COST EFFECTIVENESS OF SAFETY ENGINEERED SYRINGES FOR THERAPEUTIC USE IN INDIA

2017-2018

Contents

Contributors

Dr Shankar Prinja

School of Public Health, Post Graduate Institute of Medical Education and Research, Chandigarh

Mr Pankaj Bahuguna

School of Public Health, Post Graduate Institute of Medical Education and Research, Chandigarh

Prof. R.K. Dhiman

Department of Hepatology, Post Graduate Institute of Medical Education and Research, Chandigarh

Dr Chandrakant Lahariya

World Health Organization, India Country Office

Prof. A.K. Aggarwal

School of Public Health, Post Graduate Institute of Medical Education and Research, Chandigarh

Dr Rajesh Bhaskar

Department of Health and Family Welfare, Punjab

Dr Henk Bekedam

World Health Organization, India Country Office

Acknowledgement

We would like to thank the Department of Health and Family Welfare, Government of Punjab for having commissioned this research. We extend our special thanks to World Health Organization (WHO), India Country Office for their technical and financial support for this study.

We would like to acknowledge the critical inputs of members of the Technical Appraisal Committee (TAC), Health Technology Assessment India (HTAIn), Director Health Research (DHR) and Technical Expert Group (TEG) on Injection Safety, Government of Punjab. We extend our gratitude towards HTAIn Secretariat for organising the Technical Appraisal Committee and Stakeholders' consultation meetings; and disseminating the outcome report on web portal of DHR for wider public review.

The report has also benefitted from the feedback provided by Dr Henk Bekedam and Dr Hilde Rene Susanne Graeve, WHO, India Country Office. Lastly, we gratefully acknowledge Dr Vineeta Sharma and Mr Narotham Reddy, School of Public Health, Postgraduate Institute of Medical Education and Research, Chandigarh for their support in the extensive review for this research.

List of Abbreviations

AIDS	Acquired Immuno Deficiency Syndrome
AD	Auto-disable
BBIs	Blood borne Infections
BBV	Blood Borne Viruses
FTEs	Fixed Time Equivalents
GDP	Gross Domestic Product
GoI	Government of India
HBV	Hepatitis B Virus
HCV	Hepatitis C Virus
HCPs	Healthcare Professionals
HCWs	Health Care Workers
HIV	Human Immuno Deficiency Virus
HTA	Health Technology Assessment
IEC	Information, Education & Communication
ICER	Incremental Cost Effectiveness Ratio
IPD	Inpatient Department
IPEN	Indiaclen Programme Evaluation Network
LMICs	Low and Middle Income countries
LY	Life Years
NACO	National AIDS Control Organization
NSI	Needle Stick Injury
NRS	Non-Randomized Studies
NPPA	National Pharmaceutical Pricing Authority
OOPE	Out-of-Pocket Expenditure
OPD	Outpatient Department
PEP	Post Exposure Prophylaxis
PSA	Probabilistic Sensitivity Analysis
QALY	Quality Adjusted Life Year
QOL	Quality of Life
RCT	Randomized Control Trial
RUP	Reuse Prevention
SES	Safety Engineered Syringe
SED	Safety Engineered Device
SIGN	Safe Injection Global Network
STD	Sexually Transmitted Disease
SIP	Sharps Injury Prevention
SRS	Sample Registration System
WHO	World Health Organization

Executive Summary

Globally, 16 billion injections are administered each year of which 95% are for curative care (1). India contributes to 25-30% global injection load. Over 63% of these injections are reportedly unsafe or deemed unnecessary. We undertook this study to assess the incremental cost per QALY gained with introduction of SES as compared to disposable or conventional syringes for therapeutic care. The findings are presented from a societal perspective, both at Punjab state and national level.

We assessed the cost-effectiveness of Safety Engineered Syringes (SES) for therapeutic use in India against a counterfactual scenario of use of exiting use of disposable syringes. Three SES were evaluated – reuse prevention syringe (RUP), sharp injury prevention (SIP) syringe, and those with features of both RUP and SIP. A lifetime study horizon from a societal perspective was considered for our analysis. A systematic review and meta-analysis was used to assess the SES effects in terms of reduction in needle stick injuries (NSIs) and reuse episodes. These were then modelled in terms of life years and quality adjusted life years (QALYs) gained. Future costs and consequences were discounted at the rate of 3%. Incremental cost per QALY gained was computed to assess the cost-effectiveness. A two part dynamic transition model was used for parameterizing the model. First part of the model employs a decision tree used to compute the volume of NSIs and reuse episodes among the healthcare professionals and patient population respectively. Number of BBIs (i.e. HBV, HCV and HIV) were computed for each year (cycle length) as a result of NSIs and reuse till 20 years. Second part of the model comprised of 3 separate markov models to compute lifetime costs and QALYs for patients who were infected with HBV, HCV and HIV respectively in either of the study scenarios.

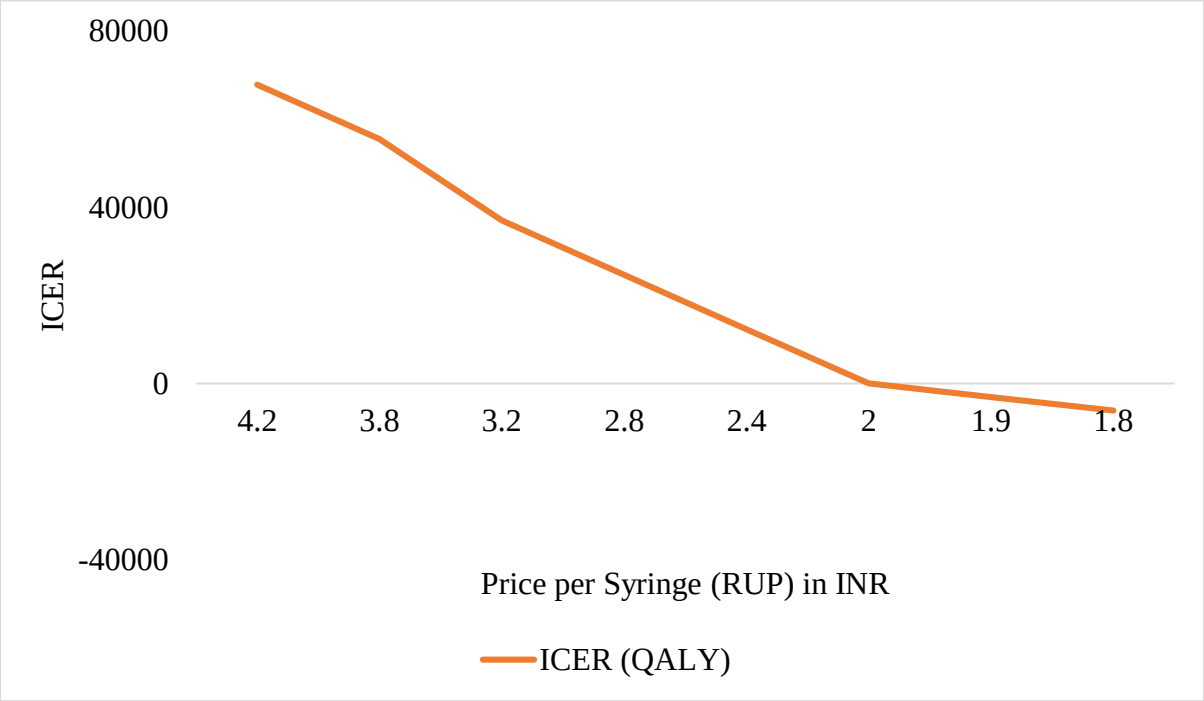
Table 1: Incremental costs, incremental health benefits and incremental cost-effectiveness ratio with use of Safety Engineered Syringes

Type of SES	Incremental costs (In million)	Incremental health benefits (QALYs)	ICER (INR per QALY gained)
RUP	113577	1673535	40358
SIP	482817	66138	6743277
RUP+SIP	462078	1739678	196021

***Note**: SES=Safety Engineered Syringes, RUP= Reuse prevention, SIP= Sharp Injury Prevention, QALY= Quality Adjusted Life Years, ICER= Incremental Cost-Effectiveness Ratio*
1) Incremental costs and health benefits are calculated considering a lifetime horizon.
2) Reference for calculation of incremental costs and health benefits is disposable syringe use as current practice.

The introduction of RUP, SIP and RUP+SIP syringes in India will incur an incremental cost of INR 40,358, INR 6,743,277 and INR 196,021 per QALY gained, respectively (Table 1). A total of 19,584 HBV, 3466 HCV and 1551 HIV deaths will be averted due to RUP in 20 years. Similarly, use of SIP and RUP+SIP will avert 591 HBV, 245 HCV and 4 HIV deaths; and 20176 HBV, 3710 HCV and 1555 HIV deaths, respectively. There is a 93% probability for RUP to be cost effective at a willing to pay threshold of gross domestic product (GDP) of India. While SIP is not cost-effective, there is only 23% probability for RUP+SIP to be cost-effective at a willing to pay threshold of 1-time GDP per capita.

Figure 1: Threshold price analysis for Introduction of RUP Syringe in India



ICER=Incremental cost-effectiveness ratio

RUP syringe will become cost saving at a unit price of INR 1.9 (Figure 1). Similarly, SIP and RUP+SIP syringes will be cost-effective at a unit price less than INR 1.8 and INR 5.9 respectively. The SIP and RUP+SIP syringes are cost-effective only at a unit price less than INR 1.8 and INR 5.9, respectively.

Our findings suggest only RUP is cost-effective in Indian context. SIP and RUP+SIP are not cost-effectiveness at current unit prices. Efforts should be made to bring down the prices of SES to improve its cost-effectiveness.

Introduction

Globally, 16 billion injections are administered each year of which 95% are for curative care (1). India contributes to 25-30% global injection load. Over 63% of these injections are reportedly unsafe or deemed unnecessary (2, 3). One in every third patient visiting an outpatient facility is prescribed with an injection in India. Furthermore, more than half (52%) of these are prescribed for conditions like fever, cough, and diarrhoea (2).

Addressing the unsafe injection practices is an important public health agenda, especially in low and middle income countries (LMICs). Firstly, these avoidable unsafe injection practices lead to the large-scale transmission of blood borne infections (BBIs) among patients (4). It is estimated that each year approximately 33% of new Hepatitis B viral (HBV) infections and 42% of Hepatitis C viral (HCV) infections (2 million new infections) are attributable to the unsafe medical injections in developing nations (2). Similarly, the unsafe injection practices accounts for 9% of new HIV cases in South Asia (2). Secondly, there is a risk of transmission of BBIs to healthcare professionals (HCPs) in case of adverse event of needle stick injuries (NSI) (4). Thirdly, poor sharp waste management practices further aggravates the problem and puts the waste handlers (and community) at risk (5).

The cost of managing HBV, HCV and HIV poses a significant economic burden for the health system. In India, much of this economic burden is borne by households, as they contribute to 71% of the total health care expenditures through out-of-pocket expenditures (OOPE) (6, 7). Average health system cost and out of pocket expenditure for treating liver disorders in intensive care tertiary setting in India is USD 2,728 (INR 163,664) and USD 2,372 (INR 142,297) respectively (8). Moreover, since this burden is faced disproportionately more by the poor, it leads to inequities in utilization of care and financing (9, 10).

Taking cognizance of this pervasive issue of unsafe injections and its adverse health and economic outcomes, the World Health Organization (WHO) and its partners – including the Safe Injection Global Network (SIGN) envision a transition to safety engineered injection devices by 2020. These syringes are specially designed to prevent NSI and reuse episodes (11). While the Government of India (GoI) introduced auto-disable (AD) syringes for immunization in 2008 (12), its use is not mandated in the therapeutic sector which constitute the bulk of injection use.

Recently, some state governments – for instance Punjab state, have shown an interest in considering introduction of SES in therapeutic sector. An important mandate for the expert group, which has been set up to consider introduction of SES, is to provide evidence on its cost-effectiveness. Moreover, the National Pharmaceutical Pricing Authority (NPPA), has requested

India's Medical Technology Assessment Board (13) to provide economic evidence on different forms of SES.

In order to inform the policy question for Punjab state and the NPPA, we undertook this study to assess the incremental cost per quality adjusted life year (QALY) gained with introduction of SES as compared to current practice of using disposable syringes for therapeutic care. The findings are presented from a societal perspective, both at Punjab state and national level.

Methodology

Model Overview

We assessed the cost-effectiveness of SES for therapeutic use in India against a counterfactual scenario of use of exiting use of disposable syringes. A lifetime study horizon from a societal perspective was considered for our analysis. Short-term intervention effects were estimated in terms of reduction in NSIs and reuse episodes. These were then modelled in terms of life years and QALYs gained. Future costs and consequences were discounted at the rate of 3%.

A two part dynamic transition model was used for parameterizing the model. First part of the model employs a decision tree used to compute the volume of NSIs and reuse episodes among the healthcare professionals and patient population respectively. Number of BBIs (i.e. HBV, HCV and HIV) were computed for each year (cycle length) as a result of NSIs and reuse till 20 years. Part 2 of the model comprised of 3 separate markov models to compute lifetime costs and QALYs for patients who were infected with HBV, HCV and HIV respectively in either of the study scenarios.

Intervention Description

Three type of SES were considered for the intervention scenario. These SES are broadly classified into four categories depending upon purpose of safety feature furnished (4). Scenario 1 consists of introduction of re-use prevention syringe (RUP) in which plunger of the syringe either breaks down, or get locked by a metal clip immediately after its use, to avoid of reuse of syringe. RUP is quite similar to an auto-disable syringe in terms of its safety features except that it comes with a variable dosing marks which is absent in AD type and therefore, more suitable

for use in therapeutic sector. Scenario 2 comprised introduction of sharp injury prevention (SIP) syringe which has a safety feature of plastic shield covering the needle automatically following its use. SIP is meant for preventing NSI among healthcare professionals and waste handlers. Scenario 3 consists of a type of SES which is a combination of RUP and SIP, thereby preventing both NSI and reuse. There are several types within the combination i.e. RUP+SIP depending upon whether the advance feature provided is manual driven or automatic in nature. We particularly considered the one with automatic safety feature, as there is still a risk associated in the type which is manual driven. Each of the scenario 1-3 included integrated trainings on safe injection practices which include training on use of SES, safe practices and waste management; along with behaviour change communication (BCC) for patients. In our analysis, we considered the costs associated with these activities, however, we did not consider any incremental benefits associated with either training or BCC activities.

Comparator

In the counterfactual arm, the most appropriate choice was the prevailing current practice of using disposable syringes for therapeutic care. In the unregulated private sector, there could be a possibility of using glass syringes, although to a lesser extent (3, 14). However, for our analysis, we assume two mutually exclusive scenarios i.e. use of either of SES versus disposable syringes for therapeutic care, and avoid complexity of mixed practices.

Costing

In the intervention arm, we included the costs for procurement of respective SES, treating HBV, HCV and HIV; providing pre-exposure prophylaxis for HBV and HIV; delivering trainings on safe injection practices (which is comprised of both training on use of SES and safe waste management practices); information education and communication (IEC) campaign; and lastly, cost of sharp waste management.

For estimating the annual cost of SES in the base case intervention scenario, we used unit prices provided by WHO for respective SES (4). The unit prices, which were available in USD, were converted to local currency i.e. INR using conversion rates for the year 2017 (15). Second, for estimating the annual treatment costs, we used the patterns of treatment utilized at different levels of health care delivery for hepatitis patients by analysing the unit level data of the 71st round of National Sample Survey (16). To elicit the patterns of care seeking for HIV, i.e. link ART centre, ART centre and Centre of Excellence; we used the reports of National AIDS Control Organization (17). Based on these patterns of utilization, diseased population was divided into subgroups, displaying combinations of three key factors. These three factors were sector

utilized (public or private qualified or private non-qualified), level of care utilized (primary or secondary or tertiary) and lastly setting utilized (outpatient – OPD or inpatient – IPD). Information on duration of stay in case of hospitalization event and annual number of visits in OPD for each disease condition was sourced both from existing literature and clinical judgement of experts (8, 18).

Unit cost of treatment were applied to each subgroups. For public health system, we considered both health system cost and out of pocket expenditure (OOPE) for treatment in public facilities. In case of treatment from private sector, the OOP expenditure was considered to capture the full cost. Data on OOPE for different disease conditions was extracted from multiple sources which include national survey, primary data analysis and available published evidence (8, 18). Data on health system costs was sourced from the published studies (8, 18-21). In case of HCV, the cost of antivirals and diagnostics was obtained from the rates finalized under Punjab state's "*Mukya Mantri* Free HCV Treatment Scheme" (22).

Third, data on training and IEC costs was obtained from the health department of Punjab state, which was developing plans for introducing the SES for therapeutic use (23). Fourth, information on costs of waste management was again sourced from the Punjab state. Since the state had outsourced waste management through public-private partnership, its rate contract per hospital bed day was obtained from the state health department (23). These rates were used to estimate cost of waste management in either scenario. All the cost estimates obtained from studies done before 2017, were adjusted for inflation using appropriate GDP cost deflator (24).

Costing for the counterfactual scenario was similar to the intervention, except for the price of disposable syringe. For the sake of comparability, the unit price provided in the WHO report was used for estimating the annual cost of disposable syringes for therapeutic care in base analysis (4). The price of procurement in Indian states were used in sensitivity analysis. Secondly, in the counterfactual scenario, we did not consider the additional cost of trainings or IEC.

Valuation of Consequences

The short-term outcomes of unsafe injection practices which were considered in the present analysis were NSI among health care professionals and reuse rate among patients (4). Initially, annual volume of injections were estimated based on per person annual frequency of injections by sector (i.e. public, private qualified and private unqualified healthcare provider), levels of

care (i.e. primary, secondary and tertiary) and nature of care (i.e. outpatient and in-patient department) (3). As our analysis is limited to therapeutic care only, we excluded the share of preventive care from volume of injections. As a next level of stratification, the volume of injections was separated based on four routes of administration i.e. intravenous, intramuscular, intradermal and subcutaneous. This was done in view of the fact that risk of transmission of BBIs is depending on route of administration. An extensive review of literature was undertaken to obtain data on extent and patterns of healthcare workforce (25), morbidity rate, treat seeking behaviours and patterns of care utilization (18), frequency of injections (3), its route of administration (26), administration different health care professionals (27), risk of NSI using a disposable syringe (27, 28), syringe reuse rates (28, 29), prevalence of HBV, HCV, HIV (30-33), risk transmission coefficient as a result of NSI or reuse (34), all-cause mortality rates (35). More details about parameter values and their sources is given in Table 1.

Table 1: List of key parameters used in cost-effectiveness model

Parameters		Base Value	Lower Limit	Upper Limit	Source	Probability Distribution
Epidemiological Parameters	Morbidity Rate (India)	0.10	0.089	0.118	NSSO,71st Round 2014	Uniform
Proportion of Injections by route in OPD	Intravenous (IV)	0.1285	0.1285	0.1285	HS Rehan et.al 2012	Uniform
	Intramuscular (IM)	0.4714	0.4714	0.4714		Uniform
	Intradermal (ID)	0.2857	0.2857	0.2857		Uniform
	Subcutaneous (SC)	0.1144	0.1144	0.1144		Uniform
Proportion of Injections by route in IPD	Intravenous (IV)	0.7667	0.7667	0.7667		Uniform
	Intramuscular (IM)	0.2167	0.2167	0.2167		Uniform
	Intradermal (ID)	0	0	0		Uniform
	Subcutaneous (SC)	0.0167	0.0167	0.0167		Uniform
Reuse rate	Disposable syringe	0.05	0.0023	0.1400	D Sahu et.al. 2015	Uniform
Needle Stick Injury (NSI) Rate	Disposable syringes	0.00353	0.00283	0.00424	Sridevi Garapati, Sujatha Peethala,2014 Sangwan, B., Kotwal, A., & Verma, A. (2011)	Uniform
	RUP	0.00174	0.00166	0.00268	Steinglass, R. et al. 1995	Uniform
	SIP	0.00256	0.00244	0.003941	Younger B et.al. 1992	Uniform
	RUP+SIP	0.00256	0.00244	0.003941	Younger B et.al. 1992	Uniform
Prevalence among patients	HBV	0.039	0.0087	0.0413	Pandit. D et. al.2014 Sood, S., & Malvankar, S(2010)	Uniform

seeking treatment					Kanodia V.et. al 2015	
	HCV	0.0068	0.0028	0.0077	Kanodia V et. al., 2015; Sood, S., & Malvankar, S. (2010) Samatha.P, 2015	Uniform
	HIV	0.0068	0.0035	0.0083	Avinash Laghawe and Sameer Singh Faujdar,2015 Varun Goel et.al,2014 Sood, S., & Malvankar, S(2010)	Uniform
Risk of Transmission: HBV	Intravenous (IV)	0.18	0.06	0.3	Blood-Borne Diseases Surveillance Protocol for Ontario Hospitals, 2012	Beta
	Intramuscular (IM)	0.018	0.006	0.03		Beta
	Intradermal (ID)	0.00001	0.00001	0.00001		Beta
	subcutaneous (SC)	0.0018	0.0006	0.003		Beta
Risk of Transmission: HCV	Intravenous (IV)	0.018	0.001	0.07	CDC, Hepatitis C Information for health professionals	Beta
	Intramuscular (IM)	0.0018	0.0001	0.007		Beta
	Intradermal (ID)	0.00001	0.00001	0.00001		Beta
	Subcutaneous (SC)	0.00018	0.00001	0.0007		Beta
Risk of Transmission: HIV	Intravenous (IV)	0.0023	0.0001	0.0046	Guidelines for the Management of Occupational Exposures to HIV CDC MMWR U.S, 2005	Beta
	Intramuscular (IM)	0.00023	0.00001	0.00046		Beta
	Intradermal (ID)	0.0000001	0.0000001	0.0000001		Beta
	subcutaneous (SC)	0.000023	0.000001	0.00007		Beta
Cost Parameters	Per unit cost of Disposable syringe	1.03	0.66	2.56	WHO(PQS), PAHO & UNICEF	Gamma
	Per unit cost of RUP syringe	4.2	3.22	5.16	WHO(PQS), PAHO & UNICEF	Gamma
	Per unit cost of SIP syringe	11	8.38	15.47	WHO(PQS), PAHO & UNICEF	Gamma
	Per unit cost of RUP+SIP syringe	11	5.8	16.2	WHO(PQS), PAHO & UNICEF	Gamma
QOL weights: HBV	Inapparent Infection	1	-	-	Levy et. al 2008	Beta
	Apparent Infection	0.95	0.93	0.96		Beta
	Non-Fulminant Hepatitis	0.95	0.93	0.96		Beta
	Fulminant Hepatitis	0.35	0.32	0.37		Beta
	Acquired Immunity	0.95	0.93	0.96		Beta
	Asymptotic Carrier	0.73	0.73	0.77		Beta

	Chronic Hepatitis	0.68	0.66	0.71		Beta
	Compensated Cirrhosis	0.69	0.66	0.71		Beta
	Decompensated Cirrhosis	0.35	0.32	0.37		Beta
	Hepatocellular Carcinoma	0.38	0.36	0.41		Beta
QOL weights: HCV	Normal	1				Beta
	Asymptotic Carrier	0.9	0.93	0.96	Wright et. al ,2006	Beta
	Chronic Hepatitis	0.7	0.63	0.76		Beta
	Compensated Cirrhosis	0.55	0.48	0.65		Beta
	Decompensated Cirrhosis	0.49	0.48	0.61		Beta
	Hepatocellular Carcinoma	0.58	0.48	0.61		Beta
QOL weights: HIV	CD4 Cell count >500 per mm^3	0.946	0.924	0.964	Simpson Kit N.et. al. 2015	Beta
	CD4 Cell count between 500-350 per mm^3	0.933	0.914	0.951		Beta
	CD4 Cell count between 350-200 per mm^3	0.931	0.914	0.951		Beta
	CD4 Cell count between 200-50 per mm^3	0.853	0.835	0.865		Beta
	CD4 Cell count <50 per mm^3	0.781	0.781	0.781		Beta
Transmission coefficients	**Male to Female: Without STD**				HIV Transmission	Beta
	Vaginal	0.0019	0.001	0.0037	Risk: A Summary Of The Evidence CDC, 2012	
	Anal	0.0169	0.0032	0.0891	Boily et al., 2009	Beta
HIV: No ART	Oral	0.0004	0.0001	0.0017	Vittinghoff et al., 1999	Beta
	Male to Female: With STD	0.0057	0.0015	0.0185		Beta
	Vaginal				HIV Transmission Risk: A Summary Of The Evidence CDC, 2012	
	Anal	0.0507	0.0048	0.4455		Beta
	Oral	0.0012	0.00015	0.0085		Beta
	Female to Male: Without STD	0.001	0.0006	0.0017	Hughes et al., 2012	Beta
	Vaginal					

	Anal	0.0016	0.0005	0.029	Boily et al., 2009	Beta
	Oral	0.0004	0.0001	0.0017	Vittinghoff et al., 1999	Beta
	Female to Male: With STD	0.003	0.0009	0.0085		Beta
	Vaginal				HIV Transmission	
	Anal	0.0048	0.00075	0.145	Risk: A Summary	Beta
	Oral	0.0012	0.00015	0.0085	Of The Evidence CDC, 2012	Beta
HBV: Without treatment	Male to Female: Without STD	0.0236	0.0236220	0.0236220	Inoue T, Tanaka Y. 2016	Beta
	Vaginal				& Author calculations	
	Anal	0.0393	0.0393700	0.0393700		Beta
	Oral	0.0078	0.0078740	0.0078740		Beta
	Male to Female: With STD	0.0708	0.0354330	0.1181102		Beta
	Vaginal					
	Anal	0.1181	0.0590551	0.1968503		Beta
	Oral	0.0236	0.0118110	0.0393700		Beta
	Female to Male: Without STD	0.0236	0.0236220	0.0236220		Beta
	Vaginal					
	Anal	0.0393	0.0393700	0.0393700		Beta
	Oral	0.0078	0.0078740	0.0078740		Beta
	Female to Male: With STD	0.0708	0.0354330	0.1181102		Beta
	Vaginal					
	Anal	0.1181	0.0590551	0.1968503		Beta
	Oral	0.0236	0.0118110	0.0393700		Beta
Coverage Parameters	Coverage of HBV Vaccination among health care workers (HCW)	0.5024	0.2576	0.72	Debbarma M et. al 2016 Iqbal Qazi M et al, 2016	Uniform
	Coverage of HBV Vaccination among general population	0.05	.02	0.1	Sujatha.R et al. 2014	Uniform
Effectiveness Parameters	Reduction in NSI with RUP	0.4	0.27	0.59	Systematic review was done separately for these parameters.	Normal
	Reduction in NSI with SIP	0.12	0.04	0.41		Normal
Efficacy of vaccine	HBV Vaccine	0.8	0.7	0.95	MG Geeta and A Riyaz 2013,	Uniform
	Post exposure prophylaxis-HIV	0.8	0.7	0.9	NACO report 2007 MoHFW, GOI	Uniform
	Post exposure prophylaxis -HBV	0.8	0.7	0.9	NACO report 2007 MoHFW, GOI	Uniform

BBI Transmission

As a next step, we estimated number of transmissions of HBV, HCV and HIV which occurred due to NSI among HCP and reuse among patients. Five key factors determined the transmission of BBI from an infected source to an uninfected recipient (36). First, *probability of prevalence*, which is defined as prevalence of a specific blood borne pathogen in the source population. Second, *probability of transfer,* which is probability of presence of viral blood borne pathogen in the syringe and depth of penetration of syringe in an NSI instance. Third, *probability of practice*, defined as rates of NSI and reuse. Fourth, *probability of infection transmission*, i.e. in case of any adverse event, the probability of transmission or simply BBI transmission coefficients. Fifth and last is *probability of susceptibility,* which is susceptibility marker of an exposed person in case of an adverse event based on his/her vaccination status (applicable only in case of HBV).

We also estimated the number of secondary BBIs in our analysis. Secondary BBIs were the infections transmitted from a primary case as a result of a NSI or reuse to their regular sexual partner through heterosexual route. Secondary BBIs were calculated for HIV and HBV using the standard Weinstein equation (37, 38). More details regarding this are given in the supplementary appendix. New infections contributed by NSI and syringe reuse were calculated for 20 cycles (i.e. 20 years) in the model.

Markov State Transitions

A markov transition state model was used to calculate life years (LY) and quality adjusted life years (QALY). Natural history of progression was used to model the health state transition in every cycle. An extensive review of literature was undertaken to determine the probability of transition from one state to another for three BBIs (39-48). In case where the rates were available for longer time period, we assumed uniform progression during intervening cycles. Year-wise all-cause mortality rates obtained from Sample Registration System (SRS) life tables were used (35). We used international literature available on quality of life (QOL) scores for different health states within three diseases (49-51). All the costs and consequences in future years were discounted at a rate of 3%.

Intervention (SES) Effect

We carried out a systematic review of evidence for assessing effectiveness of different SES on reduction in NSI. Considering the safety features of SES, we assumed that reuse will be completely prevented in case of RUP and RUP+SIP. However, for SIP, we assumed no change in reuse rate.

We included both RCTs and non-randomized studies (NRS) (such as before and after trials, time-series analysis, cohort, case control and quantitative surveys) which assessed the effect of any one of three SES, such as auto-disable or auto destruct syringes (ISO 7886-3), reuse prevention syringes (ISO 7886-4) and sharp injury prevention syringes (ISO 23908) when compared to syringes not having safety features (such as disposable, conventional or standard) on the reduction of NSIs among healthcare workers. Details of systematic review related to the search strategy, study selection, data abstraction, critical appraisal and statistical analysis are provided in supplementary material (Suppl. Appendix, Section C, Page No. 22-25). We found that the RUP and RUP+SIP syringe reduce the risk of NSI by 0.6 and 0.88 respectively.

Data Analysis

We report results in terms of incremental cost per LY and QALY gained with use of RUP, SIP and RUP+SIP compared to disposable syringes. Both undiscounted and discounter ICERs are reported for both national level, as well as Punjab state.

We undertook a univariate and probabilistic sensitivity analysis (PSA) to account for the effect of parameter uncertainties. A threshold analysis was undertaken to determine the price at which SES is cost effective and cost-saving/ dominant. In the PSA, gamma distribution was used for cost parameters, beta distribution for transmission and transition probabilities, normal distribution for SES effectiveness parameters and uniform distribution was used for remaining input parameters (52-55). Model was simulated 999 times and percentile method was used to generate 95% confidence interval for base estimate.

We also evaluated the fiscal cost of introduction of SES for both India and Punjab state. Results from this analysis are reported in terms of annual percentage increase in health budget from health system's perspective.

Results

Costs

At the national level, annual cost of disposable syringes for therapeutic care is INR 3.34 billion (USD 52.6 million) (Table 1). Introduction of RUP, SIP and RUP+SIP incurs an incremental cost of INR 10.3 billion (USD 162 million), INR 32.3 billion (USD 509 million) and INR 32.4 billion (USD 511 million) per year. Implementing SES will save INR 4.2 billion (USD 66.2 million), INR 3.07 (USD 48.4 million) and INR 4.9 billion (USD 77.2 million) annually with use of RUP, SIP and RUP+SIP, respectively on account of treatment cost averted. (Table 2).

Table 2: Cumulative Costs in different arms of cost-effectiveness model for India

		Costs (In million)			Incremental costs (In million)		
Type of cost		**INR**	**USD**	**INT. $**	**INR**	**USD**	**INT. $**
Disposable (Counterfactual)							
Syringes*		70270	1081	3253			
Biowaste Management		84	1.30	3.90			
Treatment**		89276	1373.5	4132.4			
	Undiscounted	159630	2456	7389			
Total	Discounted	105699	1626	4893			
RUP							
Syringes		286538	4408	13263	216268	3327	10011
Training		2	0.03	0.09			
Information Education and Communication (IEC)		6	0.09	0.26			
Biowaste Management		205	3.15	9.48	120	2	6
Treatment		4325	66.53	200.17	-84951	-1307	-3932
	Undiscounted	291075	4478	13473	131445	2022	6084
Total	Discounted	219276	3373	10150	113577	1747	5257
SIP							
Syringes		750457	11545	34737	680187	10464	31484
Training		2	0.03	0.09			
Information Education and Communication (IEC)		6	0.09	0.26			
Biowaste Management		93	1.43	4.29	8	0	0
Treatment		35490	546.00	1642.74	-53786	-827	-2490
	Undiscounted	786047	12093	36384	626417	9637	28995
Total	Discounted	588516	9054	27241	482817	7428	22348
RUP+SIP							
Syringes		750457	11545	34737	680187	10464	31484
Training		2	0.03	0.09			
Information Education and Communication (IEC)		6	0.09	0.26			

Biowaste Management		93	1.43	4.29	8	0	0
Treatment		519	7.99	24.03	-88756	-1365	-4108
Total	Undiscounted	751076	11555	34766	591446	9099	27377
	Discounted	567777	8735	26281	462078	7109	21388

***Syringe costs** shows costs of disposable/SES syringes for the period from 2017-2036.*
***Treatment costs** shows lifetime costs of treating individuals infected with Hepatitis B, Hepatitis C and HIV as a result of unsafe injection practices.*

At the state level, the annual cost of disposable syringes for therapeutic use in the state is INR 73.3 million (USD 1.15 million). Similarly, the replacing these will incur an incremental cost of INR 226 million (USD 3.6 million) for RUP and INR 710 million (USD 11.2 million) for SIP and RUP+SIP per year respectively. The treatment cost savings with introduction of RUP, SIP and RUP+SIP was found to be INR 59 million (USD 0.9 million) and INR 44 million (USD 0.69 million) respectively. Other detailed findings on lifetime cost are available in supplementary material (Suppl Appendix, Section B, Table 1).

Health Outcomes

Our model estimated that if the current injection practices are continued for next 20 years, there will be 99557, 47618 and 5650 new cases of HBV, HCV and HIV, respectively which are attributable to NSI and reuse (Table 2). Implementing RUP, SIP and RUP+SIP will prevent the new BBIs due to unsafe injections by 96%, 3.9% and 99%, respectively. Discounting the future outcomes at 3%, the reduction in BBIs results in an increase 1.58, 0.062 and 1.64 million life years; and 1.67, 0.066 and 1.74 million QALYs with RUP, SIP and RUP+SIP, respectively (Table 3).

Table 3: Health outcomes in different model arms and cost-effectiveness of SES syringes for India

Health Outcomes		**Disposable**	**RUP**	**SIP**	**RUP+SIP**
Disposable					
Life Years*	Undiscounted	100286460894	100290475676	100286620548	100290635328
	Discounted	47500551575	47502136852	47500614162	47502199436
QALYs*	Undiscounted	100286313371	100290469135	100286478767	100290634543
	Discounted	47500459263	47502132798	47500525401	47502198941
HBV cases#		99557	3260	96688	391

HCV cases#		47618	3536	44507	425
HIV cases#		5650	18	5634	2
Incremental cost effectiveness ratio (ICER), societal perspective					
Cost per life year gained	Undiscounted		15979	3226212	94202
	Discounted		43147	7167174	209465
Cost per QALY gained	Undiscounted		15435	3115239	91014
	Discounted		40358	6743277	196021

***Life years and QALYs** were estimated for a lifetime horizon.*
***#Blood borne infections i.e.** Hepatitis B, Hepatitis C and HIV were estimated for the time period from 2017-2036.*

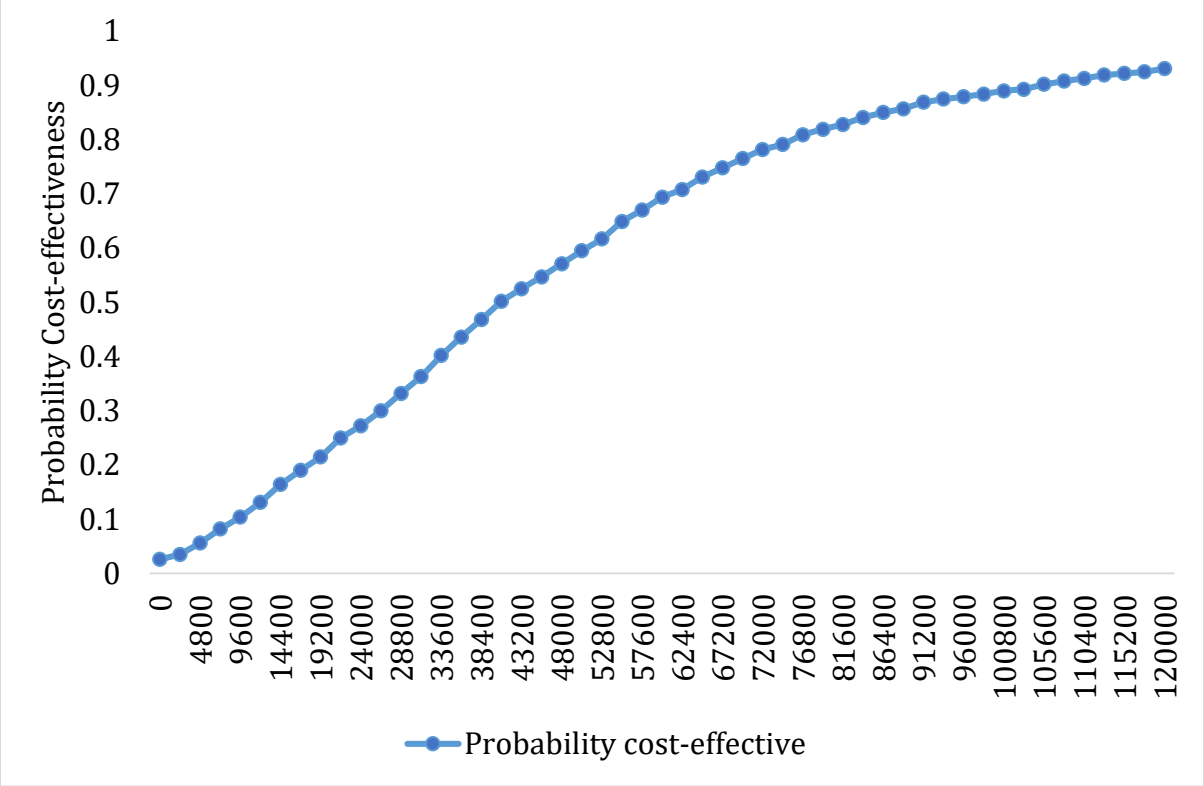
From Punjab state perspective, reduction in BBI incidence with use of RUP, SIP and RUP+SIP will result in gain of 19.8, 0.9 and 20.7 thousand life years; and 20.9, 0.96 and 21.9 thousand QALYs for, respectively (Suppl Appendix, Section B, Table 2).

Cost-effectiveness

India Scenario

The introduction of RUP, SIP and RUP+SIP in India will incur an incremental cost of INR 40,358 (USD 636), INR 6,743,277 (USD 106294) and INR 196,021 (USD 3090) per QALY gained, respectively (Table 2). There is a 93% probability for RUP to be cost effective at a willing to pay threshold of gross domestic product (GDP) of India. While SIP is not cost-effective, there is only 23% probability for RUP+SIP to be cost-effective at a willing to pay threshold of 1-time GDP per capita (Figure 1). Our findings suggest only RUP is cost-effective in Indian context at current levels of prices.

Figure 1: Probability for RUP cost-effectiveness in India at varying willingness to pay thresholds



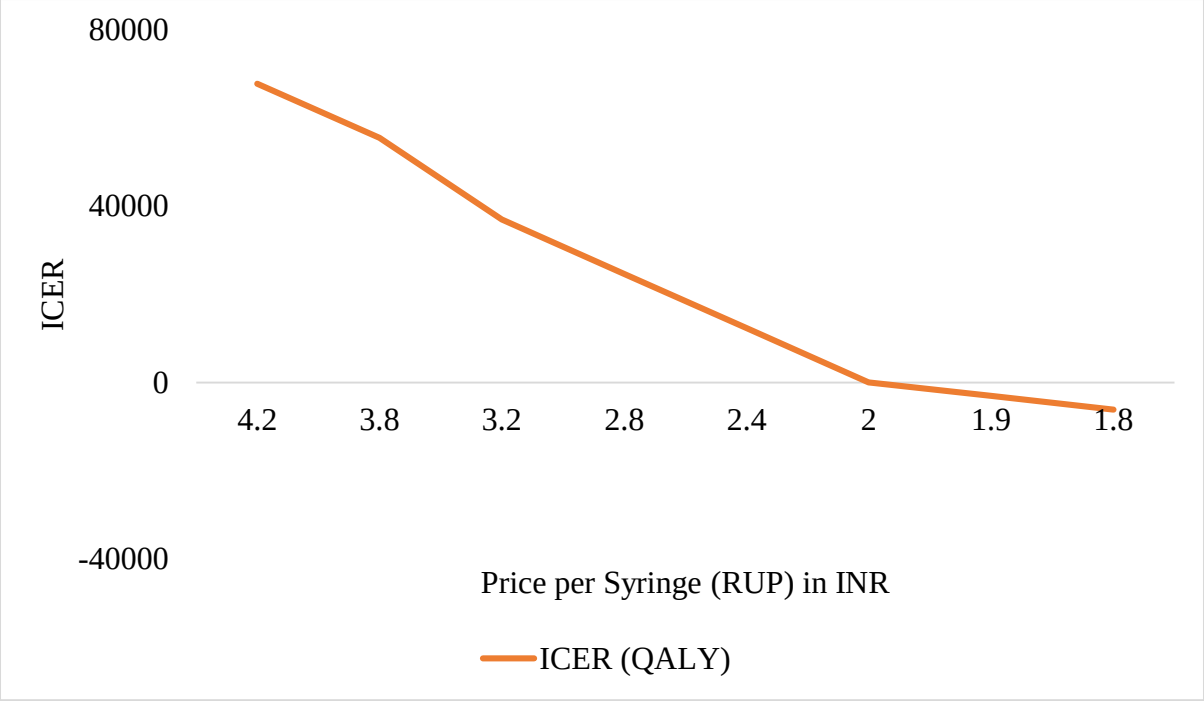
Similarly, with an incremental cost of INR 26,735 (USD 416) per QALY gained, there is a 96.5% probability for RUP to be cost effective in Punjab (Suppl Appendix, Section B, Table 2, Figure 2). The incremental cost per QALY gained with use of SIP and RUP+SIP in Punjab was found to be INR 5,471,329 (USD 86244) and INR144,425 (USD 2277) respectively (Suppl Appendix, Section B, Table 2).

Threshold Analysis

India Scenario

We found that RUP syringe will become cost saving at a unit price of INR 1.9 (Figure 2). The SIP and RUP+SIP syringes are cost-effective only at a unit price less than INR 1.8 and INR 5.9, respectively (Suppl Appendix, Section B, Table 15 and 16).

Figure 2: Threshold price analysis for Introduction of RUP Syringe in India



In context of Punjab, RUP will become cost saving at a procurement cost per unit of INR 1.4 (Suppl Appendix, Section B, Table 7). Similarly, SIP and RUP+SIP will become cost-effective, if procured at a cost of less than INR 1.15 and 3.7 per unit or below, respectively (Suppl Appendix, Section B, Table 8 and 9).

Fiscal Implications

In terms of fiscal implications, introducing SES will increase the annual health budget of Punjab state by 1.8% in case of RUP and 5.74%, if SIP or RUP+SIP is considered.

Discussion

We found only RUP syringe to be cost-effective in Indian context. At an incremental cost of INR 40,358 per QALY gained for introducing RUP, there is 93% probability to be cost-effective at a willingness to pay threshold of Indian GDP per capita. Unit cost of SES (RUP) was major determinant of overall costs, varying which we found that RUP intervention will become cost saving strategy, if procured at a unit cost INR 1.9 or lower. With the current cost of SIP and RUP+SIP, both are cost-ineffective in Indian cost but can become cost-effective if procured at a unit cost of equals to or less than INR 1.8 and 5.9 respectively.

Nations Implementing SES

SES has been adopted by many countries for therapeutic care. United states imposed a Federal Needlestick Safety and Prevention Act in year 2000 (56). As per the European Union Council Directive 2010, countries of the European Union were required to incorporate this act into municipal law, and adopt preventive measures against NSIs for healthcare workers (57). In Canada, Occupational Health and Safety Act was introduced in 2007 in Ontario Province (58). In 2011, the Japanese Ministry of Health, Labour and Welfare encouraged the adoption of appropriate infection control measures targeting healthcare workers, including investigations into the implementation of safety equipment designed to prevent NSIs. However, healthcare institutions in Japan had the full autonomy with regard to the implementation of SEDs (59). Few more countries like South Africa, Brazil and Taiwan attempted the use of SES but primarily in immunization sector (60, 61). In 2008, India too implemented use of AD syringes in immunization sector (12).

Comparison of Findings

Very few studies have been done to assess the cost-effectiveness of SES. Moreover, differences in methodologies lead to difficulty in comparability (62). For example, in a recent Japanese study, safety engineered devices (SEDs) were compared against the use of winged steel needles, catheter stylets, insulin pens etc. However, this study used a hospital perspective; reported effectiveness in terms of NSI averted rather than QALYs gained, did not consider the effect of SES on reuse prevention, and excluded HIV from consideration under BBIs based on its low HIV prevalence in Japan. Another study conducted in Belgium, had similar limitations as the

Japanese study (63). In 5 years, the Belgian study reported reduction in incidence of BBIs by 75%, compared to 96% with use of RUP syringes in 20 years in our analysis (63). Higher reduction of BBIs in our analysis could be due to higher prevalence of NSI and reuse in India.

A study done in 2003 for six WHO regions assessed the cost-effectiveness of policies in regard to safe injection use (64), concluded that single use equipment is a cost-effective strategy for preventing unsafe injection use i.e. reuse prevention. Similar to finding of this study, we found that the major determinant of cost in the intervention scenario is price of device i.e. 97%. Our study shows in terms of fiscal implications, use of RUP will increase the India (and state) budget of essential drugs by 0.8%, which is less than half estimated by Dziekan et al in 2003 (64).

Strengths

The existing evidence on cost-effectiveness of SES from the developed countries has several limitations. First, most studies estimated the incremental costs of introducing SES per NSI averted and did not quantify benefits in terms of life years and quality adjusted life years (QALYs) (62-65). With differing baseline NSI rate between India and other developed countries, such estimates on cost-effectiveness are not generalizable. Secondly, these studies did not consider reuse prevention to model benefits of SES introduction (62, 63, 65). In contrast, India has a considerable incidence of syringe reuse, and hence the same needs to be incorporated (28, 29). Thirdly, majority of studies were undertaken using a hospital perspective (62, 63, 65), however, an Indian analysis needs to take a societal perspective, given the patterns of health financing which is largely driven by OOP expenditure. In view of above said, the existing evidence becomes less relevant for application in Indian context. As per our knowledge, our study is the first to model the costs and the effects associated with use of SES in a comprehensive manner by correcting these deficiencies of the previous studies. Fourth, we also modelled the secondary HBV and HIV infections transmitted through heterosexual route among the partner population of those who get infected as a result of unsafe injection use. Fifth, our study results are generalizable as we report cost-effectiveness of SES both for India and for Punjab as a state scenario. Sixth, majority studies did not report cost-effectiveness of SES in utility terms i.e. QALYs, and hence their findings are of limited use for priority setting under health technology assessment (HTA) process. We report our study results in terms of incremental costs per QALY gained which is recommended as per HTA principles.

Limitations

First, though we considered a societal perspective for this evaluation but we did not account for the productivity loses for treatment of BBIs or premature mortality due to unsafe injection use among the HCP and the patient population. Second, our model does not account for dynamic effects in terms of natural reduction in prevalence of BBIs among the population in future years. Third, the pattern of unsafe (or safe practices) are dependent on the number of years of experience of a HCP and so, NSI rates may vary with varying years of experience of HCP. However, we considered an average risk of NSI. Fourth, though we model secondary infections for BBIs through heterosexual route among the spouses of population infected due to unsafe injection, we did not consider other modes of transmission such as needle sharing or homosexual route. Moreover, due to insufficient data, we did not model secondary infections due to HCV. More research is recommended to address these limitations in future.

Conclusion and Recommendations

Our findings suggest only RUP is cost-effective in Indian context. SIP and RUP+SIP are not cost-effectiveness at current unit prices. We found that RUP syringe will become cost saving at a unit price of INR 1.9 and; SIP and RUP+SIP syringes will be cost-effective at a unit price less than INR 1.8 and INR 5.9, respectively. In view of above conclusion, our recommendations are that RUP should replace disposable/conventional syringes for therapeutic care in India. The prices of these SES should be reduced either through price negotiation using bulk purchasing, or through price regulation by central agencies such as NPPA. More future research could be done to assess the cost-effectiveness of SES in combination with behaviour change communication (BCC) strategies which can impact the demand of injections with better sensitization among population.

References

1. Safe Injection Global Netwok Advocacy Booklet. World Health Organization. 2011.
2. Handbook on Safe Injection Practices In: Control NCFD, editor. New Delhi: GOI; 2014.
3. Arora N. Injection practices in India. WHO South-East Asia Journal of Public Health. 2012;1(2):189-200.
4. WHO. WHO Guideline on the Use of Safety-Engineered Syringes for Intramuscular, Intradermal and Subcutaneous Injections in Health Care Settings. In: Organization WH, editor. Geneva2016.
5. Solberg KE. Trade in medical waste causes deaths in India. The Lancet. 2009;373(9669):1067.
6. GoI. National Health Policy- 2017. Ministry of Health and Family Welfare. Government of India. 2017.
7. MOHFW. National Health Accounts: Estimates for India 2013-14. National Health Accounts Technical Secretariat (NHATS). National Health Systems Resource Centre (NHSRC). Ministry of Health and Family Welfare (MoHFW). Government of India. New Delhi2016.
8. Prinja S, Bahuguna P, Duseja A, Kaur M, Chawla YK. Cost of Intensive Care Treatment for Liver Disorders at Tertiary Care Level in India. PharmacoEconomics - Open. 2017.
9. Prinja S, Kanavos P, Kumar R. Health care inequities in north India: Role of public sector in universalizing health care. Indian Jounal Med Res. 2012:421-31.
10. Prinja S, Kumar M, Pinto A, Jan S, Kumar R. Equity in Hospital Services Utilization in India. Economic and Political Weekly. 2013;XLVIII(2):52-8.
11. Harb AC, Tarabay R, Diab B, Ballout RA, Khamassi S, Akl EA. Safety engineered injection devices for intramuscular, subcutaneous and intradermal injections in healthcare delivery settings: a systematic review and meta-analysis. BMC Nursing. 2015;14(1):71.
12. Reid S. Estimating the Burden of Disease from Unsafe Injections in India: A Cost–benefit Assessment of the Auto-disable Syringe in a Country with Low Blood-borne Virus Prevalence. Indian Journal of Community Medicine : Official Publication of Indian Association of Preventive & Social Medicine. 2012;37(2):89-94.
13. Prinja S, Downey L, Gauba3, Swaminathan S. Health Technology Assessment for Policy Making in India: Current Scenario and Way Forward. PharmacoEconomics Open. 2017.
14. Saoji A, Kantibhushan C, Aniruddha D, Mudey A. Injection Safety Awareness and Knowledge in a Rural Population. Global Journal of Health Science. 2011;3(1).
15. The Economic Times: Forex Rates. Available at: http://economictimes.indiatimes.com/markets/forex. 2017.
16. GoI. Key Indicators of Social Consumption in India Health. NSS 71st Round. Ministry of Statistics and Program Implementation. Government of India. Jan-Jun, 2014.
17. India HIV Estimation Report (Strategic Information Management System 2015-16). In: Organization NAC, editor.: NACO; 2015.
18. National Sample Survey Office. Health in India- NSS 71st Round [Internet]. New Delhi: National Sample Survey Office, Ministry of Statistics and Programme Implementation; Available from: http://mospi.nic.in/sites/default/files/publication_reports/nss_rep574.pdf 2014 [cited August 2017 Accessed 20].
19. Prinja S, Balasubramanian D, Jeet G, Verma R, Kumar D, Bahuguna P, et al. Cost of Delivering Secondary Level Health Care Services through Public Sector District Hospitals in India. Indian J Med Res (Forthcoming). 2017.
20. Prinja S, Gupta A, Verma R, Bahuguna P, Kumar D, Kaur M, et al. Cost of Delivering Health Care Services in Public Sector Primary and Community Health Centres in North India. . PLoS ONE. 2016;11(8):e0160986. doi:10.1371/journal.pone.
21. Chatterjee S, Levin C, Laxminarayan R. Unit Cost of Medical Services at Different Hospitals in India. PloS One. 2013;8(7):e69728.
22. Mukh Mantri Punjab Hepatitis C Relief Fund In: Department Of Health And Family Welfare P, editor. Ist ed2016.

23. Punjab State Health Department. In: Department PH, editor. Parivar Kalyan Bhawan office, Chandigarh2017.
24. Trading Economics. Availabe at: http://www.tradingeconomics.com/india/gdp-deflator. Accessed on 15, January, 2018.
25. Hazarika I. Health workforce in India: assessment of availability, production and distribution. WHO South-East Asia Journal of Public Health. 2013;2(2):106.
26. Rehan HS, Chopra D, Sah RK, Chawla T, Agarwal A, Sharma GK. Injection practices of healthcare professionals in a Tertiary Care Hospital. Journal of Infection and Public Health. 2012;5(2):177-81.
27. Kermode M, Muani V. Injection practices in the formal & informal healthcare sectors in rural north India. The Indian journal of medical research. 2006;124(5):513-20.
28. Garapati S, Peethala S. Assessment of knowledge and practices on injection safety among service providers in east Godavari district of Andhra Pradesh. Ind J Comm Health. 2014;26(3):259-63.
29. Sahu D, Gandhi N. Assessment of Safe Injection Practices in a Tertiary Care Hospital: A Cross-Sectional Study from Chhattisgarh. Ntl J of Community Med. 2015;6(4):500-3.
30. Pandit DP. Prevalence of Antibodies to Hepatitis C Virus in Voluntary Blood Donors: Are Women Better Donors? JOURNAL OF CLINICAL AND DIAGNOSTIC RESEARCH. 2014.
31. Sood S, Malvankar S. Seroprevalence of Hepatitis B surface antigen, antibodies to the Hepatitis C virus, and human immunodeficiency virus in a hospital-based population in Jaipur, Rajasthan. Indian Journal of Community Medicine. 2010;35(1):165.
32. Laghawe A, Faujdar S. Declining Trends in HIV Prevalence: A Tertiary Care Hospital Based 05 Years Retrospective Analysis. IntJCurrMicrobiolAppSci 2015;4(6):927-36.
33. Goel V, Kumar D, Patwardhan V, Balooni V, Singhal S, Singh S. Trends of Seroprevalence, Epidemiology and Clinical Presentation of HIV in North India: A Tertiary Care Hospital Based Study. World Journal of AIDS. 2016;06(02):54-8.
34. WHO. Guidelines for the Management of Occupational Exposures to HBV, HCV, and HIV and Recommendations for Postexposure Prophylaxis. World Health Organization.
35. Registrar General & Census Commissioner of India. SRS life tables 2011-2015. http://www.censusindia.gov.in/Vital_Statistics/SRS_Life_Table/Srs_life_Table_2011-15.html [Accessed 20 August 2017].
36. Sikora C, Chandran AU, Joffe AM, Johnson D, Johnson M. Population Risk of Syringe Reuse: Estimating the Probability of Transmitting Bloodborne Disease. Infection Control & Hospital Epidemiology. 2010;31(07):748-54.
37. Prinja S, Bahuguna P, Rudra S, Gupta I, Kaur M, Mehendale SM, et al. Cost effectiveness of targeted HIV prevention interventions for female sex workers in India. Sexually transmitted infections. 2011;87(4):354-61.
38. Weinstein M, Grahan J, Siegel J, al. e. Cost-effectiveness analysis of AIDS prevention programs: concepts, complications and illustrations. In: Turner C, Miller H, Moses L, eds. AIDS: sexual behaviour and intravenous drug use. Washington, DC: National Academy Press, 1989.
39. Alazawi W, Cunningham M, Dearden J, Foster G. Systematic review: outcome of compensated cirrhosis due to chronic hepatitis C infection. Aliment Pharmacol Ther. 2010;32:344-55.
40. Alberti A, Chemello L, Benvegnù L. Natural history of hepa- titis C. J Hepatol. 1999;31(1):17-24.
41. Aleman S, Rahbin N, Weiland O, Davidsdottir L, Hedenstierna M, Rose N, et al. A risk for hepatocellular carcinoma persists long-term after sustained virologic response in patients with hepatitis C-associated liver cirrhosis. Clin Infect Dis. 2013;57:230-6.
42. Bialek SR, Terrault NA. The Changing Epidemiology and Natural History of Hepatitis C Virus Infection. Clinics in Liver Disease. 2006;10(4):697-715.

43. Bruno S, Zuin M, Crosignani A, Rossi S, Zadra F, Rof L, et al. Predicting mortality risk in patients with compensated HCV-induced cirrhosis: a long-term prospective study. Am J Gastroenterol 2009;104:1147-58.
44. Chen S, Morgan T. The Natural History of Hepatitis C Virus (HCV) Infection. International Journal of Medical Sciences. 2006;3(2):47-52.
45. Degos F, Christidis C, Ganne-Carrie N, Farmachidi J, Degott C, Guettier C, et al. Hepatitis C virus related cirrhosis: time to occurrence of hepatocellular carcinoma and death Gut. 2000;47:131-6.
46. Fattovich G, Bortolotti F, Donato F. Natural history of chronic hepatitis B: special emphasis on disease progression and prognostic factors. J Hepatol. 2008;48(2):335-52.
47. Gramenzi A, Andreone P, Fiorino S, Cammà C, Giunta M, Magalotti D, et al. Impact of interferon therapy on the natural history of hepatitis C virus related cirrhosis. Gut. 2001;48:843-8.
48. Kobayashi M, Ikeda K, Hosaka T, Sezaki H, Someya T, Akuta N, et al. Natural history of compensated cirrhosis in the Child-Pugh class A compared between 490 patients with hepatitis C and 167 with B virus infections. J Med Virol. 2006;78:459-65.
49. Levy AR, Kowdley KV, Iloeje U, Tafesse E, Mukherjee J, Gish R, et al. The Impact of Chronic Hepatitis B on Quality of Life: A Multinational Study of Utilities from Infected and Uninfected Persons. Value in Health. 2008;11(3):527-38.
50. Simpson KN, Luo MP, Chumney E, Sun E, Brun S, Ashraf T. Cost-Effectiveness of Lopinavir/Ritonavir Versus Nelfinavir As the First-Line Highly Active Antiretroviral Therapy Regimen for HIV Infection. HIV Clinical Trials. 2004;5(5):294-304.
51. Wright M, Grieve R, Roberts J, Main J, Thomas H. Health benefits of antiviral therapy for mild chronic hepatitis C: randomised controlled trial and economic evaluation. Health Technology Assessment. 2006;10(21).
52. Andronis L, Barton P, Bryan S. Sensitivity analysis in economic evaluation: an audit of NICE current practice and review of its use and value in decision-making. Health Technol Assess. 2009;13(29).
53. Briggs A. Handling uncertainty in cost-effectiveness models. Pharmacoeconomics. 2000;17:479-500.
54. Briggs A, Claxton K, Schulpher M. Decision modelling for health economic evaluation. Oxford: Ocfors University Press. 2006.
55. Briggs A, Gray A. Handling uncertainty when performing economic evaluation of healthcare interventions. Health Technol Assess. 1999;3(2):iii-72.
56. US Department of Labor, Occupational Safety and Health Administration. Occupational exposure to bloodborne pathogens; needlestick and other sharps injuries: final rule. Federal Register 66. Washington, DC: Department of Labor, Occupational Safety and Health Administration; 2001.
57. Council of the European Union. Council Directive 2010/32/EU of 10 May 2010 implementing the Framework Agreement on prevention from sharp injuries in the hospital and healthcare sector concluded by HOSPEEM and EPSU. Off J Eur Union 2010;L134:66e72.
58. Chambers A, Mustard C, Etches J. Trends in needlestick injury incidence following regulatory change in Ontario, Canada (2004–2012): an observational study. BMC Health Services Research. 2015;15(1).
59. Japan Ministry of Health, Labour and Welfare. Points of attention for hospital-acquired infection control in healthcare institutions. Guidance of Medical Service Division, Health Policy Bureau Notification No. 0617-1 (June 17, 2011). Available at: http://www.mhlw.go.jp/topics/2012/01/dl/tp0118-1-76.pdf).
60. Department of Health, The Government of South Africa. https://www.westerncape.gov.za/general-publication/immunisation-safe.
61. Cooke C, Stephens J. Clinical, economic, and humanistic burden of needlestick injuries in healthcare workers. Medical Devices: Evidence and Research. 2017;10:225-35.

62. Fukuda H, Moriwaki K. Cost-Effectiveness Analysis of Safety-Engineered Devices. Infection Control & Hospital Epidemiology. 2016;37(09):1012-21.
63. Hanmore E, Maclaine G, Garin F, Alonso A, Leroy N, Ruff L. Economic benefits of safety-engineered sharp devices in Belgium - a budget impact model. BMC Health Services Research. 2013;13(1).
64. Dziekan G, Chisholm D, Johns B, Rovira J, Hutin Y. The cost-effectiveness of policies for the safe and appropriate use of injection in healthcare settings. Bull World Health Organ. 2003;81:277-85.
65. Glenngård AH, Persson U. Costs associated with sharps injuries in the Swedish health care setting and potential cost savings from needle-stick prevention devices with needle and syringe. Scandinavian Journal of Infectious Diseases. 2009;41(4):296-302.

Supplementary Appendix

Contents

Section A: Conceptual Framework and Transition matrices used in the model

Figure 1: Decision model for cost-effectiveness of SES syringes

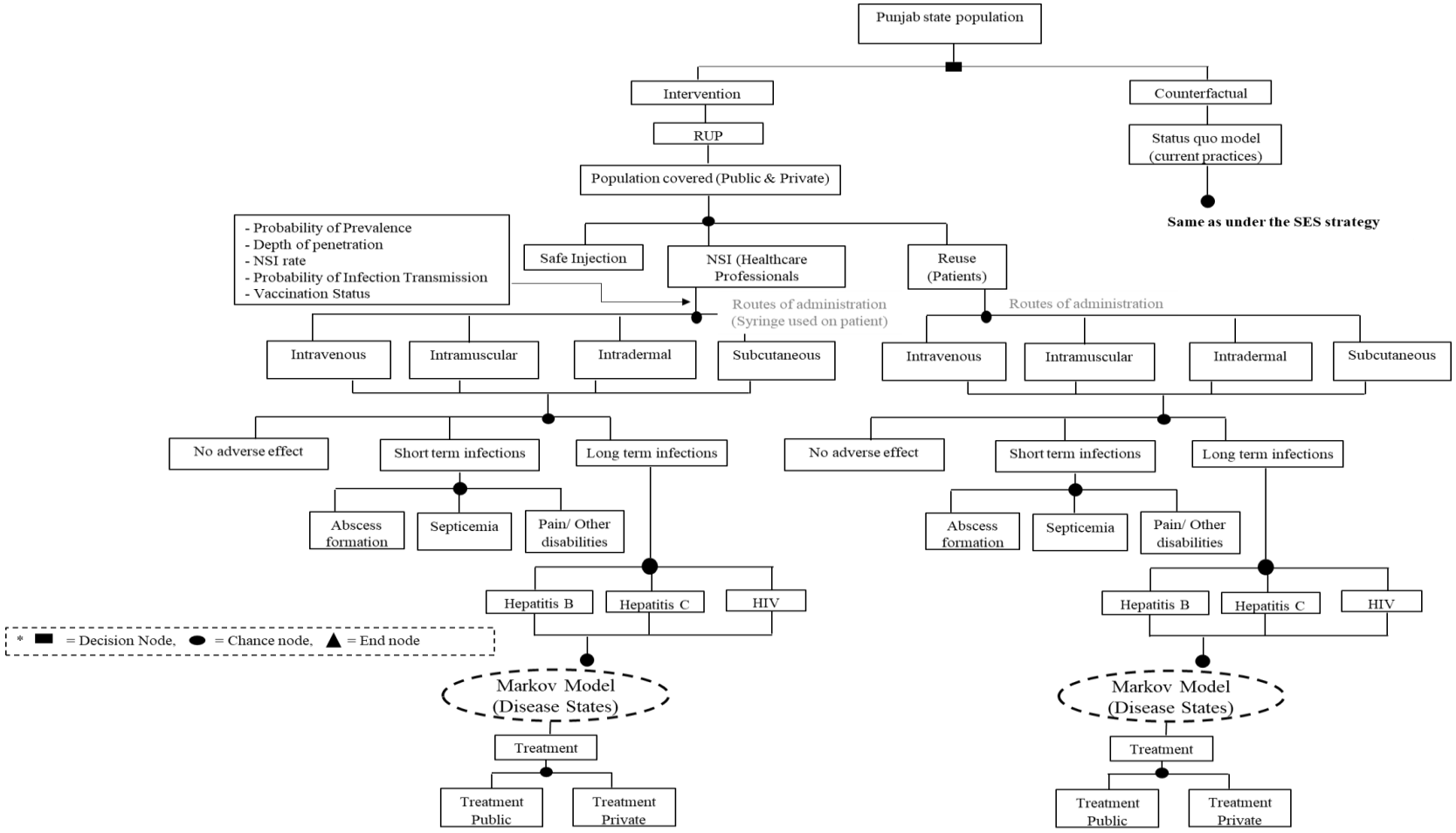


Figure 2: Markov State Transition Model for HBV

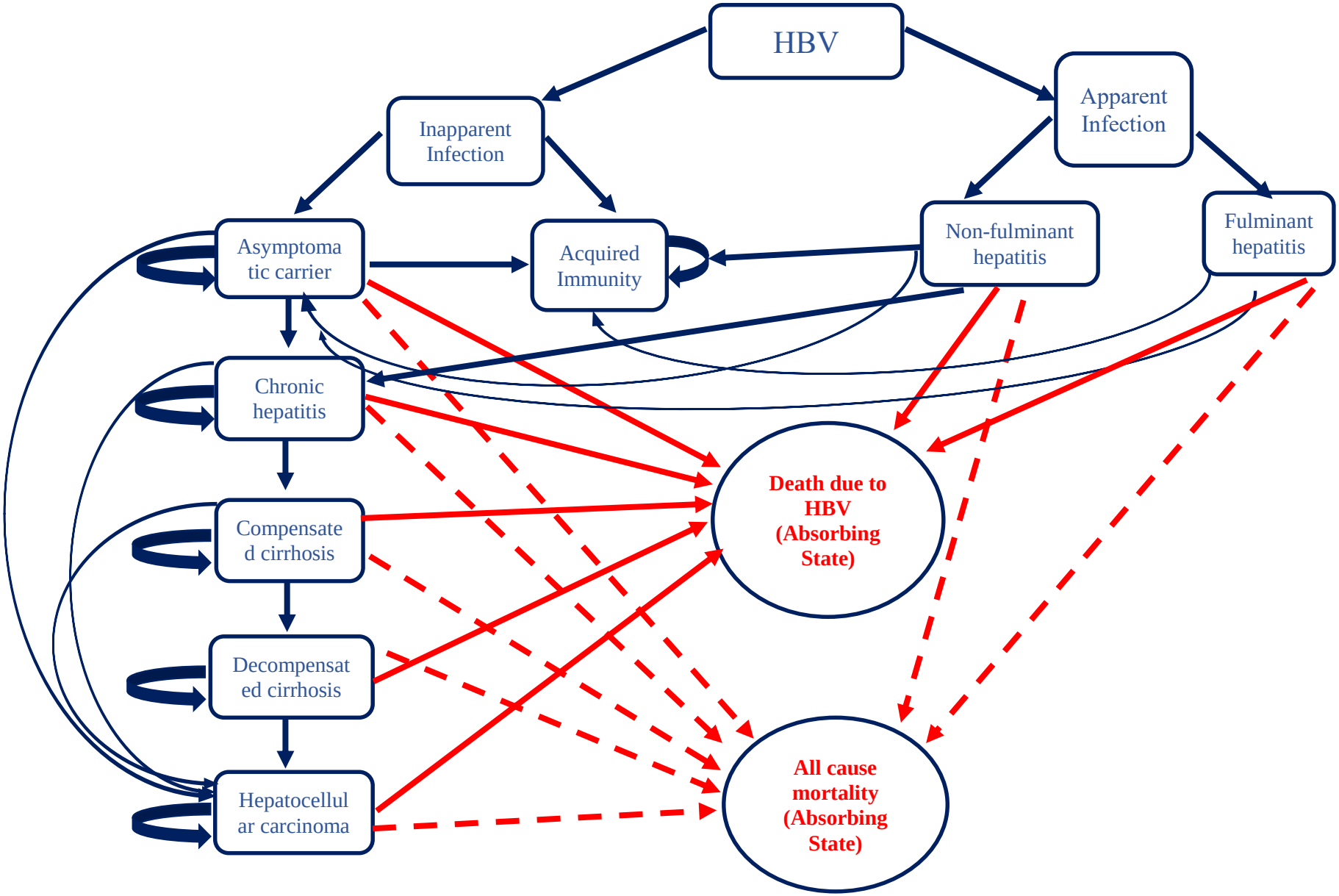


Figure 3: Markov State Transition Model for HCV

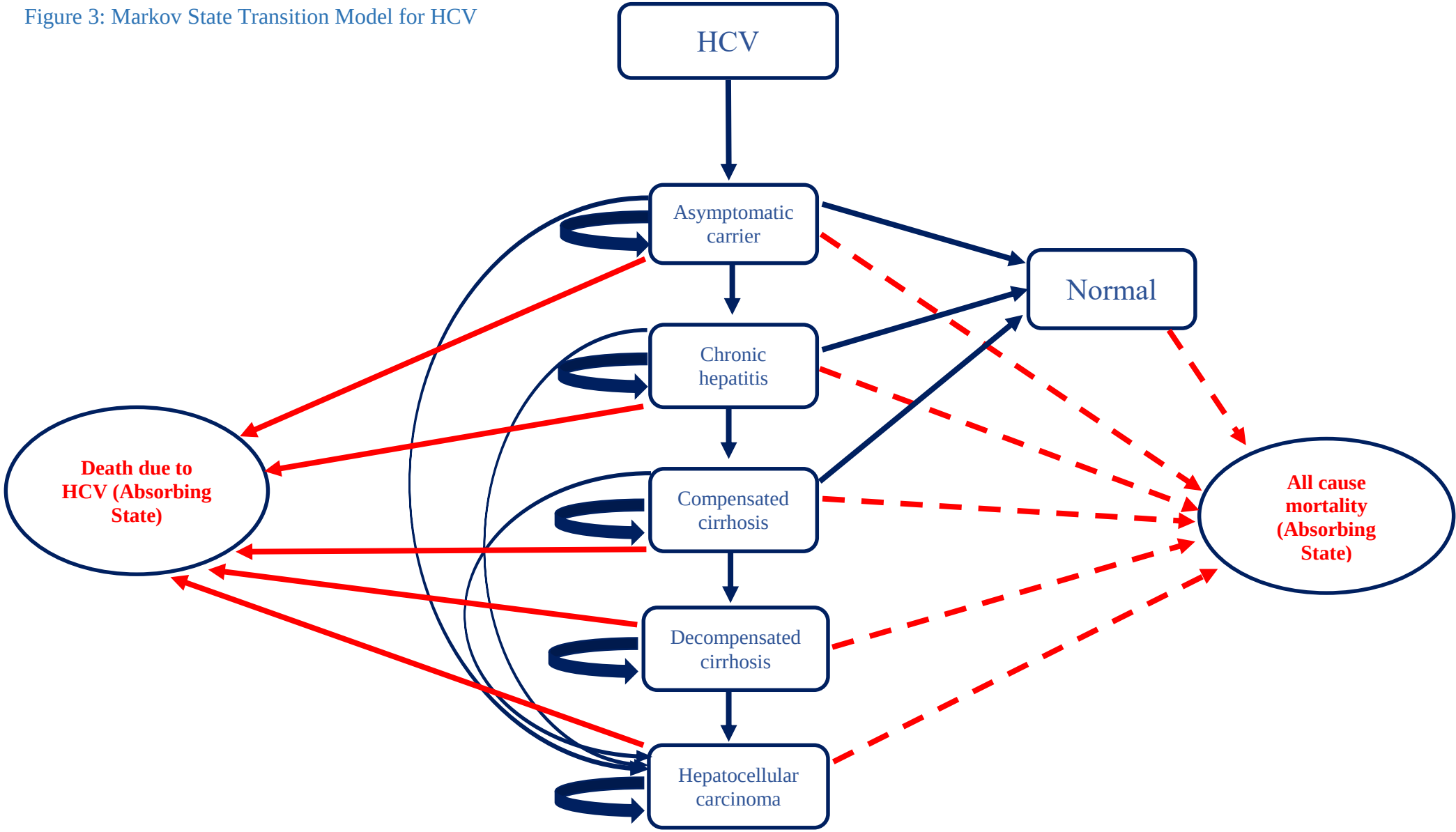


Figure 4: Markov State Transition Model for HI

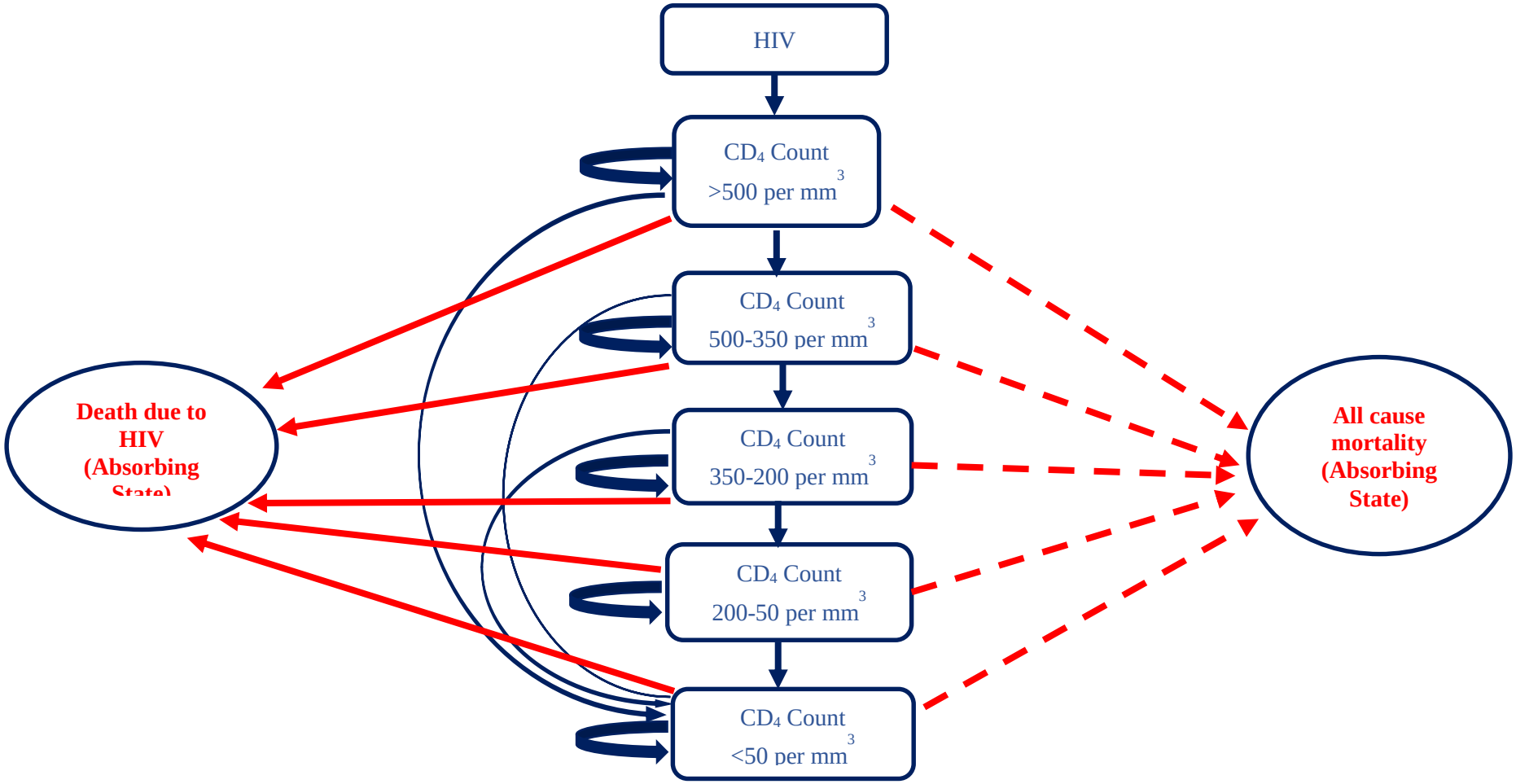
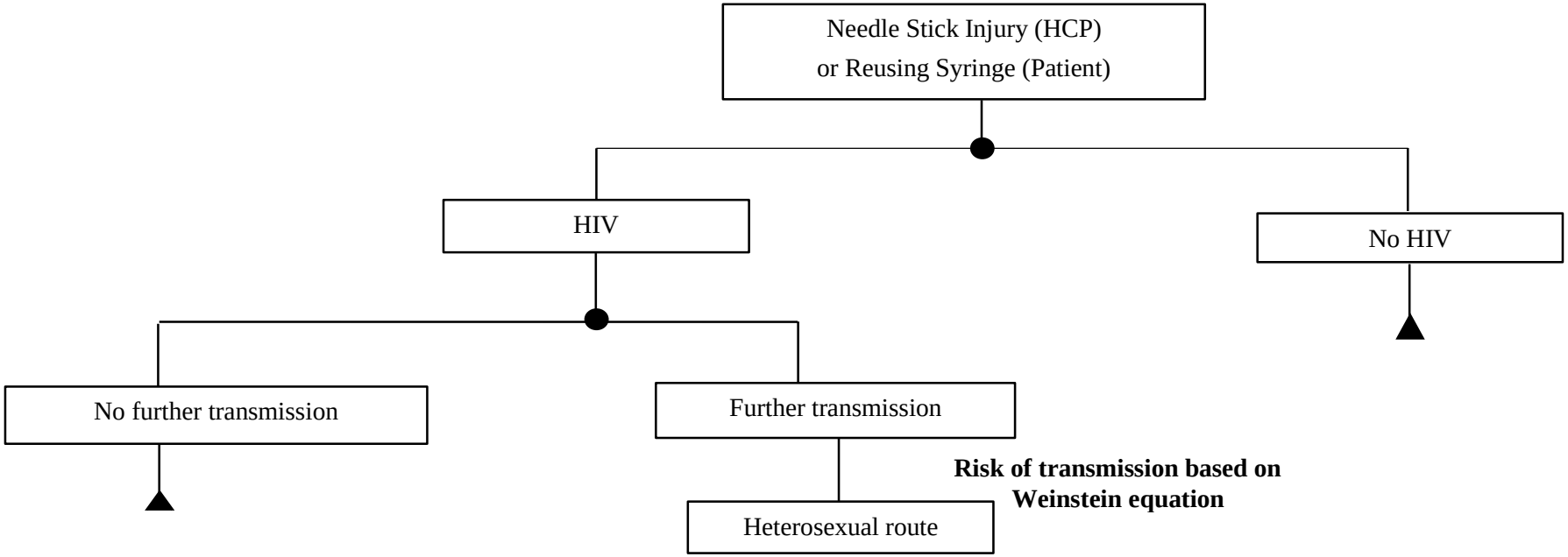


Figure 5: Transmission Model for HIV



Weinstein Equation;

$$\rho = 1 - [\Pi (1 - \lambda_{jkl} (1 - \phi * \varepsilon))^{N} + (1 - \Pi)]^{M}$$

where, ρ= Annual prob. of HIV transmission/individual

Π= Prevalence of HIV in partner group.

λ_{jkl}=Transmission coefficient per sex act based on type of sex act (k), STD status (j) of recipient and direction of transmission

ϕ= proportion condom use.

ε= efficacy of condom.

Matrix 1: Probability of Disease Progression for different stages of Hepatitis B

	Inapparent Infection	Apparent Infection	Non-Fulminant Hepatitis	Fulminant Hepatitis	Acquired Immunity	Asymptotic Carrier	Chronic Hepatitis	Compensated Cirrhosis	Decompensated Cirrhosis	Hepatocellular Carcinoma	Death	All-Cause Mortality	Total
Inapparent Infection	0	0	0	0	0.887	0.050	0	0	0	0	0	0.063	1
Apparent Infection		0	0.927	0.010	0	0	0	0	0	0	0	0.063	1
Non-Fulminant Hepatitis			0.008	0	0.829	0	0.050	0.0	0.0	0.0	0.050	0.063	1
Fulminant Hepatitis					0.267	0	0	0	0	0	0.670	0.063	1
Acquired Immunity					0.937	0	0	0	0	0	0	0.063	1
Asymptotic Carrier						0.537	0.400	0.0	0.0	0.001	0	0.063	1
Chronic Hepatitis							0.921	0.016	0	0.001	0	0.063	1
Compensated Cirrhosis								0.874	0.050	0.002	0.010	0.063	1
Decompensated Cirrhosis									0.701	0.030	0.206	0.063	1
Hepatocellular Carcinoma										0.468	0.469	0.063	1
Death													
All-Cause Mortality													

Matrix 2: Probability of Disease Progression for different stages of Hepatitis C

	Normal	Asymptotic Carrier	Chronic Hepatitis	Compensated Cirrhosis	Decompensated Cirrhosis	Hepatocellular Carcinoma	Death	All-Cause Mortality	Total
Normal	0.93716	0	0	0	0	0	0	0.06284	1
Asymptotic Carrier	0.25000	0.00001	0.68715	0	0	0	0	0.06284	1
Chronic Hepatitis			0.92839	0.00809	0	0.00067	0	0.06284	1
Compensated Cirrhosis				0.90716	0.03000	0	0	0.06284	1
Decompensated Cirrhosis					0.81004	0.03000	0.09712	0.06284	1
Hepatocellular Carcinoma						0.78956	0.14760	0.06284	1
Death									
All-Cause Mortality									

Matrix 3: Probability of Disease Progression for different stages of HIV

	CD4 Cell count >500 per mm^3	CD4 Cell count between 500-350 per mm^3	CD4 Cell count between 350-200 per mm^3	CD4 Cell count between 200-50 per mm^3	CD4 Cell count <50 per mm^3	Death	All-Cause Mortality	Total
CD4 Cell count >500 per mm^3	0.6144	0.1930	0.0871	0.0049	0.0049	0.0328	0.0628	1
CD4 Cell count between 500-350 per mm^3	0.3774	0.2781	0.2270	0.0174	0.0174	0.0198	0.0628	1
CD4 Cell count between 350-200 per mm^3	0.1778	0.2862	0.3584	0.0469	0.0469	0.0209	0.0628	1
CD4 Cell count between 200-50 per mm^3	0.0815	0.1842	0.4129	0.0920	0.1487	0.0178	0.0628	1
CD4 Cell count <50 per mm^3	0.0815	0.1842	0.4129	0.1487	0.0920	0.0178	0.0628	1
Death								
All-Cause Mortality								
Total								

Section B: Results (*Punjab State Scenario)*

Table 1: Cumulative costs in different arms of cost-effectiveness model for Punjab state, India

Parameters	Costs (In million)			Incremental costs (In million)		
	INR	**USD**	**INT. $**	**INR**	**USD**	**INT. $**
Disposable (Counterfactual)						
Syringes costs	1540	24	71			
Biowaste Management costs	2	0.03	0.09			
Treatment costs	1250	19.2	57.8			
Total costs (Undiscounted)	2791	43	129			
Total costs (Discounted)	1895	29	88			
RUP						
Syringes costs	6279	97	291	4739	73	219
Training costs	2	0.03	0.09			
Information Education and Communication (IEC) costs	6	0.09	0.26			
Biowaste Management costs	2	0.03	0.09	0	0	0
Treatment costs	62	0.96	2.87	-1187	-18	-55
Total costs (Undiscounted)	6350	98	294	3559	55	165
Total costs (Discounted)	4791	74	222	2895	45	134
SIP						
Syringes costs	16445	253	761	14905	229	690
Training costs	2	0.03	0.09			
Information Education and Communication (IEC) costs	6	0.09	0.26			
Biowaste Management costs	2	0.03	0.09	0	0	0
Treatment costs	368	5.67	17.05	-881	-14	-41
Total costs (Undiscounted)	16822	259	779	14031	216	649
Total costs (Discounted)	12659	195	586	10763	166	498
RUP+SIP						
Syringes costs	16445	253	761	14905	229	690
Training costs	2	0.03	0.09			
Information Education and Communication (IEC) costs	6	0.09	0.26			
Biowaste Management costs	2	0.03	0.09	0	0	0
Treatment costs	7	0.11	0.35	-1242	-19	-57
Total costs (Undiscounted)	16461	253	762	13670	210	633
Total costs (Discounted)	12445	191	576	10549	162	488

Table 2: Health outcomes in different model arms and cost-effectiveness of SES syringes for Punjab state, India

Health Outcomes	Disposable	RUP	SIP	RUP+SIP
Disposable				
Total Life Years (Undiscounted)	2007173025	2007223975	2007175344	2007226294
Total Life Years (Discounted)	971229935	971249737	971230840	971250642
Total QALYs (Undiscounted)	2007171142	2007223879	2007173545	2007226282
Total QALYs (Discounted)	971228712	971249676	971229669	971250633
HBV cases	960	31	932	4
HCV cases	926	69	866	8
HIV cases	77	0	77	0
Incremental cost effectiveness ratio (ICER), societal perspective				
Cost per life year gained (Undiscounted)		9156	2619969	67391
Cost per life year gained (Discounted)		28442	5845366	153808
Cost per QALY gained (Undiscounted)		8847	2527061	65115
Cost per QALY gained (Discounted)		26735	5471329	144425

Figure 1: Cost-effectiveness Plane (RUP), Punjab state

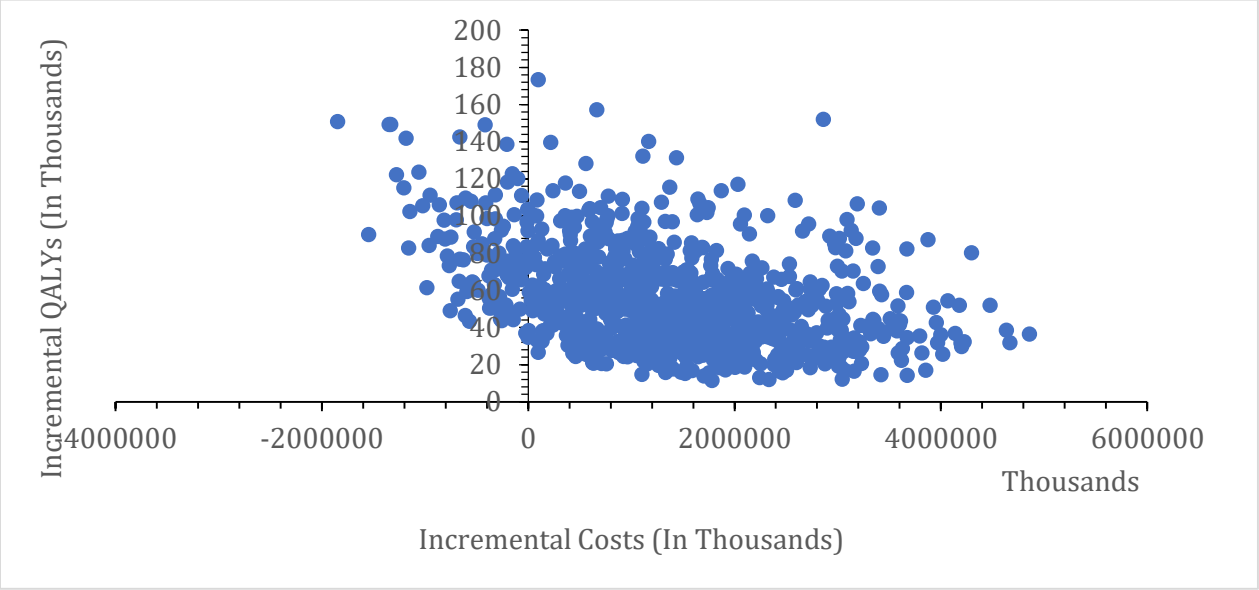


Figure 2: Probability for RUP cost-effectiveness for Punjab state at varying willingness to pay thresholds

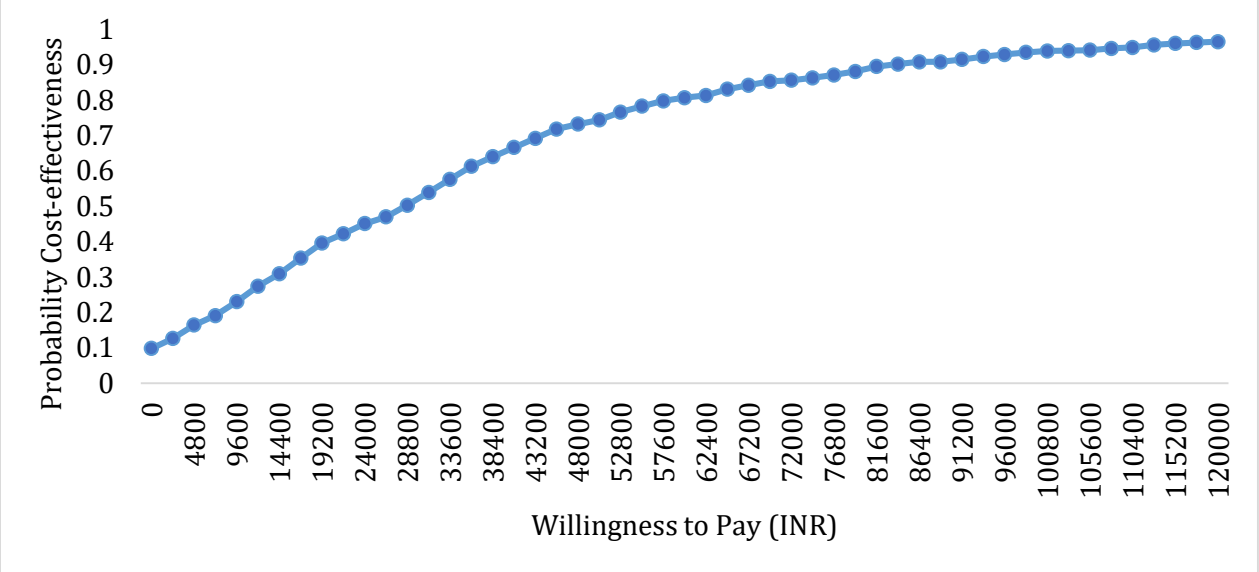


Figure 3: Cost-effectiveness Plane (SIP), Punjab state

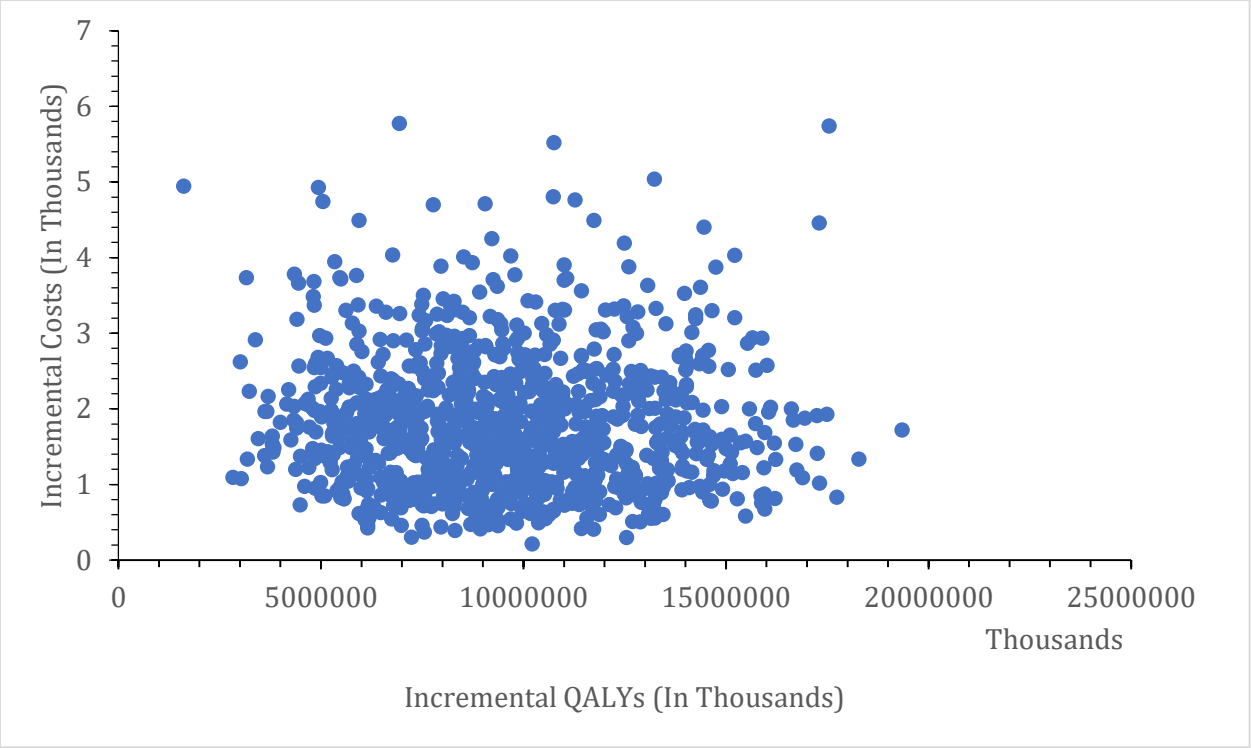


Figure 4: Probability for SIP cost-effectiveness for Punjab state at varying willingness to pay thresholds

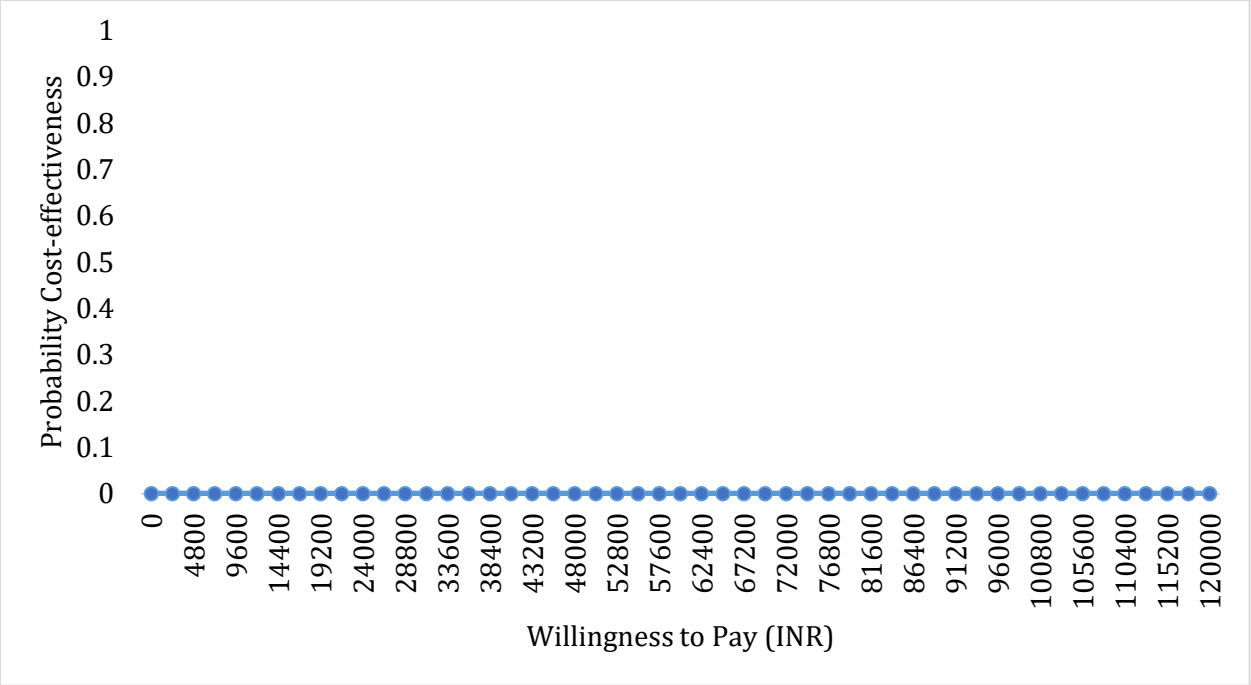


Figure 5: Cost-effectiveness Plane (RUP+SIP), Punjab state

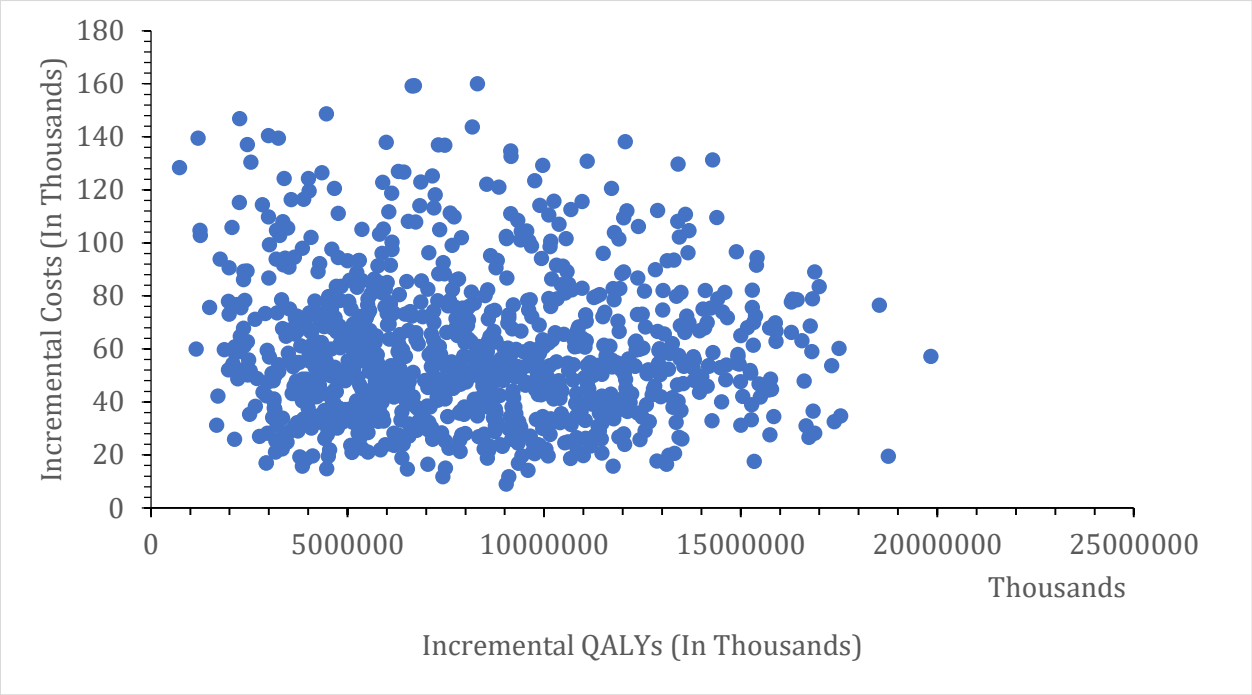


Figure 6: Probability for RUP+SIP cost-effectiveness for Punjab state at varying willingness to pay thresholds

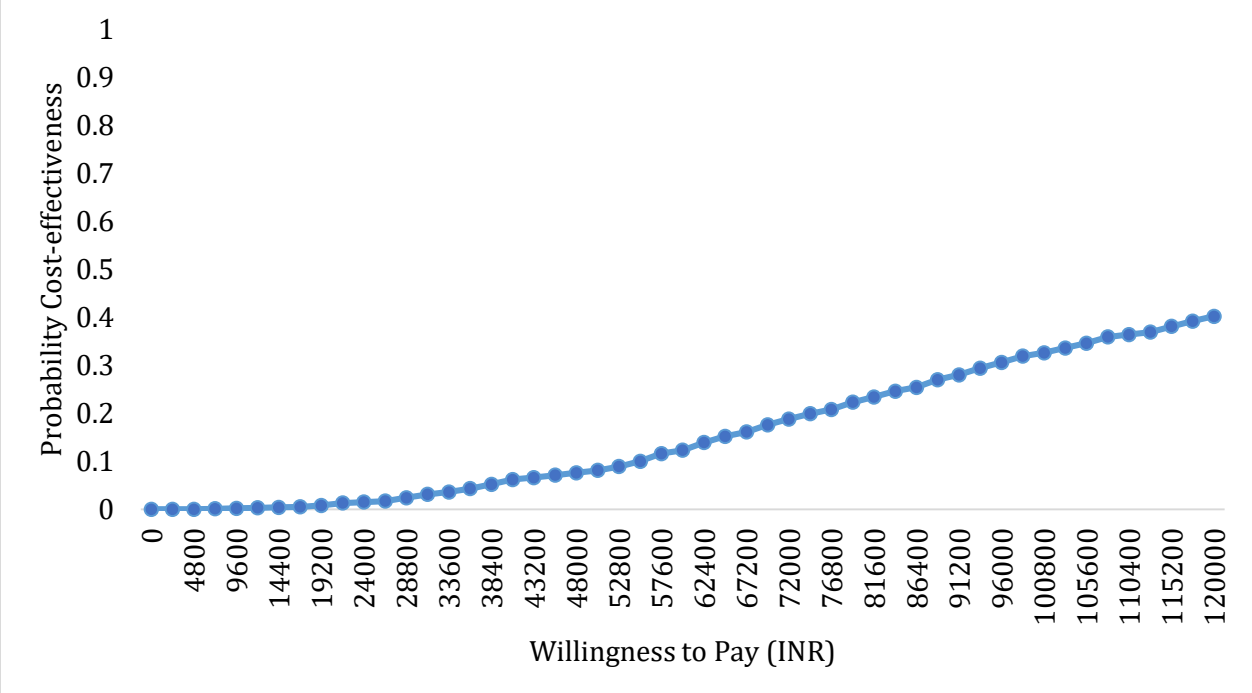


Figure 7: Threshold price analysis for introduction of RUP Syringe in Punjab state, India

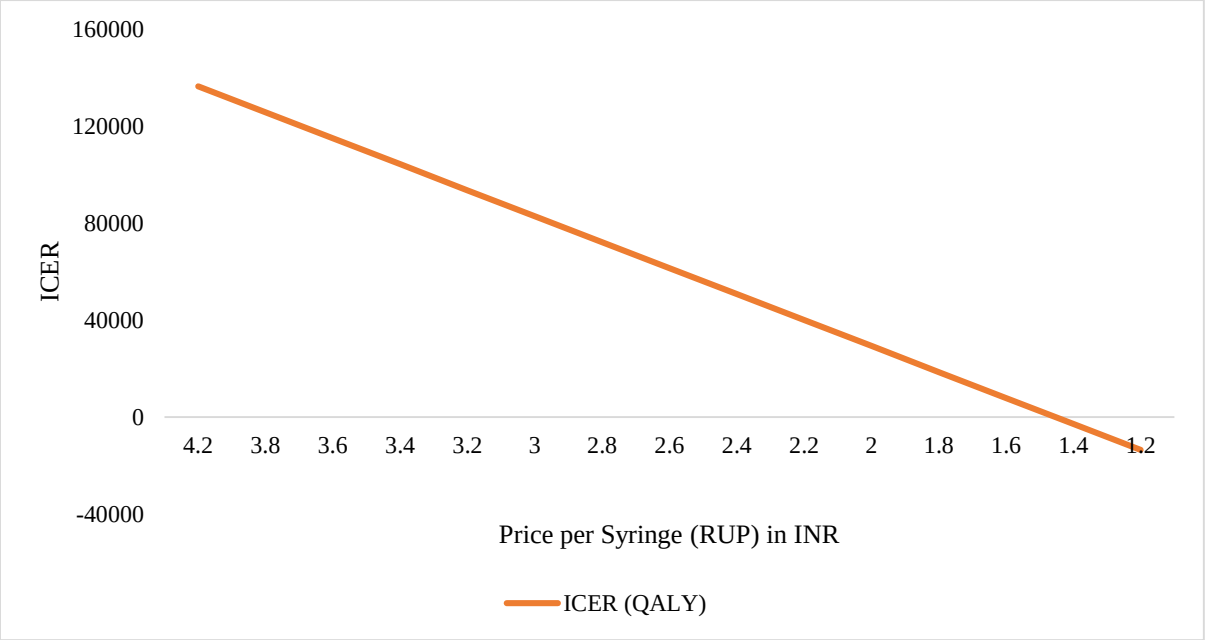


Figure 8: Threshold price analysis for introduction of SIP Syringe in Punjab state, India

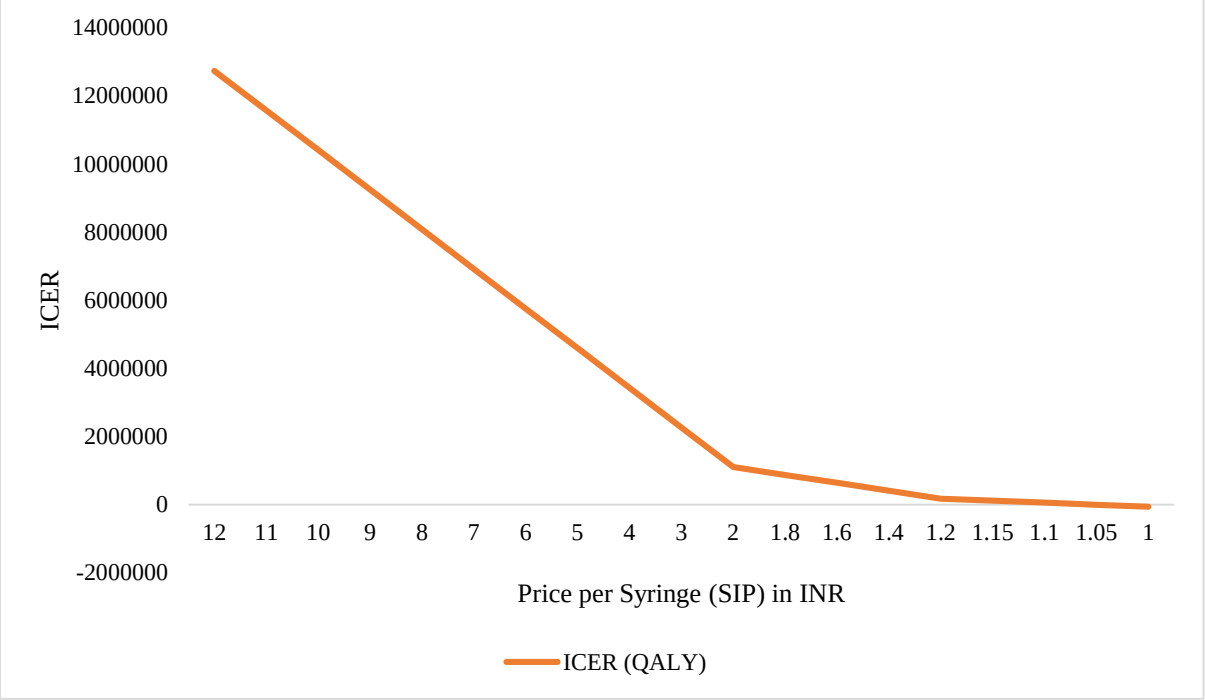
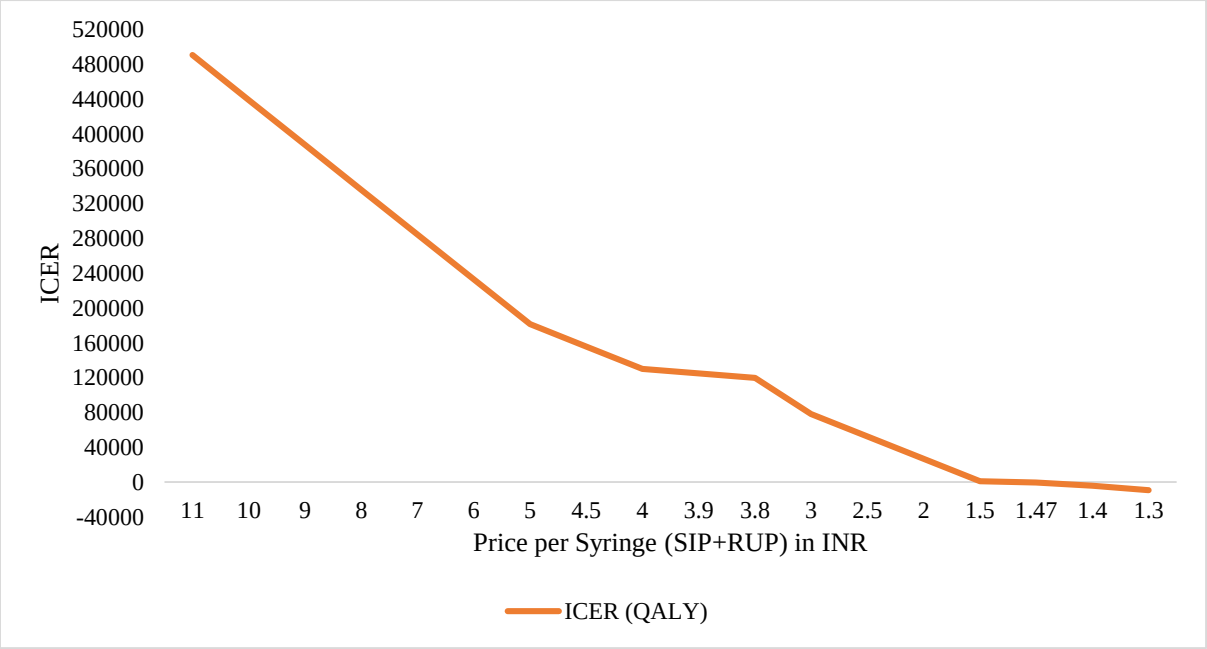


Figure 9: Threshold price analysis for introduction of RUP+SIP Syringe in Punjab state, India



India Scenario

Figure 10: Cost-effectiveness Plane (RUP), India

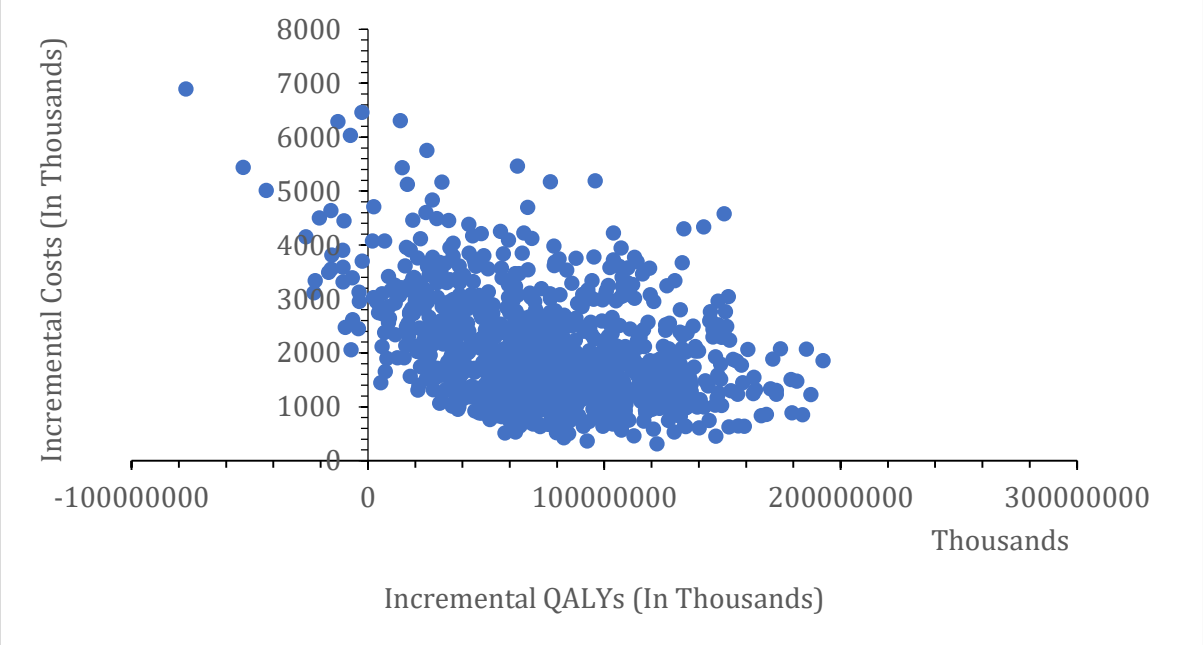


Figure 11: Cost-effectiveness Plane (SIP), India

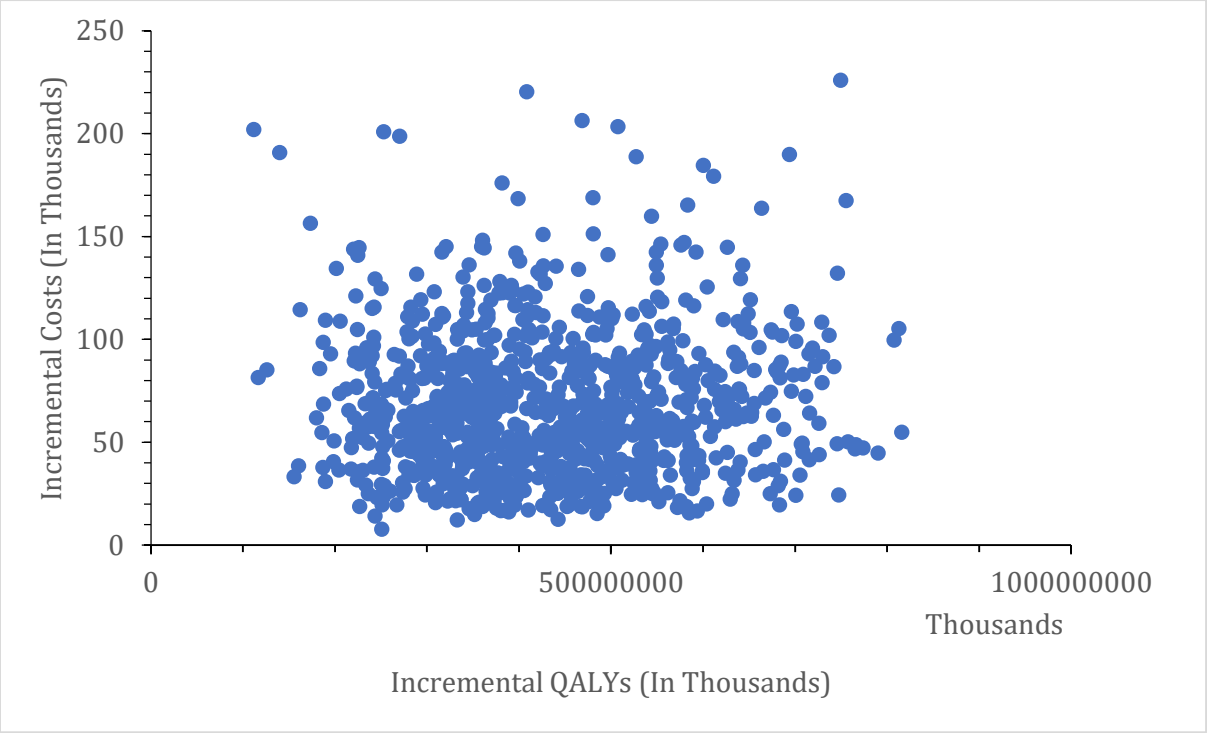


Figure 12: Cost-effectiveness Plane (RUP+SIP), India

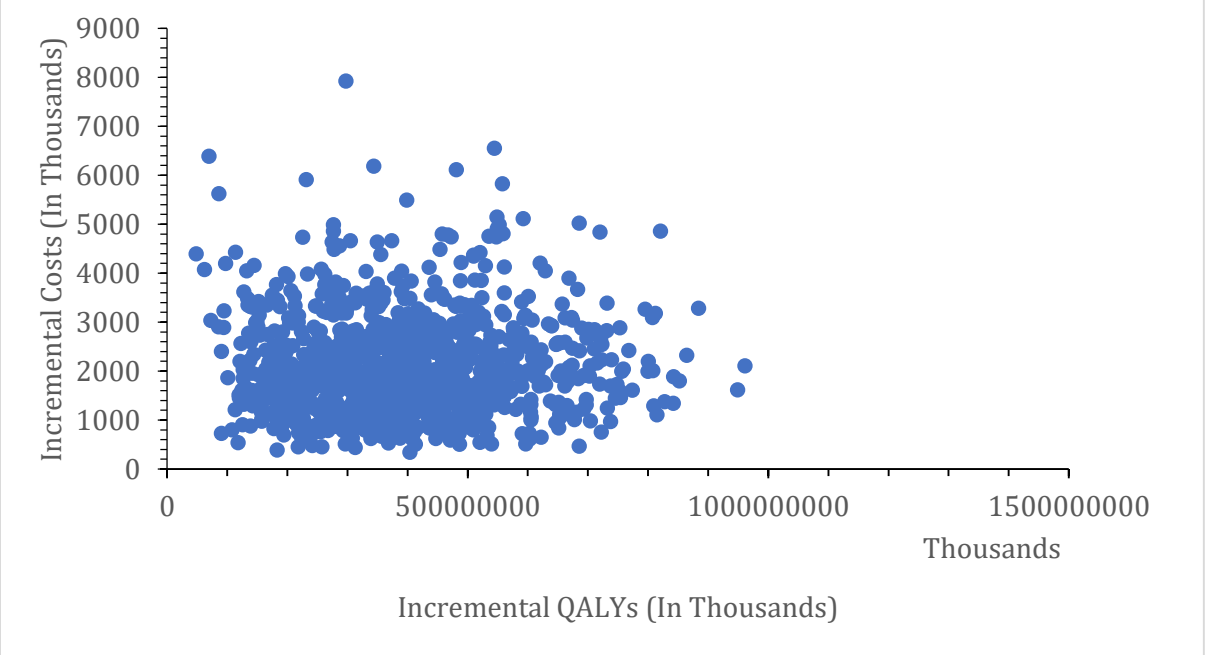


Figure 13: Probability for SIP cost-effectiveness for India at varying willingness to pay thresholds

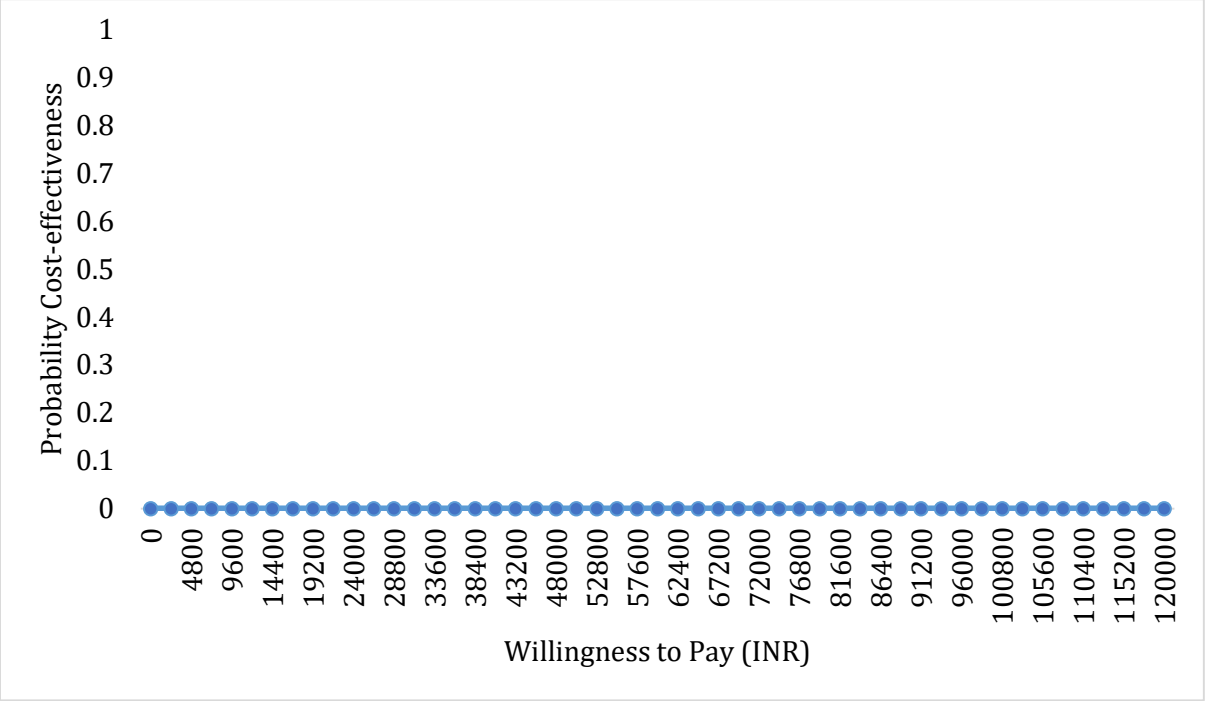


Figure 14: Probability for RUP+SIP cost-effectiveness for India at varying willingness to pay thresholds

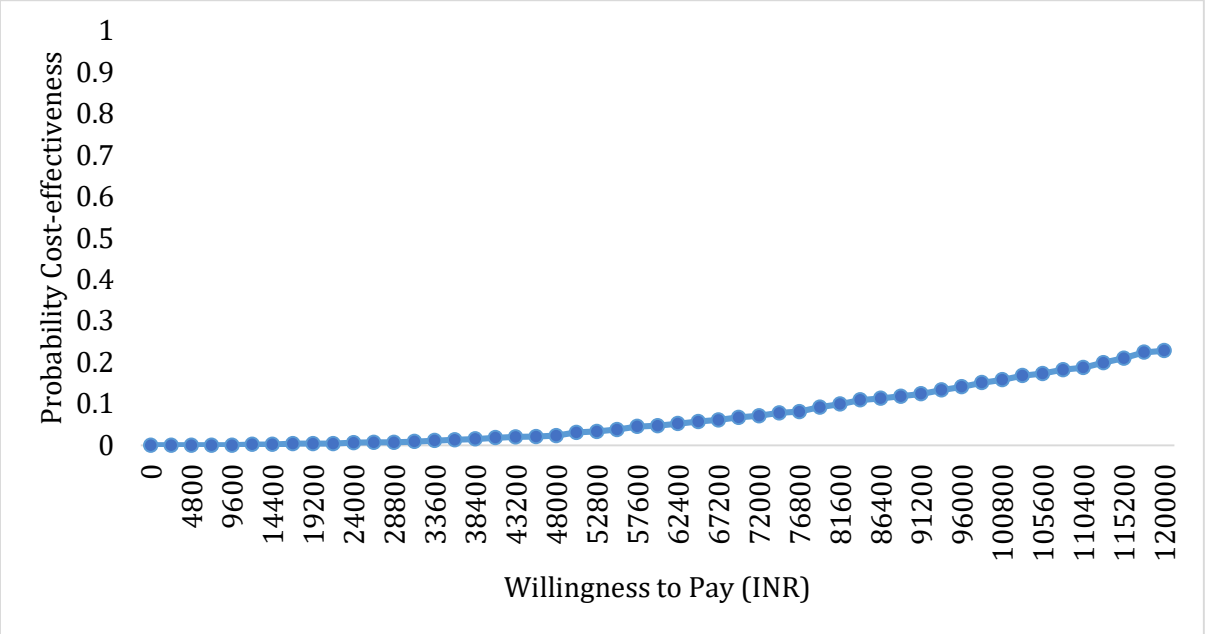


Figure 15: Threshold price analysis for introduction of SIP Syringe in India

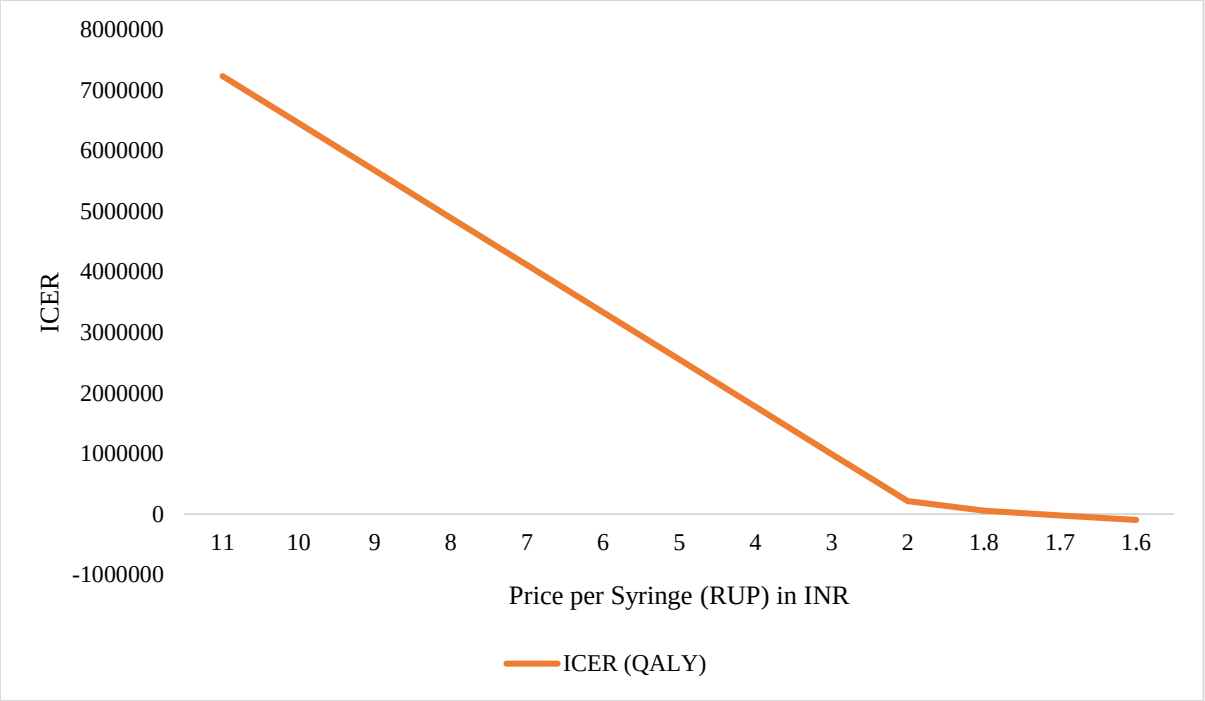
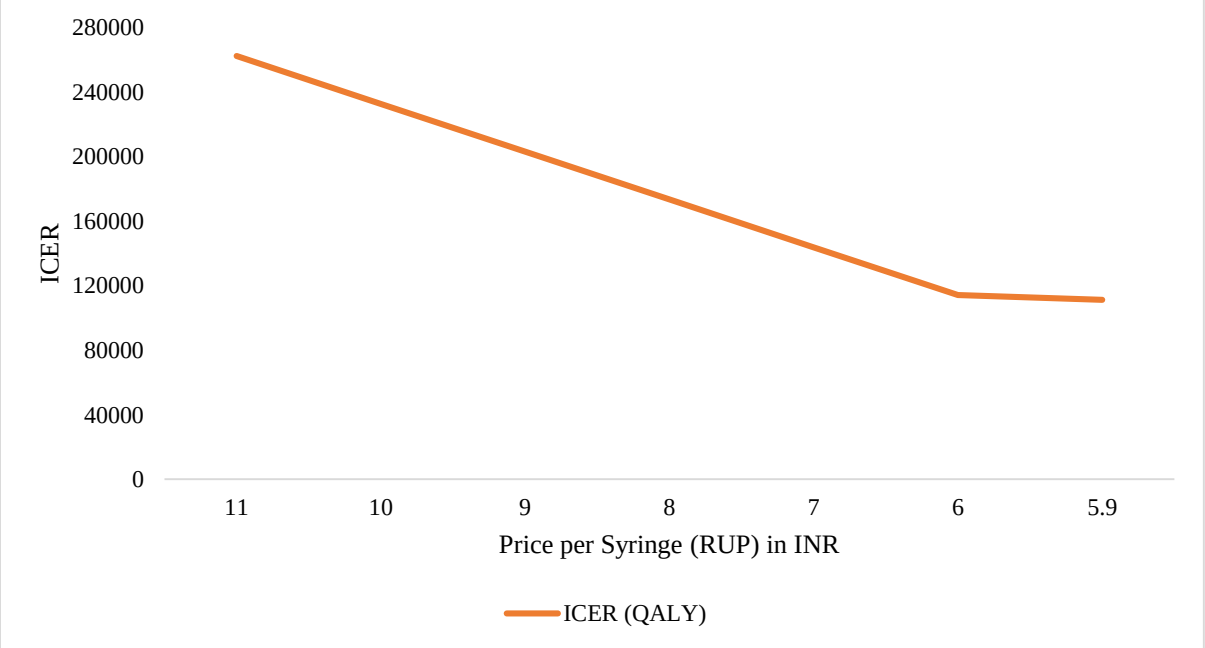


Figure 16: Threshold price analysis for introduction of RUP+SIP Syringe in India



Section C: Systematic review and Meta-analysis

Introduction

An injection is defined as safe, when it does not harm the recipient, its exposure does not put the healthcare worker at risk and its waste does not put the community at risk (66). The injection becomes unsafe if it is used for more than one person that may be because of several reasons such as insufficient volume of syringes, lack of awareness, myth of disease cure only with injection, economic unaffordability and flexibility of using the same syringe for more than one time. Developing countries like India, are facing problem with unsafe use and reuse of syringes. (67, 68) More than 90% of needle stick injuries (NSI) occur in developing countries (69). The lack of safety features such as plunger break or barrel block after single use allows the reuse of syringes and covering of needle with a shield also results in needle stick injuries (NSIs) among healthcare workers (HCWs), patients and waste handlers.

Healthcare workers in India are facing unwanted risk of NSI at their work place. The magnitude of NSI occurrence has been found to be more in doctors (21% to 74%) followed by nursing staff (7.8% to 50%) and waste handlers (1% to 25%).(70-74) Among the different departments, hospital wards (31% to 78%) are more prone for NSI followed by emergency room (5.9% to 20%) and operating rooms (10% to 31%). (70, 72, 74) Risk factors that cause NSI include unsafe procedures, difficult working conditions, unsafe devices {Wicker}, lack of knowledge about NSI and training {Zungu}, lack of attention by HCW, unexpected patient movement, heavy patient load, distraction by the surroundings, constricted workplace and excessive fatigue. (70, 75) The occurrence of NSIs transmits long term and blood borne viral (BBV) infections such as hepatitis B (HBV), hepatitis C (HCV) and human immunodeficiency virus (HIV). Occupational exposure to BBV infections increases the morbidity, work absenteeism and sometimes may higher the mortality among healthcare workers (76). The transmission rate of infection per injury is higher in HBV (30%) than (HCV) (3%) and HIV (0.3%). (77)

In developing countries, a considerable volume of syringes has been used for more than one patient at different levels of healthcare. Anja M Hauri et al. reported reuse of 75% syringes

in South-East Asia Region-D causing blood born infections like HBV (53.6%), HCV (59.5%) and HIV (24.3%).(68)

Several strategies are available to reduce NSI and reuse among HCW. More than 50% of the percutaneous exposure incidents would be reduced by adoption of newer techniques, education and safe work practices for handling needles. World Health Organization (WHO) and National Institute for Occupational Safety and Health (NIOSH) recommended the use of safety engineered syringes (auto-disable (AD), reuse prevention (RUP) and sharp injury prevention (SIP) syringes) for prevention of NSI and reuse of syringes at workplace. (78) (79) A survey also recommended to introduce the safety devices as one of the initiatives to prevent NSI. For each one international dollar spent on introduction of RUP or RUP-SIP could save an estimated 14.57 dollars as treatment and other costs.

In the United States, the Needle stick Safety and Prevention Act was passed in 2000, and the Occupational Safety and Health Administration endorsed the use of safe needles or needleless devices for the collection and/or withdrawal of body fluids and for the administration of fluids and medications. In Europe, the Council Directive 2010/ 32/EU, "Prevention from sharp injuries in the hospital and healthcare sector," fully in force since 2013, protects HCWs from NSIs and their consequences, setting up integrated policies regarding risk assessment, risk prevention, training, education, and monitoring. Among the prevention measures, SEDs must be made available based on risk assessment, whereas HBV vaccination must be universally provided free of charge. Monitoring includes investigating the causes and circumstances of the accident and immediate care for the injured HCW that includes post-exposure prophylaxis (PEP), the necessary medical tests, health surveillance, and counselling wherever appropriate. Additionally, medical treatment is guaranteed. The economic impact of this directive is expected to be significant. (80)

Three systematic reviews have been done to assess the effectiveness of safety engineered devices (SED). The first one is the review published in Cochrane library which included SED for blood collection, injection, containers for collecting sharps, use of multiple safety devices and intravenous systems but this review did not report the results of safe injection needles

in terms of AD, RUP and SIP. Moreover, inclusion criterion was limited to study designs such as randomized-controlled trials (RCTs), controlled before and after studies (CBA) and interrupted time series studies. Potential studies with other study designs were missing (e.g. uncontrolled before and after studies). No clear evidence of reduction in NSI after the introduction of safe injection devices was reported. (81) Second review published by Claire Glenton in 2013 assessed the effects, safety and acceptability of compact, pre-filled, auto-disable injection devices when delivered by lay health workers. They did not include any studies that evaluated AD syringe on the number of NSI. (82) The third review published by Harb et al. evaluated the effect of SES on reduction of NSI and other outcomes. This review included the studies that did not report the separate results for SES so this may not represent the true effectiveness of SES on the reduction of NSI. (Adams and Reddy) This review pooled the studies irrespective of the study designs and an error has been encountered in taking data from primary study which affects the pooled effect estimate.

The government of Punjab is interested in implementing the SES in the state (78). So in order to meet the purpose, we undertook this systematic review that evaluates the effect of SES.

Objective

To assess the effectiveness of safety-engineered syringes on the reduction of needle stick injuries among healthcare workers and reuse of syringes in patients compared to non-safety syringes

Methods

Inclusion criteria

In this review, we included both RCTs and non-randomized studies (NRS) (such as before and after trials, time-series analysis, cohort, case control and quantitative surveys) which assessed the effect of any one of these three safety syringes, such as auto-disable or auto destruct syringes (ISO 7886-3), reuse prevention syringes (ISO 7886-4) and sharp injury

prevention syringes (ISO 23908) when compared to syringes not having safety features (such as disposable, conventional or standard) on the reduction of needle stick injuries (NSI) among healthcare workers and on the reduction in volume of syringe reuse among patients.

Exclusion Criteria

We excluded conference abstracts, letters to the editor, qualitative studies, reviews, case series and case reports. We also excluded studies evaluating blood collection devices (such as lancets, arterial blood syringes), winged steel needles, suture needles, catheters, cannulas, port needles, implantable needles exclusively. Studies were also excluded if both the intervention and comparator have the safety features.

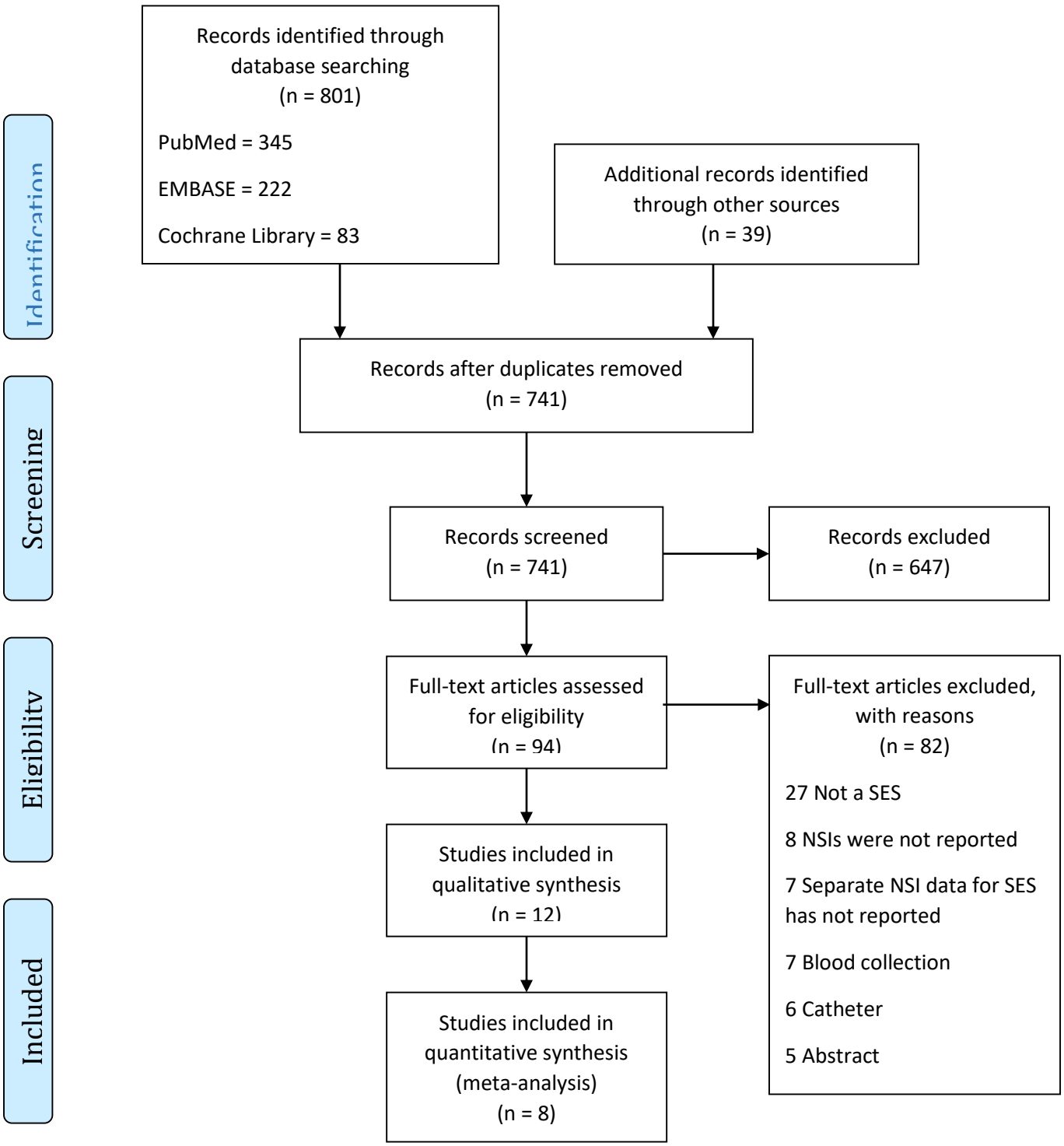
Literature Search

Electronic database searching was done in PubMed, Embase, Cochrane Library, CINAHL and Clinicaltrial.gov. from the inception to August 2017. In addition to these databases, a bibliographic search of included articles of this review, other published systematic reviews and economic evaluation studies was done to locate the additional set of articles. No search filters were applied as we were interested to include studies with different designs. No date or language restrictions were used.

Studies selection

A two-stage PRISMA screening guidelines has been followed to select the potential studies for the review. After removing duplicates, two independent authors screened the titles and abstracts of all citations. The full-text of potentially relevant articles was retrieved for further assessment of the eligibility into the review. After reading the full-text, the articles not meeting the eligibility criteria were excluded with the reasons. Any discrepancies were resolved with the consensus of third reviewer.

Prisma Flow chart



Data Abstraction

A pre-designed data abstraction template was used to abstract the data. Two review authors have abstracted data related to publication details, study design, subject characteristics, intervention details, outcome measurements, results of interested outcomes, funding and conflicts of interest.

Critical Appraisal

Two review authors critically appraised the included studies. The Cochrane risk of bias (ROB) tool was used to appraise RCTs. It consists of seven questions namely random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessor, incomplete outcome data, selective reporting and other bias. Each potential source of bias was judged as high, unclear or low risk of bias.

However, Downs and Black (1998) checklist was used for NRS studies (as recommended by the Cochrane library). It consists of 27 questions with a total score of 32, which comprises of questions related to reporting, external validity, internal validity – bias and internal validity – confounding and power. We judged the reporting bias with yes, partially yes (only for question 5) or no options. Each question of external validity, internal validity – bias and internal validity – confounding was judged as yes, no or unable to determine where as power was judged with six different options.

We have use the following criteria for assessing the risk of bias in non-randomized studies: Failure to develop and apply appropriate eligibility criteria (e.g. under- or overmatching in case–control studies, selection of exposed and unexposed in cohort studies from different populations), flawed measurement of exposure (e.g. differences in measurement of exposure such as recall bias in case-control studies), flawed measurement of outcome (e.g. differential surveillance for outcome in exposed and unexposed in cohort studies, under-reporting of needle stick injuries by HCWs, lack of surveillance), failure to adequately control confounding (e.g. failure of accurate measurement of all known prognostic factors, failure to

match for prognostic factors and/or lack of adjustment in statistical analysis), incomplete follow-up (e.g. incomplete data on needle stick injuries amongst those who used AD, RUP and SIP devices). We graded each potential source of bias into “high risk”, “unclear risk” and “low risk”. Cross-sectional e-mail surveys were appraised using the Joanna Briggs institute critical appraisal checklist which consists of eight questions.

Statistical analysis

Effect estimates for categorical variables was calculated using relative risk (RR) along with 95% confidence intervals. It refers to the risk of NSI in intervention group relative to the risk of NSI in control group.

We assumed that variability in the population, interventions, control and outcome measurements across studies will introduce heterogeneity in findings across those studies. To minimize the heterogeneity, we analyzed the outcomes of auto-disable, reuse prevention and sharp injury prevention syringes separately. A separate analysis for each type of syringe was done based on the denominator used in the included studies such as NSI per device and NSI per HCW. Heterogeneity was measured and been quantified using I statistic and Chi-square test. Random effects model has been employed if it is >50%, otherwise fixed-effects model was used.

Results

Study selection

A detailed flow of studies selection has been depicted in PRISMA flow diagram. A total of 801 citations were retrieved from the five databases and a supplemental search has found 39 potential articles. After removing duplicates, title and abstracts of seven hundred forty-one studies were screened and full-text screening has been done for one hundred and five studies. Out of fifty, a total of eleven studies were included in the systematic review and eight for the meta-analysis.

Study characteristics

Type of studies

Out of the eleven included studies, one is RCT, one is clustered RCT and remaining nine are NRS design with two being controlled before and after studies (83, 84), four uncontrolled before and after studies (one surveillance study (85-88), two cross sectional e-mail surveys (89, 90) and one is cohort study.(91) Three studies were conducted in the USA (85, 89, 90), two were in Australia (87, 88), one each in UK (83), France (91), Spain (84), Pakistan (92), Germany (86), The Netherlands (93).

Out of eleven studies, a total of seven studies exclusively evaluated sharp injury prevention (SIP), one study evaluated auto-disable syringes (92) and one study assessed the syringe with both sharp injury prevention and reuse prevention features (87). In two studies no brand name or syringe name was mentioned. (90, 91)

Three studies did not report the name of specific syringe brand (86, 90, 91). Syringe brand and manufactures were reported for eight studies which are Monoject 3cc safety syringe by Sherwood Medical (85), Safety Plus by Septodont (83), Eclipse by Becton Dickinson (84) (93) and Surshield by Terumo (84), SafetyGlide by Becton Dickinson and SurGuard by Terumo

(89), SoloShot by Becton Dickinson (92), VanishPoint by Retractable Technologies, Inc. (87), Needleguard by Biosafe Products (88)

HCW in eight studies have received education, training or workshop regarding the use of safety engineered syringes and reporting of needle stick injuries (NSIs) to the appropriate department. All studies reported use of standard, non-safety, old or conventional syringes in the control group. The study period to report NSI in RCT is one year. However, in before and after studies, the pre-intervention period ranges from 60 days to 5 years and post intervention period ranges from 60 days to 2 years (83-88), a transition period of two and three months is reported by Michael Whitby 1991 and 2008 respectively. E-mail survey has been reported for one year. Time period of one study has not been reported (92).

All studies reported the effect of safety and non-safety engineered syringes in the reduction of NSI. None of the studies reported the reduction in volume of syringe reuse in the patients.

Five studies have reported their source of funding, which are Sherwood Medical, St.Louis, Missouri (85), Septodont (83), Directorate General of Public Health of the Autonomous Community of Valencia, Spain (84), Dutch Ministry of Social Affairs and Employment (93) The National Institute for Occupational Safety and Health; the Centers for Disease Control and Prevention (90). One study did not receive any funding from other sources (91). The remaining five studies did not report their funding sources (86-89, 92)

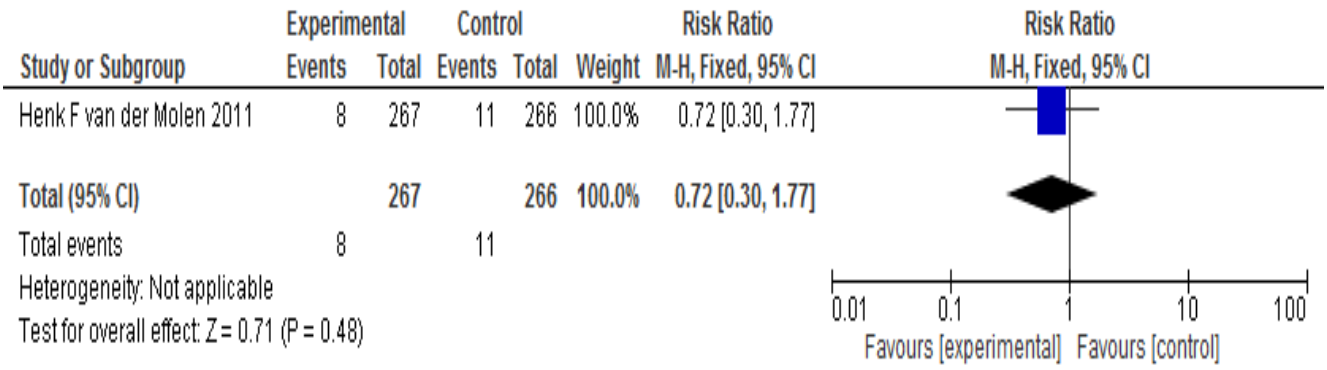
Meta-analysis

Sharp injury prevention syringes:

Included studies reported the number of NSI per device used, number of NSI per HCW involved and number of NSI per hours HCW worked. Studies of varying study designs and of different denominators were pooled separately.

RCT

Outcome: NSI per HCW



One study evaluated the effect of SES on the reduction of NSI, which resulted in a statistically insignificant reduction (relative risk 0.72; 95% 0.30 to 1.77). (93)

Controlled before and after studies

Outcome: NSI per HCW

In controlled before and after study, the risk of needle stick injuries was higher at baseline in the intervention group than in the control group (relative risk 1.80; 95% CI 0.84 to 3.88). Post-intervention, the risk of needle stick injuries became low in intervention group than in the control group (relative risk 0.67; 95% CI 0.19 to 2.35). (83)

Outcome: NSI per hours HCW worked

Number of NSI per number of hours HCW worked for sharp injury prevention: Controlled before and after study

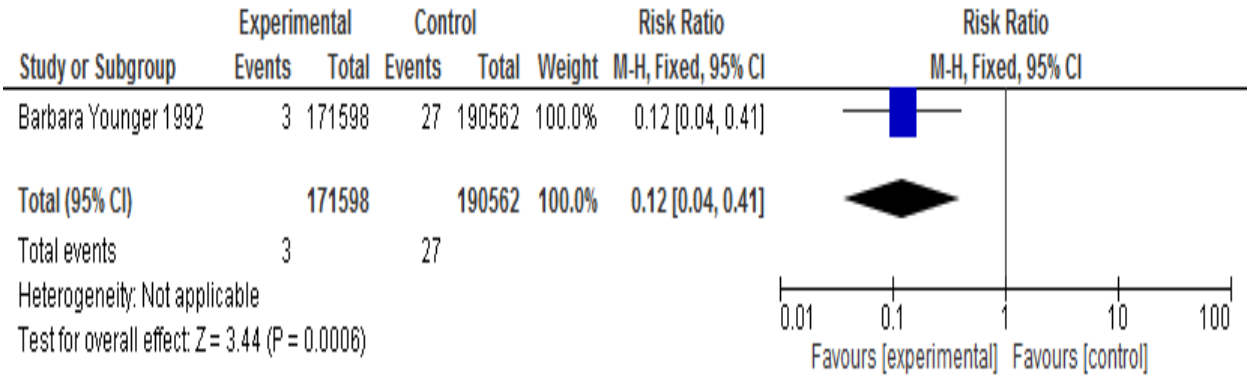
In a CBA study, the rate of NSI per number of hours healthcare worker worked was lower in the intervention group at baseline than in the control (rate ratio 0.42; 95% CI 0.28 to 0.63).

The rate of NSI remained lower in the intervention group after the introduction of safety syringe (rate ratio 0.17; 95% CI 0.08 to 0.38). (83)

Uncontrolled before and after study

Outcome: NSI per device

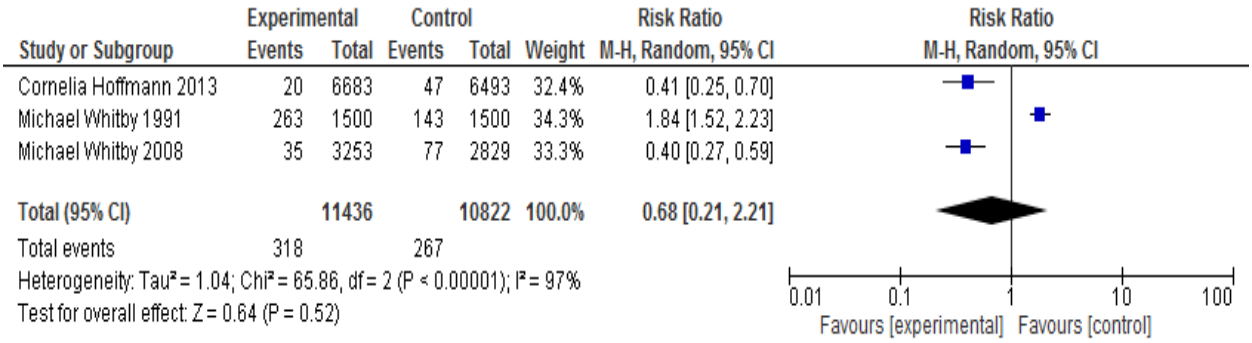
Number of NSI per device for sharp injury prevention: Uncontrolled before and after studies



In one study there was a statistically significant decrease in injuries after the introduction of safety engineered syringes (SES) (relative risk 0.12; 95% CI 0.04 to 0.41) (85)

Outcome: NSI per HCW

Number of NSI per HCW for sharp injury prevention: Uncontrolled before and after study

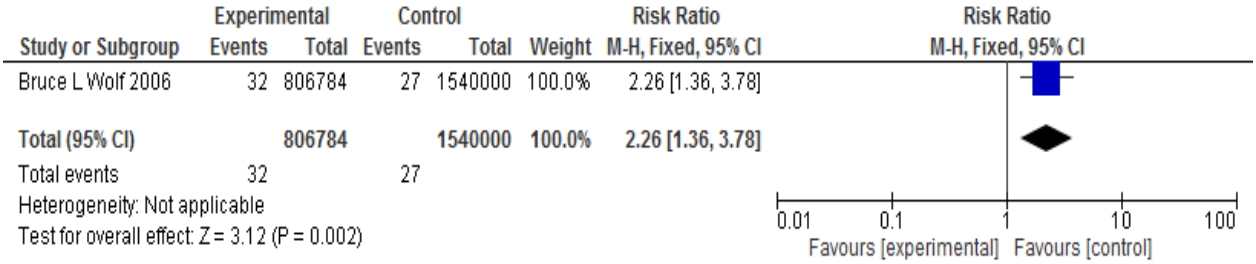


Three studies assessed the effect of three different SES, which resulted in a statistically insignificant reduction in injuries compared with the non-safety syringes (relative risk 0.68; 95% CI 0.21 to 2.21). A random effects model has been employed to deal with the heterogeneity (I^2 = 97%). (86-88)

Cross-sectional e-mail survey

Outcome: NSI per injection

Number of NSI per injection for sharp injury prevention: Survey

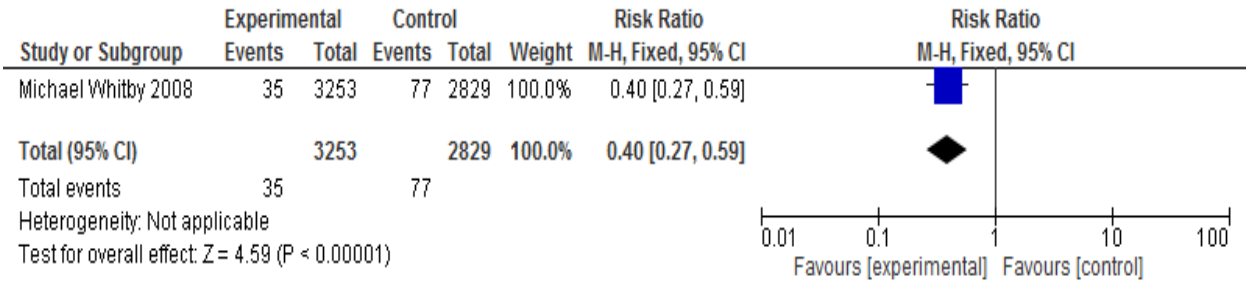


One study evaluated the effect of safety syringes compared to non-safety syringes and found statistically significant increase in injuries with safety syringes compared with the non-safety syringes (relative risk 2.26; 95% CI 1.36 to 3.78). (89)

Reuse prevention syringes

Outcome: NSI per HCW

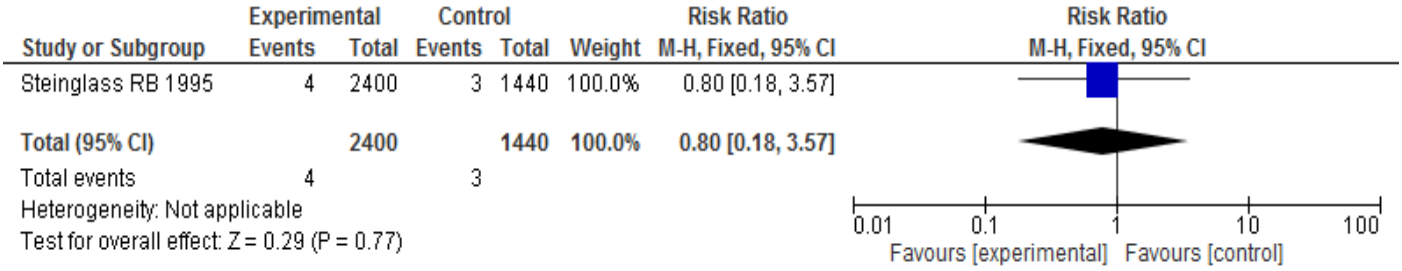
Number of NSI per HCW for reuse prevention: Before and after study



In an uncontrolled before and after study, a statistically significant reduction in injuries has been found after the introduction of SES (relative risk 0.40; 95% CI 0.27 to 0.59). (87)

Auto-disable syringe

Number of NSI per syringe for auto-disable: Before and after study



One study found a statistically insignificant reduction in injuries after the introduction of SES with a relative risk of 0.80 and 95% CI 0.18 to 3.57. (92)

Subgroup analysis

We planned to conduct a subgroup analysis to explain the reasons for heterogeneity, but we were unable to conduct because of a relatively small number of studies.

Discussion

Summary of findings from the current review:

This review included a total of eleven studies. The introduction of safety syringes with sharp injury prevention feature did not significantly reduce the NSI rate in one RCT, one CBA and in a pooled uncontrolled before and after trial. A significant reduction in NSI rate was reported with one uncontrolled before and after study. In one study conducted through e-mail survey, safety syringes did not show any effect on NSI rate. Introduction of syringes with reuse prevention feature in an uncontrolled before and after study reported a statistically significant reduction in needle stick injuries. A study conducted with auto-disable syringes did not result in a significant reduction in needle stick injuries compared with conventional syringes. Six studies reported the needle stick injury rate per healthcare worker, four studies per device used (84, 85, 89, 91), one study per number of injections used (92) and one study (90) did not report the denominator. No study assessed the effect of safety syringes on reduction in the volume of syringe reuse among patients.

A decrease in the occurrence of NSI was reported with SIP in all studies (85) (93). A similar trend with statistically insignificant reduction was reported with AD syringes (92).

Several systematic reviews are available which assessed the effect of SES. One of those is a Cochrane review which included four studies assessing the effect of safe injections. Out of those, three studies met our eligibility criteria. (83, 84, 93) One study did not report the separate data on effect of safety syringes on the rate of needle stick injuries. The generated evidence about the introduction of safety syringes is inconsistent and unclear. Another review assessed the effect of compact pre-filled auto-disable injection devices on risk reduction of NSI when delivered by lay health workers. This review did not include studies related to the effect of safety-engineered syringes on the rate of reduction of NSIs. Recently, Harb et al. published a systematic review and meta-analysis on safety syringes which included nine studies. Studies that did not provide the separate data on the effect of safety

engineered syringes on the reduction in the rate of NSI were also included. Studies were pooled irrespective of the study designs.

Strengths and limitations

Databases like PubMed, Embase, Cochrane library, CINAHL and Clinicaltrial.gov were searched, among these one was meant for nurse's studies (CINAHL). The electronic search was supplemented by screening the bibliography of published systematic reviews and economic evaluation studies to maximize the possibility of finding most of the available studies. No search filters were employed. Even though some studies have assessed the effect of safety syringes along with other safety devices, we included the studies which reported the separate NSI data for safety syringes only to find out the true effect.

Our review has some limitations. No efforts were made to search the grey literature, inadvertently some of the relevant unpublished studies might have missed in our review. We excluded the studies that have not reported separate NSI data for SES (Adams and Reddy G). This review excluded one study because of unavailability of full-text (Duesman). An effort has been made by the librarians to find out the full-text, but is not available. In one study, the NSI data for control group was not reported separately, so the mail was sent to the author (Victoria Valls). No study in this review assessed the second outcome measure i.e. reuse of syringes.

Floret et al. study is not quantitatively pooled because the information on the type of syringe is not available even after sending request to the author. In almost every type of HCF, percutaneous BBFE incidence rate per 100 beds has decreased significantly among the stable cohort 2008–12 (Table 1). However, this decrease reached statistical significance only in teaching, general public, and private hospitals.

Policy implications

The needle that was used in patient with any BBV infection may acts as a vector to transmit the disease to other patient (if it is reused) and it may transmit the disease to other HCW (if a NSI occurs). So introduction of SES reduces both the NSI and reuse as shown in our review findings.

References

1. Safe Injection Global Netwok Advocacy Booklet. World Health Organization. 2011.
2. Handbook on Safe Injection Practices In: Control NCFD, editor. New Delhi: GOI; 2014.
3. Arora N. Injection practices in India. WHO South-East Asia Journal of Public Health. 2012;1(2):189-200.
4. WHO. WHO Guideline on the Use of Safety-Engineered Syringes for Intramuscular, Intradermal and Subcutaneous Injections in Health Care Settings. In: Organization WH, editor. Geneva2016.
5. Solberg KE. Trade in medical waste causes deaths in India. The Lancet. 2009;373(9669):1067.
6. GoI. National Health Policy- 2017. Ministry of Health and Family Welfare. Government of India. 2017.
7. MOHFW. National Health Accounts: Estimates for India 2013-14. National Health Accounts Technical Secretariat (NHATS). National Health Systems Resource Centre (NHSRC). Ministry of Health and Family Welfare (MoHFW). Government of India. New Delhi2016.
8. Prinja S, Bahuguna P, Duseja A, Kaur M, Chawla YK. Cost of Intensive Care Treatment for Liver Disorders at Tertiary Care Level in India. PharmacoEconomics - Open. 2017.
9. Prinja S, Kanavos P, Kumar R. Health care inequities in north India: Role of public sector in universalizing health care. Indian Jounal Med Res. 2012:421-31.
10. Prinja S, Kumar M, Pinto A, Jan S, Kumar R. Equity in Hospital Services Utilization in India. Economic and Political Weekly. 2013;XLVIII(2):52-8.
11. Harb AC, Tarabay R, Diab B, Ballout RA, Khamassi S, Akl EA. Safety engineered injection devices for intramuscular, subcutaneous and intradermal injections in healthcare delivery settings: a systematic review and meta-analysis. BMC Nursing. 2015;14(1):71.
12. Reid S. Estimating the Burden of Disease from Unsafe Injections in India: A Cost–benefit Assessment of the Auto-disable Syringe in a Country with Low Blood-borne Virus Prevalence. Indian Journal of Community Medicine : Official Publication of Indian Association of Preventive & Social Medicine. 2012;37(2):89-94.
13. Prinja S, Downey L, Gauba3, Swaminathan S. Health Technology Assessment for Policy Making in India: Current Scenario and Way Forward. PharmacoEconomics Open. 2017.
14. Saoji A, Kantibhushan C, Aniruddha D, Mudey A. Injection Safety Awareness and Knowledge in a Rural Population. Global Journal of Health Science. 2011;3(1).
15. The Economic Times: Forex Rates. Available at: http://economictimes.indiatimes.com/markets/forex. 2017.
16. GoI. Key Indicators of Social Consumption in India Health. NSS 71st Round. Ministry of Statistics and Program Implementation. Government of India. Jan-Jun, 2014.
17. India HIV Estimation Report (Strategic Information Management System 2015-16). In: Organization NAC, editor.: NACO; 2015.
18. National Sample Survey Office. Health in India- NSS 71st Round [Internet]. New Delhi: National Sample Survey Office, Ministry of Statistics and Programme Implementation; Available from: http://mospi.nic.in/sites/default/files/publication_reports/nss_rep574.pdf 2014 [cited August 2017 Accessed 20].
19. Prinja S, Balasubramanian D, Jeet G, Verma R, Kumar D, Bahuguna P, et al. Cost of Delivering Secondary Level Health Care Services through Public Sector District Hospitals in India. Indian J Med Res (Forthcoming). 2017.

20. Prinja S, Gupta A, Verma R, Bahuguna P, Kumar D, Kaur M, et al. Cost of Delivering Health Care Services in Public Sector Primary and Community Health Centres in North India. . PLoS ONE. 2016;11(8):e0160986. doi:10.1371/journal.pone.
21. Chatterjee S, Levin C, Laxminarayan R. Unit Cost of Medical Services at Different Hospitals in India. PloS One. 2013;8(7):e69728.
22. Mukh Mantri Punjab Hepatitis C Relief Fund In: Department Of Health And Family Welfare P, editor. Ist ed2016.
23. Punjab State Health Department. In: Department PH, editor. Parivar Kalyan Bhawan office, Chandigarh2017.
24. Trading Economics. Availabe at: http://www.tradingeconomics.com/india/gdp-deflator. Accessed on 15, January, 2018.
25. Hazarika I. Health workforce in India: assessment of availability, production and distribution. WHO South-East Asia Journal of Public Health. 2013;2(2):106.
26. Rehan HS, Chopra D, Sah RK, Chawla T, Agarwal A, Sharma GK. Injection practices of healthcare professionals in a Tertiary Care Hospital. Journal of Infection and Public Health. 2012;5(2):177-81.
27. Kermode M, Muani V. Injection practices in the formal & informal healthcare sectors in rural north India. The Indian journal of medical research. 2006;124(5):513-20.
28. Garapati S, Peethala S. Assessment of knowledge and practices on injection safety among service providers in east Godavari district of Andhra Pradesh. Ind J Comm Health. 2014;26(3):259-63.
29. Sahu D, Gandhi N. Assessment of Safe Injection Practices in a Tertiary Care Hospital: A Cross-Sectional Study from Chhattisgarh. Ntl J of Community Med. 2015;6(4):500-3.
30. Pandit DP. Prevalence of Antibodies to Hepatitis C Virus in Voluntary Blood Donors: Are Women Better Donors? JOURNAL OF CLINICAL AND DIAGNOSTIC RESEARCH. 2014.
31. Sood S, Malvankar S. Seroprevalence of Hepatitis B surface antigen, antibodies to the Hepatitis C virus, and human immunodeficiency virus in a hospital-based population in Jaipur, Rajasthan. Indian Journal of Community Medicine. 2010;35(1):165.
32. Laghawe A, Faujdar S. Declining Trends in HIV Prevalence: A Tertiary Care Hospital Based 05 Years Retrospective Analysis. IntJCurrMicrobiolAppSci 2015;4(6):927-36.
33. Goel V, Kumar D, Patwardhan V, Balooni V, Singhal S, Singh S. Trends of Seroprevalence, Epidemiology and Clinical Presentation of HIV in North India: A Tertiary Care Hospital Based Study. World Journal of AIDS. 2016;06(02):54-8.
34. WHO. Guidelines for the Management of Occupational Exposures to HBV, HCV, and HIV and Recommendations for Postexposure Prophylaxis. World Health Organization.
35. Registrar General & Census Commissioner of India. SRS life tables 2011-2015. http://www.censusindia.gov.in/Vital_Statistics/SRS_Life_Table/Srs_life_Table_2011-15.html [Accessed 20 August 2017].
36. Sikora C, Chandran AU, Joffe AM, Johnson D, Johnson M. Population Risk of Syringe Reuse: Estimating the Probability of Transmitting Bloodborne Disease. Infection Control & Hospital Epidemiology. 2010;31(07):748-54.
37. Prinja S, Bahuguna P, Rudra S, Gupta I, Kaur M, Mehendale SM, et al. Cost effectiveness of targeted HIV prevention interventions for female sex workers in India. Sexually transmitted infections. 2011;87(4):354-61.
38. Weinstein M, Grahan J, Siegel J, al. e. Cost-effectiveness analysis of AIDS prevention programs: concepts, complications and illustrations. In: Turner C, Miller H, Moses L, eds. AIDS: sexual behaviour and intravenous drug use. Washington, DC: National Academy Press, 1989.

39. Alazawi W, Cunningham M, Dearden J, Foster G. Systematic review: outcome of compensated cirrhosis due to chronic hepatitis C infection. Aliment Pharmacol Ther. 2010;32:344-55.
40. Alberti A, Chemello L, Benvegnù L. Natural history of hepa- titis C. J Hepatol. 1999;31(1):17-24.
41. Aleman S, Rahbin N, Weiland O, Davidsdottir L, Hedenstierna M, Rose N, et al. A risk for hepatocellular carcinoma persists long-term after sustained virologic response in patients with hepatitis C-associated liver cirrhosis. Clin Infect Dis. 2013;57:230-6.
42. Bialek SR, Terrault NA. The Changing Epidemiology and Natural History of Hepatitis C Virus Infection. Clinics in Liver Disease. 2006;10(4):697-715.
43. Bruno S, Zuin M, Crosignani A, Rossi S, Zadra F, Rof L, et al. Predicting mortality risk in patients with compensated HCV-induced cirrhosis: a long-term prospective study. Am J Gastroenterol 2009;104:1147-58.
44. Chen S, Morgan T. The Natural History of Hepatitis C Virus (HCV) Infection. International Journal of Medical Sciences. 2006;3(2):47-52.
45. Degos F, Christidis C, Ganne-Carrie N, Farmachidi J, Degott C, Guettier C, et al. Hepatitis C virus related cirrhosis: time to occurrence of hepatocellular carcinoma and death Gut. 2000;47:131-6.
46. Fattovich G, Bortolotti F, Donato F. Natural history of chronic hepatitis B: special emphasis on disease progression and prognostic factors. J Hepatol. 2008;48(2):335-52.
47. Gramenzi A, Andreone P, Fiorino S, Cammà C, Giunta M, Magalotti D, et al. Impact of interferon therapy on the natural history of hepatitis C virus related cirrhosis. Gut. 2001;48:843-8.
48. Kobayashi M, Ikeda K, Hosaka T, Sezaki H, Someya T, Akuta N, et al. Natural history of compensated cirrhosis in the Child-Pugh class A compared between 490 patients with hepatitis C and 167 with B virus infections. J Med Virol. 2006;78:459-65.
49. Levy AR, Kowdley KV, Iloeje U, Tafesse E, Mukherjee J, Gish R, et al. The Impact of Chronic Hepatitis B on Quality of Life: A Multinational Study of Utilities from Infected and Uninfected Persons. Value in Health. 2008;11(3):527-38.
50. Simpson KN, Luo MP, Chumney E, Sun E, Brun S, Ashraf T. Cost-Effectiveness of Lopinavir/Ritonavir Versus Nelfinavir As the First-Line Highly Active Antiretroviral Therapy Regimen for HIV Infection. HIV Clinical Trials. 2004;5(5):294-304.
51. Wright M, Grieve R, Roberts J, Main J, Thomas H. Health benefits of antiviral therapy for mild chronic hepatitis C: randomised controlled trial and economic evaluation. Health Technology Assessment. 2006;10(21).
52. Andronis L, Barton P, Bryan S. Sensitivity analysis in economic evaluation: an audit of NICE current practice and review of its use and value in decision-making. Health Technol Assess. 2009;13(29).
53. Briggs A. Handling uncertainty in cost-effectiveness models. Pharmacoeconomics. 2000;17:479-500.
54. Briggs A, Claxton K, Schulpher M. Decision modelling for health economic evaluation. Oxford: Ocfors University Press. 2006.
55. Briggs A, Gray A. Handling uncertainty when performing economic evaluation of healthcare interventions. Health Technol Assess. 1999;3(2):iii-72.
56. US Department of Labor, Occupational Safety and Health Administration. Occupational exposure to bloodborne pathogens; needlestick and other sharps injuries: final rule. Federal Register 66. Washington, DC: Department of Labor, Occupational Safety and Health Administration; 2001.
57. Council of the European Union. Council Directive 2010/32/EU of 10 May 2010 implementing the Framework Agreement on prevention from sharp injuries in the hospital and healthcare sector concluded by HOSPEEM and EPSU. Off J Eur Union 2010;L134:66e72.

58. Chambers A, Mustard C, Etches J. Trends in needlestick injury incidence following regulatory change in Ontario, Canada (2004–2012): an observational study. BMC Health Services Research. 2015;15(1).
59. Japan Ministry of Health, Labour and Welfare. Points of attention for hospital-acquired infection control in healthcare institutions. Guidance of Medical Service Division, Health Policy Bureau Notification No. 0617-1 (June 17, 2011). Available at: http://www.mhlw.go.jp/topics/2012/01/dl/tp0118-1-76.pdf).
60. Department of Health, The Government of South Africa. https://www.westerncape.gov.za/general-publication/immunisation-safe.
61. Cooke C, Stephens J. Clinical, economic, and humanistic burden of needlestick injuries in healthcare workers. Medical Devices: Evidence and Research. 2017;10:225-35.
62. Fukuda H, Moriwaki K. Cost-Effectiveness Analysis of Safety-Engineered Devices. Infection Control & Hospital Epidemiology. 2016;37(09):1012-21.
63. Hanmore E, Maclaine G, Garin F, Alonso A, Leroy N, Ruff L. Economic benefits of safety-engineered sharp devices in Belgium - a budget impact model. BMC Health Services Research. 2013;13(1).
64. Dziekan G, Chisholm D, Johns B, Rovira J, Hutin Y. The cost-effectiveness of policies for the safe and appropriate use of injection in healthcare settings. Bull World Health Organ. 2003;81:277-85.
65. Glenngård AH, Persson U. Costs associated with sharps injuries in the Swedish health care setting and potential cost savings from needle-stick prevention devices with needle and syringe. Scandinavian Journal of Infectious Diseases. 2009;41(4):296-302.
66. Group IS. Injection practices in India. WHO South-East Asia Journal of Public Health 2012;1(2):189-200.
67. Simonsen L, Kane A, Lloyd J, Zaffran M, Kane M. Unsafe injections in the developing world and transmission of bloodborne pathogens: a review. Bull World Health Organ. 1999;77(10):789-800.
68. Hauri AM, Armstrong GL, Hutin YJF. The global burden of disease attributable to contaminated injections given in health care settings. International Journal of STD & AIDS. 2004;15(1):7-16.
69. (WHO) WHO. Safe Injection Global Network, Health Care Worker Safety, Aide-Memoire for a Strategy to Protect Health Care Workers from infection from blood borne virus. 2003;WHO/BCT/03.11.
70. K.P P. Epidemiology of Needle-Stick Injuries in Mangalore. Journal of Evolution of Medical and Dental Sciences. 2012;1(3):128-36.
71. Sharma A, Bhalla P, Gur R. Study on prevalence of needle stick injury among health care workers in a tertiary care hospital in New Delhi: A two-year review. Indian Journal of Public Health. 2012;56(1):101.
72. Jaybhaye D, Dahire P, Nagaonkar A, Vedpathak V, Deo D, Kawalkar U. Needle stick injuries among health care workers in tertiary care hospital in tertiary care hospital of rural India. International Journal of Medical Science and Public Health. 2014;3(1):49.
73. Chakravarthy M, Rangaswamy S, Harivelam C, Pargaonkar S, Hosur R, Pushparaj L, et al. Cost of postexposure management of occupational sharp injuries in an Indian tertiary health care facility: A prospective observational study in a tertiary care hospital. The Journal of National Accreditation Board for Hospitals & Healthcare Providers. 2015;2(2):47.
74. Malhotra S, Sharma S, Bhatia NJK, Hans C. Needle-stick injury among health care workers and its response in a tertiary care hospital. Indian Journal of Medical Microbiology. 2016;34(2):258.

75. Dulon M, Lisiak B, Wendeler D, Nienhaus A. Causes of needlestick injuries in three healthcare settings: analysis of accident notifications registered six months after the implementation of EU Directive 2010/32/EU in Germany. Journal of Hospital Infection. 2017;95(3):306-11.
76. Fisman DN, Mittleman MA, Sorock GS, Harris AD. Willingness to pay to avoid sharps-related injuries: A study in injured health care workers. American Journal of Infection Control. 2002;30(5):283-7.
77. Elmiyeh B, Whitaker IS, James MJ, Chahal CAA, Galea A, Alshafi K. Needle-stick injuries in the National Health Service: a culture of silence. JRSM. 2004;97(7):326-7.
78. Asia WS-E. india Injection Safety Implementation project 2016-2018 2016:17.
79. Cutlip K. Preventing needlestick injuries in healthcare settings. Hosp Top. 2000;78(1):5-9.
80. Mannocci A, De Carli G, Di Bari V, Saulle R, Unim B, Nicolotti N, et al. How Much do Needlestick Injuries Cost? A Systematic Review of the Economic Evaluations of Needlestick and Sharps Injuries Among Healthcare Personnel. Infection control and hospital epidemiology. 2016;37(6):635-46.
81. Lavoie M-C, Verbeek JH, Pahwa M. Devices for preventing percutaneous exposure injuries caused by needles in healthcare personnel. Cochrane Database of Systematic Reviews: John Wiley & Sons, Ltd; 2014.
82. Glenton C, Khanna R, Morgan C, Nilsen ES. The effects, safety and acceptability of compact, pre-filled, autodisable injection devices when delivered by lay health workers. Tropical Medicine & International Health. 2013;18(8):1002-16.
83. Zakrzewska J, Greenwood I, Jackson J. Introducing safety syringes into a UK dental school – a controlled study. British Dental Journal. 2001;190(2):88-92.
84. Valls V, Lozano MS, Yánez R, Martínez MJ, Pascual F, Lloret J, et al. Use of Safety Devices and the Prevention of Percutaneous Injuries Among Healthcare Workers. Infection Control & Hospital Epidemiology. 2007;28(12):1352-60.
85. Younger B, Hunt EH, Robinson C, McLemore C. Impact of a Shielded Safety Syringe on Needlestick Injuries among Healthcare Workers. Infection control and hospital epidemiology. 1992;13(6):349-53.
86. Hoffmann C, Buchholz L, Schnitzler P. Reduction of needlestick injuries in healthcare personnel at a university hospital using safety devices. Journal of Occupational Medicine and Toxicology. 2013;8(1):20.
87. Whitby M, McLaws M-L, Slater K. Needlestick injuries in a major teaching hospital: The worthwhile effect of hospital-wide replacement of conventional hollow-bore needles. American Journal of Infection Control. 2008;36(3):180-6.
88. Whitby M, Stead P, Najman JM. Needlestick Injury: Impact of a Recapping Device and an Associated Education Program. Infection control and hospital epidemiology. 1991;12(4):220-5.
89. Wolf BL, Marks A, Fahrenholz JM. Accidental needle sticks, the Occupational Safety and Health Administration, and the fallacy of public policy. Annals of Allergy, Asthma & Immunology. 2006;97(1):52-4.
90. Leiss JK, Sousa S, Boal WL. Circumstances Surrounding Occupational Blood Exposure Events in the National Study to Prevent Blood Exposure in Paramedics. Industrial Health. 2009;47(2):139-44.
91. Floret N, Ali-Brandmeyer O, L'Hériteau F, Bervas C, Barquins-Guichard S, Pelissier G, et al. Sharp Decrease of Reported Occupational Blood and Body Fluid Exposures in French Hospitals, 2003–2012: Results of the French National Network Survey, AES-RAISIN. Infection Control & Hospital Epidemiology. 2015;36(08):963-8.

92. Steinglass R, Boyd D, Grabowsky M, Laghari AG, Khan MA, Qavi A, et al. Safety, effectiveness and ease of use of a non-reusable syringe in a developing country immunization programme. Bull World Health Organ. 1995;73(1):57-63.
93. van der Molen HF, Zwinderman KAH, Sluiter JK, Frings-Dresen MHW. Better effect of the use of a needle safety device in combination with an interactive workshop to prevent needle stick injuries. Safety Science. 2011;49(8-9):1180-6.

Mesh terms and Search strategy used for systematic review

01 PubMed

Population

Healthcare workers

Healthcare worker

Healthcare worker*[TIAB]

Healthcare professionals

Healthcare professional*[TIAB]

Healthcare provider

Healthcare providers

Healthcare provider*[TIAB]

Health Personnel

Health Personnel[MH]

Hospital Personnel

Physician

Physicians

Physicians[TIAB]

Physician[TIAB]

Physicians[MH]

Doctors

Doctor

Doctor*[TIAB]

Nurse

Nurse*[MH]

Nurses

Nurses[TIAB]

Nurse[TIAB]

Hospital workers

Injection provider

Injection providers

Search Strategy

((((((((((((((((((((((((((Healthcare workers) OR Healthcare worker) OR Healthcare worker*[TIAB]) OR Healthcare professionals) OR Healthcare professional*[TIAB]) OR Healthcare provider) OR Healthcare providers) OR Healthcare provider*[TIAB]) OR Health Personnel) OR Health Personnel[MH]) OR Hospital Personnel) OR Physician) OR Physicians) OR Physicians[TIAB]) OR Physician[TIAB]) OR Physicians[MH]) OR Doctors) OR Doctor) OR Doctor*[TIAB]) OR Nurse) OR Nurse*[MH]) OR Nurses) OR Nurses[TIAB]) OR Nurse[TIAB]) OR Hospital workers) OR Injection provider) OR Injection providers **1282461** on **03/08/2017**

Intervention

Auto?disable

auto? disabled

Auto?destruct

Reuse prevention

Sharp injury prevention

Safety engineered device*

Safety engineered device

Safety engineered device*[TIAB]

Protective Devices

Protective Device*[TIAB]

Protective Devices[MH]

Safety Device

Equipment Safety

Equipment Safety[MH]

SEDs

Safety AND (syringe OR needle OR device)

Engineered AND (syringe OR needle OR device)

Safety engineered syringe

Safety engineered syringe[TIAB]

Safety engineered syringe*SESs

Safety syringe

Safety needle

Safe injection practice

Safe injection practic*

Safety-lok

SafetyGlide

SurGuard

Magellan

AutoShield

VanishPoint

UltraSafe

InterLink

SmartSite

Eclipse

Auto?disposable syringe

Auto disposable syringe*

Prevention

prophylaxis

Preventive healthcare

Preventive trial

prevention and control [Subheading]

Immunization

Immunization[MH]

Immune*

Vaccination

Vaccination[MH]

Vaccine

Soloshot

Destroject

Uniject

Yushou

Search strategy

((Auto?disable) OR auto? disabled) OR Auto?destruct) OR Reuse prevention) OR Sharp injury prevention) OR Safety engineered syringe) OR Safety engineered syringe[TIAB]) OR Safety engineered syringe*) OR SESs) OR Safety syringe) OR Safe injection practice) OR Safe injection practic*) OR Safety-lok) OR SafetyGlide) OR SurGuard) OR Magellan) OR AutoShield) OR VanishPoint) OR UltraSafe) OR InterLink) OR SmartSite) OR Eclipse) OR Auto?disposable syringe) OR Auto disposable syringe*) OR Safety engineered device*) OR Safety engineered device) OR Safety engineered device*[TIAB]) OR Protective Devices) OR Protective Device*[TIAB]) OR Protective Devices[MH]) OR Safety Device) OR Equipment Safety) OR Equipment Safety[MH]) OR SEDs) OR (Safety AND (syringe OR needle OR device))) OR (Engineered AND (syringe OR needle OR device))) OR Safety needle) OR Prevention) OR prophylaxis) OR Preventive healthcare) OR Preventive trial) OR (prevention and control [Subheading])) OR Immunization) OR Immunization[MH]) OR Immune*) OR Vaccination) OR Vaccination[MH]) OR Vaccine) OR Soloshot) OR Destroject) OR Uniject) OR Yushou **2392455** on **03/08/2017**

Comparator

Conventional syringe

Conventional syringe*[TIAB]

Conventional needle

Conventional needle*[TIAB]

Disposable syringe

Disposable syringe*[TIAB]

Disposable needle

Disposable needle*[TIAB]

disposable equipment[MH]

disposable equipment

disposable equipment[TIAB]

Syringes[MH]

Syringe

Syringe*[TIAB]

Search strategy

((((((((((Conventional syringe*) OR Conventional syringe*[TIAB]) OR Conventional needle*) OR Conventional needle*[TIAB]) OR Disposable syringe*) OR Disposable syringe*[TIAB]) OR Disposable needle*) OR Disposable needle*[TIAB]) OR disposable equipment[MH]) OR disposable equipment*) OR disposable equipment[TIAB]) OR Syringes[MH]) OR Syringe* **21523** on **03/08/2017**

Outcome

Needlestick injury

Needlestick injury[TIAB]

Needlestick injuries[TIAB]

Needlestick Injuries[MH]

Needlestick

Needlestick*[TIAB]

Needlestick exposure

Occupational Injury

Occupational Injuries

Accidents, Occupational[MH]

Occupational Accident

Occupational Accidents

Reuse injection

Injection reuse

Equipment Reuse[MH]

Reuse equipment[TIAB]

Reuse equipment

Reuse needle*[TIAB]

Reuse needle

Reuse syringe

Reuse syringe*[TIAB]

Search strategy

((((((((((((((((((((Needlestick injury) OR Needlestick injury[TIAB]) OR Needlestick injuries[TIAB]) OR Needlestick Injuries[MH]) OR Needlestick) OR Needlestick*[TIAB]) OR Needlestick exposure) OR Occupational Injury) OR Occupational Injuries) OR Accidents, Occupational[MH]) OR Occupational Accident) OR Occupational Accidents) OR Reuse injection) OR Injection reuse) OR Equipment Reuse[MH]) OR Reuse equipment[TIAB]) OR Reuse equipment) OR Reuse needle*[TIAB]) OR Reuse needle) OR Reuse syringe) OR Reuse syringe*[TIAB] **47580** on **03/08/2017**

Complete search strategy

((((((((((((((((((((((((((((Healthcare workers) OR Healthcare worker) OR Healthcare worker*[TIAB]) OR Healthcare professionals) OR Healthcare professional*[TIAB]) OR Healthcare provider) OR Healthcare providers) OR Healthcare provider*[TIAB]) OR Health Personnel) OR Health Personnel[MH]) OR Hospital Personnel) OR Physician) OR Physicians) OR Physicians[TIAB]) OR Physician[TIAB]) OR Physicians[MH]) OR Doctors) OR Doctor) OR Doctor*[TIAB]) OR Nurse) OR Nurse*[MH]) OR Nurses) OR Nurses[TIAB]) OR Nurse[TIAB]) OR Hospital workers) OR Injection provider) OR Injection providers)) AND ((Auto?disable) OR auto? disabled) OR Auto?destruct) OR Reuse prevention) OR Sharp injury prevention) OR Safety engineered syringe) OR Safety engineered syringe[TIAB]) OR Safety engineered syringe*) OR SESs) OR Safety syringe) OR Safe injection practice) OR Safe injection practic*) OR Safety-lok) OR SafetyGlide) OR SurGuard) OR Magellan) OR AutoShield) OR VanishPoint) OR UltraSafe) OR InterLink) OR SmartSite) OR Eclipse) OR Auto?disposable syringe) OR Auto disposable syringe*) OR Safety engineered device*) OR Safety engineered device) OR Safety engineered device*[TIAB]) OR Protective Devices) OR Protective Device*[TIAB]) OR Protective Devices[MH]) OR Safety Device) OR Equipment Safety) OR Equipment Safety[MH]) OR SEDs) OR (Safety AND (syringe OR needle OR device))) OR (Engineered AND (syringe OR needle OR device))) OR Safety needle) OR Prevention) OR prophylaxis) OR Preventive healthcare) OR Preventive trial) OR (prevention and control

[Subheading])) OR Immunization) OR Immunization[MH]) OR Immune*) OR Vaccination) OR Vaccination[MH]) OR Vaccine) OR Soloshot) OR Destroject) OR Uniject) OR Yushou)) AND ((((((((((((Conventional syringe*) OR Conventional syringe*[TIAB]) OR Conventional needle*) OR Conventional needle*[TIAB]) OR Disposable syringe*) OR Disposable syringe*[TIAB]) OR Disposable needle*) OR Disposable needle*[TIAB]) OR disposable equipment[MH]) OR disposable equipment*) OR disposable equipment[TIAB]) OR Syringes[MH]) OR Syringe*)) AND ((((((((((((((((((((Needlestick injury) OR Needlestick injury[TIAB]) OR Needlestick injuries[TIAB]) OR Needlestick Injuries[MH]) OR Needlestick) OR Needlestick*[TIAB]) OR Needlestick exposure) OR Occupational Injury) OR Occupational Injuries) OR Accidents, Occupational[MH]) OR Occupational Accident) OR Occupational Accidents) OR Reuse injection) OR Injection reuse) OR Equipment Reuse[MH]) OR Reuse equipment[TIAB]) OR Reuse equipment) OR Reuse needle*[TIAB]) OR Reuse needle) OR Reuse syringe) OR Reuse syringe*[TIAB])
345 on **03/08/2017**

02 Cochrane Library

#1 Healthcare workers:ti,ab,kw in Trials (Word variations have been searched)

#2 Healthcare worker*

#3 Healthcare professional*

#4 Healthcare professional:ti,ab,kw in Trials (Word variations have been searched)

#5 MeSH descriptor: [Health Personnel] explode all trees

#6 Healthcare provider*

#7 Healthcare provider:ti,ab,kw in Trials (Word variations have been searched)

#8 Health Personnel*

#9 Health Personnel:ti,ab,kw in Trials (Word variations have been searched)

#10 Physician*

#11 Physician:ti,ab,kw in Trials (Word variations have been searched)

#12 MeSH descriptor: [Physicians] explode all trees

#13 Doctor*

#14 Doctor: ti,ab,kw in Trials (Word variations have been searched)

#15 Nurse*

#16 MeSH descriptor: [Nurses] explode all trees

#17 Nurse:ti,ab,kw in Trials (Word variations have been searched)

#18 Hospital worker*

#19 Hospital worker:ti,ab,kw in Trials (Word variations have been searched)

#20 ((Healthcare or health-care or (health near/1 care)) near/2 worker*):ti,ab,kw (Word variations have been searched)

#21 Injection provider*

#22 ((Medical or nurs*) near/2 staff*)

#23 {or #1-#22}

#24 Auto-disable*

#25 Reuse prevention*

#26 Sharp injury prevention:ti,ab,kw (Word variations have been searched)

#27 Sharp injury prevention*

#28 Safety engineered device*

#29 SEDs

#30 Safety engineered syringe*

#31 Safe injection practice*

#32 MeSH descriptor: [Protective Devices] explode all trees

#33 Protective Device*

#34 Protective Device:ti,ab,kw (Word variations have been searched)

#35 MeSH descriptor: [Equipment Safety] explode all trees

#36 Safety Device

#37 Equipment Safety

#38 Safety engineered syringe*

#39 Safe injection practice:ti,ab,kw (Word variations have been searched)

#40 Safety syringe

#41 SESs

#42 Safety needle

#43 Safety-lok

#44 Eclipse

#45 SmartSite

#46 UltraSafe

#47 InterLink

#48 Auto-disposable syringe*

#49 Auto disposable syringe*

#50 Prevention

#51 prophylaxis

#52 Preventive healthcare

#53 Preventive trial

#54 Immunization

#55 MeSH descriptor: [Immunization] explode all trees

#56 Immune*

#57 Vaccination

#58 MeSH descriptor: [Vaccination] explode all trees

#59 Vaccine

#60 MeSH descriptor: [Vaccines] explode all trees

#61 Soloshot

#62 Destroject

#63 Uniject

#64 Yushou

#65 {or #24-#64}

#66 Conventional syringe*

#67 Conventional needle*

#68 Disposable syringe*

#69 (reuse near/3 (syringe* or needle* or inject* or device* or product*))

#70 Disposable needle*

#71 disposable equipment*

#72 {or #66-#71}

#73 Needlestick injury

#74 MeSH descriptor: [Needlestick Injuries] explode all trees

#75 Needlestick injur*

#76 Needlestick*

#77 Needlestick injury:ti,ab,kw in Trials (Word variations have been searched)

#78 Needlestick exposure

#79 Needlestick exposure:ti,ab,kw in Trials (Word variations have been searched)

#80 Occupational Injur*

#81 Occupation* Injur*

#82 Occupation* near/2 injur*

#83 MeSH descriptor: [Accidents, Occupational] explode all trees

#84 Reuse injection

#85 Reuse needle

#86 Reuse syringe

#87 (injur* near/3 (syringe* or needle* or inject*))

#88 MeSH descriptor: [Equipment Reuse] explode all trees

#89 {or #73-#88}

#90 #23 and #65 and #72 and #89

83 on 03/08/2017

03 Embase

No. Query Results

#104. (('health care personnel'/exp OR 'health care personnel') OR 'healthcare worker*' OR 'healthcare worker*':ab,ti OR 'healthcare professionals' OR 'health care personnel':ab,ti OR 'healthcare provider' OR 'healthcare provider*' OR 'healthcare provider*':ti,ab OR physician* OR 'physician'/exp OR doctor* OR nurse* OR 'physician*':ti,ab OR 'nurse'/exp OR 'nurse*':ti,ab OR 'doctor*':ti,ab OR 'hospital personnel'/exp OR (injection AND provider*) OR 'injection provider*' OR healthcare NEAR/3 worker OR healthcare NEAR/3 professional) AND (auto NEAR/2 disable OR auto NEAR/2 destruct OR (reuse AND prevention) OR (sharp AND injury AND prevention) OR 'safety engineered device*' OR (safety AND engineered AND device*) OR 'safety engineered syringe*':ti,ab OR 'protective equipment'/exp OR (protective AND device:ti,ab) OR protective NEXT/2 equipment OR (safety AND device) OR sed OR 'safety engineered syringe*' OR

'device safety'/exp OR ses OR 'safety syringe*'
OR (safety AND syringe:ti,ab) OR (safety AND
needle:ti,ab) OR (safe AND injection AND
practice) OR 'safety lok' OR safetyglide OR
surguard OR autoshield OR vanishpoint OR
ultrasafe OR interlink OR smartsite OR eclipse OR
'auto disposable syringe*' OR magellan OR
'prevention'/exp OR 'prophylaxis'/exp OR
(preventive AND healthcare) OR 'prevention
study'/exp OR 'immunization'/exp OR immunization
OR prevention OR prophylaxis OR immune* OR
vaccination OR 'vaccination'/exp OR vaccine OR
'vaccine'/exp OR soloshot OR destroject OR
uniject OR yushou) AND ('conventional syringe' OR
'conventional needle*' OR 'disposable syringe*'
OR 'disposable equipment'/exp OR 'syringes'/exp
OR (disposable AND syringe) OR 'disposable
needle' OR (disposable AND needle) OR
(conventional AND needle) OR (conventional AND
syringe) OR conventional NEAR/5 (needle OR
syringe)) AND ('needlestick injury' OR

'needlestick injury'/exp OR 'needle stick injur*':ti,ab OR 'needlestick exposure' OR 'occupational injury' OR 'occupational accident'/exp OR needlestick OR needlestick NEAR/3 exposure OR needlestick NEAR/2 injury OR occupational NEAR/3 accident OR 'reuse injection' OR injection NEAR/3 reuse OR injur* NEAR/3 (syringe* OR needle* OR inject*) OR 'reuse syringe' OR 'reuse needle' OR equipment NEAR/3 reuse)

#103.(('health care personnel'/exp OR 'health care personnel') OR 'healthcare worker*' OR 'healthcare worker*':ab,ti OR 'healthcare professionals' OR 'health care personnel':ab,ti OR 'healthcare provider' OR 'healthcare provider*' OR 'healthcare provider*':ti,ab OR physician* OR 'physician'/exp OR doctor* OR nurse* OR 'physician*':ti,ab OR 'nurse'/exp OR 'nurse*':ti,ab OR 'doctor*':ti,ab OR 'hospital personnel'/exp OR (injection AND provider*) OR 'injection provider*' OR healthcare NEAR/3 worker

OR healthcare NEAR/3 professional) AND (auto NEAR/2 disable OR auto NEAR/2 destruct OR (reuse AND prevention) OR (sharp AND injury AND prevention) OR 'safety engineered device*' OR (safety AND engineered AND device*) OR 'safety engineered syringe*':ti,ab OR 'protective equipment'/exp OR (protective AND device:ti,ab) OR protective NEXT/2 equipment OR (safety AND device) OR sed OR 'safety engineered syringe*' OR 'device safety'/exp OR ses OR 'safety syringe*' OR (safety AND syringe:ti,ab) OR (safety AND needle:ti,ab) OR (safe AND injection AND practice) OR 'safety lok' OR safetyglide OR surguard OR autoshield OR vanishpoint OR ultrasafe OR interlink OR smartsite OR eclipse OR 'auto disposable syringe*' OR magellan OR 'prevention'/exp OR 'prophylaxis'/exp OR (preventive AND healthcare) OR 'prevention study'/exp OR 'immunization'/exp OR immunization OR prevention OR prophylaxis OR immune* OR vaccination OR 'vaccination'/exp OR vaccine OR

'vaccine'/exp OR soloshot OR destroject OR unijject OR yushou) AND ('conventional syringe' OR 'conventional needle*' OR 'disposable syringe*' OR 'disposable equipment'/exp OR 'syringes'/exp OR (disposable AND syringe) OR 'disposable needle' OR (disposable AND needle) OR (conventional AND needle) OR (conventional AND syringe) OR conventional NEAR/5 (needle OR syringe)) AND ('needlestick injury' OR 'needlestick injury'/exp OR 'needle stick injur*':ti,ab OR 'needlestick exposure' OR 'occupational injury' OR 'occupational accident'/exp OR needlestick OR needlestick NEAR/3 exposure OR needlestick NEAR/2 injury OR occupational NEAR/3 accident OR 'reuse injection' OR injection NEAR/3 reuse OR injur* NEAR/3 (syringe* OR needle* OR inject*) OR 'reuse syringe' OR 'reuse needle' OR equipment NEAR/3 reuse)

#102.'needlestick injury' OR 'needlestick injury'/exp OR 'needle stick injur*':ti,ab OR 'needlestick

exposure' OR 'occupational injury' OR

'occupational accident'/exp OR needlestick OR

needlestick NEAR/3 exposure OR needlestick NEAR/2

injury OR occupational NEAR/3 accident OR 'reuse

injection' OR injection NEAR/3 reuse OR injur*

NEAR/3 (syringe* OR needle* OR inject*) OR 'reuse

syringe' OR 'reuse needle' OR equipment NEAR/3

reuse

#101.'needlestick injury' OR 'needlestick injury'/exp

OR 'needle stick injur*':ti,ab OR 'needlestick

exposure' OR 'occupational injury' OR

'occupational accident'/exp OR needlestick OR

needlestick NEAR/3 exposure OR needlestick NEAR/2

injury OR occupational NEAR/3 accident OR 'reuse

injection' OR injection NEAR/3 reuse OR injur*

NEAR/3 (syringe* OR needle* OR inject*) OR 'reuse

syringe' OR 'reuse needle' OR equipment NEAR/3

reuse

#100.equipment NEAR/3 reuse

#99. 'reuse needle'

#98. 'reuse syringe'

#97. injur* NEAR/3 (syringe* OR needle* OR inject*)

#96. injection NEAR/3 reuse

#95. 'reuse injection'

#94. occupational NEAR/3 accident

#93. needlestick NEAR/2 injury

#92. needlestick NEAR/3 exposure

#91. needlestick

#90. 'occupational accident'/exp

#89. 'occupational injury'

#88. 'needlestick exposure'

#87. 'needle stick injur*':ti,ab

#86. 'needlestick injury'/exp

#85. 'needlestick injury'

#84. 'conventional syringe' OR 'conventional needle*'
OR 'disposable syringe*' OR 'disposable
equipment'/exp OR 'syringes'/exp OR (disposable
AND syringe) OR 'disposable needle' OR
(disposable AND needle) OR (conventional AND
needle) OR (conventional AND syringe) OR
conventional NEAR/5 (needle OR syringe)

#83. conventional NEAR/5 (needle OR syringe)

#82. conventional AND syringe

#81. conventional AND needle

#80. disposable AND needle

#79. 'disposable needle'

#78. disposable AND syringe

#77. 'syringes'/exp

#76. 'disposable equipment'/exp

#75. 'disposable syringe*'

#74. 'conventional needle*'

#73. 'conventional syringe'

#72. auto NEAR/2 disable OR auto NEAR/2 destruct OR (reuse AND prevention) OR (sharp AND injury AND prevention) OR 'safety engineered device*' OR (safety AND engineered AND device*) OR 'safety engineered syringe*':ti,ab OR 'protective equipment'/exp OR (protective AND device:ti,ab) OR protective NEXT/2 equipment OR (safety AND device) OR sed OR 'safety engineered syringe*' OR 'device safety'/exp OR ses OR 'safety syringe*' OR (safety AND syringe:ti,ab) OR (safety AND needle:ti,ab) OR (safe AND injection AND

3,482,998 4 Aug 2017

practice) OR 'safety lok' OR safetyglide OR surguard OR autoshield OR vanishpoint OR ultrasafe OR interlink OR smartsite OR eclipse OR 'auto disposable syringe*' OR magellan OR 'prevention'/exp OR 'prophylaxis'/exp OR (preventive AND healthcare) OR 'prevention study'/exp OR 'immunization'/exp OR immunization OR prevention OR prophylaxis OR immune* OR vaccination OR 'vaccination'/exp OR vaccine OR 'vaccine'/exp OR soloshot OR destroject OR uniject OR yushou

#71. auto NEAR/2 disable OR auto NEAR/2 destruct OR (reuse AND prevention) OR (sharp AND injury AND prevention) OR 'safety engineered device*' OR (safety AND engineered AND device*) OR 'safety engineered syringe*':ti,ab OR 'protective equipment'/exp OR (protective AND device:ti,ab) OR protective NEXT/2 equipment OR (safety AND device) OR sed OR 'safety engineered syringe*' OR 'device safety'/exp OR ses OR 'safety syringe*' OR (safety AND syringe:ti,ab) OR (safety AND

needle:ti,ab) OR (safe AND injection AND practice) OR 'safety lok' OR safetyglide OR surguard OR autoshield OR vanishpoint OR ultrasafe OR interlink OR smartsite OR eclipse OR 'auto disposable syringe*' OR magellan OR 'prevention'/exp OR 'prophylaxis'/exp OR (preventive AND healthcare) OR 'prevention study'/exp OR 'immunization'/exp OR immunization OR prevention OR prophylaxis OR immune* OR vaccination OR 'vaccination'/exp OR vaccine OR 'vaccine'/exp OR soloshot OR destroject OR uniject OR yushou

#70. yushou

#69. uniject

#68. destroject

#67. soloshot

#66. 'vaccine'/exp

#65. vaccine

#64. 'vaccination'/exp

#63. vaccination

#62. immune*

#61. prophylaxis

#60. prevention

#59. immunization

#58. 'immunization'/exp

#57. 'prevention study'/exp

#56. preventive AND healthcare

#55. 'prophylaxis'/exp

#54. 'prevention'/exp

#53. magellan

#52. 'auto disposable syringe*'

#51. eclipse

#50. smartsite

#49. interlink

#48. ultrasafe

#47. vanishpoint

#46. autoshield

#45. surguard

#44. safetyglide

#43. 'safety lok'

#42. safe AND injection AND practice

#41. safety AND needle:ti,ab

#40. safety AND syringe:ti,ab

#39. 'safety syringe*

#38. ses

#37. 'device safety'/exp

#36. 'safety engineered syringe*'

#35. sed

#34. safety AND device

#33. protective NEXT/2 equipment

#32. protective AND device:ti,ab

#31. 'protective equipment'/exp

#30. 'safety engineered syringe*':ti,ab

#29. safety AND engineered AND device*

#28. 'safety engineered device*'

#27. sharp AND injury AND prevention

#26. reuse AND prevention

#25. auto NEAR/2 destruct

#24. auto NEAR/2 disable

#23. ('health care personnel'/exp OR 'health care personnel') OR 'healthcare worker*' OR 'healthcare worker*':ab,ti OR 'healthcare professionals' OR 'health care personnel':ab,ti

OR 'healthcare provider' OR 'healthcare provider*' OR 'healthcare provider*':ti,ab OR physician* OR 'physician'/exp OR doctor* OR nurse* OR 'physician*':ti,ab OR 'nurse'/exp OR 'nurse*':ti,ab OR 'doctor*':ti,ab OR 'hospital personnel'/exp OR (injection AND provider*) OR 'injection provider*' OR healthcare NEAR/3 worker OR healthcare NEAR/3 professional

#22. ('health care personnel'/exp OR 'health care personnel') OR 'healthcare worker*' OR 'healthcare worker*':ab,ti OR 'healthcare professionals' OR 'health care personnel':ab,ti OR 'healthcare provider' OR 'healthcare provider*' OR 'healthcare provider*':ti,ab OR physician* OR 'physician'/exp OR doctor* OR nurse* OR 'physician*':ti,ab OR 'nurse'/exp OR 'nurse*':ti,ab OR 'doctor*':ti,ab OR 'hospital personnel'/exp OR (injection AND provider*) OR 'injection provider*' OR healthcare NEAR/3 worker OR healthcare NEAR/3 professional

#21. healthcare NEAR/3 professional

#20. healthcare NEAR/3 worker

#19. 'injection provider*'

#18. injection AND provider*

#17. 'hospital personnel'/exp

#16. 'doctor*':ti,ab

#15. 'nurse*':ti,ab

#14. 'nurse'/exp

#13. 'physician*':ti,ab

#12. nurse*

#11. doctor*

#10. 'physician'/exp

#9. physician*

#8. 'healthcare provider*':ti,ab

#7. 'healthcare provider*'

#6. 'healthcare provider'

#5. 'health care personnel':ab,ti

#4. 'healthcare professionals'

#3. 'healthcare worker*':ab,ti

#1. 'health care personnel'/exp OR 'health care personnel'

04 CINAHL

CINAHL Search Strategy.pdf

05 Clinicaltrial.gov

(Safety engineered AND (device OR syringe) OR Safe injection practice) AND (Healthcare AND (worker OR professional OR provider* OR Personnel) OR Physician* OR Nurse* OR Hospital worker) **07**

(Healthcare AND (worker OR professional OR provider* OR Personnel) OR Physician* OR Nurse* OR Hospital worker) AND (Needle stick AND (injur* OR exposure) OR Needle stick*) **06**

(Safety engineered AND (device OR syringe) OR Safe injection practice) AND (Needle stick AND (injur* OR exposure) OR Needle stick*) **no studies found**

Section D: Input Parameter

Table 1: List of Input Parameters, India

	Parameters		Base Value	Lower Limit	Upper Limit	Source
Demographic Parameters	**Population of India (2017)**		1349701245			Census,2011 2017 Estimation
	Annual population growth rate		0.0164			Census,2011 (Average annual exponential growth rate)
	Age-specific all-cause mortality	0-1	0			SRS report, 2015
		0-4	0.0088315			
		5-9	0.00409161			
		10-14	0.0033444			
		15-19	0.00538641			
		20-24	0.0074233			
		25-29	0.00826653			
		30-34	0.01010079			
		35-39	0.01361132			
		40-44	0.01858502			
		45-49	0.0265659			

		50-54	0.04229586			
		55-59	0.06137236			
		60-64	0.09343982			
		65-69	0.14073094			
		70-74	0.20811976			
		75-79	0.29792525			
		80-85	0.44419917			
	Crude death rate		0.065			
	Healthcare professionals in public sector	Doctors	144575	115660	173490	Rural Health Statistics(2015-2016)
		Nurses	723583	578866	868299	
		Technicians	245160	196128	294192	
	Healthcare professionals in Private sector(Qualified)	Doctors	703262	562609	843914	Indrajit Hazarika, PHFI WHO South-East Asia Journal of Public Health 2013
		Nurses	2,100,753	1680602	2520903	
		Technicians	711764	569411	854116	
	Healthcare professional in Private sector (Non-Qualified)		413027	330421	495632	
	Morbidity Rate (India)		0.10	0.089	0.118	NSSO,71st Round

Epidemiological Parameters	**Proportion Sought care from public sector**		0.26	0.26	0.26	2014
	Proportion Sought care from private sector		0.74	0.74	0.74	
	Proportion Sought care from private qualified		0.626	0.626	0.626	
	Proportion Of ill population treated in OP setting		0.9	0.9	0.9	
	Public	Primary	0.03	0.028	0.028	
		Secondary	0.11	0.114	0.114	
		Tertiary	0.06	0.058	0.058	
	Private-Qualified	Primary	0.1	0.100	0.100	
		Secondary	0.27	0.270	0.270	
		Tertiary	0.13	0.130	0.130	
	Private-Non-Qualified		0.3	0.300	0.300	
	Proportion of ill population hospitalized		0.1	0.10	0.10	NSSO,71st Round
	Public	Primary	0.05	0.05	0.05	
		Secondary	0.2	0.20	0.20	NSSO,71st Round
		Tertiary	0.05	0.05	0.05	
	Private-Qualified	Primary	0.05	0.05	0.05	
		Secondary	0.5	0.50	0.50	
		Tertiary	0.15	0.15	0.15	

	Proportion patients in OP setting prescribed injections		0.44	0.44	0.44	IPEN study,2012 WHO South-East Asia Journal of Public Health
	Public	Primary	0.383	0.383	0.383	
		Secondary	0.383	0.383	0.383	
		Tertiary	0.383	0.383	0.383	
	Private-Qualified	Primary	0.457	0.457	0.457	
		Secondary	0.457	0.457	0.457	
		Tertiary	0.457	0.457	0.457	
	Private-Non-Qualified		0.56	0.56	0.56	
	Proportion patients in IP setting prescribed injections		0.85	0.85	0.85	Gawande U et al. Int J Res Med Sci. 2015
	Public	Primary	0.75	0.75	0.75	
		Secondary	0.8	0.8	0.8	
		Tertiary	0.85	0.85	0.85	
	Private-Qualified	Primary	0.84	0.84	0.84	
		Secondary	0.896	0.896	0.896	
		Tertiary	0.952	0.952	0.952	
	Frequency of injections per patient in OP setting		2.9	2	4	IPEN study,2012 WHO South-East Asia Journal of Public Health
	Public	Primary	2.3	2	4	
		Secondary	2.6	2	4	
		Tertiary	2.9	2	4	

	Private-Qualified	Primary	2.6	2	4	
		Secondary	2.9	2	4	
		Tertiary	3.2	2	4	
	Private-Non-Qualified		3.8	2	4	
	Frequency of injections per patient in IP setting		2.9	2	4	IPEN study,2012 WHO South-East Asia Journal of Public Health
	Public	Primary	2.3	2	4	
		Secondary	2.6	2	4	
		Tertiary	2.9	2	4	
	Private-Qualified	Primary	2.576	2	4	
		Secondary	2.912	2	4	
		Tertiary	4	2	4	
	Overall Proportion of Injections for Therapeutic care		0.83	0.83	0.83	Janjua NZ et al .2016 World Journal of Gastroenterology.
	Overall Proportion of Injections for Preventive care		0.17	0.17	0.17	
	Proportion of Injections for Therapeutic care in Public		0.32	0.32	0.32	
	Proportion of Injections for Preventive care in Public		0.68	0.68	0.68	
	Proportion of Injections for Therapeutic care in Private		0.68	0.68	0.68	

	Proportion of Injections for Preventive care in Private		0.32	0.32	0.32	
	Proportion of Injections by route in OP Setting	Intravenous (IV)	0.1285	0.1285	0.1285	HS Rehan et.al. J Infect Public Health. 2012 https://www.ncbi.nlm.nih.gov/pubmed/22541265
		Intramuscular (IM)	0.4714	0.4714	0.4714	
		Intradermal (ID)	0.2857	0.2857	0.2857	
		subcutaneous (SC)	0.1144	0.1144	0.1144	
	Proportion of Injections by route in IP Setting	Intravenous (IV)	0.7667	0.7667	0.7667	
		Intramuscular (IM)	0.2167	0.2167	0.2167	
		Intradermal (ID)	0	0	0	
		subcutaneous (SC)	0.0167	0.0167	0.0167	
	Use of Disposable Syringes		1	1	1	Saoji et al. 2011 Global Journal of Health Science
	Public		1	1	1	
	Primary	Intravenous (IV)	0.4476	0.4476	0.4476	Saoji et al. 2011 Global Journal of Health Science
		Intramuscular (IM)	0.34405	0.34405	0.34405	
		Intradermal (ID)	0.14285	0.14285	0.14285	
		subcutaneous (SC)	0.0655	0.0655	0.0655	
	Secondary	Intravenous (IV)	0.4476	0.4476	0.4476	
		Intramuscular (IM)	0.34405	0.34405	0.34405	
		Intradermal (ID)	0.14285	0.14285	0.14285	
		subcutaneous (SC)	0.0655	0.0655	0.0655	

	Tertiary	Intravenous (IV)	0.4476	0.4476	0.4476	
		Intramuscular (IM)	0.34405	0.34405	0.34405	
		Intradermal (ID)	0.14285	0.14285	0.14285	
		subcutaneous (SC)	0.0655	0.0655	0.0655	
	Private-Qualified		1	1	1	Saoji et al. 2011 Global Journal of Health Science
	Primary	Intravenous (IV)	0.4476	0.4476	0.4476	
		Intramuscular (IM)	0.34405	0.34405	0.34405	
		Intradermal (ID)	0.14285	0.14285	0.14285	
		subcutaneous (SC)	0.0655	0.0655	0.0655	
	Secondary	Intravenous (IV)	0.4476	0.4476	0.4476	
		Intramuscular (IM)	0.34405	0.34405	0.34405	
		Intradermal (ID)	0.14285	0.14285	0.14285	
		subcutaneous (SC)	0.0655	0.0655	0.0655	
	Tertiary	Intravenous (IV)	0.4476	0.4476	0.4476	
		Intramuscular (IM)	0.34405	0.34405	0.34405	
		Intradermal (ID)	0.14285	0.14285	0.14285	
		subcutaneous (SC)	0.0655	0.0655	0.0655	
	Private-Non-Qualified	Intravenous (IV)	0.4476	0.4476	0.4476	
		Intramuscular (IM)	0.34405	0.34405	0.34405	
		Intradermal (ID)	0.14285	0.14285	0.14285	
		subcutaneous (SC)	0.0655	0.0655	0.0655	

	Use of RUP Syringes		0	0	0	Currently, RUP syringe is not used in the therapeutic sector
	Use of SIP Syringes		0	0	0	Currently, SIP syringe is not used in the therapeutic sector
	Proportion reuse of Disposable syringe in OP setting		0.05	0.0023	0.1400	D Sahu et.al. 2015 Sridevi Garapati, Sujatha Peethala,2014
	Public	Primary	0.0459	0.00207	0.129	
		Secondary	0.0459	0.00207	0.129	
		Tertiary	0.0459	0.00207	0.129	
	Private-Qualified	Primary	0.0526	0.002369	0.147	
		Secondary	0.0526	0.002369	0.147	
		Tertiary	0.0526	0.002369	0.147	
	Private-Non-Qualified		0.0546	0.002461	0.153	
	Proportion reuse of disposable syringe in IP setting		0.05	0.0023	0.1400	D Sahu et.al. 2015 Sridevi Garapati, Sujatha Peethala,2014
	Public	Primary	0.0459	0.00207	0.129	
		Secondary	0.0459	0.00207	0.129	
		Tertiary	0.0459	0.00207	0.129	
	Private-Qualified	Primary	0.0526	0.002369	0.147	
		Secondary	0.0526	0.002369	0.147	
		Tertiary	0.0526	0.002369	0.147	
	Private-Non-Qualified		0.0546	0.002461	0.153	

	Proportion Injections administered by Doctors		0.2571	0.2571	0.2571	M Kermode,2006
	Public	Primary	0.3	0.3	0.3	
		Secondary	0.2	0.2	0.2	
		Tertiary	0.1	0.1	0.1	
	Private-Qualified	Primary	0.3	0.3	0.3	
		Secondary	0.2	0.2	0.2	
		Tertiary	0.1	0.1	0.1	
	Private-Non-Qualified		0.6	0.6	0.6	
	Proportion Injections administered by Nurses		0.5714	0.5714	0.5714	M Kermode,2006
	Public	Primary	0.5	0.5	0.5	
		Secondary	0.6	0.6	0.6	
		Tertiary	0.7	0.7	0.7	
	Private-Qualified	Primary	0.5	0.5	0.5	
		Secondary	0.6	0.6	0.6	
		Tertiary	0.7	0.7	0.7	
	Private-Non-Qualified		0.4	0.4	0.4	
	Proportion Injections administered by Technicians/Others		0.1714	0.1714	0.1714	M Kermode,2006
	Public	Primary	0.2	0.2	0.2	

		Secondary	0.2	0.2	0.2	
		Tertiary	0.2	0.2	0.2	
	Private-Qualified	Primary	0.2	0.2	0.2	
		Secondary	0.2	0.2	0.2	
		Tertiary	0.2	0.2	0.2	
	Private-Non-Qualified		0	0	0	
	Risk of Needle Stick Injury (NSI) from Intramuscular (IM) injections/ Intravenous injections(IV)/ Subcutaneous injections/Intradermal injections	Disposable syringes	0.003537	0.00283	0.0042444	Sangwan, B., Kotwal, A., & Verma, A. (2011)
		RUP	0.001746	0.00166	0.0026864	
		SIP	0.002561	0.00244	0.0039401	Younger B et.al. . Infection Control and Hospital Epidemiology 1992
	Proportion NSI come in contact with blood		0.68	0.5	0.9	Munish A,et.al.,2011 Indian Journal Of Medical Sciences
	Stage-wise distribution of HBV patients at diagnosis	Inapparent Infection	0	0	0	Namrata Kumari et al.2015
		Apparent Infection	0.321	0.321	0.321	
		Non-Fulminant Hepatitis	0.013	0.013	0.013	
		Fulminant Hepatitis	0.0064	0.0064	0.0064	
		Acquired Immunity	0	0	0	
		Asymptotic Carrier	0	0	0	
		Chronic Hepatitis	0.407	0.407	0.407	

		Compensated Cirrhosis	0.14	0.14	0.14	
		Decompensated Cirrhosis	0.045	0.045	0.045	
		Hepatocellular Carcinoma	0.0676	0.0676	0.0676	
	Stage-wise distribution of HCV patients at diagnosis	Asymptotic Carrier	0	0	0	Gupta V et. al. J Clin Exp Hepatol. 2015
		Chronic Hepatitis	0.37 0.45	0.37 0.45	0.37 0.45	
		Compensated Cirrhosis	0.11	0.11	0.11	
		Hepatocellular Carcinoma	0.07	0.07	0.07	
	Stage-wise distribution of HIV patients at diagnosis	CD4 Cell count >500 per mm^3	0.0639	0.0639	0.0639	Bishnu, Saptarshi et al The Indian Journal of Medical Research 2014
		CD4 Cell count between 500-350 per mm^3	0.0694	0.0694	0.0694	
		CD4 Cell count between 350-200 per mm^3	0.2167	0.2167	0.2167	
		CD4 Cell count between 200-50 per mm^3	0.1833	0.1833	0.1833	
		CD4 Cell count <50 per mm^3	0.4667	0.4667	0.4667	

	Prevalence of HBV among patients seeking treatment	Public	0.039	0.0087	0.0413	Pandit, D. P., Pagaro M., P., & Nabamita, C. (2014 Journal of Clinical and Diagnostic Research Sood, S., & Malvankar, S. (2010) Indian Journal of Community Medicine Veena Kanodia, Manju Yadav, Rameshwari Bittu, R K Maheshwari, S K Singh International Medical Journal March 2015
		Private-Qualified	0.039	0.0087	0.0413	
		Private-Non-qualified	0.039	0.0087	0.0413	
	Prevalence of HCV among patients seeking treatment	Public	0.0068	0.0028	0.0077	Kanodia V et. al., International Medical Journal March 2015; http://www.medpulse.in Sood, S., & Malvankar, S. (2010) Indian Journal of Community Medicine Samatha.P, 2015 Journal of Bioscience And Technology
		Private-Qualified	0.0068	0.0028	0.0077	
		Private-Non-qualified	0.0068	0.0028	0.0077	
	Prevalence of HIV among patients seeking treatment	Public	0.0068	0.0035	0.0083	Avinash Laghawe and Sameer Singh Faujdar,2015Int.J.Curr.Microbiol.App.Sci Varun Goel et.al,2014World Journal of AIDS Sood, S., & Malvankar, S. (2010) Indian Journal of Community Medicine
		Private-Qualified	0.0068	0.0035	0.0083	
		Private-Non-qualified	0.0068	0.0035	0.0083	
	Risk of Transmission					
	HBV	Intravenous (IV)	0.18	0.06	0.3	

		Intramuscular (IM)	0.018	0.006	0.03	Blood-Borne Diseases Surveillance Protocol for Ontario Hospitals, 2012
		Intradermal (ID)	0.00001	0.00001	0.00001	
		subcutaneous (SC)	0.0018	0.0006	0.003	
	HCV	Intravenous (IV)	0.018	0.001	0.07	CDC, Hepatitis C Information for health professionals
		Intramuscular (IM)	0.0018	0.0001	0.007	
		Intradermal (ID)	0.00001	0.00001	0.00001	
		subcutaneous (SC)	0.00018	0.00001	0.0007	
	HIV	Intravenous (IV)	0.0023	0.0001	0.0046	Guidelines for the Management of Occupational Exposures to HIV CDC MMWR U.S, 2005
		Intramuscular (IM)	0.00023	0.00001	0.00046	
		Intradermal (ID)	0.0000001	0.0000001	0.0000001	
		subcutaneous (SC)	0.000023	0.000001	0.00007	
	Abscess formation	Intravenous (IV)	0.078	0.078	0.078	Hashemi SH et al. Avicenna J Clin Microb Infec. 2015
		Intramuscular (IM)	0.02	0.02	0.02	
		Intradermal (ID)	0.00001	0.00001	0.00001	
		subcutaneous (SC)	0.01	0.01	0.01	
	Septicemia	Intravenous (IV)	0.053	0.053	0.053	Hashemi SH et al. Avicenna J Clin Microb Infec. 2015
		Intramuscular (IM)	0.02	0.02	0.02	
		Intradermal (ID)	0.00001	0.00001	0.00001	
		subcutaneous (SC)	0.01	0.01	0.01	

	Pain/Disabilities	Intravenous (IV)	0.053	0.053	0.053	Hashemi SH et al. Avicenna J Clin Microb Infec. 2015
		Intramuscular (IM)	0.02	0.02	0.02	
		Intradermal (ID)	0.00001	0.00001	0.00001	
		subcutaneous (SC)	0.01	0.01	0.01	
Intervention Parameters	**Use of RUP Syringes**					
	Public		1	1	1	
	Primary	Intravenous (IV)	0.4476	0.4476	0.4476	Saoji et al. 2011 Global Journal of Health Science
		Intramuscular (IM)	0.34405	0.34405	0.34405	
		Intradermal (ID)	0.14285	0.14285	0.14285	
		subcutaneous (SC)	0.0655	0.0655	0.0655	
	Secondary	Intravenous (IV)	0.4476	0.4476	0.4476	
		Intramuscular (IM)	0.34405	0.34405	0.34405	
		Intradermal (ID)	0.14285	0.14285	0.14285	
		subcutaneous (SC)	0.0655	0.0655	0.0655	
	Tertiary	Intravenous (IV)	0.4476	0.4476	0.4476	
		Intramuscular (IM)	0.34405	0.34405	0.34405	
		Intradermal (ID)	0.14285	0.14285	0.14285	
		subcutaneous (SC)	0.0655	0.0655	0.0655	
	Private-Qualified					
	Primary	Intravenous (IV)	0.4476	0.4476	0.4476	
		Intramuscular (IM)	0.34405	0.34405	0.34405	

		Intradermal (ID)	0.14285	0.14285	0.14285	
		subcutaneous (SC)	0.0655	0.0655	0.0655	
	Secondary	Intravenous (IV)	0.4476	0.4476	0.4476	
		Intramuscular (IM)	0.34405	0.34405	0.34405	
		Intradermal (ID)	0.14285	0.14285	0.14285	
		subcutaneous (SC)	0.0655	0.0655	0.0655	
	Tertiary	Intravenous (IV)	0.4476	0.4476	0.4476	
		Intramuscular (IM)	0.34405	0.34405	0.34405	
		Intradermal (ID)	0.14285	0.14285	0.14285	
		subcutaneous (SC)	0.0655	0.0655	0.0655	
	Private-Non-Qualified	Intravenous (IV)	0.4476	0.4476	0.4476	
		Intramuscular (IM)	0.34405	0.34405	0.34405	
		Intradermal (ID)	0.14285	0.14285	0.14285	
		subcutaneous (SC)	0.0655	0.0655	0.0655	
	Use of SIP Syringes		0	0	0	
	Use of Disposable syringe		0	0	0	
Efficacy Parameters	**Effectiveness of SES in reducing NSIs**	AD	0	0	0	Systematic review was done separately for these parameters
		RUP	0.4	0.27	0.59	
		SIP	0.12	0.04	0.41	
	Effectiveness of trainings on safe practices for HCW on reducing NSI		0.66	0.5	0.8	

Cost Parameters	**Per unit cost of Disposable syringe**		1.03	0.66	2.56	WHO(PQS), PAHO & UNICEF
	Per unit cost of RUP syringe		4.2	3.22	5.16	WHO(PQS), PAHO & UNICEF
	Per unit cost of SIP syringe		11	8.38	15.47	WHO(PQS), PAHO & UNICEF
	Per unit cost of RUP+SIP syringe		11	5.8	16.2	WHO(PQS), PAHO & UNICEF
	Per unit costs of Trainings for HCP on safe practices	Block level	0	0	0	
		District level	50000	50000	50000	
		State level	308000	308000	308000	
	Number of districts		672	672	672	Rural health statistics 2015-2016
	Average cost of waste disposal per bed per day		6.38	4.65	6.8	
	Average cost of waste storage and segregation at hospital per bed					
	Total number of health facilities	PHC	25308	25308	25308	Rural health statistics 2015-2016
		CHC	5396	5396	5396	
		SDH	1022	1022	1022	
		DH	763	763	763	
		MC	224	224	224	
	Average beds per health facility	PHC	6	4	8	

		CHC	30	20	40	
		SDH	50	40	60	
		DH	200	100	300	
		MC	500	400	700	
	Increase in volume of waste due to improved management (Intervention)		1	1	1	
	Average salary of Doctors in India- Public Sector		60000	40000	100000	Expert opinion
	Average salary of Doctors in India- Private Sector		100000	60000	200000	
	Average salary of nursing staff- Public Sector		40000	20000	60000	
	Average salary of nursing staff- Private Sector		20000	10000	30000	
Treatment Costs	**Proportion patients require hospitalization**					Expert opinion
	HBV					
	Inapparent Infection					
	Apparent Infection					
	Non-Fulminant Hepatitis					
	Fulminant Hepatitis		0.8	0.8	0.8	
	Acquired Immunity					

	Asymptotic Carrier					Expert opinion
	Chronic Hepatitis		0.05	0.05	0.05	
	Compensated Cirrhosis					
	Decompensated Cirrhosis		0.7	0.7	0.7	
	Hepatocellular Carcinoma					
	HCV					
	Normal		-			
	Asymptotic Carrier		-			
	Chronic Hepatitis		0.05	0.05	0.05	
	Compensated Cirrhosis		-			
	Decompensated Cirrhosis		0.7	0.7	0.7	
	Number of hospitalizations (per patient per year)					
	HBV	Inapparent Infection				NACO annual report 2016-2017
		Apparent Infection				
		Non-Fulminant Hepatitis				
		Fulminant Hepatitis				
		Acquired Immunity				
		Asymptotic Carrier				
		Chronic Hepatitis	2	2	2	

		Compensated Cirrhosis				
		Decompensated Cirrhosis	12	12	12	
		Hepatocellular Carcinoma				
	HCV	Normal				
		Asymptotic Carrier				
		Chronic Hepatitis	2	2	2	
		Compensated Cirrhosis				
		Decompensated Cirrhosis	12	12	12	
		Hepatocellular Carcinoma				
	Number of OPD contacts (per patient per year)					
	HBV	Inapparent Infection				
		Apparent Infection				
		Non-Fulminant Hepatitis				
		Fulminant Hepatitis	4	4	4	

		Acquired Immunity				
		Asymptotic Carrier				
		Chronic Hepatitis	12	12	12	
		Compensated Cirrhosis	3	3	3	
		Decompensated Cirrhosis	12	12	12	
		Hepatocellular Carcinoma	12	12	12	
	HCV	Normal				
		Asymptotic Carrier				
		Chronic Hepatitis	12	12	12	
		Compensated Cirrhosis	3	3	3	
		Decompensated Cirrhosis	12	12	12	
		Hepatocellular Carcinoma	12	12	12	
	Proportion Patient seeking care from Centre for Excellence for HIV		0.045		0.045	
	Proportion Patient seeking care from ART Centre for HIV		0.955	1	0.955	NSSO 71st Round 2014-2015

	Proportion Patients utilize public sector hospitals in OP settings for HBV/HCV	Secondary	0.086	0.086	0.086	
		Tertiary	0.132	0.132	0.132	Mukh Mantri Punjab Hepatitis C Relief Fund , Punjab Government, 2016
	Proportion Patients utilize private sector hospitals in OP settings for HBV/HCV	Secondary	0.365	0.365	0.365	
		Tertiary	0.417	0.417	0.417	
	Proportion Patients utilize public sector hospitals in IP settings for HBV/HCV	Secondary	0.06	0.06	0.06	
		Tertiary	0.4	0.4	0.4	
	Proportion Patients utilize private sector hospitals in IP settings for HBV/HCV	Secondary	0	0	0	
		Tertiary	0.54	0.54	0.54	
	Cost of Diagnostic Tests in Public sector for HCV	ELISA	50	35	65	
		HCV-RNA	2200	1540	2860	
		Routine	500	350	650	
	Cost of Diagnostic Tests in Private sector for HCV	ELISA	100	70	130	
		HCV-RNA	5000	3500	6500	
		Routine	700	490	910	

	No. of OPD contacts for diagnosis		2	2	2	
	Cost of Genotype testing in Public sector		3000	2100	3900	Mukh Mantri Punjab Hepatitis C Relief Fund , Punjab Government, 2016
	Cost of Genotype testing in Private sector		5500	3850	7150	
	Proportion Of Patients with HCV Genotype 2 and 3		0.74	0.74	0.74	Prasanta K Bhattacharya and Aakash Roy J Liver 2015
	Proportion Of Patients with HCV Genotype 1,4,5 and 6		0.26	0.26	0.26	
	Cost of SOF+DCV for 12 weeks in Public sector		7304	5112.8	9495.2	Mukh Mantri Punjab Hepatitis C Relief Fund , Punjab Government, 2016
	Cost of SOF+DCV for 12 weeks in Private sector		42000	29400	54600	Cipla Limited,2017
	Cost of SOF+DCV+RIBA for 24 weeks in Public sector		17948	12563.6	23332.4	
	Cost of SOF+DCV+RIBA for 24 week in Private sector		84000	58800	109200	
	Cost of Cenotenofovir for HBV(Annual @45.98 per tab)		16782	11747.4	21816.6	

	Cost of Entecavir for HBV (Annual @74.5 per tab)		27192	19034.4	35349.6	Cadila Healthcare (Zydus Cadila Healthcare Ltd) 2017
	Cost of Best Support Care(Annual)		38916	27241.2	50590.8	Mukh Mantri Punjab Hepatitis C Relief Fund , Punjab Government, 2016
	Length of Treatment (in years)		4	4	4	
Average cost of treatment in Public sector (OPD)			**Primary Care(INR)**	**Secondary care(INR)**	**Tertiary Care(INR)**	Prinja et al (2017). Pharmacoeconomics Open; Prinja et al (2017). Indian J Med Research Punjab Govt.-Mukh Mantri Punjab Hepatitis C Relief Fund
	HBV		1686.3	1734	2024	
	HCV		1686.3	1734	2024	
	HIV		300	705	705	Sharma et al (2016). Unpublished
Average cost of treatment in Public sector (IPD)	**HBV**		6347.1	7597	18693	Prinja et al (2017). Pharmacoeconomics Open; Prinja et al (2017). Indian J Med Research Punjab Govt.-Mukh Mantri Punjab Hepatitis C Relief Fund
	HCV		6347.1	7597	18693	
	HIV		0	995	5592	Sharma et al (2016). Unpublished
Average cost of treatment in Private sector (OPD)	**HBV**		8625	8625	1400	Prinja et al (2017). Pharmacoeconomics Open; Prinja et al (2017). Indian J Med Research Punjab Govt.-Mukh Mantri Punjab Hepatitis C Relief Fund
	HCV		8625	8625	1400	
	HIV		0	0	1358	Sharma et al (2016). Unpublished

Average cost of treatment in Private sector (IPD)	**HBV**		26774	26774	26774	Prinja et al (2017). Pharmacoeconomics Open; Prinja et al (2017). Indian J Med Research Punjab Govt.-Mukh Mantri Punjab Hepatitis C Relief Fund
	HCV		26774	26774	26774	
	HIV		0	0	8000	Sharma et al (2016). Unpublished
QOL weights	**Stage-wise QOL weights-HBV**	Inapparent Infection	1			Levy et. al 2008, International Society for Pharmacoeconomics and Outcomes Research (ISPOR)
		Apparent Infection	0.95	0.93	0.96	
		Non-Fulminant Hepatitis	0.95	0.93	0.96	
		Fulminant Hepatitis	0.35	0.32	0.37	
		Acquired Immunity	0.95	0.93	0.96	
		Asymptotic Carrier	0.7306063	0.73	0.77	
		Chronic Hepatitis	0.68	0.66	0.71	
		Compensated Cirrhosis	0.69	0.66	0.71	
		Decompensated Cirrhosis	0.35	0.32	0.37	
		Hepatocellular Carcinoma	0.38	0.36	0.41	
	Stage-wise QOL weights-HCV	Normal	1			Wright et. al ,2006 Health Technol Assess. 2006
		Asymptotic Carrier	0.9	0.93	0.96	

		Chronic Hepatitis	0.7	0.63	0.76	
		Compensated Cirrhosis	0.55	0.48	0.65	
		Decompensated Cirrhosis	0.49	0.48	0.61	
		Hepatocellular Carcinoma	0.58038276	0.48	0.61	
	Stage-wise QOL weights-HIV	CD4 Cell count >500 per mm^3	0.946	0.924	0.964	Simpson Kit N.et. al. 2015 HIV clinical trial
		CD4 Cell count between 500-350 per mm^3	0.933	0.914	0.951	
		CD4 Cell count between 350-200 per mm^3	0.931	0.914	0.951	
		CD4 Cell count between 200-50 per mm^3	0.853	0.835	0.865	
		CD4 Cell count <50 per mm^3	0.781	0.781	0.781	
	Discount Rate		0.03	0.02	0.05	
	Proportion of general population (Males)		0.514	0.514	0.514	Census 2011 report
	Proportion of general population (Females)		0.485	0.485	0.485	

	Proportion of married general population (Males)		0.459	0.459	0.459	estimated from 25-30 years age group of Census data for married males and females
	Proportion of married in general population (Females)		0.498	0.498	0.498	
	Proportion of married in HCP (Doctors, Nurses, Technicians)_Males		0.865	0.865	0.865	
	Prop. Married in HCP (Doctors, Nurses, Technicians)_Females		0.816	0.816	0.816	
	Proportion of Doctors(Males)		0.832	0.832	0.832	Sudhir Anand and Victoria Fan 2006 The Health Workforce In India Human Resources for Health
	Proportion of Doctors(Females)		0.168	0.168	0.168	
	Proportion of Nurses (Males)		0.166	0.166	0.166	
	Proportion of Nurses(Females)		0.834	0.834	0.834	
	Proportion of Technicians(Males)		0.9	0.9	0.9	
	Proportion of Technicians(Females)		0.1	0.1	0.1	
	Prevalence of STI in general population (Male)		0.035	0.01	0.1	Jindal, Neerja et al Indian Journal of Community Medicine (2009)
	Prevalence of STI in general population (Female)		0.2	0.17	0.27	

	Proportion PLHIV on ART		0.43	0.43	0.43	NACO Report 2016-2017
	Proportion PLHIV not on ART		0.57	0.57	0.57	
	Proportion HBV Patients on treatment		0.5	0.5	0.5	
	Proportion HBV Patients not on treatment		0.5	0.5	0.5	
	Condom Use Rate		0.49	0.27	0.5	Majra JP et al. Int J Reprod Contracept Obstet Gynecol. 2016
	Efficacy Condom (Vaginal)		0.9	0.8	0.95	Marfatia YS, Pandya I, Mehta K. Indian Journal of Sexually Transmitted Diseases. 2015.
	Efficacy Condom (Anal)		0.9	0.8	0.95	
	Efficacy Condom (Oral)		0.9	0.8	0.95	
	Average Sex acts per Partner Per Year (Married)		127	127	127	Sex statistics Kinsey Report, National Center for Health Statistics, 2016
	Average Sex acts per Partner Per Year in unmarried		49	49	49	
	Mean Sex Partners in married Male		1.6	1	4	Schensul, Stephen L. et al. Journal of Urban Health : Bulletin of the New York Academy of Medicine 2006
	Mean Sex Partners in unmarried Male		0.666	0	2	Kumar GA, Dandona R, Kumar SGP, Dandona L AIDS & Behaviour 2011

	Mean Sex Partners married Female		1.1	1	2	Kumar GA, Dandona R, Kumar SGP, Dandona L AIDS & Behaviour 2011
	Mean Sex Partners in unmarried Female		0.1	0	1	
	Proportion Sex acts in married	Vaginal	0.85	0.85	0.85	Durex sex survey, 2009
		Anal	0.1	0.1	0.1	
		Oral	0.05	0.05	0.05	
	Proportion Sex acts in unmarried	Vaginal	0.85	0.85	0.85	Durex sex survey, 2009
		Anal	0.1	0.1	0.1	
		Oral	0.05	0.05	0.05	
	Sexually Transmitted Disease as Co-factor in HIV Transmission		3	1.5	5	Hiv Transmission Risk: A Summary Of The Evidence CDC, 2012
Transmission Coefficients_HIV_With ART	**Male to Female without STD**	Vaginal	0.00057	0.0005	0.00037	Cohen Myron S. et.al. The New England Journal of Medicine2011
		Anal	0.00507	0.0016	0.00891	
		Oral	0.00012	0.00005	0.00017	
	Male to Female with STD	Vaginal	0.00171	0.00075	0.00185	
		Anal	0.01521	0.0024	0.04455	
		Oral	0.00036	0.000075	0.00085	
	Female to Male without STD	Vaginal	0.0003	0.0003	0.00017	
		Anal	0.00048	0.00025	0.0029	

		Oral	0.00012	0.00005	0.00017	
	Female to Male with STD	Vaginal	0.0009	0.00045	0.00085	
		Anal	0.00144	0.000375	0.0145	
		Oral	0.00036	0.000075	0.00085	
Transmission Coefficients_HIV_No ART	**Male to Female without STD**	Vaginal	0.0019	0.001	0.0037	Hiv Transmission Risk: A Summary Of The Evidence CDC, 2012
		Anal	0.0169	0.0032	0.0891	Boily et al., 2009
		Oral	0.0004	0.0001	0.0017	Vittinghoff et al., 1999
	Male to Female with STD	Vaginal	0.0057	0.0015	0.0185	HIV Transmission Risk: A Summary Of The Evidence CDC, 2012
		Anal	0.0507	0.0048	0.4455	
		Oral	0.0012	0.00015	0.0085	
	Female to Male without STD	Vaginal	0.001	0.0006	0.0017	Hughes et al., 2012
		Anal	0.0016	0.0005	0.029	Boily et al., 2009
		Oral	0.0004	0.0001	0.0017	Vittinghoff et al., 1999
	Female to Male with STD	Vaginal	0.003	0.0009	0.0085	HIV Transmission Risk: A Summary Of The Evidence CDC, 2012
		Anal	0.0048	0.00075	0.145	
		Oral	0.0012	0.00015	0.0085	
Transmission Coefficients HBV With Treatment	**Male to Female without STD**	Vaginal	0.0023622	0.00236	0.00236	Inoue T, Tanaka Y. Microbial Cell. 2016
		Anal	0.00393701	0.00394	0.00394	
		Oral	0.0007874	0.00079	0.00079	
	Male to Female with STD	Vaginal	0.00708661	0.00354	0.01181	

		Anal	0.01181102	0.00591	0.01969	
		Oral	0.0023622	0.00118	0.00394	
	Female to Male without STD	Vaginal	0.0023622	0.00236	0.00236	
		Anal	0.00393701	0.00394	0.00394	
		Oral	0.0007874	0.00079	0.00079	
	Female to Male with STD	Vaginal	0.00708661	0.00354	0.01181	
		Anal	0.01181102	0.00591	0.01969	
		Oral	0.0023622	0.00118	0.00394	
Transmission Coefficients HBV Without Treatment	**Male to Female without STD**	Vaginal	0.02362205	0.02362205	0.02362204	Inoue T, Tanaka Y. Microbial Cell. 2016
		Anal	0.03937008	0.03937008	0.03937007	
		Oral	0.00787402	0.00787402	0.00787401	
	Male to Female with STD	Vaginal	0.07086614	0.03543307	0.11811023	
		Anal	0.11811024	0.05905512	0.19685039	
		Oral	0.02362205	0.01181102	0.03937007	
	Female to Male without STD	Vaginal	0.02362205	0.02362205	0.0236220	
		Anal	0.03937008	0.03937008	0.03937007	
		Oral	0.00787402	0.00787402	0.00787401	
	Female to Male with STD	Vaginal	0.07086614	0.03543307	0.11811023	
		Anal	0.11811024	0.05905512	0.19685039	
		Oral	0.02362205	0.01181102	0.0393700	

Coverage Parameters	**Coverage of HBV Vaccination among health care workers (HCW)**	2017	0.5024	0.2576	0.72	Debbarma M et. al Br J Med Health Res. 2016
	Coverage of HBV Vaccination among general population	2017	0.05	0.02	0.1	Sujatha.R, Nidhi Pal, Arunagiri, Narendran.D 2014 International Journal of Current Medical And Applied Sciences
	Efficacy of HBV Vaccine		0.8	0.7	0.95	MG Geeta and A Riyaz 2013, International journal of paedriatics
	Proportion HCP given Post-Exposure Prophylaxis (PEP)_HIV	2017	0.05	0.02	0.1	Sharma, Rahul et al Indian Journal of Community Medicine : (2010)
	Efficacy of PEP-HIV		0.8	0.7	0.9	NACO report 2007 MoHFW, GOI
	Proportion HCP given Post-Exposure Prophylaxis (PEP)_HBV	2017	0.05	0.02	0.1	Kumar et al Hep B Vaccination and PEP Practices2015
	Efficacy of PEP-HBV		0.8	0.7	0.9	NACO report 2007 MoHFW, GOI

Table 2: List of Input Parameters, Punjab State

	Parameters		Base Value	Lower Limit	Upper Limit	Source
Demographic Parameters	Population of Punjab (2017)		29575578			Census,2011(Punjab State) 2017 Estimation
	Annual population growth rate		0.013	0.013	0.013	Census,2011 (Average annual exponential growth rate)
	Age-specific all-cause mortality	0-1	0.02561			SRS Punjab state report, 2015
		0-4	0.00542			
		5-9	0.00175			
		10-14	0.00295			
		15-19	0.00514			
		20-24	0.00772			
		25-29	0.00747			
		30-34	0.01065			
		35-39	0.01331			
		40-44	0.01883			
		45-49	0.02812			
		50-54	0.03756			
		55-59	0.05008			

		60-64	0.07616			
		65-69	0.10925			
		70-74	0.16207			
		75-79	0.21805			
		80-85	0.35102			
	Crude death rate		0.06284			
	Healthcare professionals in public sector	Doctors	3134	2507	3760	Rural Health Statistics(2015-2016)
		Nurses	5202	4162	6242.4	
		Technicians	3527	2822	4232.4	
	Healthcare professionals in Private sector(Qualified)	Doctors	25716	20573	30859	Indrajit Hazarika, PHFI WHO South-East Asia Journal of Public Health 2013
		Nurses	71461	57169	85753	
		Technicians	48448	38758	58138	
	Healthcare professional in Private sector (Non-Qualified)		17333	13866	20800	
Epidemiological Parameters	Morbidity Rate (India)		0.165	0.161	0.17	NSSO,71st Round 2014
	Proportion Sought care from public sector		0.2	0.2	0.2	
	Proportion Sought care from private sector		0.8	0.8	0.8	

	Proportion Sought care from private qualified		0.626	0.626	0.626	
	Proportion Of ill population treated in OP setting		0.9	0.9	0.9	
	Public	Primary	0.02784	0.028	0.028	
		Secondary	0.11417334	0.114	0.114	
		Tertiary	0.058	0.058	0.058	
	Private-Qualified	Primary	0.1	0.100	0.100	
		Secondary	0.27	0.270	0.270	
		Tertiary	0.13	0.130	0.130	
	Private-Non-Qualified		0.3	0.300	0.300	
	Proportion of ill population hospitalized		0.1	0.10	0.10	NSSO,71st Round
	Public	Primary	0.05	0.05	0.05	
		Secondary	0.2	0.20	0.20	NSSO,71st Round
		Tertiary	0.05	0.05	0.05	
	Private-Qualified	Primary	0.05	0.05	0.05	
		Secondary	0.5	0.50	0.50	
		Tertiary	0.15	0.15	0.15	
	Proportion patients in OP setting prescribed injections		0.44	0.44	0.44	IPEN study,2012 WHO South-East Asia Journal of Public Health

	Public	Primary	0.383	0.383	0.383	
		Secondary	0.383	0.383	0.383	
		Tertiary	0.383	0.383	0.383	
	Private-Qualified	Primary	0.457	0.457	0.457	
		Secondary	0.457	0.457	0.457	
		Tertiary	0.457	0.457	0.457	
	Private-Non-Qualified		0.56	0.56	0.56	
	Proportion patients in IP setting prescribed injections		0.85	0.85	0.85	Gawande U et al. Int J Res Med Sci. 2015
	Public	Primary	0.75	0.75	0.75	
		Secondary	0.8	0.8	0.8	
		Tertiary	0.85	0.85	0.85	
	Private-Qualified	Primary	0.84	0.84	0.84	
		Secondary	0.896	0.896	0.896	
		Tertiary	0.952	0.952	0.952	
	Frequency of injections per patient in OP setting		2.9	2	4	IPEN study,2012 WHO South-East Asia Journal of Public Health
	Public	Primary	2.3	2	4	
		Secondary	2.6	2	4	
		Tertiary	2.9	2	4	
	Private-Qualified	Primary	2.6	2	4	
		Secondary	2.9	2	4	

		Tertiary	3.2	2	4	
	Private-Non-Qualified		3.8	2	4	
	Frequency of injections per patient in IP setting		2.9	2	4	IPEN study,2012 WHO South-East Asia Journal of Public Health
	Public	Primary	2.3	2	4	
		Secondary	2.6	2	4	
		Tertiary	2.9	2	4	
	Private-Qualified	Primary	2.576	2	4	
		Secondary	2.912	2	4	
		Tertiary	4	2	4	
	Overall Proportion of Injections for Therapeutic care		0.83	0.83	0.83	Janjua NZ et al .2016 World Journal of Gastroenterology.
	Overall Proportion of Injections for Preventive care		0.17	0.17	0.17	
	Proportion of Injections for Therapeutic care in Public		0.32	0.32	0.32	
	Proportion of Injections for Preventive care in Public		0.68	0.68	0.68	
	Proportion of Injections for Therapeutic care in Private		0.68	0.68	0.68	
	Proportion of Injections for Preventive care in Private		0.32	0.32	0.32	
	Proportion of Injections by route in OP Setting	Intravenous (IV)	0.1285	0.1285	0.1285	HS Rehan et.al. J Infect Public Health. 2012

		Intramuscular (IM)	0.4714	0.4714	0.4714	https://www.ncbi.nlm.nih.gov/pubmed/22541265
		Intradermal (ID)	0.2857	0.2857	0.2857	
		subcutaneous (SC)	0.1144	0.1144	0.1144	
	Proportion of Injections by route in IP Setting	Intravenous (IV)	0.7667	0.7667	0.7667	
		Intramuscular (IM)	0.2167	0.2167	0.2167	
		Intradermal (ID)	0	0	0	
		subcutaneous (SC)	0.0167	0.0167	0.0167	
	Use of Disposable Syringes		1	1	1	Saoji et al. 2011 Global Journal of Health Science
	Public		1	1	1	
	Primary	Intravenous (IV)	0.4476	0.4476	0.4476	Saoji et al. 2011 Global Journal of Health Science
		Intramuscular (IM)	0.34405	0.34405	0.34405	
		Intradermal (ID)	0.14285	0.14285	0.14285	
		subcutaneous (SC)	0.0655	0.0655	0.0655	
	Secondary	Intravenous (IV)	0.4476	0.4476	0.4476	
		Intramuscular (IM)	0.34405	0.34405	0.34405	
		Intradermal (ID)	0.14285	0.14285	0.14285	
		subcutaneous (SC)	0.0655	0.0655	0.0655	
	Tertiary	Intravenous (IV)	0.4476	0.4476	0.4476	
		Intramuscular (IM)	0.34405	0.34405	0.34405	
		Intradermal (ID)	0.14285	0.14285	0.14285	

		subcutaneous (SC)	0.0655	0.0655	0.0655	
	Private-Qualified		1	1	1	Saoji et al. 2011 Global Journal of Health Science
	Primary	Intravenous (IV)	0.4476	0.4476	0.4476	
		Intramuscular (IM)	0.34405	0.34405	0.34405	
		Intradermal (ID)	0.14285	0.14285	0.14285	
		subcutaneous (SC)	0.0655	0.0655	0.0655	
	Secondary	Intravenous (IV)	0.4476	0.4476	0.4476	
		Intramuscular (IM)	0.34405	0.34405	0.34405	
		Intradermal (ID)	0.14285	0.14285	0.14285	
		subcutaneous (SC)	0.0655	0.0655	0.0655	
	Tertiary	Intravenous (IV)	0.4476	0.4476	0.4476	
		Intramuscular (IM)	0.34405	0.34405	0.34405	
		Intradermal (ID)	0.14285	0.14285	0.14285	
		subcutaneous (SC)	0.0655	0.0655	0.0655	
	Private-Non-Qualified	Intravenous (IV)	0.4476	0.4476	0.4476	
		Intramuscular (IM)	0.34405	0.34405	0.34405	
		Intradermal (ID)	0.14285	0.14285	0.14285	
		subcutaneous (SC)	0.0655	0.0655	0.0655	
	Use of RUP Syringes		0	0	0	Currently, RUP syringe is not used in the therapeutic sector
	Use of SIP Syringes		0	0	0	Currently, SIP syringe is not used in the therapeutic sector

	Proportion reuse of Disposable syringe in OP setting		0.05	0.0023	0.1400	D Sahu et.al. 2015 Sridevi Garapati, Sujatha Peethala,2014
	Public	Primary	0.0459	0.00207	0.129	
		Secondary	0.0459	0.00207	0.129	
		Tertiary	0.0459	0.00207	0.129	
	Private-Qualified	Primary	0.0526	0.002369	0.147	
		Secondary	0.0526	0.002369	0.147	
		Tertiary	0.0526	0.002369	0.147	
	Private-Non-Qualified		0.0546	0.002461	0.153	
	Proportion reuse of disposable syringe in IP setting		0.05	0.0023	0.1400	D Sahu et.al. 2015 Sridevi Garapati, Sujatha Peethala,2014
	Public	Primary	0.0459	0.00207	0.129	
		Secondary	0.0459	0.00207	0.129	
		Tertiary	0.0459	0.00207	0.129	
	Private-Qualified	Primary	0.0526	0.002369	0.147	
		Secondary	0.0526	0.002369	0.147	
		Tertiary	0.0526	0.002369	0.147	
	Private-Non-Qualified		0.0546	0.002461	0.153	
	Proportion Injections administered by Doctors		0.2571	0.2571	0.2571	M Kermode,2006
	Public	Primary	0.3	0.3	0.3	
		Secondary	0.2	0.2	0.2	

		Tertiary	0.1	0.1	0.1	
	Private-Qualified	Primary	0.3	0.3	0.3	
		Secondary	0.2	0.2	0.2	
		Tertiary	0.1	0.1	0.1	
	Private-Non-Qualified		0.6	0.6	0.6	
	Proportion Injections administered by Nurses		0.5714	0.5714	0.5714	M Kermode,2006
	Public	Primary	0.5	0.5	0.5	
		Secondary	0.6	0.6	0.6	
		Tertiary	0.7	0.7	0.7	
	Private-Qualified	Primary	0.5	0.5	0.5	
		Secondary	0.6	0.6	0.6	
		Tertiary	0.7	0.7	0.7	
	Private-Non-Qualified		0.4	0.4	0.4	
	Proportion Injections administered by Technicians/Others		0.1714	0.1714	0.1714	M Kermode,2006
	Public	Primary	0.2	0.2	0.2	
		Secondary	0.2	0.2	0.2	
		Tertiary	0.2	0.2	0.2	
	Private-Qualified	Primary	0.2	0.2	0.2	
		Secondary	0.2	0.2	0.2	

		Tertiary	0.2	0.2	0.2	
	Private-Non-Qualified		0	0	0	
	Risk of Needle Stick Injury (NSI) from Intramuscular (IM) injections/ Intravenous injections(IV)/ Subcutaneous injections/Intradermal injections	Disposable syringes	0.003537	0.00283	0.0042444	Sangwan, B., Kotwal, A., & Verma, A. (2011)
		RUP	0.001746	0.00166	0.0026864	
		SIP	0.002561	0.00244	0.0039401	Younger B et.al. . Infection Control and Hospital Epidemiology 1992
	Proportion NSI come in contact with blood		0.68	0.5	0.9	Munish A,et.al.,2011 Indian Journal Of Medical Sciences
	Stage-wise distribution of HBV patients at diagnosis	Inapparent Infection	0	0	0	Namrata Kumari et al.2015
		Apparent Infection	0.321	0.321	0.321	
		Non-Fulminant Hepatitis	0.013	0.013	0.013	
		Fulminant Hepatitis	0.0064	0.0064	0.0064	
		Acquired Immunity	0	0	0	
		Asymptotic Carrier	0	0	0	
		Chronic Hepatitis	0.407	0.407	0.407	
		Compensated Cirrhosis	0.14	0.14	0.14	
		Decompensated Cirrhosis	0.045	0.045	0.045	
		Hepatocellular Carcinoma	0.0676	0.0676	0.0676	
		Asymptotic Carrier	0	0	0	

	Stage-wise distribution of HCV patients at diagnosis	Chronic Hepatitis	0.37 0.45	0.37 0.45	0.37 0.45	Gupta V et. al. J Clin Exp Hepatol. 2015
		Compensated Cirrhosis	0.11	0.11	0.11	
		Hepatocellular Carcinoma	0.07	0.07	0.07	
	Stage-wise distribution of HIV patients at diagnosis	CD4 Cell count >500 per mm^3	0.0639	0.0639	0.0639	Bishnu, Saptarshi et al The Indian Journal of Medical Research 2014
		CD4 Cell count between 500-350 per mm^3	0.0694	0.0694	0.0694	
		CD4 Cell count between 350-200 per mm^3	0.2167	0.2167	0.2167	
		CD4 Cell count between 200-50 per mm^3	0.1833	0.1833	0.1833	
		CD4 Cell count <50 per mm^3	0.4667	0.4667	0.4667	
	Prevalence of HBV among patients seeking treatment	Public	0.0231	0.0161	0.0413	Sharma M et al International Archives of BioMedical and Clinical Research 2017
		Private-Qualified	0.0161	0.0161	0.0413	
		Private-Non-qualified	0.0161	0.0161	0.0413	
	Prevalence of HCV among	Public	0.0068	0.0059	0.0077	Kanodia V et. al., International Medical Journal March 2015; http://www.medpulse.in

	patients seeking treatment	Private-Qualified	0.0059	0.0059	0.0077	
		Private-Non-qualified	0.0059	0.0059	0.0077	
	Prevalence of HIV among patients seeking treatment	Public	0.0083	0.0059	0.0088	Sood, S., & Malvankar, S. (2010) Indian Journal of Community Medicine
		Private-Qualified	0.0035	0.0059	0.0088	
		Private-Non-qualified	0.0035	0.0059	0.0088	
	Risk of Transmission					
	HBV	Intravenous (IV)	0.18	0.06	0.3	Blood-Borne Diseases Surveillance Protocol for Ontario Hospitals, 2012
		Intramuscular (IM)	0.018	0.006	0.03	
		Intradermal (ID)	0.00001	0.00001	0.00001	
		subcutaneous (SC)	0.0018	0.0006	0.003	
	HCV	Intravenous (IV)	0.018	0.001	0.07	CDC, Hepatitis C Information for health professionals
		Intramuscular (IM)	0.0018	0.0001	0.007	
		Intradermal (ID)	0.00001	0.00001	0.00001	
		subcutaneous (SC)	0.00018	0.00001	0.0007	
	HIV	Intravenous (IV)	0.0023	0.0001	0.0046	Guidelines for the Management of Occupational Exposures to HIV CDC MMWR U.S, 2005
		Intramuscular (IM)	0.00023	0.00001	0.00046	
		Intradermal (ID)	0.0000001	0.0000001	0.0000001	

		subcutaneous (SC)	0.000023	0.000001	0.00007	
	Abscess formation	Intravenous (IV)	0.078	0.078	0.078	Hashemi SH et al. Avicenna J Clin Microb Infec. 2015
		Intramuscular (IM)	0.02	0.02	0.02	
		Intradermal (ID)	0.00001	0.00001	0.00001	
		subcutaneous (SC)	0.01	0.01	0.01	
	Septicemia	Intravenous (IV)	0.053	0.053	0.053	Hashemi SH et al. Avicenna J Clin Microb Infec. 2015
		Intramuscular (IM)	0.02	0.02	0.02	
		Intradermal (ID)	0.00001	0.00001	0.00001	
		subcutaneous (SC)	0.01	0.01	0.01	
	Pain/Disabilities	Intravenous (IV)	0.053	0.053	0.053	Hashemi SH et al. Avicenna J Clin Microb Infec. 2015
		Intramuscular (IM)	0.02	0.02	0.02	
		Intradermal (ID)	0.00001	0.00001	0.00001	
		subcutaneous (SC)	0.01	0.01	0.01	
Intervention Parameters	Use of RUP Syringes					
	Public		1	1	1	
	Primary	Intravenous (IV)	0.4476	0.4476	0.4476	Saoji et al. 2011 Global Journal of Health Science
		Intramuscular (IM)	0.34405	0.34405	0.34405	
		Intradermal (ID)	0.14285	0.14285	0.14285	
		subcutaneous (SC)	0.0655	0.0655	0.0655	
	Secondary	Intravenous (IV)	0.4476	0.4476	0.4476	
		Intramuscular (IM)	0.34405	0.34405	0.34405	

		Intradermal (ID)	0.14285	0.14285	0.14285	
		subcutaneous (SC)	0.0655	0.0655	0.0655	
	Tertiary	Intravenous (IV)	0.4476	0.4476	0.4476	
		Intramuscular (IM)	0.34405	0.34405	0.34405	
		Intradermal (ID)	0.14285	0.14285	0.14285	
		subcutaneous (SC)	0.0655	0.0655	0.0655	
	Private-Qualified					
	Primary	Intravenous (IV)	0.4476	0.4476	0.4476	
		Intramuscular (IM)	0.34405	0.34405	0.34405	
		Intradermal (ID)	0.14285	0.14285	0.14285	
		subcutaneous (SC)	0.0655	0.0655	0.0655	
	Secondary	Intravenous (IV)	0.4476	0.4476	0.4476	
		Intramuscular (IM)	0.34405	0.34405	0.34405	
		Intradermal (ID)	0.14285	0.14285	0.14285	
		subcutaneous (SC)	0.0655	0.0655	0.0655	
	Tertiary	Intravenous (IV)	0.4476	0.4476	0.4476	
		Intramuscular (IM)	0.34405	0.34405	0.34405	
		Intradermal (ID)	0.14285	0.14285	0.14285	
		subcutaneous (SC)	0.0655	0.0655	0.0655	
	Private-Non-Qualified	Intravenous (IV)	0.4476	0.4476	0.4476	
		Intramuscular (IM)	0.34405	0.34405	0.34405	

		Intradermal (ID)	0.14285	0.14285	0.14285	
		subcutaneous (SC)	0.0655	0.0655	0.0655	
	Use of SIP Syringes		0	0	0	
	Use of Disposable syringe		0	0	0	
Efficacy Parameters	Effectiveness of SES in reducing NSIs	AD	0	0	0	Systematic review was done separately for these parameters
		RUP	0.4	0.27	0.59	
		SIP	0.12	0.04	0.41	
	Effectiveness of trainings on safe practices for HCW on reducing NSI		0.66	0.5	0.8	
Cost Parameters	Per unit cost of Disposable syringe		1.03	0.66	2.56	WHO(PQS), PAHO & UNICEF
	Per unit cost of RUP syringe		4.2	3.22	5.16	WHO(PQS), PAHO & UNICEF
	Per unit cost of SIP syringe		11	8.38	15.47	WHO(PQS), PAHO & UNICEF
	Per unit cost of RUP+SIP syringe		11	5.8	16.2	WHO(PQS), PAHO & UNICEF
	Per unit costs of Trainings for HCP on safe practices	Block level	0	0	0	
		District level	50000	50000	50000	
		State level	308000	308000	308000	
	Number of districts		143	143	143	Rural health statistics 2015-2016
	Average cost of waste disposal per bed per day		22	22	22	

	Average cost of waste storage and segregation at hospital per bed		6.38	4.65	6.8	
	Total number of health facilities	PHC	427	427	427	Rural health statistics 2015-2016
		CHC	150	150	150	Rural health statistics 2015-2016
		SDH	41	41	41	
		DH	22	22	22	
		MC	3	3	3	
	Average beds per health facility	PHC	6	4	8	
		CHC	30	20	40	
		SDH	50	40	60	
		DH	200	100	300	
		MC	500	400	700	
	Increase in volume of waste due to improved management (Intervention)		1	1	1	
	Average salary of Doctors in India- Public Sector		80000	50000	150000	Expert opinion
	Average salary of Doctors in India- Private Sector		120000	70000	250000	

	Average salary of nursing staff- Public Sector		40000	20000	60000	
	Average salary of nursing staff- Private Sector		20000	10000	30000	
Treatment Costs	Proportion patients require hospitalization					Expert opinion
	HBV					
	Inapparent Infection					
	Apparent Infection					
	Non-Fulminant Hepatitis					
	Fulminant Hepatitis		0.8	0.8	0.8	
	Acquired Immunity					Expert opinion
	Asymptotic Carrier					
	Chronic Hepatitis		0.05	0.05	0.05	
	Compensated Cirrhosis					
	Decompensated Cirrhosis		0.7	0.7	0.7	
	Hepatocellular Carcinoma					
	HCV					
	Normal		-			
	Asymptotic Carrier		-			
	Chronic Hepatitis		0.05	0.05	0.05	
	Compensated Cirrhosis		-			

	Decompensated Cirrhosis		0.7	0.7	0.7	
	Number of hospitalizations (per patient per year)					
	HBV	Inapparent Infection				NACO annual report 2016-2017
		Apparent Infection				
		Non-Fulminant Hepatitis				
		Fulminant Hepatitis				
		Acquired Immunity				
		Asymptotic Carrier				
		Chronic Hepatitis	2	2	2	
		Compensated Cirrhosis				
		Decompensated Cirrhosis	12	12	12	
		Hepatocellular Carcinoma				
	HCV	Normal				
		Asymptotic Carrier				
		Chronic Hepatitis	2	2	2	
		Compensated Cirrhosis				

		Decompensated Cirrhosis	12	12	12	
		Hepatocellular Carcinoma				
	Number of OPD contacts (per patient per year)					
	HBV	Inapparent Infection				
		Apparent Infection				
		Non-Fulminant Hepatitis				
		Fulminant Hepatitis	4	4	4	
		Acquired Immunity				
		Asymptotic Carrier				
		Chronic Hepatitis	12	12	12	
		Compensated Cirrhosis	3	3	3	
		Decompensated Cirrhosis	12	12	12	
		Hepatocellular Carcinoma	12	12	12	
	HCV	Normal				
		Asymptotic Carrier				
		Chronic Hepatitis	12	12	12	

		Compensated Cirrhosis	3	3	3	
		Decompensated Cirrhosis	12	12	12	
		Hepatocellular Carcinoma	12	12	12	
	Proportion Patient seeking care from Centre for Excellence for HIV		0.045		0.045	
	Proportion Patient seeking care from ART Centre for HIV		0.955	1	0.955	NSSO 71st Round 2014-2015
	Proportion Patients utilize public sector hospitals in OP settings for HBV/HCV	Secondary	0.086	0.086	0.086	
		Tertiary	0.132	0.132	0.132	Mukh Mantri Punjab Hepatitis C Relief Fund , Punjab Government, 2016
	Proportion Patients utilize private sector hospitals in OP settings for HBV/HCV	Secondary	0.365	0.365	0.365	
		Tertiary	0.417	0.417	0.417	
	Proportion Patients utilize public sector hospitals in IP settings for HBV/HCV	Secondary	0.06	0.06	0.06	
		Tertiary	0.4	0.4	0.4	
	Proportion Patients utilize private sector hospitals in IP settings for HBV/HCV	Secondary	0	0	0	
		Tertiary	0.54	0.54	0.54	

	Cost of Diagnostic Tests in Public sector for HCV	ELISA	50	35	65	
		HCV-RNA	2200	1540	2860	
		Routine	500	350	650	
	Cost of Diagnostic Tests in Private sector for HCV	ELISA	100	70	130	
		HCV-RNA	5000	3500	6500	
		Routine	700	490	910	
	No. of OPD contacts for diagnosis		2	2	2	
	Cost of Genotype testing in Public sector		3000	2100	3900	Mukh Mantri Punjab Hepatitis C Relief Fund , Punjab Government, 2016
	Cost of Genotype testing in Private sector		5500	3850	7150	
	Proportion Of Patients with HCV Genotype 2 and 3		0.74	0.74	0.74	Prasanta K Bhattacharya and Aakash Roy J Liver 2015
	Proportion Of Patients with HCV Genotype 1,4,5 and 6		0.26	0.26	0.26	
	Cost of SOF+DCV for 12 weeks in Public sector		7304	5112.8	9495.2	Mukh Mantri Punjab Hepatitis C Relief Fund , Punjab Government, 2016

	Cost of SOF+DCV for 12 weeks in Private sector		42000	29400	54600	Cipla Limited,2017
	Cost of SOF+DCV+RIBA for 24 weeks in Public sector		17948	12563.6	23332.4	
	Cost of SOF+DCV+RIBA for 24 week in Private sector		84000	58800	109200	
	Cost of Cenotenofovir for HBV(Annual @45.98 per tab)		16782	11747.4	21816.6	
	Cost of Entecavir for HBV (Annual @74.5 per tab)		27192	19034.4	35349.6	Cadila Healthcare (Zydus Cadila Healthcare Ltd) 2017
	Cost of Best Support Care(Annual)		38916	27241.2	50590.8	Mukh Mantri Punjab Hepatitis C Relief Fund , Punjab Government, 2016
	Length of Treatment (in years)		4	4	4	
Average cost of treatment in Public sector (OPD)			Primary Care(INR)	Secondary care(INR)	Tertiary Care(INR)	Prinja et al (2017). Pharmacoeconomics Open; Prinja et al (2017). Indian J Med Research Punjab Govt.-Mukh Mantri Punjab Hepatitis C Relief Fund
	HBV		1686.3	1734	2024	
	HCV		1686.3	1734	2024	
	HIV		300	705	705	Sharma et al (2016). Unpublished
	HBV		6347.1	7597	18693	Prinja et al (2017). Pharmacoeconomics Open;

Average cost of treatment in Public sector (IPD)	HCV		6347.1	7597	18693	Prinja et al (2017). Indian J Med Research Punjab Govt.-Mukh Mantri Punjab Hepatitis C Relief Fund
	HIV		0	995	5592	Sharma et al (2016). Unpublished
Average cost of treatment in Private sector (OPD)	HBV		8625	8625	1400	Prinja et al (2017). Pharmacoeconomics Open; Prinja et al (2017). Indian J Med Research Punjab Govt.-Mukh Mantri Punjab Hepatitis C Relief Fund
	HCV		8625	8625	1400	
	HIV		0	0	1358	Sharma et al (2016). Unpublished
Average cost of treatment in Private sector (IPD)	HBV		26774	26774	26774	Prinja et al (2017). Pharmacoeconomics Open; Prinja et al (2017). Indian J Med Research Punjab Govt.-Mukh Mantri Punjab Hepatitis C Relief Fund
	HCV		26774	26774	26774	
	HIV		0	0	8000	Sharma et al (2016). Unpublished
QOL weights	Stage-wise QOL weights-HBV	Inapparent Infection	1			Levy et. al 2008, International Society for Pharmacoeconomics and Outcomes Research (ISPOR)
		Apparent Infection	0.95	0.93	0.96	
		Non-Fulminant Hepatitis	0.95	0.93	0.96	
		Fulminant Hepatitis	0.35	0.32	0.37	
		Acquired Immunity	0.95	0.93	0.96	
		Asymptotic Carrier	0.7306063	0.73	0.77	
		Chronic Hepatitis	0.68	0.66	0.71	

		Compensated Cirrhosis	0.69	0.66	0.71	
		Decompensated Cirrhosis	0.35	0.32	0.37	
		Hepatocellular Carcinoma	0.38	0.36	0.41	
	Stage-wise QOL weights-HCV	Normal	1			Wright et. al ,2006 Health Technol Assess. 2006
		Asymptotic Carrier	0.9	0.93	0.96	
		Chronic Hepatitis	0.7	0.63	0.76	
		Compensated Cirrhosis	0.55	0.48	0.65	
		Decompensated Cirrhosis	0.49	0.48	0.61	
		Hepatocellular Carcinoma	0.58038276	0.48	0.61	
	Stage-wise QOL weights-HIV	CD4 Cell count >500 per mm^3	0.946	0.924	0.964	Simpson Kit N.et. al. 2015 HIV clinical trial
		CD4 Cell count between 500-350 per mm^3	0.933	0.914	0.951	
		CD4 Cell count between 350-200 per mm^3	0.931	0.914	0.951	

		CD4 Cell count between 200-50 per mm^3	0.853	0.835	0.865	
		CD4 Cell count <50 per mm^3	0.781	0.781	0.781	
	Discount Rate		0.03	0.02	0.05	
	Proportion of general population (Males)		0.55	0.55	0.55	Census 2011 report
	Proportion of general population (Females)		0.45	0.45	0.45	estimated from 25-30 years age group of Census data for married males and females
	Proportion of married general population (Males)		0.47	0.47	0.47	
	Proportion of married in general population (Females)		0.53	0.53	0.53	
	Proportion of married in HCP (Doctors, Nurses, Technicians)_Males		0.844	0.844	0.844	
	Prop. Married in HCP (Doctors, Nurses, Technicians)_Females		0.834	0.834	0.834	
	Proportion of Doctors(Males)		0.832	0.832	0.832	Sudhir Anand and Victoria Fan 2006 The Health Workforce In India Human Resources for Health
	Proportion of Doctors(Females)		0.168	0.168	0.168	
	Proportion of Nurses (Males)		0.166	0.166	0.166	

	Proportion of Nurses(Females)		0.834	0.834	0.834	
	Proportion of Technicians(Males)		0.9	0.9	0.9	
	Proportion of Technicians(Females)		0.1	0.1	0.1	
	Prevalence of STI in general population (Male)		0.035	0.01	0.1	Jindal, Neerja et al Indian Journal of Community Medicine (2009)
	Prevalence of STI in general population (Female)		0.2	0.17	0.27	NACO Report 2016-2017
	Proportion PLHIV on ART		0.43	0.43	0.43	
	Proportion PLHIV not on ART		0.57	0.57	0.57	
	Proportion HBV Patients on treatment		0.5	0.5	0.5	
	Proportion HBV Patients not on treatment		0.5	0.5	0.5	
	Condom Use Rate		0.49	0.27	0.5	Majra JP et al. Int J Reprod Contracept Obstet Gynecol. 2016
	Efficacy Condom (Vaginal)		0.9	0.8	0.95	Marfatia YS, Pandya I, Mehta K. Indian Journal of Sexually Transmitted Diseases. 2015.
	Efficacy Condom (Anal)		0.9	0.8	0.95	

	Efficacy Condom (Oral)		0.9	0.8	0.95	
	Average Sex acts per Partner Per Year (Married)		127	127	127	Sex statistics Kinsey Report, National Center for Health Statistics, 2016
	Average Sex acts per Partner Per Year in unmarried		49	49	49	
	Mean Sex Partners in married Male		1.6	1	4	Schensul, Stephen L. et al. Journal of Urban Health : Bulletin of the New York Academy of Medicine 2006
	Mean Sex Partners in unmarried Male		0.666	0	2	Kumar GA, Dandona R, Kumar SGP, Dandona L AIDS & Behaviour 2011
	Mean Sex Partners married Female		1.1	1	2	Kumar GA, Dandona R, Kumar SGP, Dandona L AIDS & Behaviour 2011
	Mean Sex Partners in unmarried Female		0.1	0	1	
	Proportion Sex acts in married	Vaginal	0.85	0.85	0.85	Durex sex survey, 2009
		Anal	0.1	0.1	0.1	
		Oral	0.05	0.05	0.05	
	Proportion Sex acts in unmarried	Vaginal	0.85	0.85	0.85	Durex sex survey, 2009
		Anal	0.1	0.1	0.1	
		Oral	0.05	0.05	0.05	
	Sexually Transmitted Disease as Co-factor in HIV Transmission		3	1.5	5	Hiv Transmission Risk: A Summary Of The Evidence CDC, 2012

Transmission Coefficients HIV With ART	Male to Female without STD	Vaginal	0.00057	0.0005	0.00037	Cohen Myron S. et.al. The New England Journal of Medicine2011
		Anal	0.00507	0.0016	0.00891	
		Oral	0.00012	0.00005	0.00017	
	Male to Female with STD	Vaginal	0.00171	0.00075	0.00185	
		Anal	0.01521	0.0024	0.04455	
		Oral	0.00036	0.000075	0.00085	
	Female to Male without STD	Vaginal	0.0003	0.0003	0.00017	
		Anal	0.00048	0.00025	0.0029	
		Oral	0.00012	0.00005	0.00017	
	Female to Male with STD	Vaginal	0.0009	0.00045	0.00085	
		Anal	0.00144	0.000375	0.0145	
		Oral	0.00036	0.000075	0.00085	
Transmission Coefficients HIV No ART	Male to Female without STD	Vaginal	0.0019	0.001	0.0037	Hiv Transmission Risk: A Summary Of The Evidence CDC, 2012
		Anal	0.0169	0.0032	0.0891	Boily et al., 2009
		Oral	0.0004	0.0001	0.0017	Vittinghoff et al., 1999
	Male to Female with STD	Vaginal	0.0057	0.0015	0.0185	HIV Transmission Risk: A Summary Of The Evidence CDC, 2012
		Anal	0.0507	0.0048	0.4455	
		Oral	0.0012	0.00015	0.0085	
	Female to Male without STD	Vaginal	0.001	0.0006	0.0017	Hughes et al., 2012

		Anal	0.0016	0.0005	0.029	Boily et al., 2009
		Oral	0.0004	0.0001	0.0017	Vittinghoff et al., 1999
	Female to Male with STD	Vaginal	0.003	0.0009	0.0085	HIV Transmission Risk: A Summary Of The Evidence CDC, 2012
		Anal	0.0048	0.00075	0.145	
		Oral	0.0012	0.00015	0.0085	
Transmission Coefficients HBV With Treatment	**Male to Female without STD**	Vaginal	0.0023622	0.00236	0.00236	Inoue T, Tanaka Y. Microbial Cell. 2016
		Anal	0.00393701	0.00394	0.00394	
		Oral	0.0007874	0.00079	0.00079	
	Male to Female with STD	Vaginal	0.00708661	0.00354	0.01181	
		Anal	0.01181102	0.00591	0.01969	
		Oral	0.0023622	0.00118	0.00394	
	Female to Male without STD	Vaginal	0.0023622	0.00236	0.00236	
		Anal	0.00393701	0.00394	0.00394	
		Oral	0.0007874	0.00079	0.00079	
	Female to Male with STD	Vaginal	0.00708661	0.00354	0.01181	
		Anal	0.01181102	0.00591	0.01969	
		Oral	0.0023622	0.00118	0.00394	
Transmission Coefficients HBV Without Treatment	**Male to Female without STD**	Vaginal	0.02362205	0.02362205	0.02362204	Inoue T, Tanaka Y. Microbial Cell. 2016
		Anal	0.03937008	0.03937008	0.03937007	
		Oral	0.00787402	0.00787402	0.00787401	
	Male to Female with STD	Vaginal	0.07086614	0.03543307	0.11811023	

		Anal	0.11811024	0.05905512	0.19685039	
		Oral	0.02362205	0.01181102	0.03937007	
	Female to Male without STD	Vaginal	0.02362205	0.02362205	0.0236220	
		Anal	0.03937008	0.03937008	0.03937007	
		Oral	0.00787402	0.00787402	0.00787401	
	Female to Male with STD	Vaginal	0.07086614	0.03543307	0.11811023	
		Anal	0.11811024	0.05905512	0.19685039	
		Oral	0.02362205	0.01181102	0.0393700	
Coverage Parameters	Coverage of HBV Vaccination among health care workers (HCW)	2017	0.5	0.4	0.6	Debbarma M et. al Br J Med Health Res. 2016
	Coverage of HBV Vaccination among general population	2017	0.05	0.02	0.1	Sujatha.R, Nidhi Pal, Arunagiri, Narendran.D 2014 International Journal of Current Medical And Applied Sciences
	Efficacy of HBV Vaccine		0.8	0.7	0.95	MG Geeta and A Riyaz 2013, International journal of paedriatics
	Proportion HCP given Post-Exposure Prophylaxis (PEP)_HIV	2017	0.05	0.02	0.1	Sharma, Rahul et al Indian Journal of Community Medicine : (2010)
	Efficacy of PEP-HIV		0.8	0.7	0.9	NACO report 2007 MoHFW, GOI
	Proportion HCP given Post-Exposure Prophylaxis (PEP)_HBV	2017	0.05	0.02	0.1	Kumar et al Hep B Vaccination and PEP Practices2015
	Efficacy of PEP-HBV		0.8	0.7	0.9	NACO report 2007 MoHFW, GOI

Section E: Equations

Needle Stick Injuries

$$\sum\left(V_{ijk}^{OPD} + V_{ijk}^{IPD}\right) * (\mathcal{P}_{ijkl} * \mathcal{R}_l * \mathcal{T}_{ijm})$$

Where;

V:	Volume of injections
i:	1= Public, 2= Private Qualified, 3= Private Non-Qualified
j:	1= Primary, 2= Secondary, 3= Tertiary
k:	1= Intravenous, 2= Intramuscular, 3= Intradermal,4= Subcutaneous
$\mathcal{P}$:	Proportion use of syringe
l:	1= Disposable, 2=RUP, 3=SIP, 4= RUP+SIP
$\mathcal{R}$:	Risk of Needle Stick Injury (NSI)
$\mathcal{T}$:	Proportion of injections administered
m	1=Doctors, 2= Nurses, 3= Others

HBV Transmission in NSI

$$\sum \rho_i * (\alpha * \beta * \gamma * \delta * \varepsilon) * \mu_k)$$

Where;

ρ:	Prevalence of HBV among patient population
i:	1= Public, 2= Private Qualified, 3= Private Non-Qualified
α:	Proportion NSI come in contact with blood
β:	Coverage of HBV vaccination
γ:	Efficacy of HBV vaccine
δ:	Coverage of Post Exposure Prophylaxis (PEP)
ε:	Efficacy of PEP
μ:	Risk of HBV transmission
k::	1= Intravenous, 2= Intramuscular, 3= Intradermal,4= Subcutaneous

HCV Transmission in NSI

$$\sum \rho_i * \alpha * \mu_k)$$

Where;

ρ:	Prevalence of HCV among patient population
i:	1= Public, 2= Private Qualified, 3= Private Non-Qualified
α:	Proportion NSI come in contact with blood
μ:	Risk of HCV transmission
k::	1= Intravenous, 2= Intramuscular, 3= Intradermal,4= Subcutaneous

HIV Transmission in NSI

$$\sum \rho_i * (\alpha * \delta * \varepsilon) * \mu_k)$$

Where; ρ: Prevalence of HIV among patient population
i: 1= Public, 2= Private Qualified, 3= Private Non-Qualified
α: Proportion NSI come in contact with blood
δ: Coverage of Post Exposure Prophylaxis (PEP)
ε: Efficacy of PEP
μ: Risk of HIV transmission
k:: 1= Intravenous, 2= Intramuscular, 3= Intradermal,4= Subcutaneous

Reuse Episodes

$$\sum\left(V_{ijk}^{OPD} + V_{ijk}^{IPD}\right) * (\mathcal{P}_{ijkl} * \lambda_{ij})$$

Where; V: Volume of injections
i: 1= Public, 2= Private Qualified, 3= Private Non-Qualified
j: 1= Primary, 2= Secondary, 3= Tertiary
k: 1= Intravenous, 2= Intramuscular, 3= Intradermal,4= Subcutaneous
$\mathcal{P}$: Proportion use of syringe
l: 1= Disposable, 2=RUP, 3=SIP, 4= RUP+SIP
λ: Reuse rate

HCV Transmission (Reuse)

$$\sum \rho_i * (\beta * \gamma * \varepsilon) * \mu_k)$$

Where; ρ: Prevalence of HBV among patient population
i: 1= Public, 2= Private Qualified, 3= Private Non-Qualified
β: Coverage of HBV vaccination
γ: Efficacy of HBV vaccine
μ: Risk of HBV transmission
k:: 1= Intravenous, 2= Intramuscular, 3= Intradermal,4= Subcutaneous

HBV Transmission (Reuse)

$$\sum(\rho_i * \mu_k)$$

Where; ρ: Prevalence of HCV among patient population
i: 1= Public, 2= Private Qualified, 3= Private Non-Qualified
μ: Risk of HCV transmission
k:: 1= Intravenous, 2= Intramuscular, 3= Intradermal,4= Subcutaneous

HIV Transmission (Reuse)

$$\sum(\rho_i * \mu_k)$$

Where; ρ: Prevalence of HIV among patient population
i: 1= Public, 2= Private Qualified, 3= Private Non-Qualified
μ: Risk of HIV transmission
k:: 1= Intravenous, 2= Intramuscular, 3= Intradermal,4= Subcutaneous