

The cost-effectiveness of policies for the safe and appropriate use of injection in healthcare settings

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Objective Poor injection practices transmit potentially life-threatening pathogens. We modelled the cost-effectiveness of policies for the safe and appropriate use of injections in ten epidemiological subregions of the world in terms of cost per disability-adjusted life year (DALY) averted.

Methods The incidence of injection-associated hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV) infections was modelled for a year 2000 cohort over a 30-year time horizon. The consequences of a "do nothing" scenario were compared with a set of hypothetical scenarios that incorporated the health gains of effective interventions. Resources needed to implement effective interventions were costed for each subregion and expressed in international dollars (I\$).

Findings Worldwide, the reuse of injection equipment in the year 2000 accounted for 32%, 40%, and 5% of new HBV, HCV and HIV infections, respectively, leading to a burden of 9.18 million DALYs between 2000 and 2030. Interventions implemented in the year 2000 for the safe (provision of single-use syringes, assumed effectiveness 95%) and appropriate (patients–providers interactional group discussions, assumed effectiveness 30%) use of injections could reduce the burden of injection-associated infections by as much as 96.5% (8.86 million DALYs) for an average yearly cost of I\$ 905 million (average cost per DALY averted, 102; range by region, 14–2293). Attributable fractions and the number of syringes and needles required represented the key sources of uncertainty.

Conclusion In all subregions studied, each DALY averted through policies for the safe and appropriate use of injections costs considerably less than one year of average per capita income, which makes such policies a sound investment for health care.

Keywords Injections/adverse effects; Equipment reuse/economics; Equipment contamination/prevention and control; Health policy; Syringes/adverse effects; Needles/adverse effects; Hepatitis B/etiology; Hepatitis C/etiology; HIV infections/etiology; Cost of illness; Cost-benefit analysis; Models, Theoretical; Cohort studies (*source: MeSH, NLM*).

Mots clés Injection/effets indésirables; Réutilisation matériel/économie; Contamination matériel/prévention et contrôle; Politique sanitaire; Seringue/effets indésirables; Aiguille/effets indésirables; Hépatite B/étiologie; Hépatite C/étiologie; HIV, Infection/étiologie; Coût maladie; Analyse coût-bénéfice; Modèle théorique; Etude cohorte (*source: MeSH, INSERM*).

Palabras clave Inyecciones/efectos adversos; Equipo reutilizado/economía; Contaminación de equipos/prevenición y control; Política de salud; Jeringas/efectos adversos; Aguja/efectos adversos; Hepatitis B/etiología; Hepatitis C/etiología; Infecciones por VIH/etiología; Costo de la enfermedad; Análisis de costo-beneficio; Modelos teóricos; Estudios de cohortes (*fuelle: DeCS, BIREME*).

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يمكن الاطلاع على الملخص بالعربية على الصفحة ٢٨٤.

Introduction

Poor injection practices lead to infections with hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV) (1). In addition, unsafe injections have been important vectors for the introduction of HCV to patients in some countries, including Egypt and Pakistan (2–4). However, the burden of cirrhosis, hepatocellular carcinoma, and acquired immunodeficiency syndrome (AIDS) associated with unsafe injections is delayed and may not be directly apparent.

Although injection-associated infections constitute a silent epidemic, effective interventions are available to reduce injection use and unsafe practices (G. Dziekan & Y.J.F. Hutin,

unpublished data, 2002). First, information, education and communication (IEC) targeting prescribers, including patient–prescribers interactional group discussions, reduces injection use. Second, the provision of single-use injection equipment improves safety.

For national stakeholders faced with competing priorities, the availability of effective interventions to prevent a hidden epidemic might not be sufficient to justify investing in a policy for the safe and appropriate use of injections. Economic considerations also enter the debate. Accordingly, we set out to estimate the sectoral cost-effectiveness of policies for the safe and appropriate use of injections in terms of cost per disability-adjusted life year (DALY) averted.

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Methods

Study populations

The six regions of WHO were separated into subgroups of countries on the basis of having similar rates of child and adult mortality. This resulted in 14 Global Burden of Disease 2000 epidemiological subregions characterized by the WHO region acronyms (AFR (African Region); AMR (Region of the Americas); EMR (Eastern Mediterranean Region); EUR (European Region); SEAR (South-East Asia Region); and WPR (Western Pacific Region)) and a letter for the mortality stratum (Table 1) (5). Four subregions in which the reuse of injection equipment in the absence of sterilization is negligible were excluded from the analysis (AMR A, EMR B, EUR A and WPR A).

Effectiveness model

We considered a theoretical cohort of the population living in the year 2000 in subregions where reuse of injection equipment has been reported (figures provided by the Global Burden of Disease study group). We first applied a current, “do nothing” scenario where persons were injected using contaminated needles and consequently acquired infections. Second, we applied a series of hypothetical intervention scenarios for the year 2000, taking into account the effect of these interventions on the incidence of infections.

DALYs attributable to poor injection practices

We modelled the fraction of incident HBV, HCV, and HIV infections attributable to contaminated injections on the basis of the annual number of injections per person, the proportion of injections administered with equipment reused in the absence of sterilization, the probability of transmission following percutaneous exposure, the prevalence of active infection, the prevalence of immunity, and the incidence (6). The burden in DALYs for the years 2000–30 due to infections in the year 2000 was estimated on the basis of the natural history of viral infections (6), background mortality, Global Burden of Disease life tables (7), and the average duration and disability weights of acute hepatitis, cirrhosis, hepatocellular carcinoma, and AIDS — the four sequelae of interest (8). DALYs were age-weighted and 3% discounted (7).

Effectiveness of interventions

We examined interventions for reducing the unsafe use of injections, interventions for reducing injection use, and the effect of these two interventions when implemented jointly (G. Dziekan & Y.J.F. Hutin, unpublished data, 2002). For interventions to reduce the unsafe use of injections, we considered the effectiveness of interventions on the basis of provision of single-use injection equipment (9, 10). The effectiveness of interventions to reduce injection frequency was highly variable (1–53%) due to the variability in approaches and study designs (S. Luby, F. Hoodbhoy, A. Shah, unpublished data) (11–26). In our model, we used the estimate of effectiveness reported for interactional group discussions (30%) — a well-designed, well-evaluated intervention that has been used in developing countries (23). Interactional group discussions consist of moderated patient–prescriber discussions on the topic of injection use, during which the prescribers are confronted with the actual absence of preference for injections among patients.

Our disease model was based on the number of contaminated injections — a product of the number of injections received and the proportion of these given with reused equipment. Thus, we assumed that the effectiveness of the combined interventions was a multiplication of the effect of the two. In the absence of evidence suggesting the contrary, we also assumed that intervention effectiveness did not differ with respect to the underlying magnitude of the burden under the “do nothing” scenario.

Cost of interventions

Quantification

First, we identified the activities required for each intervention at the national and subnational level for an implementation period of ten years (27) (Table 2). Each of these activities was assigned to the intervention to reduce injection use or to the intervention to reduce unsafe practices, or both (in the case of the latter, activities necessary in the two interventions were counted only once). We then estimated the quantity of full-time-equivalent staff members and the material resources required to conduct these activities. Third, we estimated the needs of single-use syringe and needle sets on the basis of the number of injections administered and the proportion already given using sterile injection equipment (6). Fourth, the resources required for safe sharps waste collection and management was taken into account as part of the intervention. The needs quantified for 10 years were then averaged to obtain a yearly estimate that we used to cost the hypothetical intervention in the year 2000.

Costing

We estimated the average yearly programme cost for human resources and associated materials for the year 2000 by costing studies conducted in each subregion as part of the WHO-CHOICE (Choosing Interventions that are Cost Effective) project (27). The cost of injection equipment was calculated on the basis of international retail prices and the cost of distribution. First, we estimated international retail market prices among main international wholesalers. Second, we estimated international distribution costs on a standardized mark-up, taking into account the average difference between international free on board (FOB) and cost, insurance and freight (CIF) prices, as well as additional trade-related international distribution costs (28). Third, we estimated the cost of domestic distribution on the basis of a hexagon-shaped subregional distribution model that calculated the distances between the theoretical centre of a country with the highest population densities and a periphery with the lowest population density (29). The cost of personnel, capital, and fuel was estimated from a database to which fuel efficiency and maintenance cost was added (30). Finally, we used costing studies conducted by WHO to estimate the costs per syringe and needle set of sharps waste collection and disposal through incineration (Ulla Kou & Patrick Lydon, personal communication). All costs were expressed in international dollars (I\$) for the year 2000 (27). An international dollar has the same purchasing power as the US dollar has in the United States, and is derived via the application of purchasing power parity exchange rates. We assumed 100% coverage of all situations where injections were given in the formal public sector (e.g. hospitals, clinics).

Table 1. Contaminated injections in the year 2000, attributable and preventable burden of disease for the period 2000–30

	African Region		Region of the Americas		Eastern Mediterranean Region	European Region		South-East Asia Region		Western Pacific Region	All Region
	AFR D ^a	AFR E ^a	AMR B ^a	AMR D ^a	EMR D ^a	EUR B ^a	EUR C ^a	SEAR B ^a	SEAR D ^a	WPR B ^a	
Mortality in children	High	High	Low	High	High	Low	Low	Low	High	Low	
Mortality in adults	High	Very high	Low	High	High	Low	Low	Low	High	Low	
Injections per person per year ^b	2.2	2.0	1.7	1.9	4.3	5.2	11.3	2.1	4.0	2.4	3.4
Proportion of reuse (%) ^b	19	17	1.2	11	70	1.2	11	30	75	30	39.8
Total burden 2000–30^b	555 644	1 668 583	9 083	27 332	559 702	3 479	64 733	280 789	4 720 866	1 287 470	9 177 679
Preventable burden 2000–30											
Reduction of injection use ^c	166 693	500 575	2 725	8 200	167 911	1 044	19 420	84 237	1 416 260	386 241	2 753 304
Reduction of unsafe use ^d	527 862	1 585 154	8 629	25 965	531 717	3 305	61 496	266 749	4 484 823	1 223 096	8 718 795
Combined interventions ^e	536 197	1 610 182	8 765	26 375	540 112	3 357	62 467	270 961	4 555 636	1 242 408	8 856 461

^a Global Burden of Disease 2000 epidemiological subregions are characterized by the World Health Organization region acronym and a letter for the mortality stratum (5).

^b “Do nothing” scenario.

^c Interactional group discussions between patients and providers to reduce injection use.

^d Provision of single-use, disposable syringes and needles for all injections.

^e Safe and appropriate use of injection policies combining the two interventions above.

Uncertainty analysis

We first tested the upper and lower values of the attributable fraction of the comparative risk assessment (6). Second, we assumed that the effectiveness of interventions was only 7% for reducing injection use (the lowest effectiveness reported for an intervention targeting patients and providers) and 50% for reducing unsafe use of injections. Third, we ran the analysis using an upper value of the number of syringes and needle sets required. Fourth, we ran an analysis that did not take into account the additional cost of safe sharps waste collection and management. Finally, total estimated costs and effects (each simulated to have a truncated normal distribution and a coefficient of variation of 0.5) were entered into the software package MCLeague (31), which uses Monte Carlo simulation (1000 runs) to perform a stochastic uncertainty analysis of the probability that interventions represent a cost-effective use of resources given a specified budget constraint.

Results

Effectiveness of interventions

Burden of disease attributable to contaminated injections in 2000

The number of injections per person per year was estimated to range from 1.7 in AMR B to 11.3 in EUR C, of which a proportion ranging from 1.2% in EUR B and 75% in SEAR D was administered with injection equipment reused in the absence of sterilization (Table 1). Overall, contaminated injections caused 21 million HBV infections, two million HCV infections and 260 000 HIV infections. These infections led to 49 000, 24 000, and 210 000 deaths, respectively, between the years 2000 and 2030, for a total of 9 177 679 discounted and age-weighted DALYs (non-discounted, unadjusted DALYs, 48 541 032). HIV infections accounted for the highest proportion of DALYs (63%), whereas HBV and HCV infections accounted for 34% and 4% of the total, respectively. Most of this burden was caused by early death rather than by disability.

Burden of disease preventable through interventions

We assumed the effectiveness of interactional group discussion to be 30% on injection use (23). This effectiveness translated directly into projected burden of disease reduction as the incidence of injection-associated infections in the present disease model was proportional to the annual number of injections per person and the proportion of injections given with reused equipment (6). Implementation of interventions to reduce injection use would lead to a reduction of 2 753 304 DALYs. The effectiveness of provision of single-use injection equipment was assumed to be 95% on the unsafe use of injections. Implementation of interventions to reduce the unsafe use of injections would lead to a reduction of 8 718 795 DALYs. When combined, the two interventions would lead to a reduction of 8 856 461 DALYs.

Costs of interventions

The expected annual cost of the intervention to reduce injection use (Table 3) ranged from I\$ 1.1 million in AMR D to I\$ 26 million in WPR B (cost per capita, I\$ 0.009–0.024). The cost of the intervention to reduce the unsafe use of injections ranged from I\$ 2.5 million in AMR D to I\$ 459 million in SEAR D (cost per capita, I\$ 0.01–0.44). A high proportion of these costs (83–99% in all subregions other than AMR B and EUR B) consisted of injection equipment, including international retail price, international transport, and waste management. Overall, the international retail price accounted for 40% of the total injection equipment costs (Fig. 1). The estimated yearly cost of combined interventions ranged from I\$ 3 million in AMR D to I\$ 466 million in SEAR D (cost per capita, I\$ 0.03–0.45).

Cost-effectiveness of interventions

The average cost-effectiveness ratio (CER; total costs divided by total effects) for interventions to reduce injection use was I\$ 7 to I\$ 5124 per DALY averted according to the region (Table 3). The average CER for interventions to reduce unsafe use of injections, including waste management, was I\$ 12 to I\$ 1107 per DALY averted according to the region. The

Table 2. Activities included in interventions for the safe and appropriate use of injection^a

Activity	Intervention	Timing	Level	Start-up ^b	Years										
					1	2	3	4	5	6	7	8	9	10	
National planning workshop	Appropriate use	Start-up	National ^c	X	–	–	–	–	–	–	–	–	–	–	–
Development of IEC ^d material	Appropriate use	Start-up	National ^c	X	–	–	–	–	–	–	–	–	–	–	–
Training of the trainers	Appropriate use	Start-up	National ^c	X	–	–	–	–	–	–	–	–	–	–	–
Training of the procurement officer	Safe use	Start-up	National ^c	X	–	–	–	–	–	–	–	–	–	–	–
District planning workshops	Appropriate use	Start-up	Subnational ^c	X	–	–	–	–	–	–	–	–	–	–	–
Supplying injection equipment ^e	Safe use	Post start-up	Subnational ^c	–	X	X	X	X	X	X	X	X	X	X	X
Annual national follow-up workshop	Appropriate use	Post start-up	National ^c	–	X	X	X	X	X	X	X	X	X	X	X
Interactive group discussions	Appropriate use	Post start-up	Subnational ^c	–	X	X	X	X	X	X	X	X	X	X	X
Annual monitoring surveys	Both ^f	Post start-up	Subnational ^c	–	X	X	X	X	X	X	X	X	X	X	X

^a The analysis considered the 3% discounted average yearly cost of a 10 year intervention. Safe and appropriate use interventions were considered separately and combined.

^b Included in year one.

^c According to WHO-CHOICE (Choosing Interventions that are Cost Effective) methods (5).

^d IEC = Information, education, and communication.

^e With and without safe sharps waste management in the sensitivity analysis.

^f This activity appears twice, once for the appropriate use and once for the safe use intervention, but is counted only once in the hypothesis of the combined intervention.

average CER for combined interventions for the safe and appropriate use of injections, including waste management, was I\$ 14 to I\$ 2293 per DALY averted according to the region. Incremental analysis (Table 3) suggested that in the six subregions in which the proportion of reuse of injection equipment exceeds 15% (Table 1), the intervention to reduce injection use represents the single most cost-effective strategy. In the four other subregions, the reduction of unsafe use was the most efficient strategy. However, in all regions, the average CER of the combined intervention strategy remained under the threshold of one year of average per capita income.

Uncertainty analysis

Five scenarios were assessed in the sensitivity analysis (Table 4). Higher attributable fraction reduced the average cost per DALY averted by 19–86% compared with the base case, but removing the costs of sharps waste management had little additional influence on baseline results (scenarios 1 and 2, with the latter representing the best case). Attribution of a lower fraction of injection-related infections raised the average cost per DALY averted (scenario 3). Using the minimum estimates for intervention effectiveness in addition to the lower attributable fractions increased CER ratios further, particularly for the intervention to reduce injection use (scenario 4). Finally, a scenario incorporating the lower attributable fraction, minimum effectiveness, and a doubled number of syringe and needle sets (scenario 5) resulted in a four- to ten-fold increase in the average cost per DALY averted, compared with initial baseline estimates. However, even in this worst-case scenario, the average cost-effectiveness ratio of all interventions remained below the threshold of average annual income per capita (Table 4). Inclusion of best- and worst-case total costs and effects in the stochastic uncertainty analysis showed that at very low levels of resource availability, reduction of injection use represents the most cost-effective strategy in most subregions (a small health gain, but achieved at a low cost). At higher levels

of resource availability, a combination approach would be the most efficient choice (considerably greater health gains at an increased but still cost-effective level of investment).

Discussion

The average cost of a policy by which single-use syringes and needles are used for all injections amounts to less than I\$ 0.50 per person per year. This may seem an unaffordable gold standard where sterilizable injection equipment is still in use, particularly because the benefits of safe injections in terms of death and disability prevented are far ahead in the future (32). However, in Burkina Faso, it was estimated that purchasing injection equipment in quantities that match injectable medicines increased essential drug expenditures by only 2.2% (WHO, unpublished data). Supplying sufficient quantities of single-use injection equipment is cost-effective. Implemented jointly with interventions to reduce injection use, injection safety interventions can prevent more death and disability while remaining a sound investment in public health. In addition, policies for the safe and appropriate use of injections can lead to savings in the cost of injectable medicines. These savings could be redirected to finance injection equipment for injectable medicines that are essential.

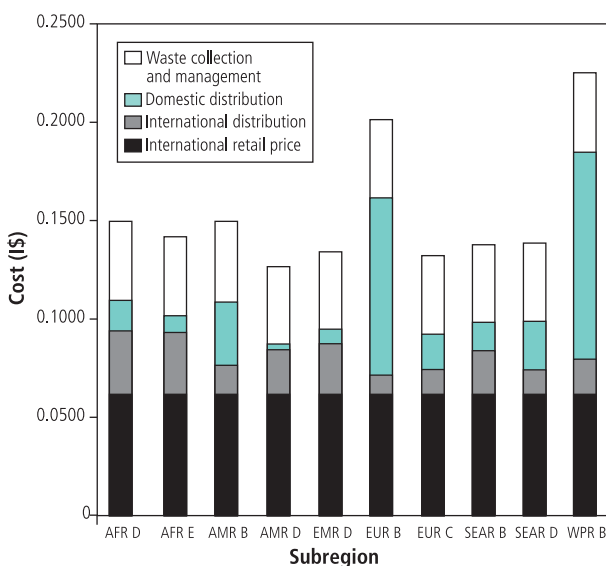
In all subregions analysed, the cost of each DALY averted through national policies for the safe and appropriate use of injections is considerably less than one year of average per capita income, which is the threshold for an intervention being highly cost-effective proposed recently by the WHO Commission on Macroeconomics and Health (33). When recently compared with other strategies to reduce leading risk factors for disease, the safe and appropriate use of injections was found to cause a modest reduction in DALYs but was one of the most cost-effective interventions (5). When compared with other modes of preventing HIV infection in sub-Saharan Africa, the cost-effectiveness ratio of policies for the safe and

Table 3. Costs and cost-effectiveness of policies for the safe and appropriate use of injections^a, 2000

	African Region		Region of the Americas		Eastern Mediterranean Region	European Region		South-East Asia Region		Western Pacific Region
	AFR D ^b	AFR E ^b	AMR B ^b	AMR D ^b	EMR D ^b	EUR B ^b	EUR C ^b	SEAR B ^b	SEAR D ^b	WPR B ^b
Total population (million)	294	346	431	71	343	218	243	294	1242	1533
Gross domestic product per capita	1381	1576	7833	3837	2393	7294	6916	2545	1449	4186
Syringes/needles^c										
Syringe/needle sets needed	122 924 628	117 475 114	8 791 014	14 887 078	1 031 154 040	6 553 752	93 625 680	185 105 732	3 725 419 491	1 103 711 844
Syringe/needle costs	19 176 242	18 208 643	1 116 459	2 084 191	148 486 182	773 343	11 422 333	25 544 591	454 501 178	144 586 252
Programme costs^d										
Reduction of injection use	2 738 289	3 308 975	10 524 021	1 080 717	3 876 085	5 349 039	5 298 743	3 568 129	10 599 413	25 579 948
Reduction of unsafe use	1 602 096	1 391 325	3 189 442	434 498	1 542 952	2 884 373	1 692 560	1 218 867	4 402 415	8 452 776
Combination	3 553 983	3 711 160	11 020 206	1 205 776	4 234 537	6 922 989	5 554 346	3 757 891	11 812 493	27 164 652
Total cost per year										
Reduction of injection use	2 738 289	3 308 975	10 524 021	1 080 717	3 876 085	5 349 039	5 298 743	3 568 129	10 599 413	25 579 948
Reduction of unsafe use	20 778 338	19 601 204	4 305 901	2 518 893	150 029 134	3 657 716	13 114 893	26 763 458	458 903 593	153 039 028
Combination	22 730 225	21 922 514	12 136 665	3 290 463	152 720 719	7 696 332	16 976 679	29 302 482	466 313 671	171 750 904
Average CER (\$ per DALY averted)^e										
Reduction of injection use	16	7	3862	132	23	5124	273	42	7	66
Reduction of unsafe use	39	12	499	97	282	1107	213	100	102	125
Combination	42	14	1385	125	283	2293	272	108	102	138
Incremental CER (\$ per DALY averted)^{e,f}										
Reduction of injection use	16	7	–	–	23	–	–	42	7	66
Reduction of unsafe use	50	15	499	97	–	1107	213	127	–	152
Combination	234	93	57 579	1882	400	77 666	3977	603	145	969

^a Costs are in international dollars (\$).
^b Global Burden of Disease 2000 epidemiological subregions are characterized by the World Health Organization region acronym and a letter for the mortality stratum (5).
^c Syringes and needle costs include the international retail price, international transport, and waste management (domestic transport included under programme costs). Not applicable to intervention to reduce injection use.
^d Programme costs include personnel, transport, equipment, and supplies but exclude syringes and needles sets.
^e CER = cost-effectiveness ratio. DALY = disability-adjusted life year.
^f Lowest value represents most cost-effective option relative to doing nothing; next-lowest value represents next most cost-effective option.

Fig. 1. Total unit cost of syringes and needle sets according to various cost components, by subregion^a



^aGlobal Burden of Disease 2000 epidemiological subregions are characterized by the WHO region acronym and a letter for the mortality stratum (5). AFR = African Region, AMR = Region of the Americas, EMR = Eastern Mediterranean Region, EUR = European Region, SEAR = South-East Asia Region, WPR = Western Pacific Region.

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appropriate use of injections remained under the threshold of I\$ 50 per DALY averted, which was in the range of the most cost-effective interventions for preventing HIV infection (e.g. blood safety, targeted condom distribution, and treatment of sexually transmitted diseases) (34).

A safe injection is defined as one that does not harm the recipient, the provider and the members of the community (35). Therefore, the costs of sharps waste collection and management were included as part of programme costs. However, the effect of safe sharps waste collection and management in terms of burden of disease secondary to needlestick injuries among healthcare workers or the community prevented could not be estimated. Thus, such a policy may be more cost-effective than the present results indicate. The sensitivity analysis indicates that the cost per DALY averted decreased by 36% to 39% if the costs of safe sharps waste collection and management were excluded to match costs and effects.

Policies for the safe and appropriate use of injections are natural additions to universal infant vaccination against hepatitis B in a national strategy to prevent HBV infection. Infant immunization against hepatitis B is probably more cost-effective than safe and appropriate use of injections, with cost per life year saved ranging from I\$ 4 to I\$ 36 (36). When global efforts for universal vaccination of infants have reached adequate coverage for a sufficient period of time, high levels of

Table 4. Sensitivity analyses for the estimate of the average cost-effectiveness ratios of interventions for the safe and appropriate use of injections per DALY averted^a

Sensitivity scenario	African Region		Region of the Americas		Eastern Mediterranean Region	European Region		South-East Asia Region		Western Pacific Region
	AFR D ^b	AFR E ^b	AMR B ^b	AMR D ^b	EMR D ^b	EUR B ^b	EUR C ^b	SEAR B ^b	SEAR D ^b	WPR B ^b
Higher attributable fraction^c										
Reduction of injection use	13	5	523	44	17	1394	140	33	6	28
Reduction of unsafe use	32	10	68	33	210	301	109	79	78	53
Combination	34	11	187	42	210	624	139	85	78	59
Higher attributable fraction, no sharps waste management										
Reduction of injection use	13	5	523	44	17	1394	140	33	6	28
Reduction of unsafe use	20	6	61	22	127	276	71	49	47	33
Combination	23	7	181	31	129	599	102	55	48	39
Lower attributable fraction										
Reduction of injection use	22	9	NA	NA	45	NA	970	57	11	NA
Reduction of unsafe use	52	16	NA	NA	544	NA	758	136	156	NA
Combination	56	18	NA	NA	546	NA	967	146	156	NA
Lower attributable fraction, minimum effectiveness										
Reduction of injection use	93	37	NA	NA	191	NA	4159	245	49	NA
Reduction of unsafe use	99	31	NA	NA	1035	NA	1441	258	296	NA
Combination	106	34	NA	NA	1038	NA	1838	278	296	NA
Lower attributable fraction, minimum effect, double injection sets										
Reduction of injection use	93	37	NA	NA	191	NA	4159	245	49	NA
Reduction of unsafe use	190	60	NA	NA	2058	NA	2696	504	589	NA
Combination	196	62	NA	NA	2046	NA	3074	520	585	NA

^a Results are in international dollars (\$). Not applicable (NA) refers to lower attributable fraction equals to zero; cost-effectiveness ratio (CER) cannot therefore be calculated. DALY = disability-adjusted life year.

^b Global Burden of Disease 2000 epidemiological subregions are characterized by the World Health Organization region acronym and a letter for the mortality stratum (5).

^c Attributable fraction refers to the fraction of new hepatitis B virus, hepatitis C virus, and human immunodeficiency virus infections attributable to contaminated injections.

immunity against HBV infection will ultimately protect populations from injection-associated HBV infection.

This study was not an attempt to compare various injection technologies. The present model did not consider the use of sterilizable injection equipment in any of the interventions because there are no data available to indicate that it can lead to safe injection practices. In fact, the use of sterilizable injection equipment has been specifically associated with infections with bloodborne pathogens (37–41), and health systems using sterilizable syringes have poorer practices than those using single-use equipment (42). No special reference was made to the use of autodisable (AD) injection equipment that inactivates itself after one use (43). AD syringes offer the highest level of safety and are now considered to be the standard for administering vaccines (44). However, immunization injections account for fewer than 10% of all injections (1). Thus, introducing AD syringes in immunization services will address only a small proportion of the burden of disease associated with unsafe injections. With respect to using AD syringes in curative services, although single-use syringes can be reused, effectiveness data indicating that AD syringes would be associated with safer injection practices compared with standard single-use syringes made available in sufficient quantities could not be identified. Nevertheless, AD syringes should be considered for use in settings where unsafe practices are common, particularly in the non-formal sector that is staffed with

unqualified health-care workers, specifically in South Asia (4, 45). In such cases, the results of our analysis could be easily extrapolated to AD syringes because they are now available at a cost that is very close to the one of standard single-use syringes. In 2002, the international retail price for an immunization AD syringe was five to seven US cents, whereas international retail prices for single use syringes ranged from four (2 ml) to eight (5 ml) US cents.

The present study presented several limitations. First, the model did not take into account any longer-term dynamic effects that reducing transmission of infection would have on the prevalence of infections with bloodborne pathogens. This could be a problem in the case of HCV infection because contaminated injections account for a high proportion of new infections. This limitation could also lead to an underestimation of the effect size, hence these interventions might be described as being less cost-effective than they really are. Second, the specific issues associated with working in the private sector were not addressed. The provision of sufficient quantities of single-use injection equipment and interactional group discussion might not be sufficient where the informal private sector accounts for a high proportion of healthcare services delivery. In such settings, demonstration projects should identify effective strategies, some of which might include the use of AD syringes in curative services or addressing financial incentives to overprescribing injections, or both.

Poor injection practice is not a leading cause of disability and death worldwide. However, the safe and appropriate use of injection equipment represents an opportunity to avert a substantial number of DALYs at a relatively low cost. Improved injection practice can be recommended for implementation worldwide, particularly in settings where the reuse of injection equipment is common and where the HIV prevalence in the general population exceeds 1%. Such policies can be developed through a better coordination of already existing programmes to facilitate implementation. Finally, in addition to being cost-effective, the safe and appropriate use of injections is an attainable way of applying the “first do no harm” principle as part of the ethics of healthcare service delivery. ■

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Résumé

Coût-efficacité des politiques en faveur de l'utilisation sûre et appropriée des injections dans les établissements de soins de santé

Objectif Des pratiques d'injection défectueuses sont à l'origine de la transmission d'agents pathogènes potentiellement mortels. Nous avons effectué une modélisation du rapport coût-efficacité des politiques en faveur d'une utilisation sûre et appropriée des injections dans dix sous-régions épidémiologiques du monde, les résultats étant exprimés en coût par année de vie ajustée sur l'incapacité (DALY) évitée.

Méthodes L'incidence des infections par le virus de l'hépatite B (VHB), le virus de l'hépatite C (VHC) et le virus de l'immunodéficience humaine (VIH) associées aux injections a été modélisée pour une cohorte de l'an 2000 sur une durée prospective de 30 ans. Les conséquences d'un scénario « statu quo » ont été comparées à une série de scénarios hypothétiques intégrant les gains, en termes de santé, d'interventions efficaces. Le montant des ressources nécessaires pour la mise en œuvre des interventions efficaces a été évalué pour chaque sous-région et exprimé en dollars internationaux (I \$).

Résultats A l'échelle mondiale, la réutilisation du matériel d'injection a été à l'origine, en 2000, de 32 %, 40 % et 5 %,

respectivement, des nouvelles infections par le VHB, le VHC et le VIH, ce qui conduirait à une charge de 9,18 millions de DALY entre 2000 et 2030. Des interventions mises en œuvre en 2000 en vue de l'utilisation sûre et appropriée des injections (grâce à la fourniture de seringues à usage unique, d'une efficacité supposée de 95 %, et à des groupes de discussion patients-dispensateurs de soins, d'une efficacité supposée de 30 %) pourraient réduire la charge des infections associées aux injections de 96,5 % (8,86 millions de DALY) pour un coût annuel moyen de I \$ 905 millions (rapport coût-efficacité moyen par DALY évitée : 102 ; intervalle selon les régions : 14-2293). Les principales sources d'incertitude concernaient la fraction attribuable et le nombre de seringues et d'aiguilles nécessaires.

Conclusion Dans toutes les sous-régions étudiées, chaque DALY évitée grâce à des politiques en faveur de l'utilisation sûre et appropriée des injections coûterait nettement moins d'une année de revenu moyen par habitant ; ces politiques représentent donc un excellent investissement en termes de soins de santé.

Resumen

Costoeficacia de las políticas de fomento del uso seguro y apropiado de las inyecciones en los entornos de atención de salud

Objetivo Las malas prácticas de inyección transmiten agentes patógenos potencialmente mortales. Procedimos a modelizar la costoeficacia de las políticas de fomento del uso seguro e idóneo de las inyecciones en diez subregiones epidemiológicas del mundo, teniendo en cuenta el costo de evitar la pérdida de un año de vida ajustado en función de la discapacidad (AVAD).

Métodos Se modelizó la incidencia de infecciones asociadas a inyecciones por virus de la hepatitis B (VHB), virus de la hepatitis C (VHC) y virus de la inmunodeficiencia humana (VIH) para una cohorte del año 2000 con un horizonte temporal de 30 años. Las consecuencias de un escenario de « inacción » se compararon con las de un conjunto de escenarios hipotéticos que incorporaban los beneficios sanitarios de las intervenciones eficaces. Se evaluaron para cada subregión los recursos necesarios para ejecutar las intervenciones eficaces, expresándolos en dólares internacionales (I\$).

Resultados A nivel mundial, la reutilización de material de inyección en el año 2000 representó el 32 %, 40 % y 5 % de las infecciones nuevas por VHB, VHC y VIH, respectivamente, lo que

entrañaría una carga de 9,18 millones de AVAD entre 2000 y 2030. Las intervenciones llevadas a cabo en 2000 para fomentar el uso seguro (suministro de jeringas monouso, suponiendo una eficacia del 95%) y apropiado (discusiones de grupo interactivas pacientes-dispensadores, suponiendo una eficacia del 30%) del material de inyección podrían reducir la carga de infecciones asociadas a las inyecciones nada menos que en un 96,5% (8,86 millones de AVAD) por un costo anual promedio de I\$ 905 millones (costoeficacia promedio por AVAD evitado: 102; intervalo por regiones, 14-2293). Las fracciones atribuibles y el número de jeringuillas y agujas requerido son las principales fuentes de incertidumbre.

Conclusión En todas las subregiones estudiadas, cada AVAD evitado mediante las políticas de fomento de un uso seguro y apropiado de las inyecciones cuesta considerablemente menos que el promedio de un año de ingresos per cápita, lo que autoriza a considerar esas políticas como una sólida inversión en atención de salud.

مردودية سياسات الاستخدام الملائم والمأمون للحقن في مواقع الرعاية الصحية

مدد العجز بين عامي ٢٠٠٠ و٢٠٣٠، ويمكن للتدخلات التي نفذت عام ألفين من أجل الاستخدام المأمون للحقن (بتأمين محاقن تستعمل مرة واحدة، والذي يفترض أن فعاليته تصل إلى ٩٥٪) ومن أجل الاستخدام الملائم للحقن (بإجراء مناقشات مع مجموعات متفاعلة من المرضى والقائمين على إنشاء الرعاية الصحية لهم، والذي يفترض أن فعاليته تصل إلى ٣٠٪) أن تنقص العبء الناجم عن حالات العدوى المصاحبة للحقن بنسبة تصل إلى ٩٦,٥٪ (وهذا ما يعادل ٨,٨٦ مليون عام من سنوات العمر المصححة باحتساب مدد العجز) وتقدر التكلفة الوسيطة السنوية بـ ٩٠٥ مليون دولاراً دولياً (باعتبار أن التكلفة الوسيطة لضياع كل عام من سنوات العمر المصححة باحتساب مدد العجز ١٠٢ دولاراً دولياً، وهو ما يتراوح بين ١٤-٢٢٩٣ دولاراً أمريكياً). وتُعدُّ الأجزاء المتعلقة بالأوصاف وعدد المحاقن والإبر اللازمة من المصادر الرئيسية لعدم الثقة.

الاستنتاج: لقد وجد أنه في كل المناطق الفرعية التي درست ضياع كل عام من سنوات العمر المصححة باحتساب مدد العجز، فإن تكاليف سياسات الاستخدام الملائم والمأمون للحقن أقل بكثير من تكاليف سنة واحدة من وسطي الدخل للفرد الواحد، وهذا ما يجعل هذه السياسات من الاستثمارات القيمة في الرعاية الصحية.

الغرض: يمكن للممارسات السيئة في الحقن أن تنقل العوامل المرضية المهددة للحياة، وقد وضعنا نماذج لحساب مردودية سياسات الاستخدام الملائم والمأمون للحقن في عشر من المناطق الإبيديميولوجية الفرعية في العالم مقدرةً بتكاليف ما يضيع من سنوات العمر المصححة باحتساب مدد العجز.

الطريقة: وضعت نماذج لحساب معدلات انتشار العدوى المصاحبة للحقن بكل من فيروس التهاب الكبد بي وسي وفيروس العوز المناعي المكتسب، وذلك خلال عام ألفين لدى الأتراب في ذلك العام وعلى مدى ٣٠ عاماً، وتمت مقارنة العواقب التي تنجم عن سيناريو يفترض عدم القيام بأي عمل مع عدد من السيناريوهات المفترضة التي تندرج فيها المكاسب الصحية التي قد تنجم عن التدخلات الفعّالة. وتم حساب التكاليف اللازمة لتغطية التدخلات الفعّالة اللازمة في كل منطقة فرعية مقدرةً بالدولارات الدولية.

الموجودات: إن الاستخدام المتكرر لأدوات الحقن في عام ألفين كان مسؤولاً عن ٣٢٪ من حالات العدوى المستجدة بفيروس التهاب الكبد بي و٤٠٪ من حالات العدوى المستجدة بفيروس التهاب الكبد سي و٥٪ من حالات العدوى المستجدة بفيروس العوز المناعي البشري، ويؤدي ذلك إلى عبء يصل إلى ٩,١٨ مليون عام من سنوات العمر المصححة باحتساب

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