Cost of Intensive Care Treatment for Liver Disorders at Tertiary Care Level in India

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Shankar Prinja[1] · Pankaj Bahuguna[1] · Ajay Duseja[2] · Manmeet Kaur[1] ·
Yogesh Kumar Chawla[2]

Abstract

Background Liver diseases contribute significantly to the health and economic burden globally. We undertook this study to assess the health system costs, out-of-pocket (OOP) expenditure and extent of financial risk protection associated with treatment of liver disorders in a tertiary care public sector hospital in India.

Methodology The present study was undertaken in an intensive care unit (ICU) of a tertiary care hospital in North India. It comprised an ICU and an HDU (high dependency unit). Bottom-up micro-costing was undertaken to assess the health system costs. Data on OOP expenditure and indirect costs were collected for 150 liver disorder patients admitted to the ICU or HDU from December 2013 to October 2014. Per-patient and per-bed-day costs of treatment were estimated from both health system and patient perspectives. Financial risk protection was assessed by computing prevalence of catastrophic health expenditure as a result of OOP expenditure.

Results In 2013–2014, health system costs per patient treated in the ICU and HDU were US$2728 [Indian National Rupee (INR) 1,63,664] and US$1966 (INR 1,17,985), respectively. The mean OOP expenditures for treatment in the ICU and HDU were US$2372 (INR 1,42,297) and US$1752 (INR 1,05,093), respectively. Indirect costs of hospitalization in ICU and HDU patients were US$166 (INR 9952) and US$182 (INR 10,903), respectively.

Conclusion Treatment of chronic liver disorders poses an economic challenge for both the health system and patients. There is a need to focus on prevention of liver disorders, and finding ways to treat patients without exposing their households to the catastrophic effect of OOP expenditure.

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Key Points for Decision Makers

Significant evidence of the health burden and consequences of liver disorders exists in India.

There has been no evidence published of the significant economic implications which emerge alongside the rising burden of risk factors for liver disorders.

Our study reports the direct medical costs from both the health system and patient perspectives, as well as the indirect costs on account of lost productivity.

Our findings could also be used for setting reimbursement decisions for treatment of liver disorders in various publicly financed insurance schemes as well as assessing the cost effectiveness of related interventions.

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1 Introduction

Liver diseases contribute significantly to the global burden of mortality and morbidity [1, 2]. Globally, liver cirrhosis alone accounts for more than a million deaths, which is 2% of overall deaths, and 31 million disability-adjusted life-years (DALYs), which is 1.2% of total DALYs.

Along similar lines, liver disorders are widely prevalent in India. These represent a wide spectrum ranging from those with chronic infections, to those affected by alcohol consumption, and finally comprising the non-alcoholic fatty liver disorders. With over 40 million hepatitis B virus (HBV) carriers in India, the country falls into the intermediate level of HBV endemicity [3]. The population prevalence of HBV and hepatitis C virus (HCV) infection in India is 3.7 and 1%, respectively. In the developed countries, dominant risk factors for chronic liver disease (CLD) include alcohol and HCV. On the other hand, HBV and HCV are responsible for the majority of CLDs in India [4]. Since 2007, alcohol has fast emerged as an important risk factor, and it constituted the leading cause of CLD-related morbidity and mortality in India during 2010–2011 [4].

Liver disorders pose a significant economic challenge in terms of management of these chronic infections. In 2007, in the US, cirrhosis was graded as one of the leading causes of death. The estimated economic burden due to liver cirrhosis was significant, with the main cost of treatment ranging from US$14 million to US$2 billion, depending on disease etiology [5]. Treatment costs of morbidities related to HCV in ten European Union countries were estimated to be €50 million, and hence a significant burden on society. Similarly, €3 billion was reported to have been lost in Spain as a result of HCV over a 20-year time period [6].

Despite such a high economic burden, as evident from Western countries, there are no Indian estimates for the cost of treating liver disorders. In fact, there is very little evidence of cost of curative care in the public sector from a health-system perspective [7–11], and whatever is available is mostly for primary and secondary care [8–11]. The economic data becomes even scarcer for the tertiary care sector [7] and chronic diseases. Apart from significant economic implications for the health system, treatment of liver disorders leads to high out-of-pocket (OOP) expenditure for patients. This OOP expenditure in turn manifests as catastrophic spending by households which pushes them below the poverty line [6, 12]. Treatment for liver disease is also likely to impose high OOP expenditure on account of its intensive resource requirement and chronic nature.

Hence, we undertook the present study to bridge this gap in the evidence base. Firstly, from a health system perspective, we estimated per-bed-day admission costs of intensive care treatment of liver diseases in a tertiary care hospital setting. Secondly, from patient perspective, we determine the OOP expenditure on treatment, the extent of financial risk protection in terms of catastrophic health expenditure (CHE), and mechanisms to cope with the OOP expenditure.

2 Methodology

2.1 Study Setting

We conducted this study in the Post Graduate Institute of Medical Education and Research (PGIMER), a tertiary care hospital, situated in the North Indian city of Chandigarh. With a total of 356 consultants and 2000 resident doctors, the hospital caters to an annual inpatient and outpatient attendance of 78,568 and 2,061,911, respectively [13].

The present cost analysis was undertaken in a specialized intensive care unit (ICU) for the treatment of liver disorders, under the Department of Hepatology. The ICU is broadly classified into two parts: the intensive care unit (ICU) and the high dependency unit (HDU). The criterion for this classification is based on the severity of patients with liver disorders, with more severe patients being admitted to the ICU. In addition to the HDU facilities, the ICU has ventilator and dialysis support, and endoscopic interventions for critical care required for more severe patients. Both the units have five beds each. A common pool of human resources was involved in provision of services in both ICU and HDU, supported by a laboratory and ultrasound and fibro-scan facility. These diagnostic facilities are utilized for the ICU (and HDU) patients along with the other liver disorder patients who consult the outpatient department and those admitted to general wards in the hospital. Besides this, the general diagnostic (pathological and radiological) facilities of the hospital are also used for the liver ICU patients. A total of 171 and 142 new admissions were treated in the ICU and HDU, respectively, during the year 2014.

2.2 Data Collection

2.2.1 Health System Costs

We adopted a bottom-up micro methodology to assess the health system costs. We collected data on health system resources used to provide patient care during a 1-year period from April 2013 to March 2014. The methodology for data collection comprised record reviews, physical inspection of facility, and staff interviews. The collected data included number of human resources (i.e. medical,

paramedical staff, administrative, support staff, etc.), space in the building, numbers and types of equipment, other non-consumable items, diagnostic tests (laboratory and radiological), medicines, consumables and other overhead costs. Data was collected on the quantity of different resources being used exclusively for ICU or HDU patients, or in shared manner for both [Supplementary Appendix, Tables S1–S7, see electronic supplementary material (ESM)].

All resources were classified as recurrent or non-recurrent/capital resources. Recurrent costs included staff salaries, medicine and consumables, diagnostic tests and overheads costs (i.e. electricity, water consumption, laundry, dietetics, etc.). Non-recurrent or capital resources mainly comprised building or space, equipment (medical and non-medical) and furniture with a lifespan of >1 year. Price data was collected from the procurement department of the Institute [14]. For prices that were not available from the procurement department, we used the average market price from among the leading three manufacturers/suppliers, which was then adjusted based on a factor between market price and government procurement price. However, since the market prices are higher than the government procurement price, we adjusted the same using a scaling factor. This scaling factor was the average ratio of health system price and market price for other drugs and consumables, where prices were available from both the sources. All prices were adjusted to current values using gross domestic Product (GDP) deflators. Besides the data on quantity of resources utilized and their prices, we also collected data on number of patients treated during the same reference period, separately for the ICU and HDU. Face-to-face interviews of staff members (faculty, resident doctors, nursing staff, support and administrative staff) were conducted to elicit time spent on different activities during a 1-week period.

2.2.2 Out-of-Pocket Expenditure

For OOP expenditure, all new patients admitted to the liver ICU during the period from December 2013 to October 2014 were recruited. Written informed consent of the patient or accompanying caregiver (if patient was not conscious) was obtained. Data was collected at the time of recruitment, followed by a daily interview to elicit OOP expenditure incurred for treatment over the last 24 h. This was continued on a daily basis till the discharge or final outcome of the patient. OOP expenditure was elicited for hospital charges, medicines, laboratory tests, procedure or surgery, transportation, boarding/lodging and meals of attendants with patient, and lastly informal payments (if any).

Secondly, we collected data on socio-demographic characteristics including household consumption expenditure (food and non-food). Patients were also interviewed to elicit mechanisms to cope with the OOP expenditure for treatment. Lastly, in order to assess indirect costs owing to lost productivity, both for patients and caregivers, we also collected data on time spent by patient on routine activities (i.e. professional work, household activities, childcare, voluntary and social activities, physical or leisure activities, etc.) in the days of good health before his/her admission to ICU or HDU.

2.2.3 Follow-Up Patient Interviews

We also followed up the patients telephonically at Month 1, 3 and 6 from the date of discharge to record OOP expenditure for further treatment (if any) and the survival status of the patient. Any OOP expenditure for out-patient or in-patient treatment after discharge from any health facility was assessed. Data on OOP expenditure collected at each follow-up was mutually exclusive in nature (i.e. specifically for that period). For example, at Month 1 follow-up, data on OOP expenditure was collected from discharge date to completion of Month 1. The same occurred for Month 1 to Month 3 (2-month period) at Month 3 follow-up, and for Month 3 to Month 6 (3-month period) at the Month 6 follow-up.

2.3 Data Analysis

2.3.1 Health System Costs

Data was analysed using Statistical Package for Social Sciences (SPSS) version 21 and MS Excel. The cost of space for the hepatology ICU was estimated by applying rental price for the area. Costs of various equipment (and furniture) available in the ICU and HDU were annualized based on their average useful life and discounting to arrive at an equivalent uniform annual cost. An average discount rate of 3% was used to compute the annualization factor [15]. Replacement costs of equipment were preferred over original costs. These replacement costs were computed by adjusting original costs using the consumer price index. All the costs were converted to US dollars (US$) for comparability at a wider level at the rate of US$1 equal to 60 Indian National Rupees (INR) [16]. Overall cost of service provision was estimated. Finally, all the cost estimates were converted to 2014 prices to adjust for inflation, applying a discounting factor of 3% per year.

2.3.1.1 Apportioning Statistics Appropriate apportioning statistics were used to allocate shared or joint resources to the ICU and HDU. Firstly, the shared cost of human resources was apportioned to ICU care, non-ICU inpatient care, outpatient care and other general teaching, research

and administrative work. Interviews with various staff working with the ICU unit were done to collect the data on time allocation patterns. We interviewed different categories of personnel involved in ICU services, which mainly included consultants, resident doctors, nurses and technicians to capture data on work flow patterns, and time spent per activity during the previous week. Proportion of time spent on each activity was used as the basis for apportioning the shared human resource costs to various cost centres and functional activities. Data obtained through these interviews was used for apportioning the share cost of human resource.

Secondly, costs of shared building/space (i.e. laboratory, waiting area, discussion room, doctor's room, etc.), equipment and overheads were apportioned among the ICU and HDU on the basis of proportion of bed-days of ICU and HDU patients in a year. Costs of medicines and consumables could not simply be apportioned based on inpatient bed-days of admission in the ICU and HDU, as these are dependent on the patients' severity of illness. Hence, we apportioned the cost of medicines and consumables being used jointly for HDU and ICU patients, based on a ratio of average OOP cost of medicines for ICU and HDU patients. This was considered appropriate as there were no prioritization criteria used for issue of medicines and consumables between the ICU and HDU.

2.3.1.2 Unit Costs Per-patient and per-bed-day costs of treatment were estimated for both ICU and HDU patients.

2.3.2 Out-of Pocket Expenditure

We estimated the mean and standard error of OOP expenditure at the overall level and by socio-demographic characteristics of individuals, and also by diagnostic category. Patients with liver disorders were classified into five categories: acute viral hepatitis/acute liver failure, cirrhosis (includes alcohol-related cirrhosis, HBV, HCV, autoimmune hepatitis (AIH), non-alcoholic steatohepatitis and others), acute-on-chronic liver failure (ACLF), hepatocellular carcinoma (HCC) and extrahepatic biliary tract obstruction (EHBO).

2.3.3 Financial Risk Protection

Financial risk protection is one of the components of universal health coverage (UHC) [17]. It ensures that the population of a state/country can access quality healthcare services at the time of need without any financial hardship [17–19]. In general, there are two methods to measure financial risk protection, which include prevalence of CHE

and impoverishment due to OOP expenditure [19–21]. We computed CHE to measure financial risk protection, which is defined as OOP spending for healthcare exceeding a given threshold of households' paying capacity [19–21]. More specifically, it implies any OOP expenditure on health which exceeds 40% of household non-food consumption expenditure.

There are two thresholds available in the literature to estimate the prevalence of CHE based on households' paying capacity. The first approach considers any health expenditure exceeding 10% of a household's total consumption expenditure as catastrophic, while the second approach considers 40% of non-subsistence expenditure (or non-food related) as the threshold. The second approach is considered more appropriate from an equity perspective, and hence we adopted the latter [19–22]. To compute prevalence of CHE, OOP expenditure that was in excess of 40% of household non-food consumption expenditure was considered as catastrophic. In addition, we undertook a sensitivity analysis by computing prevalence of CHE based on the 10% of total expenditure cut-off. Lastly, we also analysed the coping mechanisms for OOP expenditure by calculating the percentage of OOP expenditure which was met through salaries/savings, borrowing without interest, borrowing with interest, selling of assets, or any form of health insurance.

2.3.4 Indirect Costs

Data collected on indirect costs (i.e. productivity loss of patients/caregivers due to hospitalization) was analysed using a human capital (HC) approach. There are two broad approaches for valuing productivity loss due to illness, HC and friction cost (FC) [23, 24]. In the HC approach, income and fringe benefits of an employee (or market wage) are considered as a proxy of his productivity loss due to illness, while the FC approach considers replacement cost of an employee to carry out his work. Although the FC method measures the productivity loss in a more realistic way, it is data intensive which introduces significant uncertainties. On the other hand, HC demands less data and is amenable for easy communication [23, 24]. Hence, we used the HC approach for analysis of indirect cost data in our study.

2.3.5 Estimates

All the estimates for health system costs, OOP expenditure and indirect costs are reported in both INR and US$. Also, 95% confidence intervals (CI) are reported for OOP expenditure and indirect costs along with their base estimates.

3 Results

3.1 Sample Characteristics

A total of 150 patients were recruited for estimation of OOP expenditure, of which 85 and 65 were from HDU and ICU, respectively. Of all patients, males represented nearly 75% in the ICU and nearly 62% in the HDU. More than 80% of patients both in the ICU and HDU were aged >30 years and almost 45% were aged >50 years. Mean length of stay for ICU and HDU patients was 13 and 11 days, respectively. Around 72 and 87% of patients were discharged alive from the ICU and HDU, respectively (Table 1). Almost 68% of the patients admitted to the hepatology ICU had some form of cirrhosis, followed by 13.5% with EHBO and ACLF, 10.8% with hepatocellular carcinoma and 7.4% with acute viral hepatitis/acute liver failure.

3.2 Health System Costs

The annual cost incurred by the health system for ICU and HDU care in the year 2014 was US$386,199 (INR231, INR71,939) and US$336,651 (INR201, INR99,069), respectively (Table 2). For the ICU and HDU, the share of personnel costs was highest (37% ICU and 43% HDU), followed by physical infrastructure (27% ICU and 31% HDU) and diagnostics (20% ICU and 12% HDU). Per-patient treated and per-bed-day admission cost for treatment in the ICU were US$2728 (INR163,664) and US$212 (INR12,697), respectively. Similarly, the cost of treatment was US$1966 (INR117,985) per patient and US$185 (INR11,068) per bed-day in the HDU (Table 2).

3.3 Out-of-Pocket Expenditures

The mean OOP expenditures for treatment in the ICU and HDU were US$2372 (95% CI 1881–2862) and US$1752 (95% CI 1329–2174), respectively (Table 3). Medicines accounted for a major share of OOP expenditure—85 and 79% among ICU and HDU patients, respectively (Fig. 1). Mean OOP expenditures per patient bed-day in the ICU and HDU were US$220 (INR13,194) and US$151 (INR9088), respectively. Salary or savings was the predominant source of finance to meet the OOP expenditure among 51 and 57% patients treated in the ICU and HDU, respectively (Fig. 2). Mean OOP expenditure was relatively higher in patients diagnosed with ACLF [US$3170 (INR190,202)], followed by cirrhosis and acute viral hepatitis/acute liver failure [US$2131 (INR127,899) and US$1928 (INR115,668), respectively].

Using a 40% threshold for CHE, we found that 87% of patients admitted to the ICU incurred CHE, while its prevalence was 71% for HDU patients (Table 3). Prevalence of CHE in our study did not vary much when we used 10% of total consumption expenditure (i.e. 98 and 84% for the ICU and HDU, respectively). This signifies that the conclusion is robust regarding choice of thresholds used to define catastrophic expenditure. The mean indirect cost estimation for ICU and HDU patients was US$166 (95% CI 117–215) and US$182 (95% CI 139–224), respectively (Table 4).

3.3.1 Follow-Up

Out of patients eligible for Month 1, 3 and 6 follow-ups, approximately 95% were followed up to record the data on post-hospitalization OOP expenditure (Supplementary Appendix, Fig. S1, see ESM). Mean OOP expenditures for patients 1 month after discharge from the ICU and HDU were US$366 (95% CI 178–554) and US$977 (95% CI 0–2153), respectively. Mean OOP expenditures at Month 3 follow-up, which reflected a 2-month period, were US$894 (95% CI 59–1729) and US$635 (95% CI 286–985) for ICU and HDU patients, respectively, and at Month 6 follow-up, for a period of 3 months, they were US$498 (95% CI 143–778) and US$568 (95% CI 166–893) for ICU and HDU patients, respectively.

4 Discussion

4.1 Summary of Study Findings

We undertook this study to assess the health system costs and OOP expenditure on account of tertiary care intensive treatment for liver disorders in India. Overall, we found that the health system cost per patient treated and per bed-day admission to the ICU were US$2728 (95% CI 2580–3125) and US$212 (95% CI 200–242), respectively. Similarly, the cost of treatment was US$1966 (95% CI 1860–2253) per patient and US$185 (95% CI 174–211) per bed-day in the HDU. From the patients' perspective, the treatment of liver disorders incurred an OOP expenditure of US$2372 (95% CI 1881–2862) and US$1752 (95% CI 1329–2174) in the ICU and HDU, respectively. All patients admitted to the ICU, and 88% of those admitted to the HDU, experienced catastrophic expenditures. Of the total hospitalized patients, 29% had to borrow money to pay for treatment costs.

We found that the OOP expenditure during the period immediately after discharge was higher than later months. This is reflected in a higher OOP expenditure from 1 to

Table 1 Characteristics of liver disorder patients admitted to the intensive care unit of a tertiary care hospital in India

Characteristics	ICU		HDU		Total	
	N	%	N	%	N	%
Gender						
Male	49	75.4	53	62.4	102	68.0
Female	16	24.6	32	37.6	48	32.0
Total	65	100	85	100	150	100
Age group						
<30 years	10	15.4	14	16.5	24	16
31–50 years	25	38.5	31	36.5	56	37.3
>50 years	30	46.2	40	47.1	70	46.7
Total	65	100	85	100	150	100
Locality						
Urban	31	47.7	53	62.4	84	56
Slum	2	3.1	3	3.5	5	3.3
Rural	32	49.2	29	34.1	61	40.7
Total	65	100	85	100	150	100
Education						
Illiterate	5	7.7	4	4.7	9	6.0
<8th standard	17	26.2	13	15.3	30	20.0
8th–12th standard	25	38.5	30	35.3	55	36.7
Graduate and above	18	28	38	44.7	56	37
Total	65	100	85	100	150	100
Occupation						
Labourer	8	12.3	7	8.2	15	10.0
Self-employed	9	13.8	21	24.7	30	20.0
Unemployed	21	32.3	33	38.8	54	36.0
Salaried	27	41.5	24	28.2	51	34.0
Total	65	100	85	100	150	100
Marital						
Unmarried	8	12.3	8	9.4	16	10.7
Married	57	87.7	77	90.6	134	89.3
Total	65	100	85	100	150	100
Wealth status						
Poorest	12	18.5	18	21.2	30	20
Poor	12	18.5	17	20	29	19.3
Middle	17	26.2	13	15.3	30	20
Rich	14	21.5	17	20	31	20.7
Richest	10	15.4	20	23.5	30	20
Total	65	100	85	100	150	100
Duration of stay						
<3 days	11	16.9	21	24.7	32	21.3
3–10 days	20	30.8	30	35.3	50	33.3
>10 days	34	52.3	34	40.0	68	45.3
Total	65	100	85	100	150	100
Outcome at discharge						
Dead	18	27.7	11	12.9	29	19.3
Alive	47	72.3	74	87.1	121	80.7
Total	65	100	85	100	150	100

HDU high dependency unit, *ICU* intensive care unit

3 months following discharge, as compared with 4–6 months after discharge. This could be related to a relative improvement in patients' condition in subsequent months and hence a lesser need for more intense medication.

We acknowledge that there are significant variations in the healthcare infrastructure across the different states of India, as well as costs of resources which are used for delivery of services. Further, we estimated the cost of delivering treatment in one large tertiary care hospital. We chose this hospital as the treatment for most chronic liver disorders is usually not provided in secondary level hospitals and is available in similar tertiary care teaching hospitals only. However, all these factors may limit the extent of the generalizability of our cost estimates to the whole of India. We recommend undertaking a study incorporating a variety of geographic settings and levels of care in India to improve the generalizability of results.

4.2 Financial Risk Protection: Current Status

In general, In India there is a high prevalence of CHE. Some community-based research studies reported the prevalence of CHE for any kind of illness in the range of 30–56% [19, 22, 25, 26]. On the other hand, prevalence of CHE is extremely high in diseases requiring intensive care like chronic liver disorders, cancers, acute coronary syndrome, etc. One North Indian study reported the prevalence of CHE among households with a family member suffering from breast cancer to be 84% [27]. Similarly, a study done for the Asian region depicted that prevalence of CHE among households with an acute coronary syndrome event in India was more (i.e. 60% among the uninsured population) compared with other Asian countries like Malaysia, Thailand, Singapore, Vietnam, etc. [28]. Moreover, specifically in the Indian context where the income disparities are high, even a small amount of OOP expenditure becomes catastrophic for low-income segments of society [19, 26, 29]. Hence, our study findings are in concordance with the literature when specifically compared to other severe diseases requiring intensive care.

4.3 Policy Implication: Prevention of Liver Disorders

Our results have significant policy implications. Policy discourse in India is gradually building towards universal provision of healthcare services [30]. How the care provision will be organized is debatable; however, most policy documents recommend greater reliance on a tax-funded system of financing. In terms of provisioning of healthcare services, both models of publicly delivered healthcare services and purchasing of healthcare services through

Table 2 Health system costs of treatment of liver disorder patients in the intensive care unit of a tertiary care hospital in India

Health system costs	ICU US$ (INR)	HDU US$ (INR)
Annual costs		
Personnel	143,402 (8,604,123)	143,402 (8,604,123)
Equipment	30,526 (1,831,542)	20,764 (1,245,861)
Laboratory tests	76,514 (4,590,849)	38,910 (2,334,601)
Medicines and consumables	6945 (416,719)	4763 (285,778)
Stationary	2973 (178,371)	2973 (178,371)
Physical infrastructure	104,760 (6,285,600)	104,760 (6,285,600)
Utilities/overheads	21,079 (1,264,735)	21,079 (1,264,735)
Total	386,199 (23,171,939)	336,651 (20,199,069)
Unit costs		
Cost per patient	2728 (163,664)	1966 (117,985)
Cost per bed-day	212 (12,697)	185 (11,068)

Conversion rate: $US1 = INR60

HDU high dependency unit, *ICU* intensive care unit, *INR* Indian National Rupee, *US$* United States dollar

publicly financed health insurance schemes are evident [31]. The increasing incidence of liver disease and its risk factors [32, 33] highlights that prevention of liver disorders and their risk factors is likely to be a more cost-effective action and has to remain the mainstay of the policy. In terms of preventive actions, HBV vaccination remains a cornerstone.

In general, the most cost-effective vaccination strategy is usually determined by the endemicity of disease, the ease of implementing a vaccination programme with high coverage, the efficacy of vaccination, and the infectiousness of the causative agent [34]. From an Indian viewpoint, a pentavalent vaccine that includes HBV has been reported to be very cost effective with an incremental cost of US$277 per disability-adjusted life-year (DALY) averted [35]. As per the Government of India's latest policy, HBV is given as part of a pentavalent vaccine that comprises diphtheria, pertussis and tetanus (DPT), haemophilus influenza type 'b' (Hib) and HBV. The National Technical Advisory Group on Immunization (NTAGI) in India recommended the introduction of the pentavalent vaccine in the Universal Immunization Program (UIP) in 2008, which was subsequently launched in 2011 in two South Indian states [36, 37]. This has now been extended to children in several other states also. However, the coverage of this vaccine remains very low as per recent estimates [38], and hence needs strengthening for effective protection. Further, the Government of India also recommends a birth dose of HBV for all institutional births, which needs to be universalized.

The major preventive strategy for HCV remains controlling nosocomial exposure (i.e. blood screening, safe injection, and infection control) and reducing high-risk behaviours (i.e. intravenous drug use) [39]. Implementation of safe nosocomial practices reduces HCV transmission, but usually comes at a high cost of implementation that exceeds the fiscal ability of low-income countries [39, 40]. However, there have been recent instances of HCV outbreaks in India which have resulted from unsafe injection practices by unqualified practitioners and quack doctors [41]. Use of auto-disable syringes is one of the strategies to prevent re-use and its associated infections. An HCV seroprevalence of as high as 71% has been reported among injection drug users (IDUs) in North-East India [42]. In India, an Opioid Substitution Therapy (OST) strategy for IDUs was introduced by the Government of India under the National AIDS Control Program (NACP). Under OST, opiate-dependant persons are made to shift to orally administered opiates such as buprenorphine and methadone, replacing illicit drug use [43]. Accounting for the social costs, OST therapy using buprenorphine has been shown to have higher benefits at lower costs than no treatment [44].
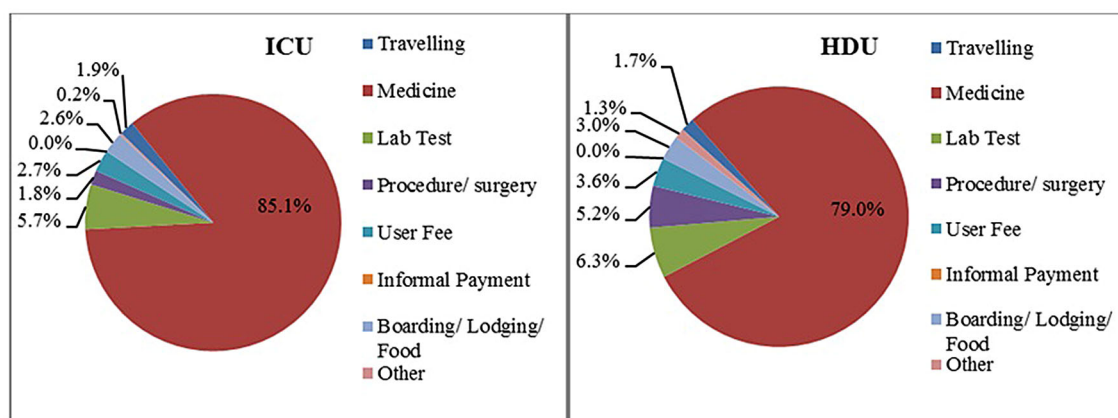
The third set of preventive interventions, besides those against HBV and HCV, are those directed against alcohol consumption and its health effects. It is evident that alcohol consumption leads to liver cirrhosis and related mortality and hence, policies and procedures intended to restrict alcohol consumption are likely to benefit [44–47]. These policies include those which are targeted to a specific population group such as school-based campaigns. Alternatively, these could be general public education campaigns on harmful effects of alcohol. Similarly, those at risk for alcoholism could also be targeted for counselling. Stringent alcohol purchase laws, government monopolies on alcohol, restrictions on alcohol marketing campaigns, and increased taxes on alcohol have all been shown to have positive effects on reduction in alcohol consumption [48].

Table 3 Direct costs (INR) as out-of-pocket expenditure and financial risk protection for treatment of liver disorder patients in the intensive care unit of a tertiary care hospital in India
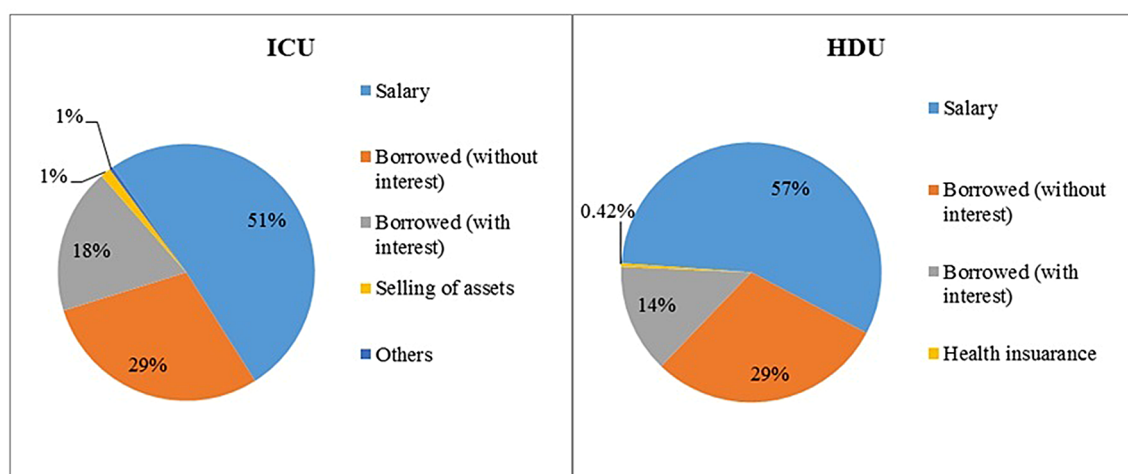
Characteristic	ICU US$ (INR)		HDU US$ (INR)		Catastrophic health expenditure (%)					
					ICU		HDU		Total	
	Mean	SE	Mean	SE	N	%	N	%	N	%
Age group										
<30 years	3179 (190,723)	1006 (60,336)	1319 (79,158)	430 (25,798)	9	90	10	77	19	83
31–50 years	1947 (116,834)	329 (19,765)	2188 (131,260)	407 (24,395)	19	76	20	71	39	74
>50 years	2456 (147,374)	328 (19,655)	1565 (93,891)	327 (19,635)	25	96	27	69	52	80
Total	2372 (142,297)	250 (15,021)	1752 (105,093)	216 (12,939)	53	87	57	71	110	78
Gender										
Male	2390 (143,424)	318 (19,082)	2120 (127,221)	289 (17,315)	38	83	40	80	78	81
Female	2314 (138,844)	308 (18,473)	1141 (68,444)	290 (17,395)	15	100	17	57	32	71
Total	2372 (142,297)	250 (15,021)	1752 (105,093)	216 (12,939)	53	87	57	71	110	78
Locality										
Urban	2331 (139,830)	376 (22,579)	1710 (102,588)	273 (16,353)	24	86	34	69	58	75
Slum	2844 (170,668)	2364 (141,868)	1133 (67,986)	274 (16,425)	2	100	3	100	5	100
Rural	2382 (142,914)	344 (20,634)	1892 (113,509)	392 (23,549)	27	87	20	71	47	80
Total	2372 (142,297)	250 (15,021)	1752 (105,093)	216 (12,939)	53	87	57	71	110	78
Education										
Illiterate	3267 (196,037)	616 (36,956)	1123 (67,400)	638 (38,298)	5	100	2	50	7	78
<8th standard	2489 (149,318)	573 (34,376)	2905 (174,283)	532 (31,943)	14	88	13	100	27	93
8th–12th standard	2595 (155,691)	405 (24,297)	1576 (94,550)	349 (20,963)	21	95	23	79	44	86
Graduate and above	1702 (102,136)	412 (24,709)	1562 (93,714)	333 (19,960)	13	72	19	56	32	62
Total	2372 (142,297)	250 (15,021)	1752 (105,093)	216 (12,939)	53	87	57	71	110	78
Occupation										
Labourer	1811 (108,666)	694 (41,666)	3330 (199,786)	778 (46,683)	6	75	6	100	12	86
Self-employed	1685 (101,082)	353 (21,201)	2302 (138,113)	485 (29,099)	6	86	17	89	23	88
Unemployed	3338 (200,258)	512 (30,698)	1219 (73,147)	285 (17,113)	20	100	21	66	41	79
Salaried	2015 (120,919)	348 (20,877)	1542 (92,507)	399 (23,920)	21	81	13	57	34	69
Total	2372 (142,297)	250 (15,021)	1752 (105,093)	216 (12,939)	53	87	57	71	110	78
Marital										
Unmarried	3504 (210,261)	1088 (65,265)	1267 (76,011)	471 (28,271)	8	100	5	63	13	81
Married	2213 (132,758)	239 (14,357)	1802 (108,114)	233 (13,977)	45	85	52	72	97	78
Total	2372 (142,297)	250 (15,021)	1752 (105,093)	216 (12,939)	53	87	57	71	110	78
Wealth status										
Poorest	2739 (164,368)	585 (35,075)	1289 (77,341)	403 (24,151)	8	100	9	69	17	81
Poor	1818 (109,103)	499 (29,946)	2030 (121,781)	551 (33,078)	11	92	15	88	26	90
Middle	2767 (166,005)	680 (40,795)	3016 (180,956)	732 (43,924)	16	94	12	92	28	93
Rich	2459 (147,568)	415 (24,878)	1351 (81,058)	289 (17,321)	12	86	11	65	23	74
Richest	1799 (107,960)	399 (23,966)	1450 (87,004)	407 (24,439)	6	60	10	50	16	53
Total	2372 (142,297)	250 (15,021)	1752 (105,093)	216 (12,939)	53	87	57	71	110	78
Duration of stay										
<3 days	692 (41,495)	65 (3923)	235 (14,100)	47 (2797)	9	82	10	53	19	95
3–10 days	1284 (77,025)	173 (10,409)	998 (59,909)	120 (7225)	16	80	21	70	37	74
>10 days	3555 (213,304)	361 (21,679)	3353 (201,163)	385 (23,082)	28	93	26	84	54	89
Total	2372 (142,297)	250 (15,021)	1752 (105,093)	216 (12,939)	53	87	57	71	110	78
Outcome at discharge										
Dead	2128 (127,651)	272 (16,308)	3553 (213,176)	761 (45,636)	13	87	10	100	23	92
Alive	2465 (147,906)	331 (19,850)	1484 (89,027)	205 (12,311)	40	87	47	67	87	75
Total	2372 (142,297)	250 (15,021)	1752 (105,093)	216 (12,939)	53	87	57	71	110	78

Conversion rate: $US1 = INR60

HDU high dependency unit, ICU intensive care unit, INR Indian National Rupee, SE standard error of the mean, US$ United States dollar

Fig. 1 Determinants (%) of out-of-pocket expenditure for treatment of liver disorders in an intensive care unit in India. *HDU* high dependency unit, *ICU* intensive care unit

Fig. 2 Coping mechanisms (%) for out-of-pocket expenditure for treatment of liver disorders in an intensive care unit in India. *HDU* high dependency unit, *ICU* intensive care unit

Table 4 Indirect costs for treatment of liver disorder patients in the intensive care unit of a tertiary care hospital in India

Admission status	N	Mean US$ (INR)	Standard error US$ (INR)
ICU	65	166 (9952)	25.1 (1507)
HDU	85	182 (10,903)	21.7 (1304)
Total	150	175 (10,491)	16.4 (984)

Conversion rate: $US1 = INR60

HDU high dependency unit, *ICU* intensive care unit, *INR* Indian National Rupee, *US$* United States dollar

A study done in 2009 to assess the cost effectiveness of various policy options available for restricting alcohol consumption reported that educational and counselling programmes for alcohol users are not cost effective, whereas enforcing increased taxes on alcohol purchase and restrictions on alcohol sales are generally cost effective [48].

4.4 Policy Implications: Treatment and Care

The high cost of treating chronic liver disorders has twin challenges: firstly from patient perspective, wherein there are a large proportion of households who face CHE as a result of treatment. Any attempt at achieving universal health care will need to bring treatment of these chronic

liver disorders into the benefit package. This brings us to the second fiscal challenge, which is for the payer or the health system to sustain the high cost of care. In view of the high cost of management of chronic liver disease, there is a need to identify more cost-effective approaches to management. For example, there are a range of drugs and newer molecules that are being used for treatment of HCV-related cirrhosis. Whether or not these are cost effective should be assessed before any decision on commissioning these drugs for clinical use is taken.

Our study reveals that around 80% of the OOP expenditure for treatment of liver disorders in an ICU setting was spent on purchasing medicines. This depicts the low availability of medicines in public sector hospitals [49, 50], which inflicts a high burden of OOP expenditure for buying medicines, specifically among those who utilize the public sector hospitals, and exposes them to CHE [19, 22, 25]. Mere allocation of funds for free availability of medicines in public sector hospitals may not be enough; in fact, procurement systems should be evaluated frequently for better efficiency and making necessary reforms for better availability of medicines [50].

4.5 Limitations

First, we did not collect data on severity of disease or risk factors associated with disease at baseline, that is, at the time of admission. We identify this as a limitation in our study as this has some bearing on OOP expenditure for treatment. Second, estimates from our study may have limited generalizability due to several factors. Our study estimates are based on data from a single tertiary care public sector hospital. In India, to date, there is no provision for intensive care treatment at secondary level in the public sector, although these services are available with private tertiary care hospitals. Patients accessing these services from the deregulated private sector are susceptible to incurring high OOP expenditure. Third, while we followed up the patients until 6 months from discharge to collect data on post-hospitalization OOP expenditure, we could not collect health system cost data for patients utilizing the public sector for post-hospitalization care.

5 Conclusion

To conclude, our study findings point to significant economic costs related to treatment of liver disorders in a tertiary care setting in India. High OOP costs impose a financial challenge to the households, with near universal occurrence of CHE. The national strategy should focus of prevention of these liver disorders. At the same time, providing subsidized treatment through public sector hospitals or purchasing treatment through publicly financed healthcare insurance schemes should be considered. Strategies to reduce cost of care through application of cost-effective methods of treatment should be considered.

Data Availability Statement Data on health system resources has been enclosed as a supplementary appendix. Patient level data analysed during the current study are available from the corresponding author on reasonable request. The corresponding author can be contacted via email: shankarprinja@gmail.com

Author Contributions Conceived the study: SP and YKC. Study design: SP, PB and MK. Study tools: SP and PB. Data collection: PB, SP and AD. Data analysis: PB and SP. Validation of estimates: SP, AD, YKC and MK. First draft: SP and PB. All authors reviewed and approved the final study draft.

Compliance with Ethical Standards

Ethical approval The study was approved by the Institute Ethics Committee of the Post Graduate Institute of Medical Education and Research, Chandigarh, India. Informed consent was taken from concerned persons at the time of data collection.

Conflict of interest Shankar Prinja, Pankaj Bahuguna, Ajay Duseja, Manmeet Kaur and Yogesh K. Chawla declare no conflict of interest.

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