A preliminary review: health worker access to prevention, treatment, care and support for HIV/TB

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HIV prevalence, mortality and morbidity among health workers

There is very little in the way of directly measured evidence of the epidemiology of HIV among health workers, for the obvious reason that stigma makes a considerable but unknown proportion of the health workforce reluctant to disclose or even to discover their status, while reliable cause of death data cross-classified by occupation is extremely rare. The following are some of the few sources relevant to high prevalence countries.

A very early study, in which the evidence came by way of analysis of blood donations by hospital workers in Kinshasa, Zaire was reported by N'Galy et al. In a cohort of 2002 health workers, HIV prevalence increased from 6.4% to 8.7% between 1984 and 1986. Disaggregation by age and sex showed prevalence was higher among women under age 30 (16.9%) and men under age 30 (9.3%) than among women aged over 30 (9.0%) and men over 30 (6.2%). Based on observations that HIV prevalence was similar among female nurses in different work settings where there were marked differences in nosocomial exposure, the study concluded that the high level of HIV prevalence in hospital workers was representative of that in the community and not nosocomial in origin.

A similar methodology was employed in a study by Chamberland et al (1994) undertaken in the USA, in that it relied on blood donations by health workers. In six collection centres at which direct measurement was possible, between March 1990 and August 1991, 8519 health care workers donated blood, of whom three were seropositive. This gave an overall prevalence rate of 0.04%, consistent with the low rate in the general population of the USA at that time. Using extrapolation from the results above, combined with the blood collection logs, an estimate was made that 36, 329 health workers donated blood at all 20 centres included in the surveillance system, of which 27 were seropositive, producing a slightly higher estimate of 0.07% prevalence. Of these 27, seven did not return for interview and therefore confirmation of their occupations. Of the 20 confirmed health workers, 11 reported non-occupational risks, and among the 9 remaining, 3 described occupational exposure.

Shisana et al (2004) reported on the results of using oral fluid samples taken from a random sample of health workers in four provinces of South Africa. There were 721 health workers in the sample drawn, of whom 595 health workers aged 18+ agreed to be tested (response rate 82.5%). The overall prevalence was found to be 15.7%, comparable to national prevalence in 15-49 cohort of 15.6%. Public sector employees had higher prevalence than others; males than females; young adults 18-35 than mature adults 46+; non-professionals than professionals, lower educational attainment than post matric---but all these differences failed to reach statistical significance. The two variables that were statistically significant were race---Africans had higher prevalence---and marital status, with the unmarried having higher prevalence than the married. The study also reports low availability of inputs to universal precautions.
More recently, Connelly et al (2007) have reported the results of a study of prevalence among 2032 professional and support staff at two hospitals in Gauteng, South Africa. Volunteers provided oral fluid or blood samples. Overall prevalence was 11.5%; by occupation, prevalence was highest among student nurses (13.8%) and nurses (13.7%). The highest prevalence by age was in the 25-34 years group (15.9%). A high proportion had CD4 counts below 200 (19%), and a further 28% counts between 201 and 350, indicating eligibility for ARV treatment.

WHO, Taking stock: Health worker shortages and the response to AIDS, WHO/HIV/2006.09 (2006) has an unreferenced statement that 17% of Botswana’s health workforce was lost to AIDS between 1999 and 2005. The main text at p2 includes a statement “Estimates show that Botswana lost 17% of its health workforce to AIDS between 1999 and 2005”. In a side heading at p6, this has become “In Botswana, between 1999 and 2005 a staggering 17% of the health workforce died from HIV”.

In the absence of (much) direct evidence, there is heavy reliance on inference from studies of overall mortality among HCWs, or even from overall attrition rates with no break down of proximate causes. A pioneering example of the gross mortality approach was Buve et al (1994) which examined mortality among female nurses in the face of the AIDS epidemic. The results from a survey of two hospitals show mortality increasing from 2 per thousand in the period 1980-1985, to 7.4 in 1986-1988, to 26.7 1989-1991. What makes the inference that HIV was the cause of death plausible is that mortality rates among HCWs show sharp rises at the same time as HIV prevalence rates in the general population were rising. What gives some pause is that the absolute numbers of deaths in the three time periods were 1, 2 and 7.

A more recent example using the gross attrition rate approach was the Zambia HIV/AIDS Workforce Study (2004) which at Table 37 gives the annual loss rates for cadres making up the HIV/AIDS workforce from the selected sites averaging 30%. Although these losses are detailed by cadre, they are not broken down by proximate cause, so it is not possible to extract overall mortality rates, let alone cause of death, from these data. Nevertheless, it is plausible that HIV/AIDS contributes powerfully not only to losses through death in service but also to medical retirements, since it is anecdotally reported that infected health workers frequently resign when their disease reaches an advanced stage rather than disclose to colleagues. Moreover, HIV/AIDS is likely to be a contributory factor in decisions to resign or to emigrate.

Tawfik and Kinoti (2006) produced a background paper for the World Health Report 2006. At p3, this paper has a figure derived from ABT Associates “The impact of HIV/AIDS on the Health Sector in Botswana”, 2000, showing projected HIV prevalence among health workers rising from around 1% in 1995 to 9% on
an age-adjusted basis (6% unadjusted) by 2010. At p9, it quotes data from
Mozambique, reported in Decima E, Dreesch N and Kairie W, Human capacity
development assessment and strategy development for the health sector in
Mozambique, draft report, 2004, showing death as proportion of total attrition
increasing from 36% in 1999 to 82% in 2003.

The Malawian health workforce study (Bongololo G et al, Are health workers
accessing HIV/AIDS prevention, treatment, care and support services in Malawi?
2007) states flatly that "HIV prevalence figures among health workers in Malawi
are not available". It goes on to report (presumably annual) figures for losses
due to death from the Ministry of Health’s Health Sector Human Resources Plan
(1999) as: registered nurses 2.7%; clinical officers 2.1%; medical assistants
2.1%; and enrolled nurses/midwives 1.9%. It also quotes the results of a study
by the Commonwealth Regional Health Community Secretariat, that half of all
losses from service were contributed by death, and of these, 80% were
attributable to HIV/AIDS. In a similar vein, it reports increasing attrition over the
period 1990-2000, with deaths a rising proportion of total attrition, with the source

The Kenyan Health Worker Survey (2005) did not seek to ascertain HIV
prevalence in the workforce, but did record the personal impact of HIV in other
ways. Nearly 40% of health workers reported an immediate family member who
was HIV positive or who had died of AIDS; in Nyanza Province, this went up to
60%. Around 20% of health workers were caring for an HIV positive immediate
family member at the time of the survey: in Western and Nyanza Provinces,
these figures were 32% and 40% respectively.

A different approach was taken by Makombe et al (2007) in a national survey of
the impact of rapid scale up of antiretroviral therapy on health workers in Malawi.
They made no attempt to ascertain overall HIV prevalence in health workers, but
they did attempt to measure the gains in life expectancy among HIV positive
health workers who accessed ART. They identified 1024 health workers in the
national ART cohort (2% of all patients) and estimated survival probabilities at 6,
12 and 18 months, which were 85%, 81% and 78% respectively. From this data
they computed the gains in available staff time (1000 staff days per week) and
compared this with the total staff days required to deliver ART to the national
cohort (916 at the time of the survey).
How significant is occupational exposure to HIV?

There is an extensive literature which reports the frequent occurrence of sharps injuries to health workers. If the sharp is contaminated by blood or certain other bodily fluids from an HIV infected person, these injuries can potentially provide the route through which health workers themselves become infected. In theory, and in a small number of reported incidents, HIV can also be transmitted from infected patients to health workers via bodily fluids coming into contact with non-intact skin or mucous membranes, but it is through percutaneous injury that the great majority of occupationally-acquired infections are believed to be transmitted. There is also an extensive literature which reports the pervasive fear among health workers of occupational exposure to HIV, a fear heightened by the frequent absence or insufficiency of infection control mechanisms. It should be noted that it is not only HIV that may be transmitted in this manner; hepatitis B and C, syphilis and other blood-borne pathogens may also be so transmitted.

The term “needlestick” is used in two senses in this literature: on some occasions, it is used in a narrow sense to refer strictly to injuries caused by handling needles, and sometimes in a broader sense to refer to injuries caused by needles and other sharp objects capable of penetrating the skin, such as lancets and broken glass. In some cases, the broader meaning is indicated by a more explicit term, such as “needlestick and sharps injury (NSI)” or “percutaneous injury (PCI)”.

One clear observation is that sharps injuries are much more frequent in developing countries than in rich countries, where attention to injection safety in recent years has sharply reduced the incidence of sharps injuries. For example, Wilburn (2004) reported a decline in needlestick injuries in the USA from an estimated 1 million in 1996 to 385,000 per year in 2000. “Reasons for the success in decreasing needlestick and sharps injuries may be attributed to the elimination of needle recapping and the use of safer needle devices, sharps collection boxes, gloves and personal protective gear, and universal precautions”. A review by Elder and Paterson (2006) of 24 studies reporting sharps injury rates in the UK found large differences between the extremely low rates obtained through standard reporting systems (range 0.0078-0.0515 injuries per person per year) and those obtained by retrospective questionnaires of clinical populations (range 0.03 to 0.284). A review by Lee et al (2005) of the situation in USA makes the same point about differences attributable to the method of reporting, and offers a very wide range (0.028 to 0.839) needlestick injuries per person per year. In Italy, a large scale study by Argentero et al found a rate of 0.185 percutaneous injuries per person/year, and a rate of mucocutaneous exposures of 0.06 per person year.

By contrast, in developing countries the use of auto-disabled syringes has generally been deemed too costly, while there are pervasive reports of inadequate supplies to make universal precautions feasible. In addition, a high
proportion of health workers report insufficient training. In these circumstances, much higher rates of sharps injuries are to be expected in developing countries.

A joint WHO/ICN presentation available on the web (http://www.who.int/occupational_health/activities/3epidemio.pdf, consulted 16 November 2008) reports data from a number of developing countries on the frequency of needlestick injury. These are expressed either as the percentage of health care workers with at least one injury per year, or the average number of injuries per person per year. The percentages ranged up to 91% in a sample of junior doctors in South Africa, and in terms of frequency from 2-3 NSI/year in Kenya to 4.9 NSI/year in Egypt. It was notable that in the same studies, two handed re-capping of needles (a procedure commonly associated with needlestick injury but one that is avoidable) was frequent practice, with a range from 32% to 60% of health workers surveyed.

An article by Taegmeyer et al (2008) in Kenya reporting a five year study among 650 health workers in Thika District at risk of needlestick injuries found a rate of 0.97 per worker per year. Nsubuga and Jaakkola (2005) reported from a sample of 526 nurses and midwives employed at Mulago Hospital, Kampa, Uganda that 57% had experienced at least one needlestick injury in the past year, and only 18% reported never having received such an injury. The rate of injury was 4.2 per person per year. Factors associated with needlestick injuries were lack of training, working more than 40 hours per week, recapping needles most of the time, and not using gloves when handling needles. A study by Gurubacharya et al (2003) found that 74% of staff at Kathmandu Teaching Hospital had a history of needlestick injuries. Chako and Isaac (2007) reported a rate of 1.58 percutaneous injuries per person/year among medical interns in a tertiary care hospital in Indian Punjab. Tarantola et al (2005) conducted a study of staff in 43 hospital wards across three West African countries. Among 1241 health workers, 567 (45.7%) had sustained at least one accidental blood exposure, of which 80.1% were needlestick injuries, giving rise to an estimated incidence of 0.33 percutaneous injuries per health worker per year. One of the highest rates reported was by Gumodoka et al (1997) in which it was estimated that among staff of nine hospitals in Mwanza Region, Tanzania, the average health worker was pricked five times and splashed nine times per year. Over shorter time spans, “9.2% of 623 nurses and 1.3% of 118 doctors and medical assistants interviewed had pricked themselves in the previous week; 22% of nurses working in labour wards and 25% of those working in operating theatres had pricked themselves in the previous month. Among the 50 laboratory technicians interviewed, 25% had been pricked in the previous month”.

A very recent article by Zhang et al (2009) reports extremely high levels of exposure to bloodborne pathogens occurring among the staff of a state owned general referral hospital in Beijing, China. However, it is important to note that this study differentiates percutaneous injury (PCI), mucous membrane exposure (MME) and exposure via non-intact skin, and the headline figure of 7.5 exposure
incidents per person per year is for the sum of all three modes of exposure. For PCI alone, the average figure for all workplace sites was 1.8. The total of 7.5 exposures is boosted by an average of 4 MME and 1.7 exposures through damaged skin, types of exposure which are either ignored by other studies or which are reported to occur at significantly lower frequencies. The highest frequencies of total exposures were found to occur in the delivery room, the haemodialysis unit and the operating room, but the highest frequency of PCIs was found in the supplies room, which is responsible for the sterilization of instruments.

Mehta and colleagues (2005) reporting on a series of needlestick injuries at a tertiary hospital in Mumbai, India, did not directly calculate the incidence of injury, but did describe the sources in some detail. Of 380 reported incidents, 254 were from known sources, but 126 were from unknown sources including garbage bags and operating theatre instruments. Most injuries occurred during intravenous line insertion (112) followed by blood collection (69), surgical blade injury (36) and recapping needles (36). The injuries were experienced by nurses (45%), attendants (33%) doctors (11%) and technicians (11%). A similar study by Gupta et al (2008) reporting from a teaching hospital in Pune, India, found an exposure rate of 0.095 per person year, with the most frequently affected staff being house staff, particularly interns whose exposure rate was 0.47. Personal protective equipment was used in only 55.1% of these exposures. A study by Stein et al (2003) investigating attitudes to infection control by doctors and nurses in 3 teaching hospitals in Birmingham, UK, found that doctors consistently de-emphasised the importance of, and reported poor compliance with, handwashing between patients and glove wearing when taking blood. They were more likely than nurses to re-sheath used needles manually, and to fail to report needlestick injury.

A study by Moro et al (2007) reported a rate of 0.65 sharps injuries per person-year for hospital workers in the Dominican Republic, where unsafe recapping was frequently observed, but a lower figure of 0.13 for staff of immunisation clinics. Only 4% of hospital workers had received training in injection safety, compared with 77% of staff in immunisation clinics.

A much lower rate of 0.07 was reported by Shiao et al (2008) from fourteen hospitals in Taiwan. From a university affiliated hospital in Korea, Oh et al (2005) reported a still lower rate of 0.026 for the more inclusive concept of occupational blood exposures, within which sharps injuries accounted for 94% of events. Park et al (2008) reported 0.026 needlesticks and sharps injuries per health worker per year from a tertiary hospital in Busan, Republic of Korea, over a 6 year period, 2001 to 2006.

Despite all the attempts enumerated above to measure the frequency of sharps injury as accurately as possible, it is important to bear in mind the observation that injuries are widely under-reported for a variety of reasons, including fear of
reprimand, ignorance of the dangers inherent in the injuries, ignorance of the option of post-exposure prophylaxis, and fear of compulsory HIV testing. While these observations span a very wide range of frequency of needlestick and sharps injuries, they do point to a situation in developing countries, and in sub-Saharan Africa in particular, where elevated rates of percutaneous injury, high HIV prevalence, and widespread absence or inadequacy of infection control mechanisms coincide.

While needlestick and sharps injuries may be very frequent, the probability of acquiring HIV infection in each individual episode of exposure to a contaminated source is low. A widely quoted figure, which is repeated in the latest WHO/ILO guidelines on PEP (2007) is 0.3% or 3/1000 (the corresponding figure for mucosal exposure is 0.09%). However, it is noted that this figure is derived from experience in well-resourced countries, and may not apply to countries with higher prevalence, fewer resources and lower safety standards. A systematic review by Young et al (2007) notes that HIV transmission was significantly associated with deep injury, visible blood on the device, procedures involving a needle placed in the source patient’s blood vessel, and terminal illness in the source patient. In slightly different language, these observations are repeated in Wilburn and Eijkemans (2007), who go on to observe that “Taken together, these factors can increase the risk of transmission of HIV from a contaminated sharp to 5%”.

A modelling exercise by Pruss-Ustun et al (2003) combined pooled estimates of the frequency of sharps injuries and risks of transmission to generate estimates of sharps associated infections in health care workers (professional categories only) by type of infection (HBV, HCV and HIV) and country groupings by mortality strata. The mean estimate for HIV infections was 1000 globally, but subject to wide lower and upper limits (200-5000). For Africa alone, the corresponding figures are a central estimate of 720 HIV infections, with a range of 130-3510. As a share of all HIV infections acquired by health workers, the estimate is that occupationally acquired infections are 4.4% globally, 4.5%-5% for Africa. These results suggest a slightly higher risk of health workers acquiring HIV occupationally than earlier estimates that 2.5% of total infections were so acquired (WHO 2002). Whichever figure is taken, it is abundantly clear that the great majority of HIV infections are acquired non-occupationally. This is consistent with the observation made above, that where HIV prevalence in health workers is directly measured, it is found to coincide closely with adult prevalence in the general population. There is an equally clear inference which follows from this finding, which is that any attempt to reduce the burden of HIV among health workers should not neglect non-occupational transmission. While the health sector is busy urging employers in other industries to introduce HIV prevention programmes in the workplace, it is equally (or more so!) incumbent on health employers to provide similar services to the health workforce.
Although occupational transmission accounts for only a small proportion of HIV infections among health workers, they merit exceptional efforts to reduce their occurrence. Because employers are responsible for the environment in which occupational transmission occurs and the means of achieving a safer work environment have already been demonstrated in developed countries, and because all employers have a duty under existing labour conventions to minimise risks of occupational accidents and diseases, the current elevated risks to health workers in developing countries should be regarded as ethically unacceptable.

A further reason for making exceptional efforts is that while the objective risk of acquiring HIV occupationally may be modest, the perceived risk in the minds of health workers is large, with consequent effects both on their willingness to work in a high prevalence environment, and their stigmatising behaviour towards patients and colleagues who are infected. There is an extensive literature reporting the fear that health workers have of occupational exposure. Dieleman et al (2007) found that in Mplika and Mazabuka districts of Zambia, 76% and 79% respectively of respondents expressed fear of infection in the workplace. Aisien and Shobowale (2005) studied 120 health care workers in the Benin City University Teaching Hospital, finding that 25% had serious misconceptions about the modes of HIV transmission, including over estimation of occupational risk, and 40% exhibited discriminatory attitudes to people living with HIV and AIDS. Another Nigerian study by Reis et al (2005) involving 1021 health professionals revealed discriminatory attitudes, with 9% of respondents refusing to care for HIV positive patients, 9% had refused HIV positive patients admission to hospital, 59% agreed that HIV infected patients should be on a separate ward, while 91% agreed that staff should be told when a patient is HIV positive so that they could protect themselves. Providers who reported working in facilities that did not always practise universal precautions were more likely to report negative attitudes towards people with HIV/AIDS. Providers who reported less adequate training in HIV treatment and ethics were also more likely to report negative attitudes.

It is not only in Africa that fear is rife. Kermode et al (2005) found that the risk of occupational infection was perceived to be high in a sample of 266 health care workers in rural India. A study of medical students at a medical college in New Delhi by Lal and colleagues (2006) revealed that 68.3% perceived themselves to be at high or very high risk of acquiring HIV during their medical career (72.9% had experienced needlestick injury). Nearly a quarter thought that the risk of exposure might make students lose interest in the medical profession, and 3.1% were personally considering alternative careers. In Bangladesh, Islam et al (2002) found poor knowledge of HIV among staff of the ICDDR:B Centre for Health and population Research, and half of them had poor attitudes towards persons with HIV. Anderson et al (2003) found that more than 90% of hospital based health care professionals in Guangxi Zhuang Autonomous Region, China, expressed apprehension about contracting HIV, and nearly 24% expressed reservations about caring for infected patients. Quach et al (2005) found very
weak understanding of the modes of transmission of HIV among a sample of 151 physicians, and only one third had positive attitudes towards HIV patients. Askarian et al (2006) reported that, from a sample of 1098 nursing staff at hospitals affiliated to the University of Shiraz, Iran, nearly half stated that they would not want to have to care for patients with AIDS and that, if assigned to care for such a patient, they would ask to be assigned elsewhere. In Serbia, Kocic et al (2008) found that 89% of health personnel perceived high professional risk of acquiring HIV infection, and more than four-fifths agreed that their personal protection was more important than the confidentiality of patients' HIV status. Despite this widespread fear of exposure, only 29% used adequate protection in their daily work.
Prevention of sharps injuries

Unlike some other topics explored in this literature review, there is a huge volume of publication on prevention of sharps injury. Much of this material is assembled in a toolkit for the prevention of needlestick injury, located on the WHO website at www.who.int/occupational_health/activities/pnитoolkit/en/index.html accessed 17 and 18 March 2009. Subsequent references to the titles of documents (with no date or author information) are all to this material.

Following the hierarchy of controls in occupational health (see below) elimination of the hazard is the first and the preferred approach to the reduction of the risks to health workers and patients of exposure to bloodborne infections by needlestick and other sharps injuries. It is estimated that more than 16 billion injections are given in developing and transition countries each year, of which 95% are given for therapeutic purposes and only 3% for immunizations (Injection safety—first do no harm). “The majority of therapeutic injections are unnecessary” (Guiding principles to ensure injection device security), presumably because either the drug is unnecessary given the condition of the patient, or there are equally effective oral formulations available. A presentation (Comparison of pharmacokinetics and efficacy of oral and injectable medicine) reached the following conclusions:

- There is minimal to no benefit of intramuscular versus oral administration of drugs in terms of pharmacokinetics
- Intravenous administration results in shorter onset of action and for some drugs higher bioavailability and peak serum levels
- The issue of onset of action is clinically relevant only in life threatening illness
- The pharmacokinetic advantage of parenteral over oral drugs does not translate to better clinical outcomes in mild-moderate illness
- Even in serious illness, sequential therapy within 2-5 days can be as effective as prolonged parenteral courses.

While other forms of exposure can transmit bloodborne infections, it is estimated that 90% of cases of occupational transmission of HIV occur as a result of skin penetration by hollow bore needles, so reduction in use of such needles is the most powerful means of reducing sharps injury at source. Other means of eliminating the use of needles are jet injectors (suitable for some immunizations), and needless connectors for IV delivery systems or urinary catheters. A presentation (Efficacy of control measures used to prevent needlestick injuries) quotes an article by Yassi et al (1995) describing the experience of an 1100 bed tertiary hospital in Winnipeg, Canada, where 26% of needlestick injuries were related to the heparin-lock intermittent intravenous procedure. Adoption of a needleless IV system resulted in a 78.7% reduction in line-related injuries, and contributed to a 43.4% reduction in injuries from all procedures. Mendelson et al (1998) report a clinical trial of a needleless intermittent intravenous system

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compared with a conventional heparin-lock system. During the study, 35 exposures were recorded, eight connected with the conventional device, none with the needleless system. Ippolito et al (1994) reported that needleless IV systems were already standard in Italy. However, not all commentators are so positive. Orenstein (1999) says: "Although these new systems are marketed as safe, many have not been widely tested and are not fail-safe. Each ... has limitations and potential benefit when applied in the appropriate circumstances". Russo et al (1999) made three points: not all the reported reduction in injury is attributable to the device (training and greater awareness could contribute); needlestick injuries prevented by needleless systems are low risk; there were increasing reports of bacteremia associated with the devices (a point explicitly contradicted by the Yassi study). Also, the crossover design of the Yassi trial obviates the first objection, although the absolute number of observations was small. Roodhouse and Wellstead (2006) note that in the urine sampling environment, there is now available a device, a new needle free port, designed specifically to reduce the occupational risk.

Acknowledging that it is not feasible to eliminate injection needles entirely, or other sharp objects, particularly those used in surgery, the next level of control is to engineer devices which are less likely to cause penetrating injury. Various safety devices are described in two documents: (Preventing needlestick injuries in health care settings - NIOSH) and (Safe needles save lives - ANA). Examples of needle protection systems are retractable needles, needles with a protective sheath, hinged re-recap needles and self blunting needles. In a review of seven studies of needle protective devices, Trim et al (2003) concluded "results ... demonstrate that needle protective devices reduced associated sharps injuries by 23-100%, with a mean of 71%, compared with conventional products".

One of the identified areas of danger is disposal of needles after use. The generic solution is the safety box or sharps container made of leak-proof and puncture-proof material, but the conventional "straight drop" design allowed staff to overfill the box, resulting in needlestick injury from protruding needles. Hatcher (2002) describes a process whereby a multidisciplinary committee drawn from the staff of the Vanderbilt University Medical Center, USA, reviewed the design of sharps containers and negotiated a modified design with a manufacturer. After a series of modifications, a "letter-drop" style was adopted, which led to a two-thirds reduction in related needlestick injuries. An article in Health Devices (2003), no authors named, reviewed 8 models of sharps container and rated 1 as Preferred, 4 as Acceptable, 2 as Not Recommended and 1 as Unacceptable.

Other devices may benefit from re-engineering. These include lancets and scalpels that retract after use, the use of plastic blood collection tubes in preference to glass tubes, and the use of blunt suture needles, though in the last case, the evidence is contradictory. Mingoli et al (1996) describe a trial at a university hospital surgery department in Italy where 200 emergency surgery
patients were randomly assigned to undergo closure of the abdominal fascia with either a round-tipped blunt needle or a sharp needle. Surgeons had 14 needlestick injuries and 76 glove perforations. Sharp needles were responsible for all injuries and 76% of perforations, leading to the conclusion that blunt needles reduce sharps injuries and improve safety for surgeons. A review by Elder and Patterson (2006) of UK studies concluded that the greatest reduction in injuries was achieved by blunt suture needles and safety cannulae. On the other hand, Wilson et al (2008) concluded, following a randomized prospective trial with 217 subjects and 221 controls at a university hospital in USA that the use of blunt needles does not reduce glove perforations during obstetrical laceration repair, and moreover, physicians reported increased difficulty performing the repair with blunt needles.

Administrative controls embrace a wide range of measures (Efficacy of control measures used to prevent needlestick injuries) including the adoption and implementation of universal precautions, the allocation of resources demonstrating commitment to health worker safety, surveillance of sharps injuries, the creation of a needlestick prevention committee, consistent training in the use of safe devices, and an exposure control plan.

The basic idea underlying universal precautions, now increasingly designated as standard precautions, is that all patients, regardless of known sero-status, should be regarded as potentially infectious and treated accordingly, thereby avoiding any false sense of security engendered by a negative test result. An Aide Memoire on Health care worker safety published by WHO in 2003 lists as components of universal precautions: hand washing after any direct contact with patients, no needle re-capping, safe collection and disposal of sharps, gloves for contact with body fluids, non-intact skin and mucous membranes, wearing a mask, eye protection and a gown, covering cuts and abrasions, cleaning up spills of blood and body fluids, and a safe system for hospital waste management and disposal.

However, it is only possible to implement universal precautions if the supplies are present, which as Corbett (2007) found in the 5 country study is far too infrequently the case in low income countries. The reluctance of health service managers to purchase safety equipment is probably a false economy even from a narrow financial standpoint when the value of working time lost and treatment of injuries and subsequent diseases are taken into account. Even the initial outlay could be offset by the simultaneous adoption of policies to reduce unnecessary injections, as observed by Wilburn and Eijkemans (2004). Issues of cost and cost savings are discussed further below in this section.

At facility level, a needlestick prevention committee, with adequate frontline staff representation, can play a critical role in defining bloodborne pathogen exposure problems, develop surveillance mechanisms, evaluating, selecting and
implementing safe devices, and ensure training in safe procedures (Needlestick Prevention Guide).

An Exposure Control Plan is a management tool for setting institutional policy for the entire range of controls over sharps injury, including as well as prevention of needlestick injury, post-exposure evaluation and follow-up, and Hepatitis B vaccination. It should clearly locate the responsibility for implementing the plan in a named individual or department. It may be too much to expect that hard pressed facility managers will spontaneously adopt all the necessary measures to protect the health and safety of health workers. In the USA, there is legislative support in the form of a federal law, the 2000 Needlestick Safety and Prevention Act which requires the use of safety engineered devices, detailed recording of needlestick injuries, and the use of an exposure control plan, which is overseen by the Occupational Safety and Health Administration with enforcement powers.

The counterpart of needlestick prevention is the adoption of safe injection practices, as set out in various publications, some joint, of WHO, the Safe Injection Global Network (SIGN), and ICN. "A safe injection does not harm the recipient, does not expose the health worker to any unavoidable risk and does not result in waste that is dangerous for the community" (Guiding Principles 2001). To obviate the risks from re-use of injection devices without adequate sterilization, WHO recommends the use of a new, single-use injection device for each injection and for the reconstitution of each unit of medication. It recommends single rather than multi-dose vials to prevent contamination of the medication (Giving safe injections). Where re-usable injection equipment is still deployed, it recommends steam sterilization in a container equipped with colour coded indicators which show whether indicated conditions of time, steam pressure and temperature have been met. The safe collection and disposal of used sharps is an integral part of the safety cycle, discussed further below. The need for all staff to be adequately trained and supervised in the correct procedures, to report injuries and to know how to access post-exposure evaluation and follow-up are essential complements to device selection.

The next level of controls is work practice controls. Examples include the avoidance of needle re-capping, or if it is necessary, the use of the one-handed "scoop" technique; the placement of sharps containers at eye level and within reach; regular checking of sharps containers and their removal before they are full. Although it is claimed (Efficacy of control measures used to prevent needlestick injuries) that implementation of a "no recapping" policy produced a two-thirds reduction in needlestick injuries at the study sites, a divergent finding was made by Edmond et al (1988). They did a before and after observational study of bedside nurses at a US university medical centre. In the before stage, they found a 93.9% frequency of recapping. Observations after an education programme, and introduction of a hospital wide bedside needle disposal system, found a 94% frequency of recapping. The authors concluded that educational programmes may be ineffective, and alternative methods of prevention may be
necessary. Porta et al (1999) point out that although recapping is prohibited by the OSHA standard in the US, it continued to be an identified cause of injury. A review by Rogers and Goodno (2000) evaluating interventions to prevent needlestick injuries found one study which evaluated a "no-touch" technique used by surgeons during wound closure and found a significant decrease in the number of glove perforations compared to the traditional "hand in" method of closure. Tarantola et al (2006) found that French surgeons were somewhat cavalier in their take up of safety measures available to them. Less than 20% of operating staff double gloved for all patients and procedures, while 55% of surgeons never used blunt suture needles in those hospitals where they were available.

The final level of control is personal protective equipment, in the form of gloves, gowns, masks and goggles. While these forms of protection are clearly effective against blood splashes, they do not provide much protection against penetrating injury, and indeed, the standard advice is that gloves should not be worn when giving injections. Surgery is a different matter, and there is intense discussion about the merits or otherwise of double gloving. A Cochrane review by Tanner and Parkinson (2002) examined randomized controlled trials that investigated various styles of gloving, and concluded that "Wearing two pairs of latex gloves significantly reduces the number of perforations to the innermost glove [and] does not cause the glove wearer to sustain more perforations to the outermost glove". Twomey (2003) referred to this review, and added "Other studies report a risk reduction of 70-78% attributed to double gloving". She noted surgeons' objections to double gloving included poor fit, loss of tactile sensitivity and increased cost, but reported that "Several studies have reported good acceptance of double gloving without loss of tactile sensitivity, two point discrimination, or loss of dexterity". In an update of the Cochrane review by Tanner and Parkinson (2006) the original main conclusion was reinforced, with the pooled results of 14 trials of double gloving showing significantly more perforations to the single glove than to the innermost of the double gloves (OR 4.10, 95% CI 3.30 to 5.09). This positive finding is confirmed in a range of countries and surgical specialties: Marin-Bertolin et al (1997) plastic surgery in Spain; Thomas et al (2001) general surgery in India; Aarnio and Laine (2001) vascular surgery in Finland, and Laine and Aarnio (2001) all forms of surgery in Finland; Kovavisarech and Seedadee (2002) gynaecological surgery in Thailand; and Punyatanasakchhai et al (2004) episiotomy repair in Thailand.

Although not clearly classified as such in the hierarchy of controls, hepatitis B vaccination should also be counted as part of personal protection. Unfortunately, there is no vaccine effective against the other two bloodborne pathogens of greatest concern, HIV and hepatitis C.

One of the outstanding questions is the cost of implementing these various safety measures. There are many studies, for example Tan et al (2001), which claim that the use of protective equipment is cost effective, because the cost of the
equipment itself is far outweighed by the costs associated with the investigation and treatment of the injuries and their sequelae in the form of chronic illness. There are several problems with these studies, their interpretation, and their implications for developing countries. The first problem is that they are all North American; this is significant, because the relative prices of equipment and health worker salaries are very different from those that obtain in developing countries. The second problem is that each study tends to focus on only one component of the ratio, either the costs of the protective equipment, or the costs consequent on injuries, but not both. The third problem is that even when absolute figures or unit costs are given, it is difficult to place them in context, because comparable figures for relevant aggregates are not provided. A fourth problem is that the range of results is extremely wide.

Focusing only on the incremental cost of an intervention, the introduction of a needleless IV system in a tertiary hospital with 1100 beds, Mendelson et al (1998) report the annual incremental cost for the hospital-wide implementation of the device to be US dollars 82,845 or 230 dollars per 1000 patient-days. In isolation, it is hard to know what to make of this information. Other studies looked at the costs imposed by needlestick injuries, but did not address the cost of interventions to reduce them. WC Lee et al (2005) estimated the short term costs associated with needlestick injuries among a group of diabetes nurses. They included the costs of medical follow up to the injury, including PEP, and the value of working time lost, but not the costs associated with long term sequelae. They calculated a unit cost of US dollars 235-328 per injured nurse, which they scaled up to a national cost of US dollars 65 million annually. JM Lee et al (2005) calculated a cost per injury ranging from US dollars 51-3766, again excluding the costs of long term sequelae. Leigh et al (2007) made the most comprehensive calculation of costs stemming from needlestick injury. Their figures relate to all US health workers, but it is possible to infer unit costs from their estimate of 644,963 total needlestick injuries in 2004 and 49% of those generating costs. They calculated medical costs at 107.3m, lost work at 81.2m, for a total of 188.5m (all figures in US dollars). Interestingly, only 4% of medical costs were associated with the treatment of 34 persons with chronic HBV, 143 with chronic HCV, and 1 with HIV, whereas 41% of lost working time was attributed to these long term effects. Yassi et al (1995) gave percentage incremental costs associated with the introduction of a needleless IV system ranging from plus 5.3% to minus 5.7%, from which they concluded that they system paid for itself. Hatcher (2002) quoted annual savings of US dollars 62,000 to a university medical centre resulting from the introduction of an improved design of sharps container. Although the container itself was more expensive, the net savings resulted from the reduced cost of dealing with fewer needlestick injuries.
Post exposure prophylaxis (PEP)

Administration of antiretroviral drugs for a period beginning shortly after exposure to HIV infection is a means of preventing the establishment of the virus in the body. According to Young et al (2007), "Animal models show that after initial exposure, HIV replicates within dendritic cells of the skin and mucosa before spreading through lymphatic vessels and developing into a systemic infection. This delay in systemic spread leaves a "window of opportunity" for post exposure prophylaxis (PEP) using antiretroviral drugs designed to block replication of HIV. PEP aims to inhibit the replication of the initial inoculum of virus and thereby prevent establishment of chronic HIV infection". PEP for HIV is potentially applicable in a number of contexts, including following occupational exposure, sexual assault and after consensual sex in some circumstances. While the chief concern for health workers is occupational exposure, the WHO/ILO guidelines (2007), hereafter the guidelines in this section, acknowledge that it is not only health workers but also others such as police, security personnel, waste collectors and firemen who are at occupational risk. They also point out that health workers are at increasing risk, as more people become infected and survive for longer in contact with health services.

The evidence for the efficacy of PEP comes largely from a single case-control study (Cardo et al 1997) involving health care workers from France, the United Kingdom and the United States of America that revealed a strong inverse association between the likelihood of HIV infection following a needlestick injury and the post exposure use of zidovudine. It is not claimed that PEP is 100% effective in preventing the establishment of HIV infection. The joint WHO/ILO guidelines (2007) note the existence of several case reports and cohort studies which document some PEP failures. Flexner (1998) quotes a CDC study that showed that AZT use of any kind was associated with an 81% reduction in the risk of seroconversion compared with controls not given AZT, and this figure (or its approximation to 80%) is widely replicated, for example in Wilburn and Eijkemans (2004). Both Young et al (2007) and the guidelines make the interesting point that stronger evidence of efficacy is unlikely ever to be produced, because the preferred methodology, a prospective randomised trial, would encounter two obstacles: an ethical objection to withholding treatment from controls, and a practical problem that an extremely large sample size would be required because of the low risk of transmission in a single exposure. In practice, PEP for at risk needlestick injuries has become routine in developed countries, but it is still far from universally available in developing countries. Even in the situations where it is available, there are a number of inhibitions on its use, discussed further below.

In establishing eligibility for PEP, the guidelines refer to four criteria. Animal studies show that PEP is not effective when initiated more than 72 hours after exposure, so it is recommended that it not be given to humans who present more than 72 hours after exposure. It should not be given if the exposed person is
already HIV positive, since PEP may complicate subsequent ART; it is for this reason that some health workers fear that they will be made to undergo an HIV test if they seek PEP, and may thereby be deterred from seeking it. (The latest guidelines encourage testing, but do not recommend withholding PEP if testing is either unavailable or consent is withheld). The nature of the exposure needs to be assessed by a trained clinician, and the decision on whether to initiate PEP made jointly by the exposed person in the light of counselling on the risks and benefits of treatment. Finally, PEP should not be given or should be discontinued if the source person tests negative (although window period considerations might modify that advice). If the source is unknown or untested, in high prevalence settings (for example, in Uganda it is assumed that 60% of hospital inpatients are HIV positive) assuming that all sources of unknown status are infected is reasonable.

Although the original estimates of the efficacy of PEP come from monotherapy with zidovudine (AZT), therapeutic regimens in use today typically require a combination of two or three drugs, exceptionally four or more where drug resistance is suspected. The guidelines explain that "there are no prospective data on the relative efficacy of two and three drug HIV PEP regimens. The advantages of using two drugs as opposed to three include the relative ease of administration (resulting potentially in better adherence, fewer side effects and lower costs) and the ease of procurement, storage and dispensing. In most cases, that is, when the source is unlikely to have infection resistant to antiretroviral therapy, two drug therapies are likely to be sufficiently potent to prevent HIV transmission. In such circumstances, the addition of a third drug is considered to supply only a small increase in potency but to add significantly to the risk of side effects and reduced adherence".

That the risk of side effects is not a negligible consideration is supported by frequent reports of adverse effects and high rates of discontinuation of PEP. Lee and Henderson (2001) observe "All of the agents currently used for post exposure prophylaxis regimens have substantial adverse effects, and significant adverse effects occur in more than two-thirds of individuals electing prophylaxis". This proportion of two thirds is echoed (approximately) in a report from the Netherlands; van der Ende et al (2002) state that use of PEP was associated with a high percentage (62%) of mild and reversible toxicity and a small proportion of serious adverse events related to antiretroviral drugs, ie nephrolithiasis (due to indinavir) and toxic hepatitis (due to nevirapine). Another report by Parkin et al (2000) observes that in a study of PEP in 28 recipients, indinavir containing regimens were poorly tolerated.

There is abundant evidence that in developing countries there are several obstacles to accessing PEP, even where it is available. If it is not available on site, there may be substantial impediments to accessing it at a remote site, such as lack of public transport or the high cost of alternative transport, and lack of time off work granted for the purpose. De Baets et al (2007) introducing a study
of access to PEP in rural Zimbabwe say "For many primary health care workers in developing countries, the limited availability and cost of public transport hinders timely access to occupational postexposure prophylaxis at referral hospitals. Adapted PEP training and a starter kit could improve access". Of other obstacles to access, the first is that many incidents of needlestick injury go unreported, as discussed above. Second, health workers often have an imperfect understanding of PEP, and may not know that it is available in their facility even when it is. Third, because of the association of PEP with HIV testing (though this should not be mandatory according to the latest guidelines), many may prefer not to seek PEP because they do not want to be tested or fear that their test results will not be confidential. Fourth, concern about side effects may deter some who are otherwise eligible, and may encourage discontinuation of treatment before the full 28 day course is completed.

In the Netherlands, a study by van Wijk et al (2008) examined the experience of all blood exposure incidents reported to an expert counselling centre over the period 2003-2005. Half the incidents reported took place outside hospitals, and a third occurred out of regular office hours. They found a progressive improvement in management of incidents over the period, with more speedy testing of source patients, and a reduction in the proportion of errors from 37% in 2003 to 8% in 2005. Pungpapong and colleagues (1999) claimed that the two Thai Red Cross hospitals followed international guidelines on postexposure management, but reported that only 78% of those who needed PEP were actually recommended for treatment, and of those, only 69% actually took the treatment. They concluded there was a need to educate clinicians managing PEP as well as their injured patients about the safety and efficacy of PEP. A later study by Barry et al (2005) in Malaysia identified weak knowledge of procedures following occupational exposure among doctors and nurses in Hospital Sungai Petani.

Several articles have explored the cost-effectiveness of PEP administration, all focused on high income countries. Marin et al (1999) estimated for the USA the cost per HIV seroconversion prevented with monotherapy and triple therapy, with the assumption that 35% of exposures were to HIV positive sources. Scheid et al (2000) used a modelling approach with USA data from 1989. Both concluded that PEP was cost effective compared with the alternative of no prophylaxis. A study by Herida et al (2006) in France using PEP surveillance data from 1999-2003 reached the conclusion that PEP is only marginally cost effective, and recommended that PEP guidelines should be revised to better target high risk exposures. It should be stressed that it is impossible to transfer conclusions from high income and low risk settings such as Europe and North America to low income and high burden settings.
Tuberculosis in health care workers

In contrast with the situation concerning HIV, there is abundant literature on the prevalence and incidence of tuberculosis in health care workers. Much of this literature relating to low and middle income countries is surveyed in a systematic review by Joshi et al (2006). The principal finding of this review is that TB is indeed a significant occupational problem, pointing to the need to design and implement simple, effective and affordable TB infection control programmes in health care facilities in these countries. There is also a considerable literature which reports on high income countries, where despite much lower prevalence in the general population, and a recent focus on infection control measures following outbreaks of multi-drug resistant tuberculosis, there is a lingering problem of higher prevalence among health care workers indicative of nosocomial transmission.

The outstanding finding of the systematic review is that, whereas occupational transmitted HIV infection accounts for only a small percentage of total infection in health workers, occupationally acquired tuberculosis infection is a multiple of the rates in the general population. Various measures are used to quantify the extent of TB, including the presence of latent TB infection (LTBI) as determined by tuberculin skin test surveys, incidence of LTBI as determined by seroconversions, and incidence of TB disease. Different studies used different measures, so that the results are grouped in a series of tables according to the measure used. The risk of TB disease attributable to nosocomial transmission is computed as the arithmetic difference between the rate in the surveyed health worker population and the rate in the corresponding general population. In Table 5, which reports incidence of TB disease (all forms), the excess risk carried by health workers ranges from 5361 cases per 100,000 population down to 25 cases per 100,000, with two studies reporting lower incidence among health workers than the general population. These apparently anomalous and counter-intuitive results were explained, in the one case (Samara Oblast, Russia) by a local variation in incidence, and in the other (South Africa) by an abrupt increase in the TB incidence rate in the general population associated with the HIV epidemic. The data in Table 5 are also expressed in the form of an incidence rate ratio (IRR), in which the numerator is the risk rate in the health worker population, and the denominator is the risk rate in the general population. For this set of studies, the IRR takes values between 20 and 1.2 (ignoring the two studies discussed above); in plain terms, health workers are up to 20 times more likely than the general population to experience TB disease.

What makes the nosocomial origin of these elevated rates even more convincing is the set of observations that relate increasing LTBI to increased exposure, either in terms of duration, or intensity as a result of specific activity related to the care of TB patients. Regarding duration, medical and nursing students had a pooled prevalence of LTBI of 12% compared with 54% for all health care workers, but even within the period of study there were marked differences in
LTBI corresponding with years of exposure. “The prevalence of LTBI in senior
years was two to three times higher compared with the junior years in two studies
from Brazil. A study from India reported a 4-fold higher prevalence in medical
students who were more than 23 years of age than in medical students aged 18-
20 (corresponding to the additional 3-5 years spent in training)”. Regarding
specific cadres or work locations, in Table 6 IRRs were calculated for individual
groups relative to the rate in the general population. For 8 studies that identified
nurses, the range of IRR was from 1.2 – 27.9 and for the five studies that
identified doctors, from 0.5 – 10.9. The highest IRRs were found in two studies
each that identified radiology technicians (5.5 - 53.0) and patient attendants (12.4
– 52.2); the figures for laboratory assistants and laboratory technicians were 7.3
and 7.9 – 16.4. By location, the highest IRRs were found in inpatient TB facilities
or TB wards (9.5 – 86.9), laboratories (78.6), inpatient general medicine (1.5 –
35.4) and emergency facilities (10.3 – 31.9). By contrast, IRRs in other areas of
patient care (surgery, obstetrics and gynaecology, operating theatre,
administration) were little different from 1. This concentration of the elevated risk
of TB disease in professions and locations most in contact with TB patients gives
further support to the occupational origin of TB in health workers. It is sobering
to reflect that the IRR figures imply that working directly with TB patients can
raise the risk of contracting TB disease to 80 times that of the general population.

This systematic review by Joshi et al analysed 42 articles describing 51 studies.
These are not separately reported here, nor included in the bibliography.
However, there are a number of similar articles published since the review cut-off
date of December 2005 which are summarised below and are included in the
bibliography.

Laniado-Laborin and Cabrales-Vargas (2006) examined the incidence of
tuberculosis disease among health care workers at a general hospital in Tijuana,
Mexico, and found a rate 10.98 times that for the general population of the city.
Medical students were at greater risk of acquiring TB than either doctors or
nurses. By contrast, a study by Drobniewski et al (2007) conducted in Samara,
Russian Federation, reported LTBI in 40.8% of all health care workers, but it was
significantly higher in doctors and nurses than in students. Particularly high rates
were encountered among TB doctors (55%) and TB laboratory workers (61%).
The finding of increased infection with increased exposure was replicated in a
programme. In Nigeria, Salami and Oluboyo (2008) reported relatively low rates
diagnosis of TB among health care workers in a university hospital (32 cases
among a total staff complement of 2173 over a 15 year period). However, of
these, 15 presented as HIV co-infection. Other data showed the customary
pattern of higher incidence associated with higher exposure in clinical settings.
The picture in high income countries is more mixed. Menzies et al (2007) report
a review of published studies since 1960 in low and middle income countries and
since 1990 in high income countries. The mean annual incidence of TB infection
attributable to health care work was 5.8% in low and middle income countries,
and 1.1% in high income countries. Rates of active TB in health workers were generally higher than in the general population in all countries, though findings were variable in high income countries (there were some reports of lower incidence in health workers than the general population, see below). Administrative infection control measures (such as patient segregation) had a modest impact in low and middle income countries, yet seemed the most effective in high income countries. The overall conclusion was that TB remains a very important occupational risk for health workers in general in low and middle income countries, and for workers in some institutions in high income countries.

However, Raito and Tale (2000) report that in Finland over a 30 year period, the overall risk (of active TB) in health workers was lower than in the general population throughout the study period. The incidence of tuberculosis in health care workers decreased from 57.9 to 6.1 per 100,000 while the corresponding figures for controls were a decrease from 156.8 to 9.1 per 100,000. Tam and Leung (2006) claimed that in Hong Kong there was no evidence of higher tuberculosis incidence among health workers. Two other studies, without reporting overall incidence in health care workers, do demonstrate differential incidence by exposure. Menzies et al (2000) show that in 17 acute care facilities in Canada, tuberculin conversion was associated with ventilation of general or non-isolation patient rooms of less than 2 air exchanges per hour, with work in moderate to high risk hospitals, with work in nursing, respiratory therapy and physiotherapy. Similarly, Cook et al (2003) report from New York higher rates of seroconversion from workers in high risk occupational settings compared to low risk settings.
TB Infection control in health facilities
Although the principles are common, there has been some divergence in the pattern of recommendations for infection control in health care settings between developed and developing country settings, primarily because of differences in the affordability of interventions. In 1994, the US Centers for Disease Control (CDC) published guidelines for preventing transmission in health care facilities, classified by categories of TB risk, with corresponding administrative, environmental and personal protection measures. According to Jensen et al (2005) "The TB infection control measures recommended by CDC in 1994 were implemented widely in health care facilities in the United States. The result has been a decrease in the number of TB outbreaks in health care settings reported to CDC and a reduction in health-care-associated transmission of Mycobacterium tuberculosis to patients and health care workers". That the guidelines were generally followed was confirmed by studies by Kellerman et al (1998) investigating paediatric hospitals, and Manangan et al (1998) surveying public and private hospital practices in 1992 and again in 1996. In both cases, the positive findings were largely based on the provision of isolation rooms meeting the criteria of negative pressure, 6 or more changes of air per hour, and air directly vented to the outside. However, the Occupational Safety and Health Administration (OSHA) in 1997 proposed a standard that would require employers to protect TB exposed employees; unlike the voluntary CDC guidelines, the OSHA standard would be enforceable by law, and was more stringent in some of its provisions (for example, it required six monthly tuberculin skin testing, and the use of respirators in more instances). In 2005, the CDC Guidelines were modified, mainly in the direction of making them applicable in a wider range of settings, including correctional facilities, home based care and laboratories handling clinical specimens.

According to Humphreys (2007) recent guidelines on the prevention of tuberculosis in healthcare facilities from Europe and the USA have many common themes. In the UK, however, negative pressure isolation rooms are recommended only for patients with suspected multi-drug resistant TB, and the use of personal respirators is recommended only when multi-drug resistant TB is suspected or aerosol inducing procedures are to be carried out. Acknowledging that the absence of clinical trials precludes dogmatic recommendations, Humphreys nevertheless expresses a clear preference for the more stringent US recommendations on ventilation and personal protection.

An article by Harries et al (1997) stated robustly " Measures used in industrialized countries to control nosocomial transmission TB transmission (ventilation systems, isolation rooms, personal protective equipment) are beyond the resources of low-income countries. Protecting health workers in these settings involves practical measures relating to diagnosis and treatment of infectious cases; appropriate environmental control; and relevant personal protection and surveillance of health care workers". The article goes on to say that "The most cost effective method of interrupting the chain of TB transmission
is the rapid diagnosis and treatment of infectious TB patients". Isolation of patients suspected to have pulmonary TB is recommended; in practical terms, this means provision of a separate TB ward for those inpatients diagnosed or suspected of having TB. It is further recommended that effective short course treatment using multiple drugs should be preferred to traditional treatments which involved a delay in sputum-smear conversion; with effective short course therapy, 85-95% of patients become smear negative after two months, regardless of HIV status. The environmental control which is appropriate is good natural ventilation in TB wards, general medical wards and outpatient departments through large open windows, and doors to other hospital departments which are closed most of the time. Ultra-violet light has a germicidal effect, but rather than expensive UV lamps, it can be provided by the sun. In terms of personal protection, the most important measure is to prevent HIV positive workers coming into contact with TB patients or specimens; since many health care workers do not know their HIV status, this puts a premium on HIV testing. The wearing of personal respirators by staff is assumed to be prohibitively expensive, but the use of face masks by patients or staff in specific circumstances could be helpful. Screening of staff by regular tuberculin skin testing is not recommended, given the ambiguity of interpretation of results, but instead health worker education on the symptoms of TB, early diagnosis and a high index of suspicion of TB are recommended as the more cost effective interventions.

In 1999, WHO published Guidelines for the Prevention of Tuberculosis in Health Care Facilities in Resource Limited Settings which largely echoed the above recommendations. What the Guidelines add is the hierarchy of controls, and an insistence on respecting the priorities. "The first and most important level of control is the use of administrative controls to prevent droplet nuclei from being generated and thus reducing the exposure of HCWs and patients to M tuberculosis. . . .Important administrative measures include early diagnosis of potentially infectious TB patients, prompt separation or isolation of infectious TB patients, and prompt initiation of appropriate anti-tuberculosis treatment. Other important measures include an assessment of the risk of transmission in the facility, the development of an IC plan that details in writing the measures that should be taken in a given facility, and adequate training of HCWs to implement the plan. It is essential that one individual be assigned responsibility and accorded authority to monitor the implementation of the IC plan". The second level of controls is environmental controls to reduce the concentration of droplet nuclei in the air. Such measures include maximizing natural ventilation and controlling the direction of airflow (by opening windows and the use of fans). Personal respiratory protection is described as the last line of defence for HCWs, which should only be considered as an adjunct to administrative and environmental controls. An important distinction is made between face masks and respirators. Face masks do prevent the spread of organisms from the wearer, but do not prevent inhalation of infectious droplets in the air. Respirators which can filter out small organisms (1-5 microns) are needed to prevent
inhale, but these are relatively expensive. Accordingly, it is recommended that the use of respirators be confined to high risk areas and procedures. The use of face masks by patients should be considered in certain circumstances, for example, during transport to the radiology department.

Unfortunately, the evidence from the recent five country study by Corbett et al (2007) is that even the low cost infection control measures recommended in these Guidelines are frequently neglected in situations where co-infection with HIV magnifies the risk of TB transmission.

As at March 2009, WHO is close to finalizing a new policy on TB infection control, with special attention to health care and other congregate settings, and a new section on infection control in households. The new policy document (in draft) is broadly in line with the earlier version reported above, but there are some new and modified emphases. Among the new is a strong focus on national managerial activities, with a legal framework conducive to action by various stakeholders (TB, HIV, occupational health, correctional services and civil society) coordinated by existing national infection control bodies—and if they do not already exist, they should be created. Among the activities which should be carried out are comprehensive planning and budgeting for infection control, building human resource capacity to implement infection control, address health facility design including potential renovation of existing premises, conduct surveillance at all levels of the health care system and in congregate settings, address TB infection control advocacy, communication and social mobilization, conduct monitoring and evaluation, and undertake operational research. At the facility level, recommended managerial activities include development of a local infection control plan, on-site training of health care workers, advocacy, communication and social mobilization with civil society involvement, and evaluation of infection control measures.

The new draft policy retains the threefold hierarchy of controls, with administrative controls uppermost. These are the development of strategies to promptly identify potentially infectious cases, separate them, control the spread of pathogens (cough etiquette) and reduce hospital stay. On the last point, it is emphasized that the best way of minimizing hospital stay is not admitting TB suspects in the first place: "Hospital stay is generally not recommended for the evaluation of TB suspects or the management of patients with drug-susceptible TB, except in cases that are complicated or have concomitant medical conditions that require hospitalization".

The provisions for health care workers bear replication in full: "All health workers should be informed and encouraged to undergo TB diagnostic investigation if they have signs and symptoms suggestive of TB. All health workers should be informed and encouraged to undergo HIV testing and counselling. If diagnosed with HIV, they should be offered a package of prevention and care that includes regular screening for active TB and access to antiretroviral therapy. Based on
the evaluation, health-care providers should be put on either IPT or a full regimen of anti-TB treatment. HIV positive health workers should not be working with patients with known or suspected TB and in particular MDR-TB or XDR-TB, and they should be relocated from positions where exposure to untreated TB is high to lower risk areas”.

Environmental controls focus as before on ventilation, but there is a conditional recommendation to use ultra-violet germicidal irradiation in favourable circumstances. The discussion of personal protection controls is limited to urging the use of particulate respirators by health workers, in particular during high risk aerosol-generating procedures (bronchoscopy, intubation, sputum induction procedures, aspiration of respiratory secretions, and autopsy or lung surgery with high speed devices) and when providing care to MDR-TB and XDR-TB patients or suspects. Adequate training in the use of respirators is essential.
Isoniazid preventive therapy

It is now commonplace that TB is the most common opportunistic infection in people living with HIV. Latent TB infection more readily progresses to active disease when the patient's immune system is compromised. This places health care workers living with HIV, who are constantly exposed to contact with TB patients in an environment of weak infection control, at great risk of contracting TB. The risk may be reduced by administrative measures, such as assignment to duties in a low risk area, or by the administration of isoniazid as a prophylactic regimen. The rationale for isoniazid preventive therapy is analogous to that for PEP, in that the aim is to overwhelm the initial inoculum before it can establish a firm foothold of infection in the body.

Much of the evidence on the effectiveness of IPT is not specific to health workers, or even persons with HIV. Smieja et al (2000) carried out a review of 11 randomised trials involving 73,375 patients without HIV of IPT for six months or more compared with placebo. Preventive therapy reduced the risk of active TB disease by 60%, and the risk of death from TB, but not all cause mortality. There was no significant difference between 6 month and 12 month treatments.

Wilkinson (2000) carried out a review of six trials in people with HIV but without active tuberculosis. Compared to placebo, preventive therapy was associated with a lower incidence of active disease, but the risk of death was little different. The incidence of tuberculosis was reduced in people with a positive tuberculin skin test, but was not significantly lower in those with a negative skin test. Different drug combinations (isoniazid alone, isoniazid plus rifampicin, isoniazid plus rifampicin plus pyrazinamide, rifampicin plus pyrazinamide) had similar protective effects for people with positive skin tests. A study by Whalen et al (1997) in Uganda suggested that isoniazid alone conferred greater protection than other, multi-drug, regimens. A review by Woldehanna and Volmink (2004) of 11 trials involving 8,130 participants reached similar conclusions to that of Wilkinson. An article by Padmapriyadarshini and Swainathan (2005) argued for an optimum duration of IPT greater than 6 months, as did Gerard (2000). Comstock (1999) suggested that 9-10 months might be the optimal duration.

However, IPT is not without its hazards, the most prominent of which is hepatic toxicity. Durand et al (1996) point out that isoniazid and pyrazinamide are major hepatotoxins, while rifampicin may enhance the hepatotoxicity of isoniazid. The review by Woldehanna and Volmink (2004) observed that, compared with isoniazid monotherapy, short course multi-drug regimens were much more likely to require discontinuation of treatment due to adverse effects. The article by Whalen et al (1997) also noted that side effects were more common with the multi-drug regimens, and particularly with that containing pyrazinamide.

Stuart et al (1999) reported on a cohort of 83 health care workers receiving a six month course of IPT, in whom clinical toxicity and liver function were monitored.
Thirty four health care workers (41%) developed an adverse event; in 26, toxicity was sufficiently severe to require cessation of treatment. This high level of side effects may be part of the explanation for the reluctance of some health care workers to take up the offer of IPT. Gershon et al (2004) reporting from a specialised downtown tuberculosis clinic, found that only 58% of all eligible patients took up the offer of treatment, and the odds of a health worker initiating treatment were approximately one half of a non-health care worker initiating treatment. Moreover, starting treatment is no guarantee of completing it. Rowe et al (2005) carried out a study of adherence to IPT in rural South Africa. Of 229 HIV-positive clinic attendees, 94 (41%) were eligible for IPT. Of 87 patients initiating treatment, only 41 (47%) completed the course. Of the 46 interrupters, 16 (34.7%) did not return to the clinic after receiving their first dose of IPT. Barriers to adherence included fear of stigmatization, lack of money for food and transport, the belief that HIV is incurable, competition between allopathic and traditional medicine, and a reluctance to take medication in the absence of symptoms. Chan and Tabak (1985) found that among house staff in a US urban teaching hospital, despite a high risk of tuberculosis infection, the compliance rate for tuberculin testing and chemoprophylaxis was less than 50%. Tavitian et al (2006) describe a pharmacist-managed clinic for treatment of LTBIs in health care workers. It was initiated in 1993 after a review showed that only 0.8% of HCWs prescribed isoniazid completed the course. After an initial assessment visit, the clinic schedules monthly appointments to evaluate treatment adherence and potential adverse effects. Over the period 1993-1997, 93% of employees who started treatment completed it. Over the period 1997-2001, completion rates have been between 90% and 100%, no cases of active tuberculosis were reported in treated patients, and only nine adverse drug reactions.

The other major concern about IPT is that it may induce isoniazid resistance. Cohen et al (2006) developed a mathematical model of the TB and HIV co-epidemics, and concluded that the community wide use of IPT would reduce the incidence of TB in the short term, but may also speed the emergence of drug resistant TB. Balcells et al (2006) reviewed 13 studies involving 18,095 patients given isoniazid and 17,985 controls. They concluded that the relative risk for resistance was 1.45, with no significant differences between results for HIV positive and negative subjects. Their cautious conclusion was that the findings do not exclude an increased risk for isoniazid-resistant TB after IPT, and continued surveillance for isoniazid resistance is therefore essential.
Occupational health services for health workers

Among the functions which occupational health services perform, the first and that which is of paramount importance is the protection and promotion of the health of workers by preventing and controlling occupational diseases and accidents. This is a general proposition relevant to all industries, but as Wilburn and Eijkemans (2007) observe "the health workforce is entitled to the same rights as all workers --- to a safe and healthful workplace". Many observers have pointed out that, despite their outward appearance as places of safety and restoration of health, health facilities are dangerous places, full of potential hazards to those who work in them. Dement et al (2004) say: "Workers in the health care industry may be exposed to a variety of work-related stressors including infectious, chemical and physical agents; ergonomic hazards; psychological hazards; and workplace violence. Hood and Laranaga (2007) make the point that hospitals in particular are very complex from the standpoint of risk assessment and surveillance, because several "mini-industries" exist within each. In the context of TREAT, it is the potential risks to health workers from exposure to HIV and TB which are the greatest concern, but these risks can be approached from the same perspective that informs all occupational health interventions.

According to the WHO Global Strategy on Occupational Health for All (1995), "successful prevention requires (a) information on the causal relationship between the risk factor and health outcome (b) knowledge of the mechanism of action of hazardous factors and conditions (c) knowledge of how the causal relationship can be broken (d) resources, tools and mechanisms for the implementation of preventive measures (e) political, managerial and target group support for the preventive programme". The first three requirements can be met by scientific research, while the last requires effective information and education of multiple stakeholders. "To identify occupational health hazards, to provide appropriate advice on their control and prevention, to contribute to the development of healthy and safe workplaces and to follow up and take the necessary actions for the health of workers, a comprehensive and competent occupational health service is necessary. Such a service should be available at each workplace and accessible by each worker". Assuming that a service is established, it should then be possible to institute the hierarchy of controls (adapted from Wilburn and Eijkemans 2007, quoting WHO/ ILO 2005). This specific application is to the risk of exposure to bloodborne pathogens---note that it re-orders and expands the hierarchy of controls for tuberculosis infection control discussed above.
<table>
<thead>
<tr>
<th>Method of control</th>
<th>Examples</th>
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<tbody>
<tr>
<td><em>Elimination of hazard</em> - complete removal of a</td>
<td>Eliminating unnecessary injections, using</td>
</tr>
<tr>
<td>hazard from the workplace</td>
<td>needle-less IV systems</td>
</tr>
<tr>
<td><em>Engineering controls</em> - controls that isolate or</td>
<td>Safety boxes, needles that retract, sheathe</td>
</tr>
<tr>
<td>or remove a hazard</td>
<td>or blunt immediately after use</td>
</tr>
<tr>
<td><em>Administrative controls</em> - controls to limit</td>
<td>Exposure control plan, allocation of resources,</td>
</tr>
<tr>
<td>exposure to a hazard</td>
<td>consistent training in use of safe devices</td>
</tr>
<tr>
<td><em>Work practice controls</em> - reduce exposure</td>
<td>No needle recapping, placing safety boxes</td>
</tr>
<tr>
<td>through worker behaviour</td>
<td>at eye level and within arm's reach, regular</td>
</tr>
<tr>
<td></td>
<td>emptying of safety boxes</td>
</tr>
<tr>
<td><em>Personal protective equipment</em> - barriers and</td>
<td>Eye goggles, gloves, masks, gowns</td>
</tr>
<tr>
<td>filters between the worker and the hazard</td>
<td></td>
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What is recognized as an occupational disease varies from country to country. The ILO General Conference adopted the List of Occupational Diseases Recommendation 2002, urging that corresponding national lists be formulated and updated "with due regard to the most up-to-date list" established by the ILO. An Annex lists occupational diseases under four main categories: 1) diseases caused by agents, of which 1.1 lists chemical agents, 1.2 physical agents, and 1.3 biological agents; 2) diseases by target organ systems, of which the largest subdivision 2.1 is occupational respiratory diseases, 3) occupational cancers; and 4) other diseases. Neither HIV nor TB is specifically mentioned, but both might be regarded as occupational diseases by the further specification of 1.3.1 as "Infectious or parasitic diseases contracted in an occupation where there is a particular risk of contamination". As noted above, the majority of HIV infections are not occupationally acquired, but there is clear occupational risk to health workers and others (waste disposal workers, emergency service workers) who handle infected material and are prone to needlestick injury or other forms of exposure. In a high proportion of cases involving health workers, there is the potential to trace the infection to an identified source. By contrast, given the incidence risk ratios, there is a very high probability that TB infection in a health worker was occupationally acquired, but by the nature of the transmission mechanism (inhalation of droplets which can stay airborne for days) relating that infection to a specific source is impossible.

While prevention of disease and injury is the primary task, occupational health customarily embraces also the provision of services for the promotion of healthy lifestyles and the treatment and rehabilitation of workers with conditions which are not necessarily occupationally related. It can be very much in the employer’s
interest, in order to reduce sickness absence and to minimize the associated costs, to provide access to such services at the workplace or via the employment relationship. In some cases, these benefits may also be extended to dependants of the employee. Ozminkowski et al (2002) report an evaluation of a wellness program run by the US pharmaceutical company Johnson and Johnson. Employees were followed for up to five years before and four years after programme implementation. Results indicated a large reduction in medical care expenditures, stemming from reduced inpatient use, fewer mental health visits and fewer outpatient visits in comparison with the baseline period. The authors concluded that programmes designed to better integrate occupational health, disability, wellness and medical benefits may have substantial health and economic benefits in later years. A review by Pelletier (2001) of 15 studies (all in the US) of the clinical and cost effectiveness of comprehensive health promotion and disease management programmes at the worksite concluded that the vast majority of the research to date indicates positive clinical and cost outcomes. Providing individualized risk reduction for high risk employees within the context of comprehensive programming is the critical element of worksite interventions. Reardon (1998) observes that US employers now pay an estimated 30% of the national health care bill, but despite this, their efforts to pre-empt medical care expenditures by providing wellness services to their employees are insufficient. “Most employers in the health care arena are seen as doing too little to promote wellness among its own employees”.

Commentators acknowledge that occupational health services are infrequently provided in low income countries. According to Fedotov (2004) the average coverage figures are only 5-10% in developing countries, compared with 20-50% in industrialized countries. Eikemans (2004) suggests that worldwide only 15% of the working population have any access to occupational health services. It might be supposed that the health care industry would be a leader, with its good access to facilities and heightened sensitivity to health risks, but as Thomas (1997) says of Canada “in reality, too few facilities offer too little in the way of services”. Rogers and Haynes (1991) referring to the USA contrast the well documented hazards in hospital environments with the need to increase services and target specific groups. At its 60th session in May 2007, the World Health Assembly approved the Global Plan of Action on Workers’ Health 2008-2017 which states “Specific programmes should be established for the occupational health and safety of health-care workers” and goes on to refer specifically to the need for immunization of health-care workers against hepatitis B.

The literature on occupational health services for health workers in developing countries is notably thin. A search of PubMed using these search terms threw up 15 references, none of which proved to be relevant on closer examination. The Zambia HIV/AIDS Workforce Study by Huddart et al (2004) focuses on the capacity of health workers to give services to patients, and says nothing about the needs of the caregivers themselves. A World Bank (2008) report, Human Resources and Financing for the Health Sector in Malawi, acknowledges
significant work-related risks and points out that all government departments are required to set aside 2% of their budgets for HIV/AIDS which could (but by implication does not) support HIV-related occupational health activities. One study by Krusun et al (2005) examined a health check up programme for office and nursing staff of a university hospital in Thailand. It found that office workers visited physicians much more frequently, a finding associated with a higher rate of obesity and metabolic disorders. A similar pattern of higher utilization by non-clinical staff was found in a study of an employee health clinic at a tertiary hospital in Greece by Falagas et al (2006). Moodley and Bachmann (2002) describe the results of a survey of occupational health services in government hospitals in South Africa. They report that 32% of hospitals had an occupational health clinic, mostly providing primary care and chronic disease services, but these covered 61% of employees as they tended to be concentrated in larger hospitals. A safety officer was found in 39% of hospitals, 41% had access to an industrial hygienist or environmental safety officer, while 80% had health and safety committees, as required by law. Large differences between provinces were associated less with differences in resources but with the presence or absence of coherent occupational health policies.

We know from the 5 country study by Corbett (2007) that special arrangements for health staff seeking HIV services are relatively uncommon, and that being made to queue with the general public in order to access routine services is a substantial deterrent to take up of services (this applies more strongly to HIV testing than either ART or TB services). The provision of a dedicated staff clinic, either in a separate space, or in reserved time, which offers a general medical service to staff (and possibly dependants) offers some protection from this embarrassment, but may not totally overcome the reluctance of staff if they have little confidence in the confidentiality of consultations and records. An account of a staff clinic at Thyolo District Hospital in Malawi was given by Dr B Mwangombe at ICASA (2008) under the provocative title "Fear of stigma is stronger than fear of death". The clinic was opened in July 2006, providing services to 813 health staff in the district and their primary dependants, and used the time of one clinician and one counsellor for one hour per week. Up to the reporting date, there were 2664 consultations; 94 individuals were offered VCT, among whom 77 were found positive, and 27 were initiated on ART. Staff appreciated the "one-stop-shop" and the implied privacy of the clinic. In December 2006 a hospital staff support group was initiated with 53 members willing to acknowledge their HIV status, holding bi-weekly meetings.

Kitt et al (2006) describe an occupational health service initiative at a women's hospital in Kabul, Afghanistan, undertaken by a US technical assistance team. Under the extreme conditions of post-Taliban Afghanistan, which experienced some of the world's highest infant and maternal morbidity, inadequate hospital infection control and neglect of the personal care of health workers, a needs assessment revealed a desperate situation where the mainly female labour force experienced poor health and high rates of consequent absenteeism. When a
medical history was analysed for the staff of the obstetrics/gynaecology and paediatric departments, it was found that over 80% reported past needlestick injury, over 50% had vision problems and nearly 20% hearing difficulties. Only 8% had been vaccinated against hepatitis B. Nearly two thirds reported symptoms of anxiety, with concerns about both livelihoods and personal safety. The intervention consisted of preparation of a basic occupational safety and health training programme, providing preventive education on bloodborne pathogen exposure, needlesticks and other workplace injuries, tuberculosis transmission and dermatological problems. Individual health assessments were offered to all staff of the two departments, and 113 (80% of those eligible) took part. These assessments included documenting self-reported health histories, measuring vital signs, performing vision, hearing and hepatitis B screening tests, symptom screening for tuberculosis, (followed by chest X-ray if necessary) administering vaccines, dispensing iron and folic acid supplements, and maintaining a computerized database to track immunizations. Over 90% of employees thought that having a staff clinic would improve their health, and 89% thought it would improve their ability to do their work. The technical assistance mission drew up a report recommending adopting a national policy on the delivery of occupational health services. It stressed the importance and practicality of delivering services to health care workers, a population that is critically important in improving conditions within the country. On a smaller scale, the mission proposed to open a staff clinic at a second women’s hospital in Kabul.

An alternative model to the hospital staff clinic which has been widely reported in press handouts is the Wellness Centre, an offsite clinic dedicated to the use of healthcare workers and their families. The first such clinic was officially opened in September 2006 in Manzini, Swaziland, operated by the Swaziland Nursing Association and supported by a diverse public-private partnership including the International Council of Nurses, the Danish Nurses Organization, the Stephen Lewis Foundation and BD Corporation, a manufacturer of medical devices. It was planned that similar centres would be opened in Lesotho, Zambia and Malawi, and more recently Uganda. The programme will offer a range of services, including testing, counselling and treatment for HIV and TB; antenatal services, including PMTCT; stress management; post exposure prophylaxis; screening for chronic conditions and a training and resource/knowledge centre for continuous professional development. In Swaziland, the centre was seen as a response to the needs of a very demoralized workforce coping with a very high HIV burden, high rates of emigration, and low salaries. One of the achievements claimed for the centre was that it made health workers feel valued. It was also claimed that there had been no nurse emigration in the year since its foundation. On the other hand, sceptics have focussed on three issues. One is the presumed high cost (all the publicity material is notably coy about the level of costs and their distribution among the project sponsors). In the absence of direct financial information, the cost level can be inferred from the creation of a dedicated building with five rooms and a similar number of full time staff. The
second issue is that, given the focus on HIV and TB, any health worker seen using the centre is at risk of being stigmatized, as acknowledged in the study by Galvin et al (2008). The third issue is that while the model might be well suited to large urban centres where one centre could serve staff of several hospitals and many clinics, it is less clearly suited to the situation of smaller administrative centres with a single hospital. Although in a very small country like Swaziland, where with the aid of mobile outreach services, one centre might be accessible to the entire national health worker population, this clearly would not be the case with larger countries like Tanzania or Zambia. A centre located in the national capital of most countries could effectively serve the health workers within a maximum 30-50 kilometre radius.

In addition to occupational health services at facility level, there is an implied need for some wider oversight, for two distinct reasons. One is the need for surveillance of occupational disease and injury on a national basis to detect trends and emerging threats which may not be perceived at the individual facility level. Giudotti (1985) distinguishes surveillance as a strategy to determine a group experience with a particular disease outcome, while monitoring focuses on the overall health experience of the group. Dement et al (2004) and Hood and Larranaga (2007) have also focused on the value of surveillance systems. Yassi (1998) reports on surveillance systems established at the Winnipeg Health Sciences Centre in Canada, where data on 6000 employees was collected which helped to prioritize, monitor and improve occupational health services. Using the databases permitted the targeting of groups requiring immunization, thereby increasing coverage. A return-to-work post injury programme was found to be particularly cost-beneficial. Over the five years following the implementation of occupational health programmes, savings in workers’ compensation assessments were more than half a million dollars annually.

The second reason why some higher level of oversight is required is because there may be undue pressure brought to bear on occupational health service personnel by their employer in order to escape the costs of compliance with safety or disease prevention measures. The existence of an external body with powers to set standards and enforce them reinforces the authority of the occupational health staff and protects the workforce from employer negligence. To guarantee the professional autonomy of the external body, it is desirable that it is removed from the direct control of service providers (such as the Ministry of Health).
Policies to outlaw discrimination against HIV positive health workers

This topic is very thinly represented in the literature. All but one of the articles found using the search term "discrimination" refer either to the USA or UK. None address the issue from the perspective of protecting the job security and prospects of HIV positive health workers. The dominant concern is discriminating behaviour by health workers towards HIV positive patients, and the extent to which a duty-to-care can be imposed on health professionals, over- riding common law notions of freedom of contract in the patient-practitioner relationship.

An article by McHaffie (1994) describes a survey conducted throughout the UK to examine the provision being made to train nurses to care safely and sensitively for patients with HIV and AIDS. It states flatly: "Problems relating to intolerance and prejudice are still commonly encountered . . . . Nurses, both students and qualified staff, need to gain insight into their own values and prejudices if these are not to inhibit the giving of good quality care," and goes on to recommend providing opportunities for nurses to meet with people whose lives have been profoundly affected by the virus as a powerful form of learning. Corley and Goren (1998) address the same issue for the US in an article with the evocative title "The dark side of nursing" although in a broader context of stigmatized groups. From India, Balasubrahmanyan (1995) gives an account of how three prestigious medical institutions in Calcutta behaved insensitively in the treatment of a man dying of AIDS, and goes on to report "despite the commitment of the central and state governments to provide treatment to AIDS patients, AIDS patients tend not to receive care, hospital personnel from top management down are unaware of WHO guidelines on the management of patients and of the ethical norms concerning confidentiality; and AIDS patients and their families have no-one to help them with treatment or the social stigma". This is entirely consistent with the many other reports worldwide of stigmatizing behaviour, including refusal to treat, by health care workers.

In the USA, Freedman (1988) reports that the professional associations were initially more concerned with the freedom of their members than the welfare of their patients. The 1986 American Nurses Association "Statements regarding the risk v responsibility in providing nursing care" posits a positive duty whenever the value of care outweighs any harm the nurse might incur and does not entail more than "minimal risk". The American Medical Association's 1986 "Statement on AIDS" permits physicians who are emotionally unable to care for AIDS patients to refer them elsewhere. These positions were progressively seen as incompatible with the highest duties of the professions. Huerta and Oddi (1992) point out that "Nurses historically have accepted the risk of contagion while caring for patients with infectious diseases". Annas (1988) not only described how the law courts had defined responsibilities, but argued for ways to strengthen antidiscrimination statutes. He maintained that physicians have special legal obligations because society has granted them special privileges, and he supports delineation and
enforcement of ethical obligations by organized medicine, state licensing boards, hospitals and medical schools. Halevy and Brody (1994) regarded the ethical debate as effectively foreclosed by the passage of the Americans with Disabilities Act which created, through civil rights mechanisms, a legal duty to treat patients with HIV, enforceable under heavy penalties. This legislation was soon tested. Two articles in AIDS Policy Law (1995), no authors listed, describe a landmark case in which a dentist was ordered to pay compensatory damages for refusing to treat two HIV positive patients.

The other theme in US literature is the appropriateness of restrictions on the scope of practice of HIV positive health workers. Lo and Steinbrook (1992) describe a modification in CDC recommendations. It originally planned to specify a list of invasive procedures which HIV infected health care workers should not perform, but then proposed that expert review panels should make decisions on a case-by-case basis. The Society for Healthcare Epidemiology of America (SHEA) in an article (1997), no authors listed, recommended that HCV and HIV infected providers use double gloving for procedures, but should not be excluded from any aspect of patient care unless epidemiologically incriminated in the transmission of these infections despite adequate precautions. The society also recommended against specific competence-monitoring procedures directed at these workers, arguing for managing them in the context of a comprehensive approach to the management of all impaired providers. Bartlett (2000) reports CDC recommendations against mandatory testing of health workers and recommends that infected workers not be restricted unless they perform invasive procedures in a blind body cavity. Gostin (2000 and 2002) argued that, since the risks of transmission from health worker to patient had proven to be very small, the CDC recommendations should be changed, arguing that they put the human rights of health workers at risk while doing little for patient safety. A new national policy should focus on management of the workplace environment, injury prevention, encouraging infected workers to promote their own health, discontinue expert review panels and restrictions which stigmatized health care workers, discontinue mandatory disclosure of HIV status in low risk procedures, and impose practice restrictions if a health worker is unable to practice safely because of a physical or mental impairment, or failure to follow careful infection control procedures.

It is clear from this sequence that in the USA, policy has moved markedly in the direction of protecting the privacy and removing the risk of stigmatization of the infected health care worker, partly because of greater sensitivity to the rights of all HIV infected persons, and partly because the hypothetical risk to patients from being treated by an infected health worker have proved to be so minute.
Good private sector practices in occupational health and HIV/TB

In contrast to the previous section, virtually all the literature about workplace health programmes for HIV and TB comes from southern and eastern Africa, and particularly from South Africa. It might be speculated that it is only in high burden countries that the workplace is seen as an appropriate setting for interventions. The prominence of South Africa might be explained by a conjunction of features almost unique to that country: the high prevalence of HIV; the presence of a large number of large scale enterprises (over 60 with more than 6000 employees each); and the historic and still persisting reliance of many of these enterprises on a pattern of migrant labour which may well have accelerated the epidemic. Political factors, such as the reluctance of government to recognize or address the epidemic, and the desire of foreign or minority owned business to project a good public image, may also have contributed to the prominence of the private sector role in HIV programmes.

Somewhat surprisingly, in view of the high esteem in which private sector programmes are held, not a single article gives a clear account of exemplary practice. Even an article with the title "Best practices: a review of company activity on HIV/AIDS in South Africa" by Michael (1999) turned out to be highly critical in tone. However, it can be inferred that the private sector is commended for providing HIV education, including peer educator programmes; preventive measures, especially distribution of condoms; treatment of STDs, opportunistic infections, and more recently, provision of ART at workplace clinics; making reasonable accommodation for infected workers unable to perform hard physical work; and employing consultative processes with the workforce to establish and manage programmes.

There seems widespread agreement that educational efforts have failed in the South African mining industry. Heywood (1996) identifies obstacles to effective HIV education as discrimination, a psychological factor related to underground work that induces recklessness, poor living conditions, and illiteracy. Williams and Campbell (1998) and Campbell and Williams (1999) concur with the view that prior interventions had little impact, attributing this to neglect of the social and community contexts within which transmission takes place. Both sets of authors argue for a more holistic response, including outreach to communities and the prostitutes frequently patronised by single male migrant mineworkers, and attention to STDs. Heywood points out that the mining sector is in a unique position to fight HIV because it already has an extensive medical infrastructure with the capacity to treat STDs effectively, a unionized workforce to provide a pool of peer educators, and recruitment agencies to extend HIV prevention into rural areas.

Rosen and Simon (2003) explain how the private sector generally has tried to evade the costs of HIV. "Common practices that transfer the burden to households and government include pre-employment screening, reductions in
employee benefits, restructured employment contracts, outsourcing of low-skilled jobs, selective retrenchments and changes in production technologies. Between 1997 and 1999 more than two-thirds of large South African employers reduced the level of health care benefits or increased employee contributions. Most firms have also replaced defined-benefit retirement funds, which expose the firm to large annual costs but provide long-term support to families, with defined-contribution funds, which eliminate the risk to the firm but provide little for the families of younger workers who die of AIDS. Connelly and Rosen (2006) were also critical of the medical care offered by the largest enterprises. Among those firms that agreed to participate in their enquiry, 63% of their employees had access to employer sponsored treatment and care for HIV/AIDS. However access differed widely by sector. Approximately 27% of suspected HIV positive employees were enrolled in disease management programmes, or 4.4% of the total workforce. Fewer than 4000 employees in the entire sample were receiving ART. The article concluded that publicity by large employers about their treatment programmes should be interpreted cautiously. While there was a high level of access to treatment, uptake of services was low and only a small fraction of employees medically eligible for ART were receiving it. If large scale enterprises were actually doing so little, it might be anticipated that smaller firms would do even less. According to Rosen et al (2007) across southern and eastern Africa managers of small and medium sized enterprises reported low AIDS-related employee attrition, little concern about the impacts of AIDS, and relatively little interest in taking action. Feeley et al (2007) detected a significant change induced by the advent of low cost ART. Employer clinics have reported impressive results in patient recruitment and survival, and public or donor funded drugs have been used to leverage the expansion of populations treated at employer clinics. Mahajan et al (2007) made a review of workplace programmes in southern Africa using grey literature and key informant interviews. They found widely varying policies and practice, and noted the difficulty in assessing performance, echoing the call for more research made by Rosen et al (2007). As positives, they counted the institution of a legal apparatus that safeguards against discriminative practice, the high prevalence of HIV education programmes, growing provision of VCT, and supply chain linkages to facilitate engagement of smaller firms. Challenges included poor recognition and monitoring of legal violations by management and unions, lack of monitoring and evaluation methodologies for workplace prevention programmes, persistent stigma in the workplace resulting in poor take-up of HIV testing, and low enrolment into workplace ART programmes.

An underlying question is: what motivation do private sector firms have to provide HIV services? Some firms seem to accept some sense of responsibility, either because of the work practices in their industry, or the mode of recruitment of the workforce. Firms whose staff have to travel extensively for their work (transport industries, sales representatives) understand that there is elevated risk in frequent absence from home, as do those that recruit single males from distant areas, as acknowledged by Greener (1998). A more prevalent response is that it
is a simple matter of self interest; high levels of HIV infection in the workforce imply high labour absenteeism and turnover at a minimum, and medical care costs and other benefits if these are assumed by the employer. Doyle (1997) and Moore (1999) produced estimates of the increasing prevalence of HIV in the South African workforce, and identified medical care costs and the threat to stability of retirement funds as two major impacts on employer finances.

Allowing for differences in firm size, employer responses in East Africa were broadly similar. Roberts and Wangombe (1995) report on an interview survey with managers of 16 businesses in Kenya. Only one company followed all the workplace policy principles recommended by WHO/ILO. Six businesses required all applicants and employees to undergo HIV testing. All their managers claimed that they would not discriminate against HIV infected workers, but many workers suspected that they would be dismissed if they were, or were suspected to be, HIV positive. In terms of services, 11/16 firms had some form of HIV education programme, 90% distributed condoms, 60% offered STD diagnosis and treatment, 33% counselling and 25% voluntary HIV testing. Kironde and Lukwago (2002) judge that the private sector had done little in Uganda, but argued that there could be substantial financial savings from the prevention or at least the delay of HIV related expenditures from absenteeism, erosion of company skills and knowledge through key employee deaths, and the costs of hiring and training replacements. Ramachandran et al (2007) exploited a World Bank database of 860 formally registered firms in the manufacturing sector in Kenya, Uganda and Tanzania. They found that approximately one third of enterprises in their sample engaged in HIV prevention activities, the proportion varying with firm size. They assumed that larger firms are more likely to be active in HIV prevention because they have more skilled workers and higher staff replacement costs. Even among larger firms, less than half provided VCT. They did discover a high willingness of workers to be tested for HIV, a finding which coincides with that of Corbett et al (2006) who carried out a cluster-randomized trial of two VCT strategies in Zimbabwe. They found a strong preference for workplace VCT as measured by a 51.1% uptake, compared with provision of a voucher for off-site testing with 19.2% uptake.

Rosen et al (2007) reviewed studies from southern and eastern Africa of the economic impact of HIV/AIDS at the firm level. Estimated workforce prevalence ranged from 5-37%. The average cost per employee lost to AIDS varied from 0.5 to 5.6 times the average annual compensation of the employee affected. Labour cost increases were estimated at 0.6 to 10.8% but exceeded 3% at only 2 of 14 companies. ART at an annual cost of US dollars 360 per patient/year was found to have positive financial returns for most but not all companies. The authors concluded that HIV is causing a moderate increase in labour costs, varying with HIV prevalence, employee skill level and employment policies. Treatment of HIV positive employees is a good investment for many large firms, but smaller firms have less capacity to respond to worker illness and little concern about it. Marseille et al (2006) compared three strategies for treating HIV infected workers
in Uganda: co-trimoxazole prophylaxis (CTX) starting at WHO stage 2; Highly active antiretroviral treatment (HAART) plus CTX starting at WHO stage 2; and a hybrid strategy, starting with CTX at WHO stage 2 and later adding HAART. The hybrid strategy proved most cost-effective, producing US dollars 38,939 savings per 100 skilled workers.

Two articles were found which explored workplace staff committees. Morris et al (2001) describe a committee formed at a sugar factory with 400 employees in Kwa-Zulu Natal, South Africa. This was a freestanding committee dedicated to addressing HIV/AIDS issues and included representatives of unions, management, medical researchers and medical personnel. Vaas (2008) conducted an in-depth study of workplace committees at five small and medium enterprises in South Africa which were actively implementing HIV/AIDS policies and programmes. Management through the human resources department and the occupational health practitioner often drove the initial policy formulation, and had virtually sole control of the budget. Employee representatives were volunteers, usually production workers, and there was a notable lack of participation by white collar employees, line management or trade unions. While the powers of committees were largely consultative, employee members often managed to secure and extend social protective rights on HIV/AIDS to employees, and monitor their effective implementation in practice. The author concluded that workplace committees represented one of the best means to facilitate more effective workplace HIV/AIDS governance, though anticipated rises in AIDS-related morbidity and mortality might put strains on the role of such voluntary committees.

Finally, two articles by Sinanovic and Kumaranayake (2006a and 2006b) examined the success of workplace TB programmes. Three settings, all using DOTS, were compared for quality using three dimensions---structure, process and outcomes. The settings were purely public; public/NGO partnerships; and public/private workplace partnerships. On all three measures of quality, the workplace programmes scored best. They recorded the highest treatment completion rates, possibly because of the convenience to the employee of taking treatment at the worksite and the ease of follow-up of defaulters. Similarly, the workplace programmes entailed by far the lowest cost to the public budget per new patient (presumably because the private firm absorbed all treatment costs other than drugs) and entailed zero costs borne by patients, since they attended the site for employment purposes. On the basis of these findings, the authors recommend an expansion of workplace based public/private partnerships for the treatment of TB.
The costs of providing services to health workers

While there are a number of reports of the costs of HIV services, particularly the costs of ART, they collectively merit a health warning because they are not strictly comparable with one another. They refer to different treatment regimes, in different countries, at different dates, using different currencies and employing different cost concepts and methodologies. Only one refers explicitly to the cost of treating health care workers, but in itself that should not be a major problem. There is no strong a priori reason for supposing that the cost of treating a health worker is materially different from the cost of treating any other patient.

The one article which does focus on health workers is by Deghaye et al (2006), who investigated the time and resources used to provide HAART to health care workers at two public sector hospitals in Durban, South Africa. It gives a range of financial costs for treating a patient for a year of R 5697 - 8762 depending on number of patients and the hospital concerned, and a slightly higher range for economic costs of R 6123 -8893. Another South African study by Badri et al (2006) converted costs in South African Rand into US dollars. The estimated cost per patient year for those on HAART was US dollars 1342 using South African public sector prices for WHO first line regimens, and US dollars 793 if anticipated local drug prices were assumed.

A study by Freedberg et al (2007) modelled the costs of treating a cohort on ART using Indian data on natural history, treatment effectiveness, and input costs. Results were calculated in US dollars, but refer to lifetime costs, not annual costs as in the two previous studies. These were US dollars 5430 per person, with a mean survival of 73.6 months after treatment initiation at a mean CD4 count of 318.

Paton et al (2006) calculated costs and cost effectiveness for patients managed at the national HIV referral centre in Singapore over the period 1996 to 2001. Their results are presented in the form of incremental Singapore dollars per life years gained (LYG) for patients on dual therapy or HAART compared with those not receiving ART, for three stages of disease progression. For CDC stage A, the average incremental cost per LYG was $17,007 and $22,511 for dual therapy and HAART respectively. At CDC stage B, the figures were $10,868 and $21,094, and at CDC stage C the corresponding figures were $9,848 and 16,513. The authors conclude that both dual therapy and HAART were cost-effective interventions in Singapore. They add the telling point that cost effectiveness would be likely to improve if drug prices continued to decrease, as indeed they have done.

Kimura (2002) estimated the hospital costs of treating HIV infected individuals in Japan for the year 1999. The figures are expressed as the monthly cost of treatment in Japanese yen. The average cost for those treated as outpatients lay between 180,000 and 216,000 yen per month, of which 83% was the cost of
ARVs. For inpatients, monthly costs averaged 373,000 yen for those with CD4 counts 200-499, 768,000 yen for those with CD4 counts 50-199, and 1,715,000 yen for those with CD4 counts below 50. Compared with cost estimates in 1995, outpatient costs had risen by 2.7 to 8.6 times, and inpatient costs had increased by 25%.

The pattern of these results was broadly confirmed in a Canadian study by Krentz et al (2003), which found that the average cost per patient per month for the entire HIV positive population of southern Alberta rose from Canadian dollars 6555 in 1995/96 before the advent of HAART, to Canadian dollars 1036 in 1997/98, at which level it remained stable for the next three years. ARVs accounted for 30% of the cost in 1995/96, rising to 69% in 2000/01.

Yazdanpanah et al (2002) estimated the lifetime cost of HIV care in France using data from a cohort of patients followed from 1994 to 1998. In the absence of an AIDS defining event, the average total costs of treatment ranged from 670 euros per month in the highest CD4 stratum, above 500 to 1060 euros per month in the stratum with CD4 count less than 50. The average cost of care was 3370 euros per month during the initial months around an AIDS defining event: 1750 euros per month during the period 2 months after initial diagnosis to 1 month before death; and at 13,010 euros for the last month before death. If clinical management began at a CD4 cell count of 378 as in this cohort, the undiscounted lifetime cost were 309,000 euros over a projected life expectancy of 16.4 years.

Schackman et al (2006) performed a parallel calculation of lifetime costs for the US, using data from the HIV Research Network, a consortium of high volume HIV primary care sites. As with other studies, a computer simulation model was used to generate outcomes and project costs. For adults entering treatment with a CD4 less than 350, projected life expectancy is 24.2 years, and the undiscounted cost is $618,900. Of that total, 73% is ARVs, 13% inpatient care, 9% outpatient care and 5% other medications and laboratory costs. For patients who initiate treatment with CD4 counts less than 200, projected life expectancy is 22.5 years, and undiscounted lifetime cost is $567,000.

Hubben et al (2008) aimed to measure the direct and indirect costs of HIV care in Italy, based on prospective data from a cohort of 121 patients. They divided their patient population into three categories: No HAART (asymptomatic and never before on HAART); Stable HAART (HAART with mild infection and no prior opportunistic infections); and HAART failure (primary HAART regimen altered for severe side effects or immunological failure). From their model, predicted annual costs for the three groups were 1818, 9820 and 12,332 euros respectively.

Sax et al (2005) examined the narrower question of the costs and benefits of adding enfuvirtide to the treatment regimen in treatment experienced patients with advanced disease in the USA. At the then current annual cost of US dollars
18,500 per year, the addition of enfuvirtide to the regimen added 9.5 quality adjusted months of life.

Studies by Badri et al (2006) using South African data and Mauskopf et al (2005) using US data examined the question of the optimal time to initiate ART. Both reached the conclusion that earlier initiation of ART at CD4 counts above 350 produced clinical benefits including additional life expectancy and improved quality of life, at a higher total cost of treatment. Cost effectiveness ratios were highly sensitive to the cost of ARVs.

It needs to be stressed that the utility of all of this literature is extremely limited if the perspective is adopted of a developing country government contemplating the provision of free ART for its health workforce. This is because none of the literature refers to WHO standardized treatment at contemporary ARV prices. Moreover, the prices of other inputs to treatment are hugely variable across countries, and possibly quality of care and treatment outcomes.

Levy et al (2006) also took a jaundiced view of the current state of the costs literature. "We reviewed published studies reporting the direct medical costs of treating HIV infected people in countries using highly active antiretroviral therapy (HAART). Of 543 potentially relevant studies, only nine provided adequate data to make a meaningful statement about costs. Within studies, people with more advanced disease incurred higher total costs. Valid comparisons of total direct medical costs between studies were not possible because of differences in the specific components included, the heterogeneous nature of the study populations in terms of disease stage, the sources and methods used to calculate unit costs, and the level of aggregation at which costs were reported."
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