysterectomies performed. But there was a sharps exposure in five (5.1%) of 97 abdominal hysterectomies. Annex 8 lists the codes where a sharps exposure occurred in two or more procedures, and at least 20 procedures were recorded during the study period.

Liver transplantation has the highest incidence of blood exposures with a sharps exposure occurring in five (21.7%) of 23 operations. The next highest incidence is for 'excision of tissue of the brain' with a sharps exposure in two (8.3%) of 24 operations.

Univariate analysis

Univariate analysis of variables associated with occurrence of blood exposures is shown in table 3.14. Incidents were more likely to occur if; the "scrub" was a nurse, corrective spectacles were worn by the surgeon, more than 500mls. of blood was lost, fat was closed with a blunt needle and/or skin with staples, two or more surgical assistants were present and the surgeon was not wearing a visor.

Blood exposure rates for individual surgical specialties were examined by comparing them with the rates for all other specialties combined. Table 3.15 shows that vascular, general and neurosurgery had significantly higher rates of blood exposure incidents than other specialties.

Multiple linear logistic regression

Table 3.16 shows the results of the two multiple logistic regression analyses. In Table 3.16A the response variable was taken to be the occurrence or not of any blood exposure incident. In table 3.16B the outcome was the occurrence or not of a sharps exposure incident.

The three variables relating to time were looked at separately. Because their distributions were not normal, the medians rather than means are quoted. The median duration of operations without blood exposures was 45mins. compared with 1hr.15mins. for those with blood exposures. The median time into theatre on a 24 hour clock for operations without blood exposures was 12 noon and for operations with blood exposures, 11.30hrs. The median duration from the start of a list to the end of an operation for those without exposure was 2hrs.30mins. For operations with exposure it was 3hrs.32mins. In order to relate these variables to the risk of blood exposure, univariate logistic regression analysis was carried out. The outcome variable was the occurrence of a blood exposure, and this was regressed on each variable in turn. Individually each time variable was significantly associated with risk of blood exposure but when analysed simultaneously only duration of operation remained significant (table 3.17). Thus longer operations had a higher risk of blood exposure than shorter operations but there was no effect of start time of the operation or time from the beginning of the list when duration of operation was taken into account.

The time of operation on a 24 hour clock was categorised into various shift patterns for comparison with other authors' data. None of the models examined identified any particular shift as having a higher risk of blood exposures.

The distribution of blood exposure incidents over time within the individual operations is shown in figure 3.10. This appears to suggest that blood exposure incidents most frequently occur between 45mins and 60 mins into the operation. It may be more important to know at what stage during the operation such incidents occur; for example are they more common during the closing stages of an operation. This would require analysis of the stage of operation during which the blood exposures occurred as well as their distribution over time.

Nine variables were independently associated with blood exposures (table 3.16). Of these only one, renal team operating, failed to reach the 5% level of significance. Eye operations carried a significantly lower risk of blood exposure than other types of surgery. The remaining 7 variables have odds ratios which in general show that the risk of a blood exposure is at least doubled. Operations lasting longer than 45 minutes were three times more likely to have a blood exposure incident compared with operations of less than 45 minutes duration. Operations with a blood loss greater than 500mls had two and a half times as many blood exposure incidents as operations where the blood loss was less than 500mls . Major operations had two and a half times as many blood exposure incidents when compared with intermediate and minor operations. A blood exposure incident was twice as likely during operations performed in the first two months of the study period compared with the following four months. Incidents were almost four times as common in operations where the person acting as 'scrub' was a qualified nurse compared with procedures where the scrub was not a qualified nurse or there was no scrub. Operations where the wound was closed with staples had twice the risk of blood exposure incidents compared with those operations where staples were not used, and operations where the main surgeon wore corrective spectacles had one and a half times the risk of a blood exposure incident compared with those where spectacles were not worn. All the above variables except for use of staples remained significant when sharps exposures only were entered into the regression model.

Table 3.10 Total number of operations performed by surgical specialty, and proportion with blood exposure incident

Surgical Specialty	Number (%) of operations performed		Number (%) with exposure incident	
Vascular	101	(1.7)	9	(8.9)
Neuro	418	(6.9)	25	(6.0)
Renal	179	(2.9)	9	(5.0)
General	1156	(19.0)	45	(3.9)
Thoracic	30	(0.5)	1	(3.3)
Plastics	73	(1.5)	2	(2.7)
Orodental	147	(2.4)	3	(2.0)
Orthopaedic	779	(12.8)	15	(1.9)
Urology	608	(10.0)	11	(1.8)
Obs. & Gynae.	1426	(23.4)	19	(1.3)
ENT	421	(6.9)	4	(1.0)
Ophthalmology	483	(7.9)	2	(0.4)
Other	270	(4.4)	1	(0.4)
TOTAL	6091*	(100)	146	(2.4)

* Surgical specialty was missing for 5 operations.

Table 3.11 Number and percentage of operations during which personal protective equipment of different types was worn.

SAFETY EQUIPMENT WORN BY MAIN OPERATOR	NUMBER (%) OF OPERATIONS DURING WHICH WORN
Own spectacles	1354 (22.3)
Safety glasses	123 (2.0)
Safety goggles	50 (0.8)
Visor	43 (0.7)
Plasticised gown	2119 (34.8)
Double gloves	601 (9.9)
Other safety equipment	87 (1.4)

Table 3.12. Instruments involved in sharps exposures.

SHARP INSTRUMENT	NUMBER (%) OF EXPOSURES
Suture needle	45 (53)
Knife	10 (12)
Diathermy	10 (12)
Hypodermic needle	4 (5)
Forceps (2 artery, 1 sinus)	4 (5)
Drain introducer	2 (2)
Towel clip	2 (2)
Retractor, microdissector, perforator, cannula, bone nibblers, bone spicule, jaw wire, bottle glass.	8 (9) (1 of each)
TOTAL*	85 (100)

* Information was missing for 22 sharps exposures (the sharp instrument could not be identified for 13 of these because the exposure was not recognised until the glove was removed at the end of the operation).

TABLE 3.13 Activities during which blood exposures occurred

ACTIVITY		SHARPS	NON-SHARPS	TOTAL
Dissecting tissue		13	13	26
Closing muscle and subcut. layer		16	0	16
Passing sharp instrument from	scrub to surgeon	9	0	9
	surgeon to scrub	8	0	8
Tying off vessel/cutting suture		5	3	8
Using diathermy		6	0	6
Making incision		3	2	5
Using suction		0	5	5
Disposing of suture needle		5	0	5
Obtaining venous access (anaesthetist.)		1	3	4
Drilling		1	3	4
Suturing		3	0	3
Closing skin		3	0	3
Handling hypodermic needle		3	0	3
Changing scalpel blade		2	0	2
Ellick washout		0	2	2
Inserting drain		1	1	2
Closing instrument tray		1	0	1
Extracting clots of blood from abdomen, evacuating retained products of conception, running through unit of blood, passing N.G. tube, chiselling tooth, irrigating wound, retracting, cannulating mesenteric artery, using bone graspers, holding guide wire to ureteroscope.		0	10 (1 of each)	10
Knife cut while wiping blood in wound, handling instruments on trolley, placing bone nibbler in tray, applying Roberts artery forceps, mounting needle on holder.		5 (1 of each)	0	5
TOTAL		85	42	127*

* Information missing for 29 exposures

Table 3.14 Table of variables significantly associated with blood exposure incidents in univariate analysis.

VARIABLE (N = 6096)	No. (PROPORTION*) OF OPERATIONS WITH INCIDENT	DIFFERENCE IN PROPORTIONS	95% C.I. OF DIFFERENCE
n = 6050 Scrub = nurse	142 (2.96)	2.63	2.06 to 3.21
Scrub = other or none	4 (0.32)		
n = 6081 Spectacles worn by surgeon	58 (4.28)	2.42	1.28 to 3.57
No spectacles worn by surgeon	88 (1.86)		
n = 4875 Blood loss more than 500mls.	45 (9.96)	8.25	5.47 to 11.0
Blood loss less than 500mls.	78 (1.70)		
n = 6089 Fat closed with blunt needle	21 (5.36)	3.18	0.92 to 5.44
Fat not closed with blunt needle	124 (2.18)		
n = 6090 Wound closed with staples	52 (8.16)	6.46	4.30 to 8.61
No staples used to close wound	93 (1.73)		
n =4046 2 or more surgical assistants	46 (8.42)	6.48	4.11 to 8.86
None or 1 surgical assistants	68 (1.94)		
n = 6078 Surgeon not wearing visor	146 (2.42)	2.42	2.03 to 2.81
Surgeon wearing visor	0 (00.0)		

(* expressed as a percentage)

Table 3.15 Surgical specialties with significantly higher or lower numbers of blood exposure incidents when compared with all other specialties combined.

VARIABLE	No. (PROPORTION*) WITH INCIDENT	DIFFERENCE IN PROPORTIONS	95% C.I. OF DIFFERENCE
Neurosurgery	25 (5.98)	3.85	1.54 to 6.15
All other	121 (2.13)		
General surgery	45 (3.89)	1.85	0.66 to 3.03
All other	101 (2.05)		
Vascular surgery	9 (8.91)	6.62	1.05 to 12.2
All other	137 (2.29)		
Obs. & Gynae. surgery	19 (1.33)	-1.39	-2.15 to -0.63
All other	127 (2.72)		
ENT surgery	4 (0.95)	-1.55	-2.57 to -0.54
All other	142 (2.50)		
Ophthalmic surgery	2 (0.41)	-2.15	-2.86 to -1.45
All other	144 (2.56)		

(* expressed as a percentage)

Table 3.16 Multiple logistic regression analysis of variables associated with blood exposure incidents.

A Response variable = presence/absence of any blood exposure

	Coeff	SE	p value	Odds Ratio	95% CI
Constant	-6.994	0.544			
Operations during first 2 months of study	0.754	0.175	<0.001	2.125	1.509 to 2.991
Blood loss more than 500 mls	0.937	0.210	<0.001	2.552	1.691 to 3.851
Major operation	0.886	0.237	<0.001	2.425	1.524 to 3.860
Renal team operating	0.690	0.376	<0.07	1.993	0.953 to 4.168
Operation 45 mins. (median duration) or longer	1.109	0.289	<0.001	3.031	1.720 to 5.341
Scrub = nurse	1.362	0.519	<0.01	3.903	1.411 to 10.799
Spectacles worn by surgeon	0.438	0.185	<0.02	1.550	1.079 to 2.226
Wound closed with staples	0.645	0.201	<0.001	1.905	1.285 to 2.825
Eye operations	-1.618	0.728	<0.03	0.198	0.048 to 0.827

* Deviance=1137, d.f.=6080

B Response variable = presence/absence of a **sharps** exposure

	Coeff	SE	p value	Odds Ratio	95% CI
Constant	-7.566	0.749			
Operations during first 2 months of study	0.555	0.209	<0.01	1.742	1.156 to 2.625
Blood loss more than 500 mls	0.766	0.257	<0.003	2.151	1.299 to 3.562
Major operation	0.750	0.274	<0.006	2.117	1.238 to 3.619
Renal team operating	0.556	0.448	<0.21	1.744	0.725 to 4.195
Operation 45 mins. (median duration) or longer	1.274	0.353	<0.001	3.577	1.792 to 7.139
Scrub = nurse	1.697	0.725	<0.02	5.458	1.318 to 22.609
Spectacles worn by surgeon	0.454	0.219	<0.04	1.574	1.024 to 2.420
Wound closed with staples	0.398	0.247	<0.11	1.488	0.918 to 2.414
Eye operations	-1.977	1.020	<0.05	0.138	0.019 to 1.022

* Deviance=862, d.f.=6078

*The deviance is a measure of the amount of variation in the data which is unaccounted for by the regression model.

Table 3.17 Multiple logistic regression analysis of the three time variables

TIME VARIABLE	Coeff.	SE	p value	Odds* Ratio	95% C.I. of Odds Ratio
Constant	-4.159	0.348	<0.001		
Time operation started (24hr. clock)	-0.041	0.027	<0.13	0.96	0.910 to 1.012
Duration of operation	0.548	0.058	<0.001	1.73	1.542 to 1.939
Duration from start of list to end of operation	0.057	0.046	0.21	1.06	0.969 to 1.158

* The odds ratio represents the risk of an incident at the higher level of each variable in relation to its lower level. For example the risk of an incident for an operation whose duration was above the median was approximately 1.7 times that for an operation whose duration was below the median.

Instruments commonly involved in sharps exposure incidents:

Figure 3.1 Suture needle

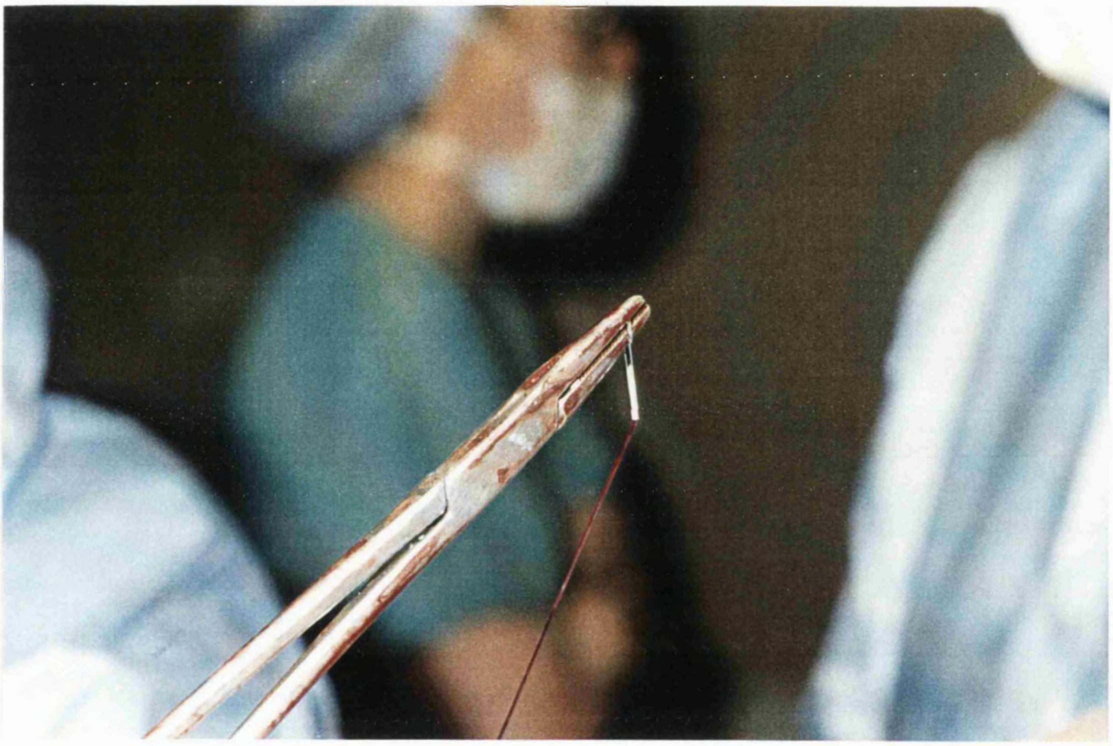
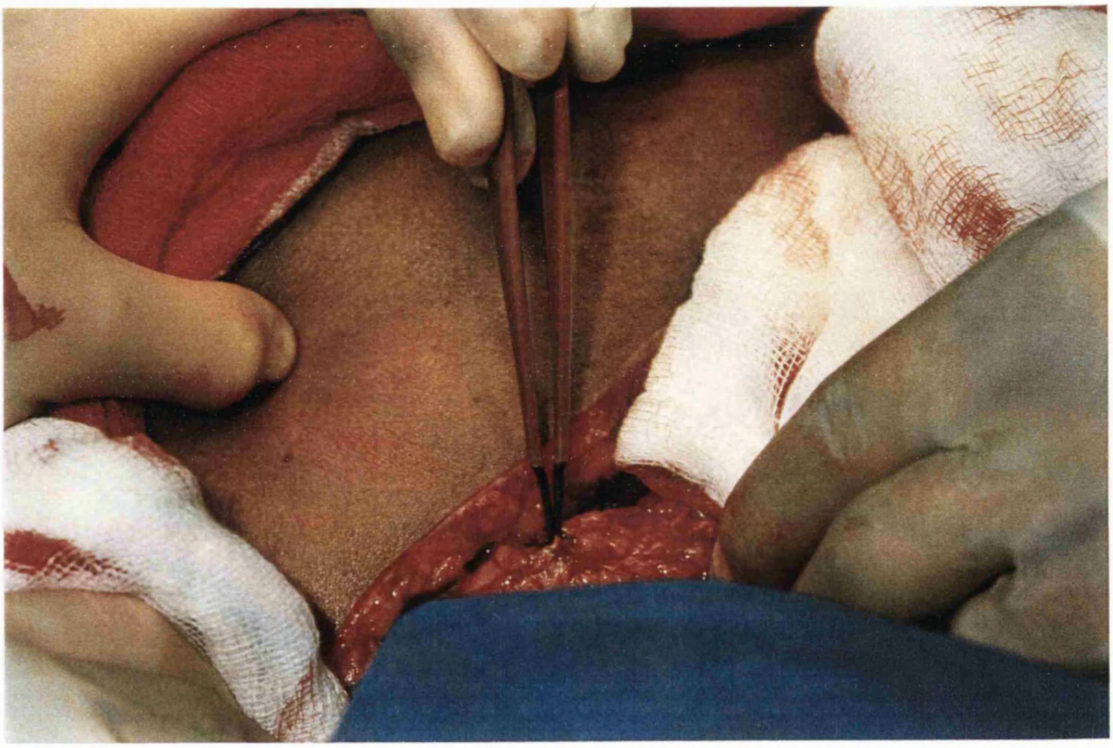


Figure 3.2 Scalpel

Figure 3.3 Diathermy



Activities during which blood exposures commonly occur:

Figure 3.4 Making the incision

Figure 3.5 Dissecting the tissues

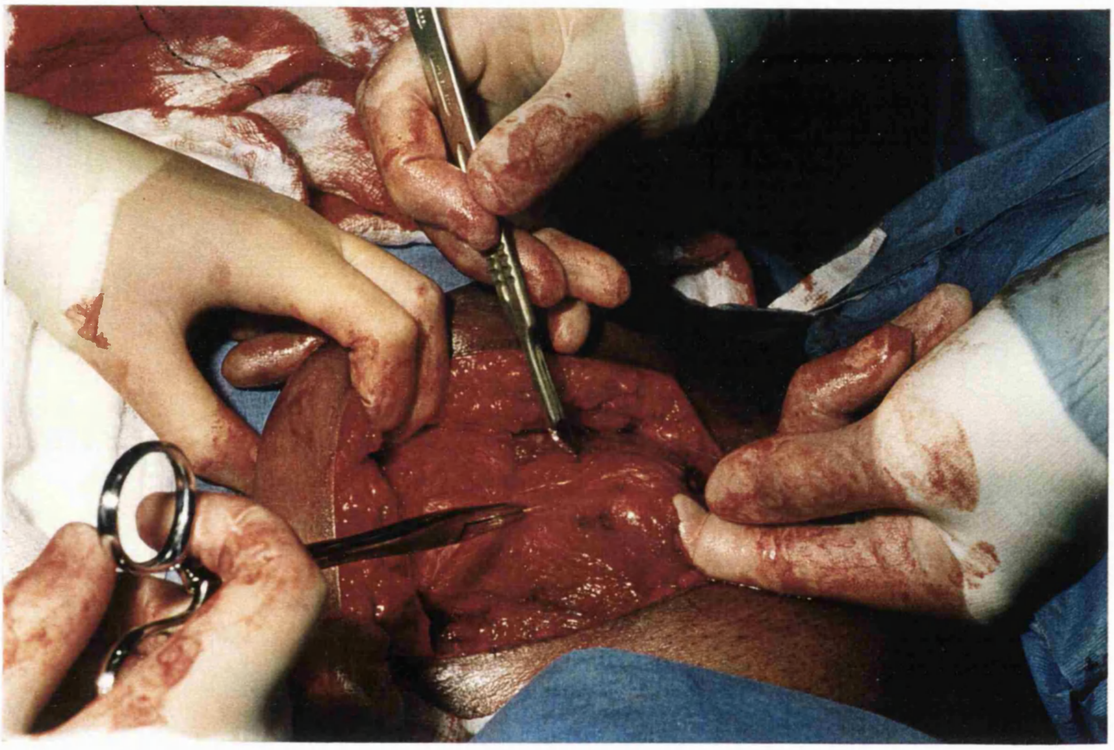


Figure 3.6 Passing a sharp instrument from the surgeon to the scrub nurse

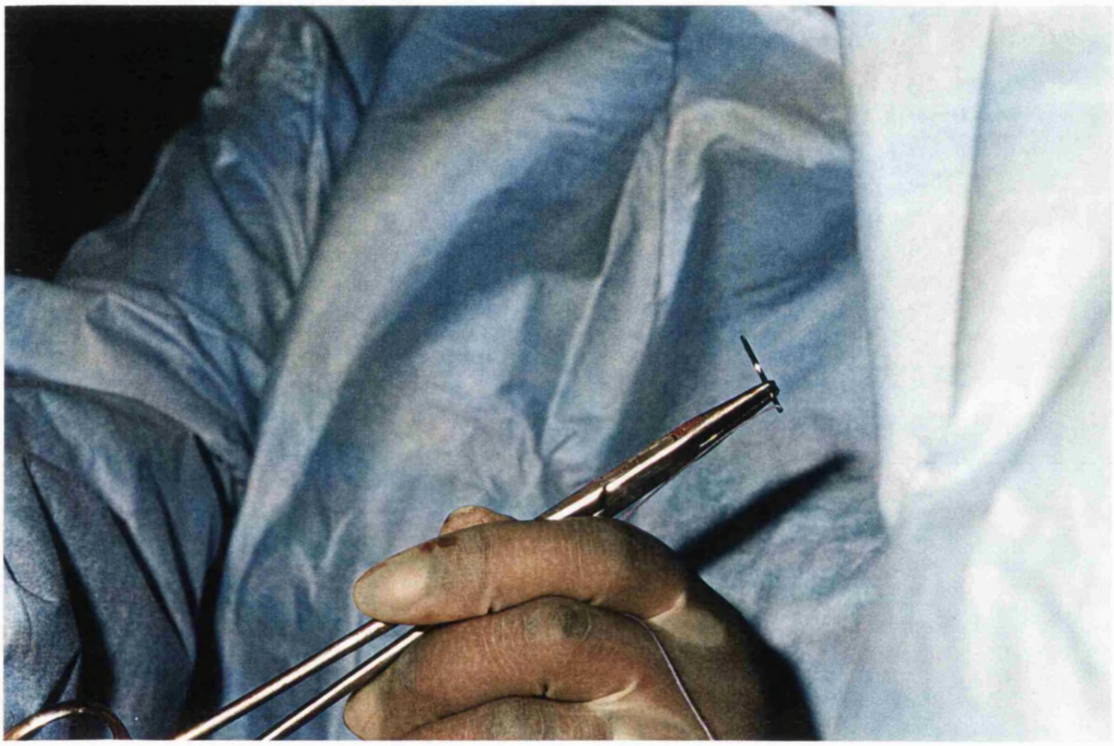
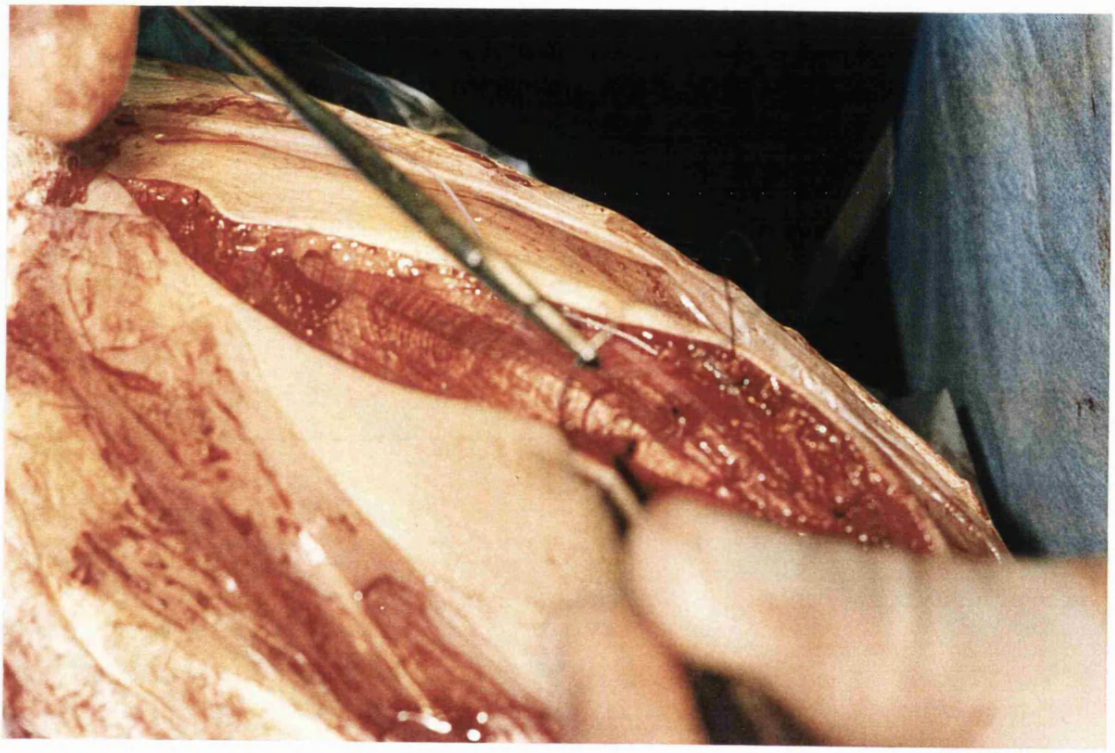


Figure 3.7 Suturing the subcutaneous tissues



Miscellaneous:

Figure 3.8 Disarmer for safe removal of scalpel blade

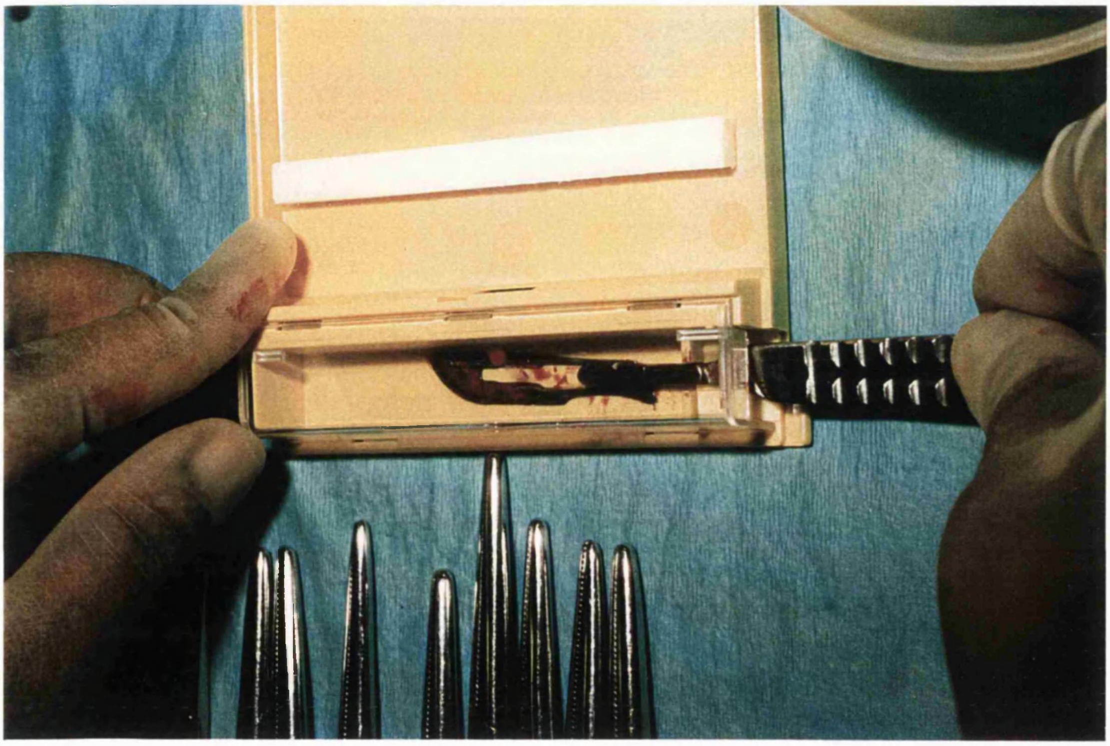
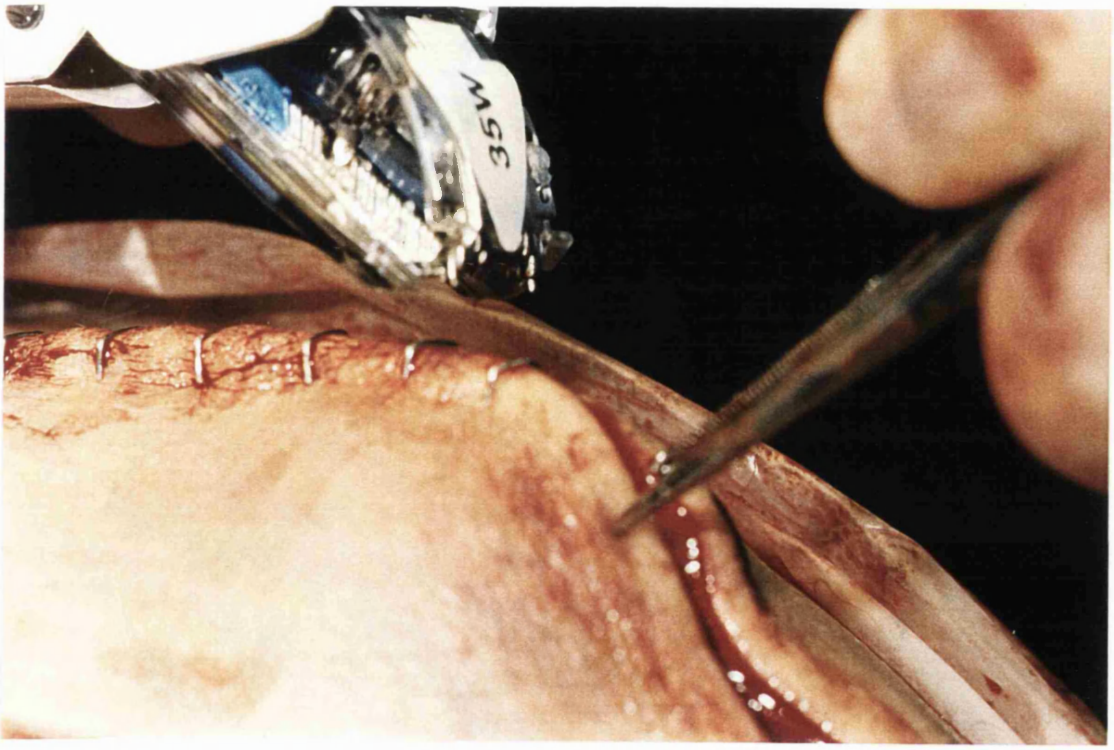


Figure 3.9 Staples being used to close the wound



Distribution of blood exposure incidents per 15 minutes of surgery

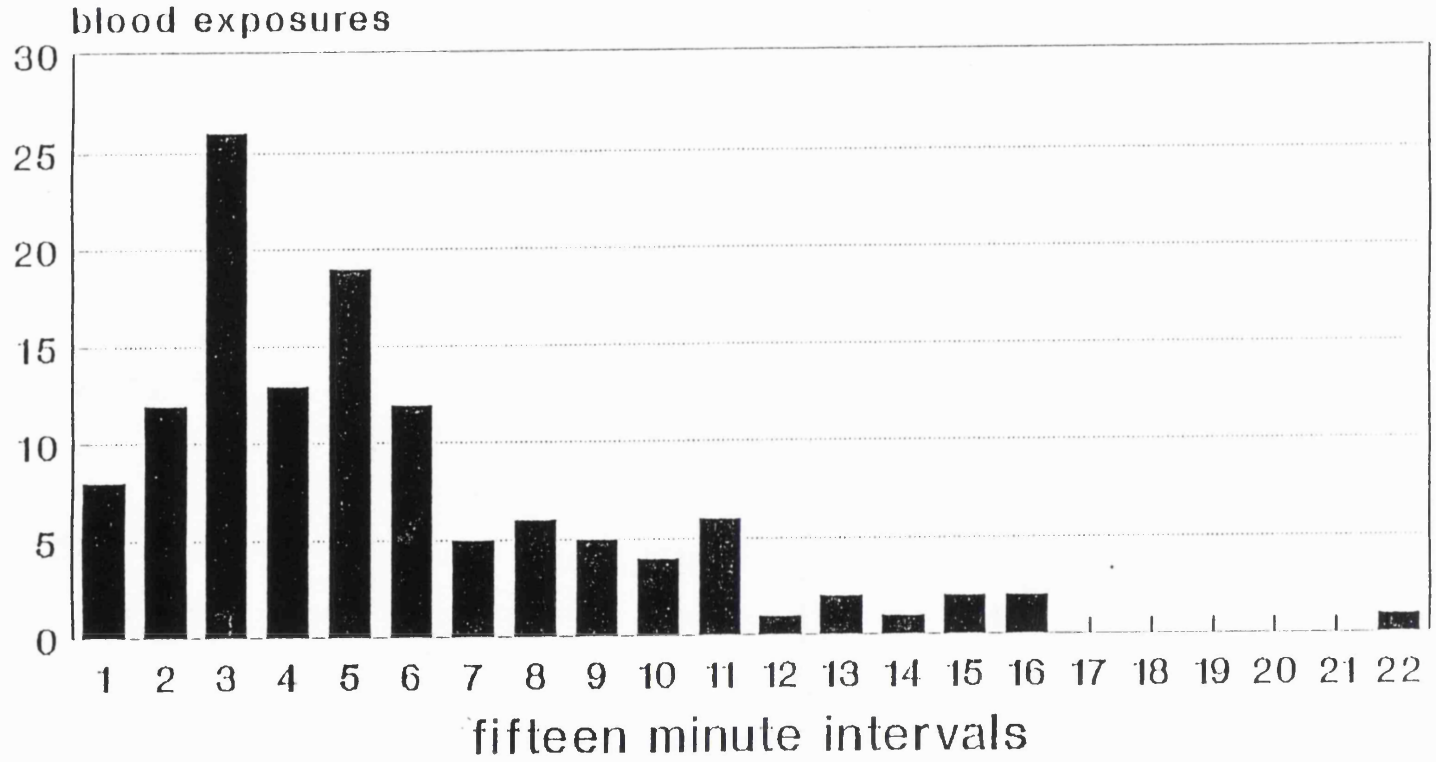


Figure 10

CHAPTER 4 - DISCUSSION

Methodological issues

In this study of operating department staff one or more blood exposures occurred during 2.4% of 6096 operations over a 6 month period. 156 blood exposure incidents were recorded in 146 operations. The exposure rate is lower than similar studies with a self-reporting system (6.4%, Gerberding et al. 1990, to 32%, McNicholas et al. 1989) and studies with trained observers (range 30%, Panlilio et al.1991, to 50%, Quebbeman et al. 1991). When looking at sharps exposures alone, the result of 1.6% was within the range recorded by other self reporting studies (1.3%, Gerberding et al. 1990 to 4.6%, Camilleri et al. 1991). But it was below the range obtained in observational studies (4.9%, Panlilio et al.1991, to 15%, Quebbeman et al. 1991). There are several possible explanations for these differences. It could be that the staff being studied were extremely careful. However it is also possible that it reflects a low rate of reporting. This study used a form of self-reporting in order to obtain data on a large number of operations within a restricted budget. Such self-reporting relies on the active cooperation of the whole operating team which may not always be forthcoming; this probably explains the generally lower rates obtained in studies using this system. This study collected information on over 6000 operations - more than twice as many as other published single centre studies. The extended duration to achieve these numbers may have resulted in decreased motivation of staff to record exposures. The significant drop in reported incidents over the last four months of the study when compared with the first two months suggests this is likely. This drop in reporting will have contributed to the low frequency of incidents in this study compared with other studies. While this may mean that the overall incident rate in this study is an under-estimate, there is no reason to believe that this biases the analysis of variables associated with blood exposures.

This study included consecutive operations in all specialties over the six month study period. This may help explain the low blood exposure rate when compared with other studies. Most of these used some form of non-random selection criteria for operations to be included, and tended to include mainly specialties and procedures expected to have a relatively high frequency of blood exposures.

All the studies reviewed for this work recorded a greater number of non-sharps blood exposures than sharps exposures (table 1.3). In this study there were fewer non-sharps exposures than sharps exposures. But the proportion of operations with a sharps exposure was comparable to the proportion in Gerberding's study (Gerberding et al. 1990), which is of similar design to this study. This suggests that the under-reporting of blood exposures in this study affected mainly non-sharps exposures.

Missing data is always a concern in assessing the validity of a study. In this study there was a high response rate with part one of the proforma completed for 93% of all operations during the study period. It is possible that the missing 7% differ significantly but the details of these operations were not readily available. An assumption has been made that there was no difference. To improve compliance part one of the proforma was restricted to one side of paper with a further side to be completed following a blood exposure. This limited the amount of information collected on each procedure. It is likely that the data set was less complete than would have been achieved if an observer had been used. A limitation of this study is the incompleteness of some data. The worst response was about blood loss with 20% of the data missing. If the assumptions used to correct the missing data were incorrect then the importance of blood loss could have been overestimated.

Throughout this study the blood exposure rate per operation has been considered. Some authors have calculated risk to individual surgeons per 1000 hrs. of operating. Clearly there is a difference in rate between individual surgeons. In this study a decision was made not to identify individuals in case this compromised reporting. This means that it is not possible to relate blood exposure rates to individual surgeons.

Variables related to blood exposure incidents

Multiple logistic regression identified high blood loss, long duration of operation, major operations, renal team, nurse acting as scrub, the use of staples to close wound and surgeon wearing spectacles as variables independently associated with procedures in which exposures occurred. Several of these variables have been identified by other studies of similar design (Tables 1.7). For all blood exposures, and sharps exposures alone, these were high blood loss and long duration of operation. For sharps exposures alone major status of operations was also significantly associated with exposures. In other studies vascular surgery and intra-abdominal gynaecological surgery had a significantly higher risk of any blood exposure. And vascular surgery had a significantly higher risk of sharps exposure. Of the surgical specialties involved in this study only the renal team were found to have a significantly higher risk of exposure compared with the others. This was not the case when looking at sharps injuries alone. One author looked at named individual procedures and found that vaginal hysterectomy carried a high risk for sharps exposures (Gerberding et al. 1990). This finding is interesting as four out of the eleven epidemics of hepatitis B among patients of infected surgeons involved major gynaecological operations (Heptonstall 1991). This suggests again that a high number of sharps injuries occur during this procedure. In this study no sharps exposures were recorded during vaginal hysterectomy but only 28 were performed during the six month study period. Interestingly five (5.1%) of the 97 abdominal hysterectomies had a sharps exposure incident.

This study identified three variables independently associated with risk of blood exposure that have not been previously reported as increasing the risk of blood exposure; operations in which the main surgeon wore spectacles, the wound was closed with staples and the person filling the role of scrub nurse was a trained nurse as opposed to a student nurse, ODA, other or absent. The need for corrective spectacles in adults increases with age and one interpretation of this finding could be that older surgeons are more likely to experience blood exposures. Another explanation could be that corrected vision is not as good as vision in those who do not require correction. The study did not enquire about the use of contact lenses.

The reason for the association with staple use is not clear. In these operations it was not the staples that actually caused the blood exposure. Surgeons asked about this issue report that operators who are in a hurry use staples as they are faster than suturing. Their use may reflect pressure of time on the surgeon throughout the operation increasing the risk of accidental blood exposure. Or it may reflect difficult operations where other factors were actually responsible for the exposure.

The finding that a nurse acting as scrub is associated with a higher risk of blood exposure during the operation than when a non-nurse acts as scrub is unexpected. It could reflect a lower degree of caution on the part of the nurse for whom the sharps handling activities have become routine. Another explanation could be that trained nurses more frequently scrub in major procedures. However, no such interaction between type of "scrub" and category of procedure was found in the analysis. But it could be that trained nurses scrub for the more difficult operations within each category. It could be a reporting artifact in that the nurses acting as scrub were better at reporting exposures when they occurred. This is quite possible since this group was particularly targeted for training in completing the reporting forms.

Table 1.7 shows that other studies identified longer duration of training, high numbers of surgical personnel and day shift as having a significantly higher risk of exposure. This study examined these variables but did not find them to be significantly associated with the risk of blood exposure.

Protective equipment

In univariate analysis, there was a significant reduction in exposure incidents in operations where the surgeon was wearing a visor. The protective effect of visors was not significant when other variables were taken into account in multivariate analysis. The lack of evidence of a protective effect of visors may be because the wearing of protective equipment introduces its own problems such as a reduction in dexterity or field of view. Or it may be that the "effect" of the visor is explained by its association with something else that really did reduce risk of exposures.

Timing of blood exposure incidents

The interpretation of the timing of blood exposure incidents is complex. In univariate analysis the position of an operation on the list was significant, with operations later on the list having a higher risk of blood exposures. This association was no longer significant when the effect of 'duration of operation' was taken into account. These two variables are closely related because position on list was described as time from beginning of list to **end** of operation; longer operations would tend to end later on the list.

It is difficult to interpret the distribution of blood exposure incidents over time during each operation. Figure 3.10 shows the distribution of blood exposure incidents per 15 minutes of surgery. Few exposures occurred during the first 15 minutes of an operation, with the highest number occurring during the third 15 minute period (between 30 and 45 minutes). This suggests that the very early stages of an operation, which include opening of the tissues, are not particularly hazardous. The gradual reduction in the number of incidents after the third 15 minute interval cannot be interpreted as meaning that there is a reduction in risk later on in the operation. This is because many operations are relatively short (median duration 45 minutes). The number of incidents would need to be expressed in relation to the number of operations in progress for each 15 minute interval. The smaller number of incidents occurring in later 15 minute intervals may be higher in relation to the number of operations still continuing. The situation is further complicated because it is likely that during any 15 minute period into the operation the activity being carried out by the operating team will vary depending on the type of operation and its total length. The second 15 minutes of a 30 minute procedure will include wound closure whereas in a 3 hour operation it is likely that very different activities will be carried out during the second 15 minute period. It certainly cannot be concluded from this study that the risk of blood exposures increases as long operations proceed (for example, due to fatigue). It is often not feasible for operators to take breaks during longer operations, and this study does not provide any evidence that doing so would influence the risk of blood exposure incidents. The findings do suggest a need to look further at specific characteristics of, and activities within, longer operations. This would require having an observer present during operations.

During wound closure the proportion of sharps exposures among assistant operators was not statistically significantly higher than among main operators. However, for all operations in the study, it is not known how often the assistant closed the wound compared with the main operator. It is well recognised that towards the end of a procedure the main operator often hands over to his/her assistant to close the wound. And some studies have demonstrated that junior surgeons are more at risk of sharps exposure than their seniors. If this is the case, one would expect a higher number of assistants to experience blood exposures during wound closure than main operators. In fact the data in this study suggest that there is not an increased risk of blood exposures to assistants. If assistants truly close the wound more often and have more blood exposures they should have experienced a significantly higher proportion of their sharps exposures during wound closure; this was not the case. To look at this question more closely information would be needed on the grade of operator carrying out wound closure. This would probably require an observer study.

SUPPLEMENTARY STUDIES

CHAPTER 5

STUDY OF BLOOD EXPOSURE INCIDENTS: DATA COLLECTION AND UNDER-REPORTING

INTRODUCTION

Hospitals in the UK and USA have developed formal systems for the reporting of workplace accidents and injuries, including blood exposure incidents. Some hospitals have an additional separate reporting system for blood exposure incidents. These schemes are usually co-ordinated by the Occupational Health Department, employee medical centres or personnel departments. It is important to record information about incidents fully and accurately, because it may assist employees in future claims for compensation. In the UK the National Health Service injury benefits scheme provides benefits for NHS employees who lose remuneration because of a disease attributable to their NHS employment (NHS Injury Benefits Scheme 1988). It must be established that the disease was acquired during the course of work. While a record of a specific blood exposure incident and evidence of seroconversion are not regarded as essential they would be helpful in proving causation. Analysis of data on reported incidents can also help employers to identify risky areas and procedures where preventive efforts should be targeted.

Despite the existence of reporting schemes, serious under-reporting is common (Popejoy and Fry 1991, Williams et al. 1993, Lowenfels et al. 1989, Vergilio et al. 1993, Astbury and Baxter 1990, Mangione et al. 1991, McGeer et al. 1990, Tait and Tuttle 1994, O'Neill et al. 1992, Hersey and Martin 1994, Heald and Ransohoff 1990, Lynch and White 1993, Hamory 1983, Collins and Kennedy 1987, Henriksen and Lock-Anderson 1994). This chapter reviews the literature on under-reporting and compares three methods of collecting data about blood exposures used at this hospital during the main study period.

LITERATURE REVIEW

Background

Interest in the reporting of blood exposures and the extent of under-reporting began in the late 1970's and early 1980's (Hamory 1983). This concern followed the development of Hepatitis B Immune Globulin (HBIG) and the recommendation that it be given early following exposure to hepatitis B infected blood (Seeff and Wright 1975, Grady et al. 1978, Seeff et al. 1978). Since the beginning of the HIV era there has been renewed interest in blood exposure incident reporting rates. There are several reasons why health care workers should report all blood exposure incidents at the time that they occur.

Accurate and complete data on situations in which blood exposures occur will allow efforts to reduce exposures to be appropriately targeted. For example at one hospital a disproportionate number of reported sharps incidents resulted from equipment used to obtain a capillary blood sample for blood glucose estimation. Safer equipment was substituted with a subsequent large reduction in the number of reported sharps resulting from this activity (Cockcroft 1993 p.527).

Individual health care workers who become infected with a blood borne virus following a blood exposure incident may wish to seek compensation. In the UK, their claim is likely to be aided if the exposure is reported, serum is taken at the time of the incident, and seroconversion is shown to be temporally related to the exposure (UK Health Departments, December 1991).

Health care workers who are not protected against Hepatitis B (either due to non-immunisation or non-response to vaccine) can benefit from early post-exposure prophylaxis with HBV vaccine and/or HBIG following exposure to infectious carriers of HBV (Seeff et al. 1978, PHLS subcommittee 1992).

Finally, recording of exposures and follow-up monitoring for seroconversion is important for epidemiological purposes. Large national studies of individuals exposed to HIV positive blood have provided the information which has allowed seroconversion rates to be estimated (Tokars et al. 1993, PHLS AIDS centre at CDSC 1993). And local surveillance schemes allow individual organisations to review their management of blood exposures (Oakley et al. 1992).

Reporting levels

Table 5.18 shows the results of 10 retrospective questionnaire surveys (Williams et al. 1993, Lowenfels et al. 1989, Vergilio et al. 1993, Astbury and Baxter 1990, Mangione et al. 1991, McGeer et al. 1990, Tait and Tuttle 1994, O'Neill et al. 1992, Hersey and Martin 1994, Heald and Ransohoff 1990) which asked about reporting of blood exposures. Various groups of health care workers were asked how many blood exposures they had experienced over a period of time and how many of these they had reported to their Occupational Health Department or other designated Department. The reporting rates range from 0% for non-sharps exposures experienced by staff of an operating department in a London Teaching Hospital (Williams et al. 1993) to 81% for housekeepers nationally in the USA (Hersey and Martin 1994). Two prospective studies have also looked at reporting rates. Henriksen directly observed 94 blood exposures in 77 of 746 operations. He noted that only 2% of these were reported as an occupational injury (Henriksen and Lock-Anderson 1994). Lynch in the USA reports on the Collaborative Operative Blood Exposure (COBEX) study of 8502 operations in nine hospitals in the USA. Data from three participating hospitals were used to estimate the rate of under-reporting. He compared the number of parenteral exposures (punctures, mucous membrane and non-intact skin contact with patient blood) observed in these three hospitals during the study with the number of incident report forms completed during the 12 months immediately preceding the study period. He estimated that only 4% of all parenteral exposures sustained were recorded on incident report forms (Lynch and White 1993).

Several authors have attempted to identify reasons for under-reporting. The most common reasons identified were time constraints and a belief that reporting would not influence outcome (O'Neill et al. 1992, Heald and Ransohoff 1990). One author recorded a higher reporting rate for exposures to known and suspected HIV positive blood when compared with exposures to blood of unknown HIV status or known HIV negative status (Mangione et al. 1991).

STUDY METHOD

During the six month study period three different methods of collecting data on blood exposure incidents amongst operating theatre staff were used. The first method was that of the main study (see chapter 2). All members of the operating team were asked to inform the scrub nurse if they sustained a blood exposure. The scrub nurse was responsible for documenting the incident immediately after each procedure.

Secondly, during the final two months of the main study, a postal questionnaire survey of all operating department staff was carried out (Williams et al. 1993). The main purpose of the survey was to check the hepatitis B immunisation status of these staff. The questionnaire also asked the staff member how many blood exposure incidents (sharps and non-sharps) they had sustained in the previous month (annex 9), and whether they had reported the incidents to the Occupational Health Unit.

Finally all blood exposure incidents reported to the Occupational Health Unit by individual members of staff were recorded routinely throughout the study period. Annex 10 shows the form used for recording information on routinely reported incidents. These data are routinely entered into a computer database and analysed to give information on time-trends for reported blood exposure incidents and their management.

Blood exposure incidents recorded for the main study were compared with the blood exposure incidents which were reported to the Occupational Health Unit during each month of the six month study period. The blood exposure incidents recorded on the postal questionnaire could not be compared month by month with those reported by the other two methods; there were two mailings followed by telephone follow up of non-responders and the exact time period of the incidents recalled therefore varied. In the postal questionnaire, staff were asked to recall their previous month's exposures, and these incidents were multiplied by 6 so as to represent a 6 month period. This figure was compared with the cumulative six month results from the other methods of data collection.

RESULTS

The postal questionnaire was sent to all 158 operating department staff. 119 (93%) of the 128 respondents gave information on blood exposure incidents during the previous month. There were 26 sharps exposures and 240 non-sharps exposures. By extrapolation from this survey it can be estimated that during any 6 month period there would be approximately 156 sharps exposures and 1440 non-sharps exposures among the respondents. If an assumption is made that the experience of the 39 non-responders was similar to that of the 119 responders, then the corrected 6 month estimate is 207 sharps exposures and 1911 non-sharps exposures. An assumption has also been made that the month recalled by the responders was typical of their overall experience of blood exposure incidents.

The scrub nurses recorded 107 sharps exposures and 47 non-sharps exposures during the six months of the main study period amongst the theatre staff directly involved in the surgical procedures, using the proformas of the main study.

During the same six month period 11 sharps exposures and three non-sharps exposures were reported to the Occupational Health Unit by theatre staff. Table 5.19 compares the results from the three data collection methods. It shows that 10% (11/107) of the sharps exposures and 6% (3/47) of the non-sharps exposures recorded for the main study were reported to the Occupational Health Unit. The numbers of incidents recorded for the main study were 50% (sharps) and 2.5% (non-sharps) of those recalled by staff in the postal questionnaire. Table 5.20 compares the blood exposures recorded by the scrub nurses for the main study with those reported to the Occupational Health Unit for each month of the study period. For each month, the number of sharps exposures reported to the Occupational Health Unit (range 0-4) was a small fraction of the number recorded by the scrub nurse for the main study (range 11-24). A similar pattern is seen for non-sharps exposures.

In the main study the surgeons were most frequently exposed, sustaining 51% (54) of all sharps exposures and 44% (25) of non-sharps exposures. Of the 14 incidents reported to the OHU during the study period, one of 11 sharps exposures (9%) and no non-sharps exposures were reported by a surgeon.

Two (14%) of the exposures reported to the OHU were to known HIV positive blood. One was a sharps exposure and one a non-sharps exposure. Both were sustained by student nurses.

DISCUSSION

This study confirms the findings of previous reports which showed a high level of under-reporting of sharps and other blood exposure incidents (Popejoy and Fry 1991, Williams et al. 1993, Lowenfels et al. 1989, Vergilio et al. 1993, Astbury and Baxter 1990, Mangione et al. 1991, McGeer et al. 1990, Tait and Tuttle 1994, O'Neill et al. 1992, Hersey and Martin 1994, Heald and Ransohoff 1990, Lynch and White 1993, Hamory 1983, Collins and Kennedy 1987, Henriksen and Lock-Anderson 1994).

The number of sharps exposures in the main study (107) was less than in the questionnaire survey corrected for non-response (207). Perhaps it is not surprising that the number is greater for the questionnaire survey as this included incidents in all areas of the operating department whereas the main study was confined to peri-operative exposures only. However, most exposures are peri-operative so most of the discrepancy between recorded and recalled incidents is likely to be due to under-recording by the scrub nurses on study proformas. Of course, the retrospective questionnaire relies on recall and may either under or over estimate the frequency of incidents. But the exposure rates from the questionnaire survey are of the same order of magnitude as those found in similar studies, suggesting that the postal questionnaire method of data collection may give a valid idea of the true number of sharps exposures experienced in the operating theatre. There was a bigger difference in the number of non-sharps exposures recorded in the main study (47) and the questionnaire survey (1911). This suggests that these exposures were less well recorded by the scrub nurses for the main study. A postal questionnaire survey can give a good idea of the number of sharps and non-sharps exposures experienced by members of the surgical team, but it cannot provide detailed information of the circumstances of the exposure. A prospective study provides the detailed information needed to identify activities and instruments responsible for injuries. This could lead to safer methods and exposure reduction.

Routine reporting schemes are well known to under-estimate the number of exposures. There may also be an over-representation of incidents involving known infected blood and other incidents in which the injured person makes a judgement about risk. This suggests that while analysis of reported incidents is important it does not necessarily reflect the true incidence and nature of blood exposures in the exposed population. In this review of exposures reported to the Occupational Health Unit, two of the 14 exposures (14%) were to known HIV positive blood. No data were collected on HIV status of patients in blood exposure incidents recorded for the main study. The prevalence of HIV positive patients undergoing surgery in the hospital is likely to be far lower than 14%. One explanation for a high percentage of reported HIV exposures could be that operating staff are more likely to injure themselves when knowingly operating on an HIV positive patient. Many people would argue that this is unlikely as surgeons are likely to be more careful when knowingly operating on HIV positive patients. Gerberding in her study of blood exposures in the operating theatres of San Francisco (Gerberding et al. 1990), found no difference in the rates of sharps injuries (or non-sharps exposures) in operations on "high risk" and "non-high risk" patients. It is probable that exposures to known HIV positive blood were more likely to be reported than those to unknown or known HIV negative blood (Mangione et al. 1991). This suggests that where staff are knowingly exposed to infected blood they are more likely to comply with advice to report exposures.

In conclusion, while a retrospective questionnaire survey probably provides the highest count of blood exposure incidents, it cannot provide a detailed description of events surrounding the incidents. This requires a special prospective study. Such a study may record fewer incidents but the detailed information collected can be useful for developing preventive strategies. The problem with on-going routine reporting schemes is that there is usually a very high level of under-reporting and much bias. However, such schemes allow the treatment of reported incidents, and these are likely to be those with more risk. They can yield information useful to guide prevention provided the likely reporting bias is taken into account.

Table 5.18 Retrospective questionnaire studies of blood exposures showing percentage reported to Occupational Health Departments / Medical Centres

AUTHOR	NUMBER & TYPE OF STAFF	REPORTING RATES		
		SHARPS	NON-SHARPS	ALL BLOOD EXPOSURES
LOWENFELS 1989	202 surgeons New York, USA	12%	-	-
WILLIAMS 1993	119 operating dept. staff, London, UK	15%	0%	-
Mc GEER 1990	88 medical and surgical housestaff Toronto, Canada	4.3%	-	-
HEALD 1990	221 medical and surgical housestaff Connecticut, USA	19%	-	-
MANGIONE 1991	86 medical housestaff San Francisco, USA	30%	38%	-
ASTBURY 1990	803 clinical staff Cambridge, UK	5%	-	-
TAIT 1994	493 anaesthetists Throughout USA	45%*	-	-
HERSEY 1994	1115 patient care staff 157 physicians 77 housekeeping staff Throughout USA	68% 20% 81%	- - -	- - -
VERGILIO 1993	97 medical students (66 surgical) New York, USA	-	-	15% (15%)
O'NEILL 1992	180 medical students 232 medical residents 110 surgical residents Los Angeles, USA	- - -	- - -	14% 21% 4%

* Author states that 45% 'sought further treatment'. An assumption has been made that this involved reporting incident to the Occupational Health Unit.

Table 5.19 Comparison of the 3 different methods of data collection, showing number of blood exposure incidents estimated to have occurred over the 6 month study period (percentage of exposures reported to the Occupational Health Unit are shown in parentheses)

METHOD OF DATA COLLECTION	Sharps exposures	Non-sharps exposures	Total
Main study	107 (10%)	47 (6%)	154 (8%)
Questionnaire survey	156 (7%)	1440 (0.25%)	1596 (1%)
reports	11	3	14

Table 5.20 Comparison of blood exposures recorded during main study with blood exposures reported to the Occupational Health Unit during the same period.

MONTH OF STUDY	SHARPS EXPOSURES		NON-SHARPS EXPOSURES	
	Recorded for study	Reported to OHU	Recorded for study	reported to OHU
JUNE	21	4	17	2
JULY	24	2	8	-
AUGUST	13	3	6	-
SEPTEMBER	11	1	7	-
OCTOBER	22	-	5	-
NOVEMBER	16	1	4	1
TOTAL	107	11 (10)	47	3 (6)

Exposures reported to the Occupational Health Unit as percentage of exposures recorded for study are shown in parentheses.

CHAPTER 6

UK OPERATIONS IN WHICH TRANSMISSION OF HEPATITIS B FROM SURGEON TO PATIENT HAS OCCURRED: COMPARISON WITH MAIN STUDY DATA

INTRODUCTION

Over the last 20 years approximately 15 outbreaks of hepatitis B amongst patients of Hepatitis B positive surgeons have been documented by the Public Health Laboratory Service (Heptonstall 1991, Heptonstall et al. 1994). In the outbreaks where the surgeon has been tested for hepatitis B e antigen, all have been found to be positive for this marker of infectivity.

For transmission to occur from surgeon to patient, blood or body fluid of the infected surgeon would have to contaminate the open wound of the patient being operated on. The most likely vehicle of transmission is a sharp instrument such as a suture needle, which has injured the surgeon and then been reintroduced into the operating field. In an observational study of operative procedures in the USA, Tokars noted that 32% of sharp objects which caused injuries to surgeons recontacted the patients' tissues (Tokars et al. 1992).

The surgical specialties which have been involved in hepatitis B outbreaks in the UK are general, obstetrics and gynaecology and cardiothoracic (Heptonstall 1991, Heptonstall et al. 1994). Transmission from surgeons in other specialties such as urology, renal, plastics and orthopaedic surgery has not been documented. In the three outbreaks involving surgeons in obstetrics and gynaecology, serological surveys of exposed patients were conducted. An attempt was made to identify operations in which there was a 'high risk' of transmission. Major operations such as hysterectomy were significantly more likely than minor gynaecological operations to result in transmission of hepatitis B from surgeon to patient (PHLS Collaborative Study Report 1980, A District Control of infection Officer 1987, Welch et al. 1989).

This study compares the main study data on all operation codes with the subset of operation codes for which the PHLS has documented transmission of hepatitis B from surgeon to patient. The analysis sought to find out whether there were special features of those operations that had been associated with transmission of HBV to patients. In particular it examined whether they had a high risk of sharps injury to the operators and whether they were particularly commonly performed. A combination of these factors could help explain why they were associated with transmission of HBV to patients.

METHOD

Details of procedures in which transmission of Hepatitis B from surgeon to patient has been shown to occur since 1975 were obtained from the PHLS. These procedures were then coded using the OPCS system. (OPCS Classification of Operations and Surgical Procedures 1990). Where two procedures were performed during one operation, the more invasive procedure was coded. For one patient who contracted hepatitis B, complicated major bowel surgery was performed on two occasions. The OPCS code chosen for this transmission represents the initial operative procedure. Operations performed during the main study with these same OPCS codes were examined. Sharps exposure rates for these operations were calculated and compared with the rate for all operations performed during the study period. Using data from the main study, the mean number of operations per code were calculated for;

1. Codes where transmission of hepatitis B has been demonstrated
2. All codes used in main study

RESULTS

Table 6.21 shows the sharps exposure rates for operations in which hepatitis B transmission has been documented. Of the 11 codes, over half had zero or very low sharps exposure rates. Three codes had a sharps exposure rate much higher than the mean of 1.6% for all operations in the study. The combined sharps exposure rate for all operation types in which transmission has been documented is 1.54%.

Table 6.22 shows the mean number of operations for all code groups used in the main study and for code groups where hepatitis B transmission has been documented. The mean number of operations performed for each OPCS code used in the main study was 12. For OPCS coded operations where hepatitis B transmission has been documented the mean number performed was 59. In other words, operations of the type where hepatitis B transmission has been documented were commonly performed operations in the main study.

DISCUSSION

A limitation of this study is that the data are from only one London teaching hospital. For some codes, the number of operations performed during the study period was very low. This means that it would be unlikely to detect any sharps exposures for these codes unless the incident rate was extremely high. For example only 28 vaginal hysterectomies were performed during the 6 month study period. Secondly it was not possible to look at some important codes since cardiothoracic surgery is not performed at the hospital.

The PHLS data on outbreaks of hepatitis B amongst patients of hepatitis B positive surgeons is likely to be incomplete. Detection of outbreaks relies on the link being made between hepatitis B infection and a history of surgery within the previous six months. It is likely that larger outbreaks are more often detected than isolated cases.

These data show that while the percentage of sharps exposures per operation was not greater in those operations where transmission has been recorded, the absolute number of operations performed was higher in the transmission group. So surgeons may have a greater chance of receiving a sharps exposure and subsequently transmitting hepatitis B, not because there is a higher **rate** of sharps exposure for these operation types, but because they are more likely to perform these operations in large numbers.

There may be factors associated with transmission which this study has not addressed. An interesting exercise, beyond the scope of this study, would be to carry out a 'lookback' on all HBeAg positive surgeons, similar to those which have been carried out with HIV positive surgeons. This should include all operations performed by these surgeons during their likely period of infectivity. It should also include those surgeons identified as carriers of HBeAg by routine screening procedures as well as those where transmission has been demonstrated. This would allow a comparison to be made between operations in which transmission did and did not occur.

Table 6.21 Sharps exposure rates in study operations where hepatitis B transmission has been documented.

Operations in which Hepatitis B transmission from surgeon to patient is documented	**OPCS code**	**Operations performed during 6 month study period**	**Number with sharps exposure**	**% of operations with sharps exposure**
Colectomy/Volvulus resection and ?repairs	H04-H30	35	2	5.7
Abdominal hysterectomy	Q07	97	5	5.15
Appendicectomy (emergency)	H01	49	2	4.08
Total hip replacement	W37	71	1	1.4
Inguinal hernia repair	T20	141	1	0.71
D & C (& MRP)	Q10	154	0	0
Cholecystectomy	J18	43	0	0
Vaginal hysterectomy	Q08	28	0	0
Revision of knee replacement	W40	28	0	0
Thyroidectomy	B08	21	0	0
Pneumonectomy	E54	8	0	0
TOTAL		**675**	**11**	**1.63**

Table 6.22 Mean and percentage number of operations for codes:
a) in main study
b) where transmission of hepatitis B has been documented

Category of operations	Number of OPCS codes used	Total number of operations performed	Mean number of operations per code
All operations in main study	516	6096	12
Operations where transmission of Hepatitis B has been documented	11	647	59

CHAPTER 7 - IMPLICATIONS AND THE WAY FORWARD

The study of blood exposure incidence and causation has confirmed some of the findings of other similar studies. Long duration of operation, high blood loss and major operations are factors which this study and several others have found to be associated with an increased risk of blood exposure. Additional risk factors, not identified by other studies, are operations in which the wound is closed with staples, the surgeon is wearing spectacles and those in which a trained nurse is acting as scrub. Of the individual surgical specialties performed at the hospital during the study period, only renal surgery was associated with an increased risk of blood exposure. Unlike some other studies, this study did not find a significantly increased risk for operations performed as an emergency or those at night. Nor were the number of surgical assistants or the grade of main surgeon relevant to the risk of blood exposure.

This study has identified a number of variables where there is the potential for change which could lead to a reduction in blood exposures. The renal team in particular should consider impervious gowns, boots and eye protection such as goggles or a full face shield. Indeed given the high rate of non-sharps blood exposures for most types of surgery recorded by the retrospective questionnaire survey, all operating teams should review their barrier protection.

But barrier methods of protection are not enough. They are unlikely to eliminate the risk of sharps exposures. The real issue is how to reduce sharps injuries, as these are the exposures which are most likely to result in transmission of blood borne virus from patient to surgeon and from surgeon to patient. Since most of these injuries are caused by suture needles some people have suggested using blunt needles wherever possible, and many surgeons are adopting this instrument. There is convincing evidence for the protective effect of double gloving, but this technique is not acceptable to some surgeons because of concerns about loss of manual dexterity. This study identified other variables where there might be the potential for change. The association between spectacle wearers and blood exposures is interesting. If spectacle wearing is a marker for age, then the finding could indicate a reduction in manual dexterity in older surgeons. This may be relevant to the whole issue of reaccreditation of surgeons, especially if such a programme were to include evaluation of manual skills and outcome of operations. The sensitive issue of spectacles, age and manual skills needs to be raised with surgeons. There could be an indication for a further study in which individual surgeons were identified, but this would need careful planning and safeguards for confidentiality.

The association between staple use and blood exposures is concerning. there is a belief that staples are protective yet there is no evidence of this in the literature. There were significantly more sharps incidents in operations where staples were used even though none of the exposures was caused by a staple. So it is still possible that staple use may reduce the risk of sharps injuries when closing the wound, but something else about these operations (or the operators who have chosen to use staples) increases the risk. There is a need to look more closely at operations in which staples are used, comparing practices in these operations with those in operations in which staples are not used.

The study of operations in which transmission of hepatitis B from surgeon to patient has been documented, has provided support for some beliefs which were previously based mainly on speculation or anecdote. The data obtained in the main study indicate that procedures which have been associated with transmission of hepatitis B to patients were performed frequently and so were more likely to have been associated with at least one sharps exposure. A further investigation, beyond the scope of this thesis, may be to look at all operations performed by hepatitis B 'e' antigen positive surgeons, comparing those in which hepatitis B was transmitted with those in which there was no transmission.

Finally the study on blood exposure reporting confirmed that very few exposures are reported to hospital occupational health units or medical centres. Even a well advertised and supported prospective study recorded fewer exposures than a retrospective questionnaire survey. This emphasizes the limitations of using statistics about blood exposure incidents from routine reporting systems. While it is important to document routinely reported exposures at the individual level, the aggregated data are of limited use for epidemiological purposes. Probably the best method for collecting detail of circumstances in which the blood exposures happen is the prospective observational study. Simply to estimate incidence the retrospective questionnaire survey may be the most complete.

Simply delineating the problem of blood exposures in surgical practice is not enough. The next step is to give the information to the surgeons in a form which can precipitate dialogue from which actions can arise to reduce the risk of blood exposure. The only people who can recommend and implement changes are surgeons and other members of the operating theatre staff. But they need the detailed information from studies such as this to allow them to make informed decisions.

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PUBLICATION INVOLVING WORK FROM THIS THESIS

Williams S, Gooch C, Cockcroft A. Hepatitis B immunisation and exposure to blood among surgical staff. Br J Surg 1993;80:714-716.

Own Work

This study was conceived and arranged by me. I was responsible for data collection, analysis and interpretation of the results. Mr Gooch provided statistical guidance and Dr Cockcroft oversaw the study.

ANNEXES

PLEASE FILL IN THIS TOPSHEET AFTER EVERY OPERATION

Patient no. |_|_|_|_|_|_|_|

Date |_|_|_|_|_|_|_|
day mth yr

Name of opern.____________

____

Routine |_| 1
Emergency |_| 2
Into theatre |_|_|_|_|
Out of theatre |_|_|_|_|
hrs min

MAIN OPERATING TEAM
(tick one box only)

General Surgeons |_| 01
Obs. & Gynae. |_| 02
Orthopaedics |_| 03
Urology |_| 04
Thoracic |_| 05
Vascular |_| 06
Neuro |_| 07
Ophthalmology |_| 08
ENT |_| 09
Oral & dental |_| 10
Plastics |_| 11
Renal |_| 12
Other____________________|_| 13

MAIN OPERATOR
(tick one box only)

Consultant |_| 1
Senior Reg. |_| 2
Reg. |_| 3
SHO |_| 4
Other |_| 5

ANAESTHETIST
(tick one box only)

Consultant |_| 1
Senior Reg. |_| 2
Reg. |_| 3
SHO |_| 4
Other |_| 5

SCRUB NURSE
(tick one box only)

G |_| 1
F |_| 2
E |_| 3
D |_| 4
Student nurse |_| 5
ODA |_| 6
Other |_| 7

PROTECTIVE EQUIPMENT WORN BY MAIN SURGEON
You may tick more than one box

Own spectacles |_| 1 0
Safety glasses |_| 1 0
Goggles |_| 1 0
Visor |_| 1 0
Plasticized gown |_| 1 0
Double gloves |_| 1 0
Other(please state)_____ |_| 1 0

____

BLOOD LOSS
Less than 500mls |_| 1
500mls or more |_| 2

Tick if fat closed with blunt needle |_| 1 0

Tick if wound closed with staples |_| 1 0

NO.OF SURGICAL ASSISTANTS |_|

TIME LIST STARTED |_|_|_|_|
(24 HR CLOCK) hrs min

	YES	NO
WAS THERE A CONTAMINATION INCIDENT OF ANY KIND?	|_|	|_| 1 2

(sharps injury, glove puncture, diathermy burn, splash etc.)

IF YES, PLEASE FILL IN DETAILS ON NEXT PAGE.

DETAILS OF INCIDENT-Please tick ONE box ONLY under each heading
If more than one, use a separate sheet for each incident and attach to this sheet.

TYPE OF INCIDENT

Sharps injury with Skin perforation |_| 1

RECOGNISED GLOVE perforation (skin intact) |_| 2

UNrecognised GLOVE perf.(blood on hand after op.) |_| 3

Splash/Soak |_| 4

Other, please state___ |_| 5

INJURED PERSON

Main operator |_| 1

Assistant |_| 2

Scrub Nurse |_| 3

Anaesthetist |_| 4

Other |_| 5

please state____________

IF A SHARP INSTRUMENT INVOLVED, WAS IT A;

Suture needle |_| 1

Knife |_| 2

Hypodermic needle |_| 3

Diathermy |_| 4

Cannula/butterfly |_| 5

Bone spicule |_| 6

Other(please name)__ _ |_| 7

MAIN PART OF BODY CONTAMINATED (tick one)

Hand |_| 1

Forearm |_| 2

Eyes |_| 3

Nose |_| 4

Mouth |_| 5

Foot |_| 6

Other(please state) |_| 7

BEFORE CONTAMINATION

WAS SKIN: Unbroken |_|

Broken |_| (eg.eczema\wound)

ACTIVITY WHEN INJURY OCCURED

Obtaining venous access by anaesthetist |_| 01

Making incision |_| 02

Passing sharp instrument:

from surgeon to scrub |_| 03

from scrub to surgeon |_| 04

Tying off vessel/cutting suture |_| 05

Dissecting tissues |_| 06

Changing scalpal blades |_| 07

Drilling |_| 08

Closing muscle and subcut |_| 09

Closing skin |_| 10

Disposing suture needle |_| 11

Closing tray |_| 12

Other(please specify_____ |_| 13

TIME OF INCIDENT |_|_|_|_|

(24 HR CLOCK) hrs mins

THE ROYAL FREE HAMPSTEAD

OCCUPATIONAL HEALTH UNIT

Director: Dr. A. Cockcroft, M.D., M.R.C.P., D.I.H., M.F.O.M.
Operational Manager: Catherine Ellinghouse, R.G.N., O.H.N.Cert.

5 Rosslyn Hill
Hampstead
London NW3 5UL

Telephone
071-794 6952
071-794 1525

9.4.91

Dear

We are concerned about the high incidence of blood contaminations reportedly occuring in operating theatres, and we are aware that concern is growing in our own theatres with the rising prevalence of H.I.V. in the community. We are also aware that the views of those at risk vary widely; from concern that not enough is being done to protect them, to the belief that these incidents are an unavoidable occupational risk.

Data collected so far are very limited. Much of the recent research has been carried out in the States, where there may be significant differences in surgical practices. Most studies have looked at surgeons alone, whereas anaesthetists, nurses and O.D.A.s are also at risk. To enable us to give practical advice on how to reduce risk of contamination, and to enable you to make informed decisions, we have designed a study which will require the co-operation of all those working in theatre. The scrub nurses have kindly agreed to complete a one page questionnaire which will be filled in along with the computer return following every operation.

Where there has been a contamination incident, a second page will be completed, again by the scrub nurse, for consistency. Contamination incidents will include glove perforations with or without skin damage, burns and splashes.

We shall be piloting the questionnaire this month, and would welcome comments. We would also be very grateful if you could alert your junior staff as we are dependent on their co-operation. All contaminations, however minor, should be mentioned to the scrub nurse. S/he will then need to know the grade of the contaminee, the specific action leading to the incident and whether the contaminated skin was intact prior to the incident.

We would like to point out that the reporting of contaminations to the Occupational Health Unit is entirely separate from this study and the usual procedures should continue to be followed.

Thank-you in advance for your co-operation - we look forward to working with you and discussing the results, with a view to reducing contamination incidents in theatres.

Yours sincerely,

Dr Anne Cockcroft
CONSULTANT IN
OCCUPATIONAL MEDICINE

Dr Sian Williams
SENIOR REGISTRAR

THE ROYAL FREE HAMPSTEAD

OCCUPATIONAL HEALTH UNIT

Director: Dr. A. Cockcroft, M.D., M.R.C.P., D.I.H., M.F.O.M.
Operational Manager: Catherine Ellinghouse, R.G.N., O.H.N.Cert.

5 Rosslyn Hill
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Telephone
071-794 6952
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Dear

I am writing to inform you about the study of blood contamination incidents in the operating theatres. This study involves YOU, so I will outline the study design and your involvement.

A questionnaire is attached to the computer return which accompanies every patient into theatres. The first page must be completed along with the computer return, after every operation. This page takes only a few moments to fill in and the Scrub nurses are very kindly taking responsibility for its completion.

The second sheet asks for details of any glove perforation or blood contamination incident (splashes, soaks etc.) involving any member of the theatre team. This includes anaesthetists, surgeons, nurses, ODAs, students and any visiting staff. The scrub nurse will again be responsible for completion of the incident sheet, so PLEASE tell him/her of any incidents. If it is more appropriate at the time of the incident, you may wish to complete the form yourself.

At the end of the study we will feed back the collated information (individuals are not being identified) to all those who work in theatres. It should enable you to make a more objective assessment of risk of blood contamination overall and also provide you with information on which activities in theatres lead to the most incidents.

It is very important that all contaminations are reported to the scrub nurse, and the details recorded on the incident sheet.

Please note that this study is entirely separate from the normal procedure for reporting needlesticks and other blood contaminations to Occupational Health. Following an incident the needlestick hotline should be used in the usual way.

I am in theatres every weekday morning between 8 and 9am; please let me know if you have any problems with the forms or any comments or questions about the study as a whole (good or bad!).

Thankyou in advance for your participation,

THE ROYAL FREE HAMPSTEAD

OCCUPATIONAL HEALTH UNIT

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Operational Manager: Catherine Ellinghouse, R.G.N., O.H.N.Cert.

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Dear

29.8.91

We have now completed three months of data collection in the blood contamination study, and I would like to thank you all for the extra effort you are putting into completing the questionnaires. We have analysed the data from the pilot study and also a sample from the first month of the study proper- both show a contamination rate of 6%. Since then however the number of reported incidents has dropped to a rate of about 2%.

While we are obviously pleased that this figure is low, from the point of view of analysis, it does not provide us with enough data to identify significant differences between operations with and without incidents.

I am very aware that the forms are an additional burden on you, however in order to obtain valuable data we really need to continue for a further three months.

I am asking all involved in the study to make an extra effort to report/fill in details of **every** blood contamination incident that occurs, however minor they may consider it to be. The success of the study depends on this.

As most of you are aware, I am in theatres every weekday morning between 8 and 9am; please let me know if you are having any problems with the forms, and also if you have any comments to make on any aspect of the study (good or bad!).

Yours sincerely,

Sian Williams
SENIOR REGISTRAR
OCCUPATIONAL HEALTH

A grim new meaning for surgical dressing

by Victoria Macdonald

THIS IS THE future of surgery in Britain. Space suits encasing doctors from head to foot, tubes to filter the air, plastic masks to protect the face.

It is a direct result of the increasing fear of Aids, which has already infected health workers in the United States after they have been cut by sharp instruments covered in the blood of people infected with the HIV virus.

Doctors in Britain, traditionally concerned with not infecting the patient, are now questioning their own safety in the operating theatre.

This is particularly so among orthopaedic surgeons, who use chisels, drills and other sharp tools for cutting in to bones, and who deal with accident victims unable to be asked if they are HIV positive. It is surgery in which blood and bone chips fly around the theatre, sometimes in minuscule particles, called aerosols.

Despite the incidence of Aids and HIV infection still being relatively low in Britain, Mr Chris Colton, consultant orthopaedic surgeon at Nottingham University Hospital, has persuaded his hospital to buy three suits.

He has made what he says is an informed and responsible decision to protect himself and his team when there is a known risk. In November, he imported the space suit from America to operate on an HIV-infected haemophiliac, and has since used it on a known drug-user.

The suit consists of a head piece, fitted with a sterile hood and visor.

Around the waist, a belt holds two battery packs and two air pumps with filters. The air is filtered up one tube into the mask at the top of the head. A second tube sucks the air back down, filters it again and pumps it back into the theatre.

This protects both the surgeon from inhaling the blood and bone particles and the patients from being contaminated by the surgeon.

The suit costs between £800 and £1,000, with the filters and hoods bought each time for about £30. The rest of the surgeon is covered by disposable paper gowns or ones made out of synthetic fabrics which can be sterilised and used again.

He wears rubber gloves covered by cotton gloves, and wellington boots which are supposed to be cleaned after every operation. Every inch of skin is enclosed, gloved or gowned.

Instruments are no longer passed by hand from nurse to doctor, and are instead placed in a dish. This prevents accidental pricks or stabs.

The latter is a result of recommendations from the Department of Health issued in January 1990, and the British Orthopaedic Association, which produced guidelines for the prevention of cross-infection between patients and staff in January this year.

Mr Colton said: "I do not go to work thinking 'is this going to be the day I'm going to get Aids?' But neither should I forget the risk to me and my staff."

He points to a recent conference in America in which orthopaedic surgeons were anonymously tested and several were found to be infected, to their horror and surprise.

However, Mr Geoffrey Newton, a senior orthopaedic surgeon at the Derbyshire Royal Infirmary, is scathing about the suits. As a member of the team which put the orthopaedic association's guidelines together, he said it was "all a bit macho" and very emotive.

"It is my feeling that people have taken the wrong tack. Instead of looking at it logically people have leaped on the aerosols risk as most important. They should be looking at the basic surgical practices, particularly in the way they handle sharp instruments."

The new space suit in operation *Photograph: Steve Connors*

Operations codes for which at least one operation had a sharps exposure

CODE	OPERATION	NO. OF OPS.	NUMBER (%) WITH SHARPS
A02	Excision of tissue of brain	24	2 (8.3)
A12	Creation of connection from ventricle of brain	37	1 (2.7)
A18	Diagnostic endoscopic examination of ventricle of brain	2	1 (50)
A38	Extirpation of lesion of meninges of brain	8	1 (12.5)
A48	Other operations on spinal cord	1	1 (100)
B04	Other operations on pituitary gland	2	1 (50)
B27	Total excision of breast	37	2 (5.4)
B28	Other excision of breast	81	1 (1.2)
C71	Extracapsular extraction of lens	328	1 (0.3)
D14	Repair of eardrum	16	2 (12.5)
F09	Surgical removal of tooth	109	1 (0.92)
F26	Other operations on tongue	6	1 (16.7)
G27	Total excision of stomach	2	1 (50)
G28	Partial excision of stomach	4	1 (25)
G76	Intraabdominal manipulation of ileum	1	1 (100)
H01	Emergency excision of appendix	49	2 (4.1)
H09	Excision of left hemicolon	3	1 (33.3)
H10	Excision of sigmoid colon	7	1 (14.3)
H33	Excision of rectum	17	2 (11.8)
H50	Repair of anus	1	1 (100)
H51	Excision of haemorrhoid	34	1 (2.9)
H59	Exision of pilonidal sinus	12	1 (8.3)
J01	Transplantaion of liver	23	5 (21.7)
J02	Partial excision of liver	5	1 (20)
J13	Diagnostic percutaneous operations on liver	1	1 (100)
J69	Total excision of spleen	11	1 (9.1)

L18	Emergency replacement of aneurysmal segment of aorta	1	1 (100)
L20	Other emergency bypass of segment of aorta	1	1 (100)
L21	Other bypass of segment of aorta	5	1 (20)
L25	Other open operations on aorta	1	1 (100)
L29	Reconstruction of carotid artery	7	1 (14.3)
L33	Operations on aneurysm of cerebral artery	19	2 (10.5)
L59	Other bypass of femoral artery	10	1 (10)
L85	Ligation of varicose vein of leg	179	4 (2.2)
L87	Other operations on varicose vein of leg	28	1 (3.6)
L91	Other vein related operations	94	2 (2.1)
M01	Transplantation of Kidney	26	1 (3.8)
M02	Total excision of kidney	14	2 (14.3)
M06	Incision of kidney	2	1 (50)
M20	Replantation of ureter	3	2 (66.7)
M30	Diagnostic endoscopic examination of ureter	23	1 (4.3)
M37	Other repair of bladder	2	1 (50)
M45	Diagnostic endoscopic examinat'n of bladder	215	1 (0.5)
M52	Abdo op to support outlet of female bladder	13	1 (7.7)
M61	Open excision of prostate	5	1 (20)
P23	Other repair of prolapse of vagina	14	1 (7.1)
Q07	Abdominal excision of uterus	97	5 (5.1)
Q09	Other open operations on uterus	25	1 (4.0)
Q22	Bilateral excision of adnexa of uterus	6	1 (16.7)
Q34	Other open operations on fallopian tubes	2	1 (50)
Q39	Diag'c endoscopic exam'n of fallopian tube	187	2 (1.1)
S27	Other local flap of skin	1	1 (100)
S36	Other autograft of skin	2	1 (50)
T20	Primary repair of inguinal hernia	141	1 (0.7)
T26	Repair of recurrent incisional hernia	2	1 (50)

T30	Opening of abdomen	71	2 (2.8)
T41	Other open operations on peritoneum	1	1 (50)
T43	Diag'c endoscopic exam'n of peritoneum	74	1 (1.3)
T69	Freeing of tendon	5	1 (20)
T87	Excision or biopsy of lymph node	30	1 (3.3)
V01	Plastic repair of cranium	11	1 (9.1)
V05	Other operations on cranium	10	1 (10)
V17	Fixation of mandible	6	1 (16.7)
V22	Primary decomp'n ops on cervical spine	19	1 (5.3)
V25	Primary decomp'n ops on lumbar spine	19	1 (5.3)
V29	Primary excis'n of cervical intervert. disc	10	1 (10)
V33	Primary excis'n of lumbar intervert. disc	40	1 (2.5)
V49	Exploration of spine	6	1 (16.7)
W19	Primary open reduc'n of # of bone & intramedullary fixation	105	2 (2)
W20	Primary open reduction of # of bone and extramedullary fixation	92	2 (2.2)
W37	Total prosthetic replacement of hip joint using cement	71	1 (1.4)
X41	Placement of ambulatory apparatus for compensation for renal failure	29	2 (6.9)
X42	Placement of other apparatus for compensation for renal failure	20	1 (5.0)
X45	Donation of organ	2	1 (50)

Operation codes where there were at least two operations with a sharps exposure, and at least 20 operations per code

CODE	OPERATION	NO. OF OPS	NUMBER (%) WITH SHARPS
JO1	Transplantation of liver	23	5 (21.7)
A02	Excision of tissue of brain	24	2 (8.3)
X41	Placement of ambulatory apparatus for compensation for renal failure	29	2 (6.9)
B27	Total excision of breast	37	2 (5.4)
Q07	Abdominal excision of uterus	97	5 (5.1)
H01	Emergency excision of appendix	49	2 (4.1)
T30	Opening of abdomen	71	2 (2.8)
W20	Primary open reduc'n of # of bone and extramedullary fixation	92	2 (2.2)
L85	Ligation of varicose vein of leg	179	4 (2.2)
L91	Other vein related operations	94	2 (2.1)
W19	Primary open reduction of # of bone and intramedullary fixation	105	2 (2)
Q39	Diag'c endoscopic exam'n of fallopian tube	187	2 (1.1)

THE ROYAL FREE HAMPSTEAD

OCCUPATIONAL HEALTH UNIT

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Telephone
071-794 6952
071-794 1525

HEPATITIS B VACCINATION

Dear

we are updating our records on Hepatitis B immunisation among hospital staff.

Our records indicate that;

1. You have completed a course of Hepatitis B vaccination and had a blood test to measure your antibody level. |_|
2. You are currently receiving a course of vaccination/awaiting the post vaccination blood test. |_|
3. You have not yet commenced a course of Hepatitis B immunisation. |_|
4. You commenced immunisation but did not complete the course of 3 injections. |_|
5. You completed the course but did not have the blood test to measure your antibody levels. |_|
6. Other(please give details)____________________ |_|
   ____
   ____

If our records are incorrect, please could you indicate below by ticking the appropriate box.

1. I have now commenced a course of Hep. B immunisation. |_|
   (date of first dose________________)
2. I have now completed the course of 3 injections |_|
   (please state when___________) but have not had a blood test.
3. I have now completed a course of 3 injections and had a |_|
   blood test.(please state when____________).
4. Other(please give details)____________________ |_|
   ____
   ____

IN ORDER TO HELP US IMPROVE OUR SERVICE, PLEASE COULD YOU ALSO ANSWER THE QUESTIONS ON THE REVERSE OF THIS SHEET.

SECTION ONE

Approximately how many blood contaminations have you had in the last month? (skin/moucous membrane splashes, cuts, needlesticks etc). |_|_|

How many of these were 'sharps' injuries? |_|_|

How many did you report to Occupational Health? (Either by visiting the department in person or using the needlestick hotine).

Sharps |_|_|
Non-sharps |_|_|

SECTION TWO

Please answer the following questions if you have not yet completed a Hepatitis immunisation course. You may tick more than one box.

I have not completed a course of immunisation because:

1. I do not consider myself at risk of Hepatitis B infection. |_|
2. I have difficulty finding time to attend for immunisation. |_|
3. I do not have enough information about risks of Hep B infection. |_|
4. I do not have enough information about Hep B vaccination |_|
5. I just haven't got round to it |_|
6. Other____ |_|
   ____
   ____

PLEASE RETURN THIS QUESTIONNAIRE TO:

DR SIAN WILLIAMS
OCCUPATIONAL HEALTH UNIT
5 ROSSLYN HILL

Thank-you for your cooperation.

SHARPS/CONTAMINATION INCIDENT FORM N° |__|__|__|__|

STAFF MEMBER/RECIPIENT: NAME...

DEPT.................... TEL...................... OH N° |__|__|__|__|__|

INCIDENT TIME |__|__|__|__|
REPORT OH TIME |__|__|__|__|

INCIDENT DATE |__|__|__|__|__|__|
REPORT OH DATE |__|__|__|__|__|__|

INCIDENT FORM? YES/NO/AWAITED
ANSAPHONE REPORTED? YES/NO
DETAILS OF INCIDENT:

First Aid at the time?

Protective Clothing Worn? YES/NO

(Specify)

PREVIOUS SHARPS INCIDENT? YES |__| 1
NO |__| 2

INCIDENT LOCATION:

WARD	|__|	1
OPERATING DEPT	|__|	2
DAY THEATRES	|__|	3
ACCIDENT & EMERGENCY	|__|	4
OUTPATIENTS/DAY CENTRE	|__|	5
CSSD/TSSU	|__|	5
X RAY	|__|	7
CARDIOLOGY	|__|	8
LABORATORY	|__|	9
OBSTETRICS/GYNAECOLOGY	|__|	10
LAUNDRY	|__|	11
RENAL DIALYSIS UNIT	|__|	12
OTHER	|__|	13

RECIPIENT'S JOB:

STUDENT NURSE	|__|	1
TRAINED NURSE	|__|	2
MEDICAL STUDENT	|__|	3
DOCTOR SURGICAL	|__|	4
DOCTOR MEDICAL	|__|	5
PHLEBOTOMIST	|__|	6
PORTER	|__|	7
LAUNDRY WORKER	|__|	8
LAB WORKER	|__|	9
THERAPIST	|__|	10
CSSD/TSSU WORKER	|__|	11
RADIOGRAPHER	|__|	12
DOMESTIC	|__|	13
AGENCY STAFF	|__|	14
HEALTH CARE ASST/N.AUX	|__|	15
OTHER STAFF	|__|	16

RECIPIENT'S HEP B IMM. STATUS:

UNVACCINATED	|__|	1
1 INJECTION ONLY	|__|	2
2 INJECTIONS ONLY	|__|	3
3 OR MORE INJECTIONS	|__|	4
HB CORE Ab POSITIVE	|__|	5

If 3 or more injections:
ANTI HBs LEVEL |__|__|__|
(if within one year)
(if > one year test now)

DATE OF ANTI HBs |__|__|__|__|__|__|

Bloods ordered: Serum Save ..... Anti HBs .....

EXPOSURE TO:	BLOOD (INCL. BLOOD-STAINED)	¦__¦	1
	OTHER BODY/LAB FLUID	¦__¦	2
TYPE OF INCIDENT:	INJURY RESHEATHING	¦__¦	1
	OTHER INJURY DURING VENEPUNCTURE	¦__¦	2
	INJURY INVOLVING SHARPS BOX	¦__¦	3
	INJURY CLEARING EQUIPMENT	¦__¦	4
	INJURY TAKING FINGER PULP BLOOD	¦__¦	5
	INJURY FROM RUBBISH BAG	¦__¦	6
	OTHER SHARP INJURY	¦__¦	7
	EYE SPLASH	¦__¦	8
	SKIN SPLASH	¦__¦	9
	MOUTH SPLASH	¦__¦	10
	SKIN SCRATCH	¦__¦	11
	HUMAN BITE	¦__¦	12
	OTHER	¦__¦	13
TYPE OF SHARP : (IF APPLICABLE)	STRAIGHT INJECTION NEEDLE	¦__¦	1
	BUTTERFLY	¦__¦	2
	OTHER HOLLOW NEEDLE	¦__¦	3
	SOLID NEEDLE	¦__¦	4
	OTHER SHARP INSTRUMENT (specify)	¦__¦	5
	SHARP TISSUE (eg BONE/TOOTH etc)	¦__¦	6
SOURCE PATIENT:	known	¦__¦	1
	unknown	¦__¦	2

Known Source Patients:
Name .... Hospital No ....
Consultant .... House doc/blp ....
Diagnosis ....
OH requested tests:date ....HBsAg......HIV Ab......HCV.......

HIV tested before	yes	¦__¦	1 date...........	HIV negative	¦__¦	1
	no	¦__¦	2	HIV positive	¦__¦	2
				not tested	¦__¦	3
HBsAg tested before	yes	¦__¦	1 date...........	HBsAg negative	¦__¦	1
	no	¦__¦	2	HBsAg positive	¦__¦	2
				not tested	¦__¦	3
HCV tested before	yes	¦__¦	1 date...........	HCV negative	¦__¦	1
	no	¦__¦	2	HCV positive	¦__¦	2
				not tested	¦__¦	3

REASONS FOR NOT TESTING KNOWN SOURCE PATIENTS:

Clinical team refused to do testing	¦__¦	1
Source patient had gone home	¦__¦	2
Staff member didn't want patient tested	¦__¦	3
Source patient had died	¦__¦	4
Source patient refused consent	¦__¦	5
Minimal/no risk incident (details below)	¦__¦	6
Other	¦__¦	7

EXAMINATION AND TREATMENT IN OHU (Sign and date all entries):

Date:

Follow-up appt. date...........time...........to see.................
Workplace visit required? ...... Form updated 20.1.94