

Unsafe injections in the developing world and transmission of bloodborne pathogens: a review

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Unsafe injections are suspected to occur routinely in developing countries. We carried out a literature review to quantify the prevalence of unsafe injections and to assess the disease burden of bloodborne infections attributable to this practice. Quantitative information on injection use and unsafe injections (defined as the reuse of syringe or needle between patients without sterilization) was obtained by reviewing the published literature and unpublished WHO reports. The transmissibility of hepatitis B and C viruses and human immunodeficiency virus (HIV) was estimated using data from studies of needle-stick injuries. Finally, all epidemiological studies that linked unsafe injections and bloodborne infections were evaluated to assess the attributable burden of bloodborne infections. It was estimated that each person in the developing world receives 1.5 injections per year on average. However, institutionalized children, and children and adults who are ill or hospitalized, including those infected with HIV, are often exposed to 10–100 times as many injections. An average of 95% of all injections are therapeutic, the majority of which were judged to be unnecessary. At least 50% of injections were unsafe in 14 of 19 countries (representing five developing world regions) for which data were available. Eighteen studies reported a convincing link between unsafe injections and the transmission of hepatitis B and C, HIV, Ebola and Lassa virus infections and malaria. Five studies attributed 20–80% of all new hepatitis B infections to unsafe injections, while three implicated unsafe injections as a major mode of transmission of hepatitis C.

In conclusion, unsafe injections occur routinely in most developing world regions, implying a significant potential for the transmission of any bloodborne pathogen. Unsafe injections currently account for a significant proportion of all new hepatitis B and C infections. This situation needs to be addressed immediately, as a political and policy issue, with responsibilities clearly defined at the global, country and community levels.

Keywords: bloodborne pathogens; disease transmission, horizontal, hepatitis B; hepatitis C; HIV infections; syringes.

Voir page 797 le résumé en français. En la página 798 figura un resumen en español.

Introduction

WHO estimates that at least 12 billion (12 thousand million) syringes are sold each year for injection purposes and that approximately 1 billion injections are given yearly in the course of childhood vaccination programmes (1).

In industrialized countries, it became clear early this century that unsafe injections can lead to transmission of bloodborne infections. For example, in Britain in 1917, an outbreak of malaria among

soldiers was linked to injection treatments for syphilis (2). In a 1945 memorandum from the United Kingdom Ministry of Health, it was concluded that viral hepatitis following injection treatment was “communicated by traces of blood transferred on syringes and needles from patient to patient” (3). Outbreaks of jaundice following injection campaigns in the 1940s and 1960s among Royal Air Force servicemen who received multiple immunizations clearly linked infection with injections for which syringes were reused after changing the needle only (4). This observation has been supported by laboratory studies demonstrating that syringes become contaminated because negative pressure is generated when the needle is removed (5, 6). After decades of awareness of the risks related to unsafe injections, the policy of “one sterile syringe and needle for each patient” was eventually adopted widely by the medical community in industrialized countries (4). The subsequent introduction of disposable syringes largely reduced the problem in industrialized countries to needle-stick injuries

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among health care workers and needle-sharing among injecting drug users, with a residual risk for the public through medical and dental procedures (7).

In contrast, the general population in developing countries continues to be at risk of acquiring blood-borne diseases from unsafe injections (1, 8). Several studies have identified unsafe injections as a major risk factor in outbreaks of bloodborne infectious diseases (9–12). However, the problem is not limited to occasional outbreaks; unsafe injections cause a steady number of unrecognized transmissions of bloodborne infections in developing countries on a daily basis.

Methods

We undertook a systematic search for literature published in English and French as well as English abstracts of foreign-language literature available via MEDLINE for the years 1966 through 1998. Other relevant articles were identified from the bibliographies of these papers. We also abstracted observations on injection use and safety from all WHO country reports and consultations since 1980 from the WHO Expanded Programme on Immunization (EPI); all of these are unpublished as of 1999. Each country report was based on visits to several health centres that delivered vaccines as a part of their services. The country names were coded, since the content of these reports cannot be used without permission from the countries concerned.

The definitions shown below were adopted for the purposes of this study.

- An **injection** is a skin-piercing event performed with a syringe and needle with the purpose of introducing a curative substance or a vaccine into a patient by the intramuscular, intravenous or subcutaneous route. This excludes all other skin-piercing procedures, such as blood transfusions, surgery, tattoos and body-piercing.
- An **unsafe injection** is one in which the syringe, needle, or both, have been reused without sterilization. This conservative definition was chosen to facilitate a quantitative comparison of injection safety information. It does not include other unclean handling of sterile equipment.
- An **unnecessary injection** is one where oral alternatives are available, where the injected substance is inappropriate or harmful, or where the symptoms or diagnosis do not warrant treatment by injection.

Potential for transmission of blood-borne infections via unsafe injections

Injection use

History. Injection therapy was first introduced to the developing world population with the mass campaigns against yaws and kala-azar in the 1920s, and became widespread after the Second World War following the introduction of penicillin (13). Anthro-

polo-ologists have described the flourishing business of untrained “injection doctors” in several developing countries (14–17).

Frequency of injections. Data on the prevalence of injections were collected from WHO country reports, published anthropological household surveys and epidemiological case-control studies (injection use among healthy controls) and were converted to conservative estimates of the number of injections per person per year. From anthropological interview surveys, biweekly household injection rates were converted to estimates of the average yearly rate per person.

The number of injections per person per year was estimated for 13 countries representing five regions of the developing world, as classified by the World Bank (Table 1). The conservative estimates of the average number of injections ranged from 0.9 to 8.5 per person per year, with a median of 1.5 injections per person per year. The highest prevalence was found for Pakistan, Ecuador and a country in the former Soviet Union. For eight countries, the proportion of outpatient visits that resulted in at least one injection ranged from 25% to 96%.

The distribution of injections within the population of each country appeared to be strongly clustered. In one East European country, half the surveyed population received no injections in 1997, while the other half had received an average of 10 (18). In general, the factors associated with high rates of injections were illness (12, 19, 20), admission to a hospital (12, 20–22), being infected with HIV (12, 20) and young age (19, 20, 22, 23). The highest injection frequency documented was 500 per year for an institutionalized orphan in a country in the former Soviet Union; healthy infants received 20 injections and institutionalized children 120 injections per year on average (23). In the Ukraine, hospitalized children received an average of 65 injections per hospital stay (20).

Unnecessary injections. Two studies from the United Republic of Tanzania, one of which was a survey of 66 health clinics, concluded that 70% of all curative injections given were unnecessary (Table 1) (24). Using data presented in a study of injection practices in five health clinics in Indonesia (25), we calculated that 82% of curative injections were unnecessary. In India, a survey found that 96% of all injections given by private doctors were for antibiotics, vitamins and analgesics (26). Two studies set in Moscow concluded that 85% and 99% of injections given to children hospitalized with respiratory diseases were unnecessary (27, 28). Outside the formal health care system, injections are frequently purchased without prescriptions and administered by unqualified persons in pharmacies and in market-places; most of these injections were judged to be unnecessary (13, 16, 17). Overall, the most frequently injected medications included antibiotics, vitamins and analgesics (26–30) and quinine (31). The indications for injection treatment included several nonspecific symptoms such as mild diarrhoea, fever with no other symptoms, colds and fatigue (29–32) (Fig. 1).

Table 1. Injection use in developing countries

Region	Country ^a (references)	Year	No. of injections per person per year	% of outpatient visits resulting in injection	Ratio of curative to immunization injections	% of injections that were unnecessary
Sub-Saharan Africa	Uganda (29)	1993	0.9 ^b	60–68	5.6:1 (85) ^c	–
	AFR G (23)	1998	2	–	20:1 (95)	–
	AFR B (23)	1989	–	74	–	–
	Cameroon (75)	1980	1.3	–	–	–
	AFR I (23)	1993	–	96	–	–
	United Republic of Tanzania (24, 79)	1996, 1998	1.2	25	–	70, 70
	AFR A (23)	1997	3	–	–	–
Asia	Indonesia (25, 29)	1993, 1996	2.1 ^b	53, 70–90	27:1 (96)	82
	Thailand (30)	1994	1.6 ^b	–	50:1 (98)	–
	India (26, 76)	1992	1.2	33, 50	–	Common
Former Soviet Republics	Republic of Moldova (18)	1998	5	–	–	–
	EUR A (23, 80)	1997	7.5	–	20:1 (95)	–
	Russian Federation (27, 28)	1988	–	–	–	99, 85
Latin America	Ecuador (32)	–	7.3	46	–	–
	Pakistan (81)	1999	8.5	49	–	Common
Middle East and North Africa	EMR A (23)	1997	1.5	–	–	–

^a For Expanded Programme on Immunization country reports (23), country names are coded since the content of these reports cannot be used without individual country permission.

^b These estimates were based on household interview surveys and are likely to underestimate the true injection prevalence, as the collected data on the percentage of households with at least one injection could represent several persons injected and one or more injections per person.

^c Figures in parentheses are percentages.

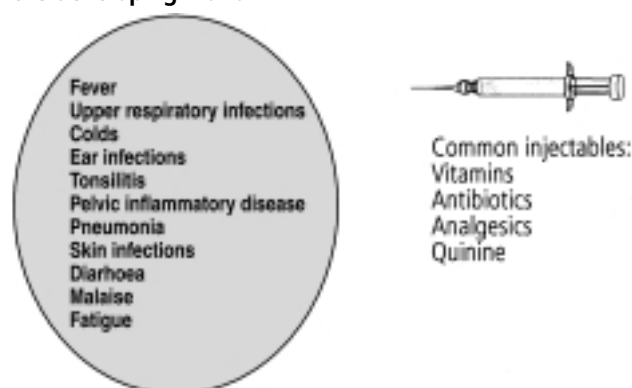
Curative versus immunization injection. Five studies addressed the purpose of injections (Table 1). The ratio of curative to immunization injections ranged from 5.6:1 (85% curative) in Uganda (29) to 50:1 (98% curative) in Thailand (30), with an average (median) of 95% curative and 5% immunization injections.

Prevalence of unsafe injections

Data on the frequency of unsafe injections based on direct observations of injection practices were abstracted from WHO country reports for visits carried out over the period 1987–98, and from published anthropological studies. Conservative estimates were based on information such as: “Each syringe was routinely used on three to ten patients before discarding/sterilizing” (in this example, at least two out of three injections (66%) were considered unsafe). When the prevalence of unsafe injections could not be estimated, we abstracted other indicators of injection safety problems, such as the proportion of facilities that reported abscesses or routinely reused unsterile syringes (Table 2).

We were able to estimate injection safety for 19 countries representing five regions of the developing world. For 14 of these countries, at least 50%

Fig. 1. Symptoms that are commonly treated with injections in the developing world



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of injections were unsafe. Of the remaining five countries, two had 20% and >31% unsafe injections, while three countries had no documented problems with injection safety. Latin America was only represented by one of the small, poorer countries in which at least 50% of injections were unsafe (33). In addition, a recent report from a large country in South America indicated the presence of indicators of unsafe injections during a recent vaccination campaign (recapping, unsafe waste disposal, shortage of

Table 2. Prevalence of unsafe injections in developing countries

Region	Country ^a (references)	Year	Type of data used in the estimation	% of unsafe injections	Other indicators of injection safety
Sub-Saharan Africa	Uganda (29)	1994	Observed 35 providers, 2 districts	>62	—
	AFR D (23)	1998	Survey of multiple health centres	—	60% of centres reused syringes/needles
	AFR E (23)	1998	Survey of multiple health centres	—	15% of centres reused syringes/needles
	AFR G (23)	1998	Observed 1 nurse for 1 day in 5 regions, 28 clinics	>67	—
	Burkina Faso (82)	1989	Observed 6000 injections in 4 clinics, 1 district	>90	—
	AFR H (23) ^b	1997	National sample of 12 districts; observations of EPI and curative injections	20	—
	AFR F (23)	1995	Observed common practice in health centres: reuse of BCG syringes in health centres	>50	—
	AFR I (23)	1993	Observed common practice in health centres: reuse of syringes and needles	>50	—
	AFR J (23)	1998	Randomized survey; observed 87 injections performed in 26 clinics	>31	—
Asia	Gabon (83)	1989	Medical records survey in 9 health facilities, all regions represented	—	Rate of injection-related abscesses, 2.3 per 1000 population per year
	AFR M (23)	1998	Survey of multiple health centres	—	0% of centres reused syringes/needles
	Indonesia (25, 29)	1993, 1996	Observed reuse of syringes and needles in 5 health centres, several regions	>50	—
	SEAR B (23) ^b	1998	Observed 6000 curative injections given with 1500 syringes in a health centre	>75	—
Former Soviet Republics	Thailand (30)	1994	Observational study set in one urban and one rural village in one region	—	Frequent reuse of unclean syringes
	WPR B (23)		Observation of routine reuse of unclean syringes in 5 immunization sites in rural and urban settings	>90 ^c	—
	India (76)	1992	Anecdotal: observed reuse of syringes and needles in one hospital on one day	>93	—
Middle East and North Africa	EUR B (23)	1993	Observation of common practice in health care facilities in several regions	—	55% of facilities reused unsterilized syringes
	Ukraine (20)	1990	Nurse interview: sharing of syringes and medication between patients common practice in 1 hospital studied	>50	—
	Republic of Moldova (57)	1998	Anecdotal observation from 1 hospital	—	Unclean syringes commonly reused
Latin America	EMR C (23)	1988	Observation of common practice in refugee immunization programme in a province: reuse of syringe and needle for 5 patients	>80	—
	EMR E (23)	1987	Immunization programme review	0	—
	EMR F (23)	1998	Immunization programme review	0	—
	Saudi Arabia (54)	1997	50% of nurses in one hospital reused syringes for several heparin locks	>50	—
	Pakistan (84)	1999	Observational study of 52 injections given in 18 clinics in one region	94	—
	Dominican Republic (33)	1988	Observation during survey of rural health services: disposable unclean syringes reused multiple times	>50	—

^a For Expanded Programme on Immunization country reports (23), country names are coded, since the content of these reports cannot be used without individual country permission.

^b These figures were for curative injections where re-use of disposable syringes without sterilization was common. In contrast, the immunization programme had no safety problems in SEAR B and less safety problems in AFR H (11%).

^c For the immunization programme that employs reusable glass syringes. No information about safety of curative injections was available.

syringes and needles) but the prevalence of unsafe injections could not be assessed (23).

For two countries, one in sub-Saharan Africa and one in Asia, data were available on both vaccines and curative injections. For these countries there was evidence that childhood immunizations were safer than curative injections. However, several reports from countries in sub-Saharan Africa, Asia and the Middle East estimated that 31% to >90% of childhood vaccinations were unsafe (23).

Pathogen transmissibility

The likelihood of acquiring an infection upon exposure to an unsafe injection depends on the transmissibility of any pathogen present. To assess the absolute and relative transmissibility of blood-borne pathogens via unsafe injections, we reviewed data from prospective studies of health care workers who had experienced a percutaneous needle-stick injury. The results indicated that hepatitis B virus was approximately ten times more transmissible than hepatitis C virus, and more than twenty times more transmissible than HIV (Fig. 2).

Hepatitis B. In studies that included all hepatitis B carriers, the seroconversion rate varied between 5% and 43% (34). The variability was explained by the presence or absence of the hepatitis B e-antigen (HBeAg) in the contaminating blood (an indicator of active viral replication). In four studies that involved HBeAg-positive blood, 19% (35), 27% (36), 31% (37), and 43% (34) of the health care workers involved seroconverted. For demographic reasons, the majority of hepatitis B carriers in the developing world are children and young adults who are likely to be HBeAg-positive (38). We therefore assess the probability of transmission of hepatitis B via blood traces on syringes/needles as 20–40% in this setting (Fig. 2).

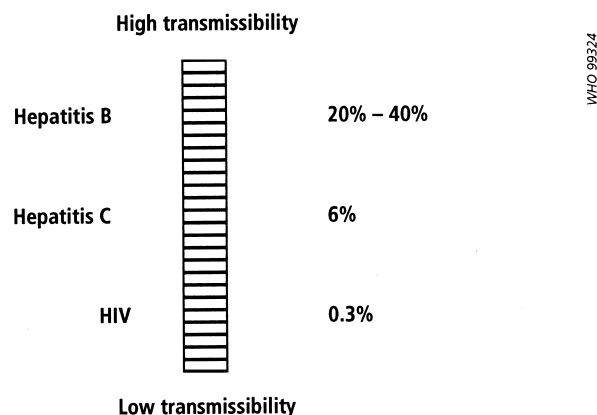
Hepatitis C. In five independent prospective studies of needle-stick injuries involving hepatitis-C-positive patients, seroconversion occurred in 3% (39), 5.4% (40), 5.4% (41), 6% (42) and 10% (43) of the episodes. Pooling observations from these five studies, we calculated that, on average, 6% of needle-stick injuries (18 of 301) involving hepatitis-C-infected patients led to infection.

HIV. For HIV we considered pooled estimates that had tighter confidence intervals on the point estimates, while excluding the smaller studies from which they were derived. In five studies (44–48) the point estimates of the percentage of seroconversions following HIV-contaminated needle-stick accidents varied between 0.2% and 0.5%, with a median of 0.3%. The transmission rate may vary considerably depending on the infectious stage and age of the HIV-positive patient.

Prevalence of HIV, hepatitis B and hepatitis C

The likelihood of becoming infected through an unsafe injection also depends on the prevalence of the bloodborne pathogen in the population. We

Fig. 2. Probability of transmission if injection equipment is contaminated with blood infected with HIV, hepatitis B or C virus



estimated the prevalence of HIV, hepatitis C and hepatitis B carriers in developing regions of the world based on the country-specific prevalence estimates for HIV (49), hepatitis C (50) and hepatitis B (51), and using 1996 country-specific census data for the weights (Fig. 3). In addition to the regional variability illustrated, the prevalence of all three pathogens varied considerably between countries.

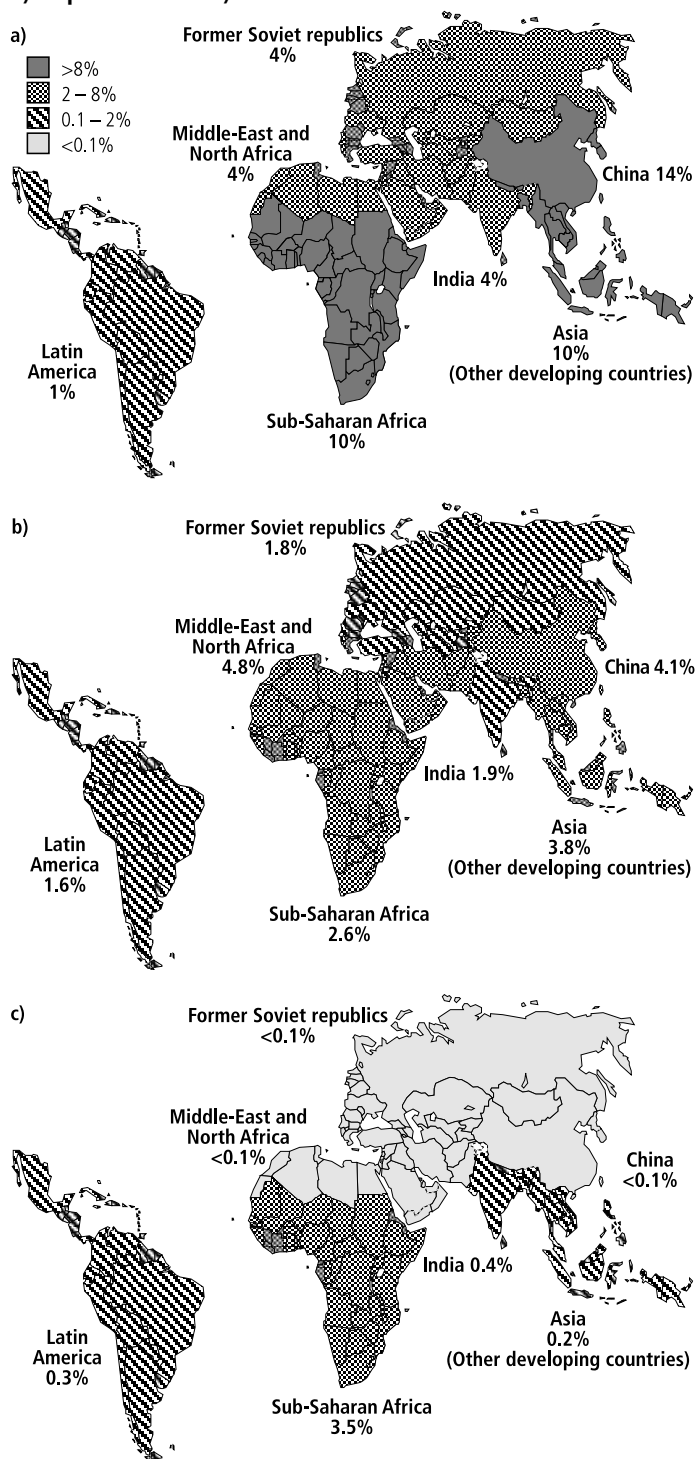
Studies that linked unsafe injections and bloodborne infections

We examined epidemiological studies that reported an association between injections and bloodborne infections, and selected those that convincingly implicated unsafe injections as the cause of infection by including other potential risk factors such as blood transfusions, surgery and hepatitis-B-carrier siblings. We rejected studies with a design that did not allow controlling for possible confounding factors. For example, symptomatic hepatitis B patients may be more likely than controls to have been treated with injections for their symptoms – and this could falsely implicate these injections as the causal factor. Finally, early hepatitis C and HIV serology studies were excluded on the grounds that the first-generation serology test kits were highly prone to giving false-positive readings.

We identified 18 epidemiological studies that we considered presented sufficient evidence of a link between unsafe injections and the transmission of bloodborne pathogens (Table 3).

Haemorrhagic fever viruses. In 1976 in Zaire, an outbreak of haemorrhagic fever caused by the emerging Ebola virus was linked to unsafe injections given at a hospital where the index patient had been treated for fever with injections (52). In Nigeria in 1995, an outbreak of Lassa fever occurred with a very similar epidemic pattern: febrile patients had been treated for suspected malaria with injections of quinine (53), which had probably led to loops of

Fig. 3. Average regional prevalence (%) of a) hepatitis B, b) hepatitis C and c) HIV infections



Lassa fever transmissions via contaminated injection equipment.

Malaria. In 1992 in Saudi Arabia, an outbreak of *Plasmodium falciparum* malaria occurred in a paediatric hospital (54). The outbreak investigation linked transmissions to infusions received through use of a heparin lock. Nurses were in the habit of using a single syringe on several consecutive patients. This outbreak occurred in a nonmalarious area and the patients had been admitted for unrelated reasons.

HIV. Over the period 1989–91, 10% of all orphans in Romania became infected with HIV via a large number of unsafe injections given in hospitals and institutions (55). While HIV appears to have been seeded in this population by a practice of micro-transfusions involving imported HIV-contaminated blood, the majority of HIV-positive children had not received any blood products. In Ukraine, 1% of all children in a township were infected with HIV over a one-year period; these transmissions were linked to unsafe injections (20). In India, seven children awaiting adoption seroconverted for HIV over a 3-month period in 1996–97 (56). These children had all been treated at the same health care facility during October 1996, and all harboured very similar HIV strains. Intravenous antibiotics and routine immunizations were identified as the major risk factor, after blood transfusions and surgery had been ruled out (56).

Hepatitis B. Nine studies convincingly linked unsafe injections and transmission of hepatitis B virus. In six, the population attributable risk (PAR) of unsafe injections, i.e. the proportion of infections attributable to unsafe injections, was estimated to be in the range 20–80% for children and adults in China (including Province of Taiwan), India, the Republic of Moldova, and Romania (Table 3). In a study of acute hepatitis B patients in Republic of Moldova, the PAR of unsafe injections was 21% for children and 52% for adults (57). In Romania, a similar study in 1997–98 among a group of children not yet vaccinated against hepatitis B, estimated that the PAR was 40% (58). In three prospective studies of hepatitis B infections among pre-school children in China (Province of Taiwan) prior to the introduction of hepatitis B vaccinations, exposure to unsafe injections was identified as a major risk factor (59–61). One study found that exposure to unsafe injections was at least as risky as having a sibling who was a carrier of hepatitis B (60). On the basis of data presented in a previous study (61), we estimated that 61% of all new hepatitis B infections among children were attributable to unsafe injections. In India, a study of risk factors for adult acute hepatitis B reported that 57% of the infections were attributable to unsafe injections (62). Finally, in a prospective intervention study undertaken in a Chinese village over a 4-year period, the hepatitis B carrier rate among children (< 2 years of age) born to HBeAg-negative mothers dropped by 80% after the introduction of sterile injection practices (63).

Hepatitis C. In Egypt, nationwide injection campaigns against schistosomiasis between 1920 and 1980 played a major role in the extensive spread of hepatitis C virus, leading to the high current prevalence (18%) of the virus in the population (10, 11, 64). These campaigns involved several injections over the course of weeks, and the reuse of syringes without sterilization (64). In a village hyperendemic for hepatitis C in China (Province of Taiwan), the high prevalence (50–70%) among older age groups was linked to injections received at the local clinic

Table 3. Studies linking unsafe injections to transmission of bloodborne pathogens in developing countries

Pathogen	Year (reference)	Region	Country	Type of study	Proportion of infections attributed to unsafe injections, PAR
Ebola	1976 (52)	Sub-Saharan Africa	Zaire	Outbreak	Major risk factor
Lassa	1995 (53)		Nigeria	Outbreak	Major risk factor
<i>Plasmodium falciparum</i>	1992 (54)	Middle East	Saudi Arabia	Outbreak	Major risk factor
HIV	1990 (20)	Former Soviet Republics	Ukraine (Elista)	Outbreak	Major risk factor
	1993 (12)		Romania	Nationwide	Major risk factor
	1998 (56)	Asia	India	Outbreak	Major risk factor
Hepatitis C	1997 (65)		China (Province of Taiwan)	Population-based	Major risk factor
	1998 (64)	Middle East	Egypt	Nationwide	Major risk factor
	1997 (66)		Pakistan	Population-based	Major risk factor
Hepatitis B	1991 (61)	Asia	China (Province of Taiwan)	Intervention, children <2 years	80% ^a
	1982 (59)		China (Province of Taiwan)	Population-based, children	Major risk factor
	1991 (61)		China (Province of Taiwan)	Prospective study, children	61%
	1993 (60)		China (Province of Taiwan)	Population-based, children	Major risk factor
	1993 (62)		India	Population-based, Acute hepatitis B, adults	57%
	1998 (85)		India	Outbreak	Major risk factor
	1991 (20)	Former Soviet Republics	Ukraine	Outbreak	Major risk factor
	1998 (58)		Romania	Population-based, acute hepatitis, children	40%
	1998 (57)		Republic of Moldova	Population-based, acute hepatitis	52% (adults) 21% (children)

^a Preventable fraction is equivalent to population-attributable risk (PAR). This figure was calculated on the basis of information provided in an English abstract.

before 1985 (65). A study set in a Pakistani town found a dose–response relationship between injections received and hepatitis C infection; it was concluded that unsafe injections were the major mode of hepatitis C transmission in this setting (66).

Discussion

Summary of results

This review illustrates that injection therapy is popular and widespread in the developing world. Of all injections given, 5% or less were for immunizations; 95% were given for curative purposes, and most of these were judged to be unnecessary. This pattern of overuse is a complex behavioural problem caused in part by patients demanding injections, which they believe to be the most powerful route of administering the substance concerned, and in part by economic and other incentives, which lead providers to prescribe unnecessary injections.

Furthermore, in 14 of the 19 developing countries for which data were available, representing five world regions, more than 50% of all injections were unsafe, e.g. the syringes and needles were used

on consecutive patients without sterilization. Typically the unsafe injections were delivered with reused disposable syringes (23). Thus, whereas the introduction of disposable syringes largely eliminated the problem of unsafe injections in developed countries, it did not lead to safe injection practices in developing countries; rather, it imposed an environmental problem in countries with no infrastructure for safe disposal of sharps.

This global situation of unsafe injection practice, the well-established transmissibility of hepatitis B and C and of HIV via needle-sticks, and the considerable prevalence of these viruses in the populations concerned, provide compelling indirect evidence that transmission of bloodborne pathogens through unsafe injections is a common event in developing countries. Because febrile, ill and HIV-infected persons tend to receive 10–100 times more injections than healthy people, the true probability of a syringe being contaminated with blood tainted with a pathogen may actually be considerably higher than the average population prevalence of that pathogen.

Although transmissions of bloodborne pathogens via unsafe injections are bound to occur on a routine basis, the bulk of them are never attributed to this route owing to the time-lag (months or years)

before an infection manifests itself as acute or chronic illness.

In support of this indirect evidence, 18 epidemiological studies convincingly linked the transmission of bloodborne pathogens to unsafe injections. These included investigations of outbreaks as well as population-based studies of hepatitis B and C, HIV, and haemorrhagic fever viruses and malaria infections in Africa, republics of the former Soviet Union, Asia, and the Middle East. Each of these studies reported that only a small proportion of patients had been exposed to blood transfusions or blood products.

Five population-based studies estimated that 20–80% of horizontally acquired hepatitis B infections were attributable to unsafe injections. This implies that at least 13 million hepatitis B infections are attributable to unsafe injections each year, estimated as 20% of the 67 million new hepatitis B infections that are thought to occur in the developing world each year (67). Given the documented history of decades of injection popularity and unsafe practices in the developing world, it is likely that a substantial proportion of current morbidity and mortality due to chronic hepatitis B may be attributable to unsafe injections that occurred decades ago.

The results of four population-based studies implied that unsafe injections played a major role in the spread of hepatitis C in China (Province of Taiwan), Egypt, and Pakistan. Indeed, the nationwide schistosomiasis campaigns in Egypt may represent the world's largest iatrogenic transmission event that led to the high endemic rate of hepatitis C infection in Egypt (64). The studies in China (Province of Taiwan) and Pakistan were set in villages and townships with extremely high rates of hepatitis C and reported that unsafe injections were the dominant mode of transmission (65, 66). We hypothesize that unsafe injections may, in general, be a major source of hepatitis C transmission in the developing world, since blood transfusions are not widely available in these countries (68).

In contrast, the overall contribution of unsafe injections to the spread of HIV/AIDS is probably minimal compared with that of vertical and sexual transmission and injecting drug use. Nevertheless, there may be situations where unsafe injections represent an unacceptable risk for subpopulations not otherwise at risk for HIV infections. For example, the results of epidemiological studies indicated that unsafe injections played a significant role in the early phase of the HIV epidemic in Romania and a former socialist republic (12, 20, 55). Furthermore, it has been estimated that routine vaccination schedules may lead to one HIV infection per 1000 children in a high prevalence region such as sub-Saharan Africa (69). Finally, the likelihood of becoming infected with HIV through unsafe injections during a hospital stay in an endemic area, where half of the other patients may be HIV-positive (70), may well be considerable.

Caveats

Because of the general lack of representative randomized studies, we included all quantifiable information on injection use and safety that was available in the literature, provided it was derived from direct observation of injection practices. The country-specific estimates of injection safety were, in some cases, based on adequate surveys of large random samples of clinics in a country, and in other cases may not truly be representative of the general health care system. To avoid overstating the case, we used a systematic approach for abstracting and analysing data to generate conservative estimates. In itself, the country selection in each region tended towards a conservative assessment, as the literature and reports on injection safety are biased towards countries with more functional public health services. For example, there were no data available from several large sub-Saharan African countries with a history of unrest, breakdown of public health services and anecdotal evidence of particularly poor injection safety. Thus, while the representativeness of individual data points may be questioned, we believe that the estimated high levels of unsafe injections for the majority of countries studied support the conclusion that injection safety is a serious and widespread problem in the developing world. Latin America was represented by one small country only; therefore, an adequate evaluation of injection safety for this region awaits more data.

Several of the epidemiological studies that reported a link between injection safety and infections were based on interviews with very long recall periods, were set in small communities or involved few study patients. Further, extrapolating the results of such studies to generate global estimates may overstate the case, given that it might be difficult to publish studies that do not find an association between injections and bloodborne infections.

To further consolidate the general finding in these studies that unsafe injections play a major role in the transmission of viral hepatitis B and C, more studies are warranted in several regions in the developing world.

Perspective

In order to quantify the available data systematically, we chose to focus exclusively on patient-to-patient transmission of bloodborne pathogens. However, for a comprehensive discussion of injection safety issues and a proper search for solutions, several other major aspects of this problem need to be considered. These include the hazards of needle-stick injuries in health care workers and waste management personnel due to unsafe handling of sharps, and the risks to children playing in or around improperly disposed sharps in the environment. As we defined unsafe injections as the reuse of syringes or needles without sterilization, we excluded other unsafe practices that may lead to other infections such as tetanus (71, 72) or aggravation of poliomyelitis (73–76). Finally, our

study was largely limited to the official health sector in each country. However, it has been reported that a large number of injections are given by persons other than trained health care workers, for example, "injection doctors", family members or friends (14, 17, 77). Such injections are likely to be even more unsafe than those given in health care centres, but there are no quantitative data available to indicate the magnitude of this problem.

As reported elsewhere in this issue, we used a mathematical modelling approach to estimate the global incidence of bloodborne infections that may be attributable to unsafe injections (78). Using a conservative approach we calculated the annual incidence of infections attributable to unsafe injections to be 8–16 million for hepatitis B, 2.3–4.7 million for hepatitis C and 80 000–160 000 HIV infections worldwide (78). This modelling approach may be extended to include other outcome measures of disease burden such as severe morbidity, mortality, years of life lost or disability-adjusted life years (DALYs).

The problem of unsafe injections is complex and therefore solutions will not be straightforward. For example, efforts could be made to improve the education and supervision of health care workers with the aim of reducing unnecessary injections and promoting injection safety. But even so, in poorer countries objects of value are not thrown away and thus the deeper incentives for recycling of syringes remain. Programmes may educate patients about the hazards of unsafe injection and seek to reduce their demand for injections, but knowledge alone may not be enough to break the habit; the reasons why injections are thought to have magic powers must be addressed at a deeper level. Although national hepatitis B vaccination programmes may efficiently halt hepatitis B transmission due to unsafe injections,

they cannot eliminate the transmission of other pathogens by this route. Technical solutions, such as "auto-disable" (AD) syringes that can be used only once, are available; however, they are more expensive and do not eliminate the hazards of sharps waste in the environment. Finally, interventions aimed at securing injection safety for childhood vaccines are currently being implemented, but this does not address the problem of unsafe curative injections (accounting for 95% of all bloodborne infections attributable to unsafe injections).

Any safe injection initiative must therefore tackle the problem at the global, country and community level as well as among practitioners and patients. The starting-point is awareness that this is, indeed, a serious public health problem and a conviction that, however complex it seems, it is preventable. While collection of more data is warranted and has already been planned to determine more accurately the magnitude of the problem, the transition to safer injection practices in developing countries should begin immediately. After all, the principle of "first do no harm" should apply equally to developing and industrialized countries. ■

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Résumé

Injections à risque dans les pays en développement et transmission de micro-organismes pathogènes présents dans le sang : mise au point

Les injections à risque sont fréquentes dans les pays en développement. On trouvera dans cet article les conclusions d'une mise au point bibliographique faite pour évaluer les risques de transmission de maladies par le sang et la charge de morbidité attribuable aux injections à risque.

Des données quantitatives sur le recours aux injections et la fréquence des injections à risque (c'est-à-dire faites à l'aide de seringues ou d'aiguilles réutilisées sans stérilisation) ont été tirées de la littérature publiée et d'observations non publiées de l'OMS. La transmissibilité des virus de l'hépatite B et C et du virus de l'immunodéficience humaine (VIH) a été estimée sur la base de données tirées d'études sur les blessures par piqûre d'aiguille. Enfin, toutes les études épidémiologiques établissant une relation entre les injections à risque et les infections transmises par le sang ont été évaluées.

Il a été estimé que dans le monde en développement chaque personne reçoit en moyenne 1,5 injection par an. Toutefois, ce nombre est souvent 10 à 100 fois supérieur pour les enfants placés dans des institutions ainsi que pour les enfants et adultes malades et hospitalisés, dont ceux qui sont infectés par le VIH/SIDA. En moyenne, 95% des injections sont faites à des fins thérapeutiques et la plupart ne sont pas indispensables.

Dans 13 des 16 pays pour lesquels des données étaient disponibles, au moins 50% des injections étaient à risque. Dans 18 études, un lien convaincant a pu être établi entre les injections à risque et la transmission des hépatites B et C, du VIH, et des virus Ebola et de Lassa. Dans cinq études, 20 à 80% des cas nouveaux d'hépatite B ont été attribués à des injections à risque et trois donnent à penser que les

injections à risque sont un mode majeur de transmission de l'hépatite C.

Les injections à risque sont monnaie courante dans la plupart des pays en développement et constituent un moyen potentiel non négligeable de transmission de tout micro-organisme présent dans le sang. Les injections à risque sont actuellement

responsables d'un pourcentage important de cas nouveaux d'hépatite B et C. Il est impératif de remédier d'urgence à cette situation qui doit être considérée comme un problème politique et stratégique, et de définir clairement les responsabilités aux niveaux mondial, national et communautaire.

Resumen

Inyecciones peligrosas en el mundo en desarrollo y propagación de patógenos transmitidos por la sangre: revisión

Las inyecciones peligrosas son habituales en los países en desarrollo. En este artículo damos cuenta de una revisión de la literatura llevada a cabo para evaluar el potencial de propagación de enfermedades transmitidas por la sangre y la carga de morbilidad atribuible a las inyecciones peligrosas.

La información cuantitativa utilizada sobre el uso de inyecciones y la prevalencia de inyecciones peligrosas (definidas como la reutilización de jeringas o agujas entre pacientes sin ninguna medida de esterilización) procede de la revisión de trabajos publicados y de informes inéditos de la OMS. La transmisibilidad de los virus de la hepatitis B y C y de la inmunodeficiencia humana (VIH) se estimó a partir de los datos de estudios sobre las lesiones por puntas de aguja. Por último, se evaluaron todos los estudios epidemiológicos que relacionaban las inyecciones peligrosas y las infecciones transmitidas por la sangre.

Se estimó que, como promedio, cada persona del mundo en desarrollo recibe 1,5 inyecciones cada año. Sin embargo, los niños al cuidado de instituciones especiales y los niños y adultos enfermos y hospitalizados, incluidos

los infectados por el VIH/SIDA, se ven expuestos a menudo a 10–100 veces esa cantidad. Como promedio, un 95% de las inyecciones son terapéuticas, pero la mayoría de ellas son innecesarias.

Al menos un 50% de las inyecciones eran peligrosas en 13 de los 16 países para los que se disponía de datos. En 18 estudios se informaba de una relación convincente entre las inyecciones peligrosas y la transmisión de las hepatitis B y C, el VIH y los virus Ébola y Lassa. En cinco estudios se atribuía el 20%-80% de los nuevos casos de hepatitis B a inyecciones peligrosas, mientras que en tres se identificaba esta práctica como el principal modo de transmisión de la hepatitis C.

Las inyecciones peligrosas son habituales en la mayoría de los países en desarrollo, lo que entraña un riesgo importante de propagación de cualquiera de los patógenos transmitidos por la sangre. Esa práctica explica actualmente un porcentaje considerable de todos los casos nuevos de hepatitis B y C. Es necesario abordar inmediatamente esta situación, como un problema político y normativo, definiendo claramente las responsabilidades a nivel mundial, nacional y comunitario.

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