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Original Article

An implementation on the social cost of hospital acquired infections

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Abstract: Hospital Acquired Infections (HAIs) are defined as infections developing in relation to health services at inpatient treatment facilities in general. Although health services improve, HAIs continue to be seen both in underdeveloped and developed countries. HAIs result in a range of negative externalities. Negative externalities include factors such as an increase in morbidity and mortality, extension of the hospitalization duration, impaired quality of life, loss of working power and performance. HAIs pose a big burden regarding population and community health care. This study aims to calculate the financial burden of HAIs by evaluating it within the scope of negative externality. The communal costs of HAIs patients were calculated by using a genuine approach with reference to samples obtained from the Duzce University Research and Application Hospital. This approach includes 4 stages and the results of each stage is sorted according to the data of 2013 as follows: (i) HAIs expenditure undertaken by the Social Security Institution is 5,832,167 TL, (ii) the monetary value of the work power loss of the HAIs patients who are at a working age is 126,154 TL, (iii) the relative cost of HAIs patients compared to a group of normal patients is 21,507 TL and (iv) HAIs patients' communal cost is 6,013,101 TL. Based on the received results, the annual communal cost of the estimated HAIs patients in Turkey is predicted to be 3,640,442,057 TL. In addition to these findings, HAIs patients experience 14 times longer in-patient stay at the hospitals as compared to normal patients, and their treatment expenditures are 23 times higher than the normal patients. In the conclusion part of the study, regarding the preventability (internalization) of HAIs, which was evaluated as part of negative externality, alternative applicable political suggestions are presented for the use of policymakers.

Keywords: Hospital acquired infections, financial burden of infection, negative externality, social cost

Introduction

The effective provision of health services constitutes the basic element of social development. Due to the fact that health services concern wide range of population and are indivisible in this respect, they are mostly provided by the public institutions. However health services fall also in the scope of the qualifications of *semi-public* product, where the beneficiaries can participate to the expenditures. In this context, health services can be produced by the market economy as trafficable and quotable services and present opportunities to the private sector for offering health services, as well. Regarding the services with a semi-public qualification, right along with many external benefits, some external damage may also arise. Infections related to health service delivery, which may occur during the procurement of health services, are possible to be evaluated within the scope of negative externality originating from producer and then leading to consumer. The effects of HAIs which may be evaluated in the scope of negative externalities can be listed as follows: functional disorders at patients, emotional stress, impaired quality of life, extended hospitalization duration, loss in work power and productivity, increase of medication usage, utilization of additional laboratory and diagnosis methods and cause of death.

In this study the negative externalities, caused by infections related to health service delivery, which may develop during health service procurement, are tackled with a genuine approach. This approach consists of four phases, containing HAIs expenditure for the Social Security Institution (SGK), monetary value of work power loss due to HAIs patients, the relative cost of

HAIs patients compared to normal patients and the expenditure of HAIs patients for the society. For the analysis, the database of Duzce University Research and Application Hospital was utilized. With reference to the acquired results and ratios, a comparative outlook is provided by referring to the other countries' samples and the results of the applied studies and the communal cost of the HAIs patients all over Turkey is estimated.

Conceptual framework: infection and externality

HAIs or nosocomial infections are infections that develop during the maintenance period of the patient at a hospital or in another health institution. This shows that HAIs were not existent at the time of the medical application or were not in an incubation period previously. They can be seen also among the hospital attendants or visitors.

Inpatient treatment institutions have defined the hospital infection within the Infection Control Regulation as *all infections developing due to health services at inpatient treatment institutions* [1]. HAIs are identified according to the criteria of Centers for Disease Control and Prevention (CDC): Hospital infections are stated as infections which occur at patients who come to the hospital for various reasons, which are not in the incubation period when they apply to the hospital and which develop within 48-72 hours after hospitalization or emerge within 10 days after being discharged [2, 3]. Infection physicians decide whether it is a hospital infection or not, by clinical observation, laboratory results, evaluation of the patient records and by the use of other supporting findings.

HAIs cause medical and economic consequences both for the patients and hospitals, and also for the administration, including SGK. HAIs hurt patients, causes mortality, increase the severity of the disease, cause the increase of re-hospitalization rates, and extend the hospitalization period of patient and causes severe increases regarding the cost of expenses for patients who are exposed to infections. Deaths caused by hospital infections rank among first death reasons in the developed countries. Additional mortality caused by hospital infections are between 4-33% and the highest mortality rates are seen with hospital associated pneumonia and severe sepsis/septic shock [4].

Notwithstanding the medical aspects, it should be noted that the infection bears administrative processes, as well. The administrative factors of the difficulties caused by the infection are namely; the determination period of the infection, the incidence and prevalence of the infection, accelerating the mortality and morbidity process, the financial burden loaded on the patient, insurance and reimbursement institutions and preventability levels.

In developed countries, it is seen that 5 to 10% of patients get one or more infection within the duration of their hospitalization. HAIs rank at the top of the most common complications effecting patients. The CDC (American data) estimates that approximately 2 million patients are infected with HAIs every year. These infections result in approximately 100,000 deaths and lead to an additional cost of 4.5 to 6.5 billion US dollars. 32% of these infections (562,000 persons) are urinary system infections whereas 22% (290,000 persons) are infections of surgical sites and 14% (249,000 persons) are blood flow infections [5, 6].

According to the World Health Organization (WHO) report, the expenditure for HAIs in the United States of America is between 4.5 and 5.7 billion US dollars a year. The costs of hand antiseptics are generally minimal and the expenditure is less than 34 cents per patient on a daily basis. The management, education and implementation costs of the *Clean your Hands* campaign in England is less than 0.1% of the national treatment expenditure that is spent for HAIs. The organizers of the campaign calculated that the annual potential savings reached the amount of 140 million pounds [6]. With the help of the hand hygiene, the number of hospital infections and the total patient costs are decreasing.

Solely in the USA, HAIs constitute the causes of more than 2 million infections, the death of 90,000 persons (one death every 6 minutes) and expenses of additional 6.7 billion US dollars (2002 prices) per year. In England, the expenditures for hospital infections are 1.7 billion US dollars per year whereas in Norway, a country with a rather small population of approximately 4 million, the expenses are calculated as 132 million US dollars [7].

When underdeveloped countries are examined, along with some difficulties in obtaining reliable data, the current state in Turkey shows that the rate of hospital infections is accepted to be changing between 5 and 15% [2]. Although there is not any country-based cost analysis, the additional cost per patient is estimated to be around 1,500 US dollars. The general cost for the whole population is estimated to be between 500 million to one billion US dollars [7].

When the infection process regarding the breakdown is explored, it is assessed that hand hygiene inconsistency, influenza costs, central venous catheter associated infections, surgical site infections, ventilator-associated pneumonia, multiple numbers of medication resistant organisms and catheter associated urinary system infections are detected as the most common factors of costs.

It is calculated that the cost of *central venous catheter associated infections,* or in medical terms the Central Line-Associated Bloodstream Infections (CLABSI), in the total direct financial costs of the USA, is more than 9 billion US dollars per year [8, 9]. Direct hospitalization costs of CLABSI documented in various studies vary between 12,000 US dollars and 56,000 US dollars, depending on the specifications of the case [10, 11].

Surgical Site Infections' (SSI) costs vary according to the surgery types and infecting pathogen types. Calculations obtained from practical studies show that these costs are between 3,000 and 29,000 US dollars [12-14]. However, recently the Pennsylvania Health Care Cost Containment Council found that the average of SSI costs is 153,132 US dollars and causes more than 119,872 US dollars of additional expenses per patient. SSI corresponds to an amount of 10 billion US dollars expenditure in the health care expenses every year [6].

The total annual cost of Ventilator-Associated Pneumonia (VAP) to USA hospitals get close to 2.5 billion US dollars (2002 dollar value) [8, 9]. Studies conducted at only one health centre between 1998 and 1999 found that the hospitalization cost of VAP patients was 48,948 US dollars higher than the cost of patients without VAP and likewise their hospitalization duration was 25 days longer [15]. The national database analysis comprising 9,000 patients highlights the same extreme costs.

After the discharge of VAP patients, the average hospitalization costs are calculated as 41,285 US dollars higher [6]. It is found that among the paediatric patients who are hospitalized at the paediatric intensive care, the average hospitalization cost of VAP patients is 30,932 US dollars [16].

The additional costs of patients with Methicillin-Resistant Staphylococcus Aureus (MRSA) surgical site infection are reported to be 39,000 US dollars per case [17]. A wide research regarding the compensation claims of patients who were discharged in 1995 from New York City hospitals showed that the mortality rate of patients with MRSA infection was about 13% higher [17, 18]. The prospective surveillance study done by Kyne in 2002 [19], revealed that Clostridium Difficile Infection (CDI) extended the average hospital duration about 3.6 days and caused 3,669 US dollars of additional costs. The Carmeli study [20] undertaken in a four year period between 1993-1997, included more than 800 patients and found that during the hospitalization of Vancomycin-Resistant Enterococcus patients, an additional cost of 12,766 US dollars has occurred and the duration of hospitalization has been extended for 6.2 days.

The financial burden of Catheter-associated *Urinary Infection* is very high, because the catheter is often used for inpatients [21, 22]. In 2006, national data received from NHSN acute treatment hospitals showed that for 1,000 catheters per day, the average rate of Catheter-associated Urinary Infections was between 3.1 and 7.5 [23]. 15 to 25% of hospitalized patients can use short-term permanent urinary catheter [23, 24]. In 2002, the CDC reported that solely in the USA, 561,667 catheter-associated urinary infection cases occurred and it played a role at the death of 13,088 persons [9].

It was calculated that the total direct medical cost of influenza associated diseases in the USA in 2003 was 10.4 billion US dollars. In a study where the database of health insurance demands' was used, it was found that the average direct medical cost of the patients with high influenza risk was 41,309 US dollars for the ages 50 to 64 and 16,750 US dollars for the ages above 64 (dollar currency 2003) [25].

Table 1. Classification of the Hospital infections according to their various qualifications in terms of negative externalities

Study (first author)	Incremental Cost	Extra Mortality	Additional Hospitalization Day	Infection Type	Preventability
Carmeli (2002)	12,766 $	ND	6.2	ND	ND
Coello (1993)	1,759 $	ND	ND	HAI	ND
Engemann (2003)	39,000 $	13	ND	MDRO	ND
Foglia (2007)	30,392 $	ND	ND	VAP	ND
Jarvis (1997) [43]	4,794 $	ND	9.2-20	VAP	ND
Kirkland (1999)	3,000-29,000 $	21.4%	20.1	SSI	40-60%
Sheng (2005) [44]	5,335 $	ND	8.2	ND	ND
Mahieu (2001) [45]	11,750 Euro	ND	24	ND	ND
Klevens (2007)	2.5 billion* $	ND	ND	VAP	ND
Klevens (2007)	ND	13,088 person	ND	CAUTI	ND
NQF (2009)	119,872 $	ND	ND	SSI	ND
NQF (2009)	ND	14.4-23.8%	ND	VAP	ND
Pitet (1994)	ND	14,000 person	ND	CLABSI	ND
Saint (2003)	ND	ND	ND	CAUTI	17-69%
Umscheid (2011)**	ND	ND	ND	CAUTI-CLABSI VAP-SSI	65-70% CAUTI-CLABSI 55% VAP-SSI
Warren (2003)	48,948 $	ND	25	VAP	ND
Wiegand (2012)	7,147 euro	6.8-42%	7.8-25	CDI	ND
Winstein (1997)	ND	10%	ND	CAUTI	ND
Wong (2004)	10 billion* $	ND	ND	SSI	ND
Septimus (2014)	9.8 billion* $	ND	ND	HAI	ND

Note: *The figures representing the entire country; ND: No Data; VAP: Ventilator Associated Pheumonia; MDRO: Multi Drug Resistant Organisms; CLABSI: Central Line Associated Blood Stream Infection; CAUTI: Catheter Associated Urinary Tract Infection; SSI Surgical Site Infection; CDI: Clostridium difficile Infection; HAI: Healthcare-Associated Infections (Hospital Infections). **Financial figures according to Umschied et al.; Thanks to prevention, financial figures are as follows: VAP, 2.19-3.17 billion dollar; CAUTI, 115 million-2.82 billion dollar; SSI, 166-345 million dollar. CLABSI, 960 million-1.82 billion dollar [27].

Table 2. Data Set and Observational Data

Year	Number of Patients with HAI (with infection attack number)	Number of people subject to cost (with no infection attack number)
2011	476	285
2012	323	213
2013	453	249

Table 3. Cost of the HAIs to SGK

	1	2	3
Year	N_i	D_i	C_{SGK}
2011	285	11,611	3,761,043
2012	213	6,901	1,133,483
2013	249	10,584	5,832,167

Note: Column 1 states the number of patients (person) with HAIs, Column 2 states the number of patients (person) with HAIs and Column 3 states HAIs' cost to the SGK.

The Karen study [26] analyzed the paediatric hospitalizations due to influenza and assessed that the average cost for individual hospitalization was 13,159 $ whereas the average cost for hospitalization of children at the intensive care units was 39,792 $.

With reference to the practical literature, a compilation of the financial reflections of negative externalities related to HAIs are constructed. The categorization is made regarding additional cost, additional hospitalization day, extra mortality and preventability in **Table 1**. Data Set and Observational Data shown in **Table 2**. Cost of HAIs to SGK shown in **Table 3**.

In Turkey, in the scope of HAIs, a database called National Hospital Infection Surveillance Network (UHESA). UHESA is collecting data under 14 topics, including data of surgical site infection, primary bloodstream infections, urinary system infections, bone and joint infections, cardiovascular system infections, central nervous system infections, eye-ear-nose-throat and mouth infection, gastrointestinal system infections, lower respiratory system infections (except pneumonia), genital system infections, skin and soft tissue infections, systemic infections, nosocomial pneumonia and nosocomial pneumonia developing after surgery [28].

The UHESA network is expanded with the inclusion of further information on 42 diseases supporting the severity level of the infection during the data feeding process and 42 risk factors supporting the process. The database also includes a 5 step ASA score if surgical procedure was performed on the patient and a 4 step injury evaluation scale for the patients with an injury data [29].

Infections related to health services delivery can be evaluated within the scope of negative externalities deriving from producer and leading to consumer. Hospitals may bear unpredictable costs deriving from the externalities occurred during the delivery of health services to the patients. On top of these negative externalities, hospital associated infections exist. Hospital associated infections extend the duration of hospitalization of patients; impair life quality and cause work power and productivity loss.

The concept of externality is explained as *effects either good or bad, on parties not directly involved in the production or use of a commodity, known as the third party* [30]. Nobel prize-winning economist James Buchanan and his co-author defined an externality as *potentially relevant when the activity, to the extent that it is actually performed, generates any desire on the part of the externally benefitted (damaged) party to modify the behavior of the party empowered to take action* [31]. It articulates the case of changing the decision period of the actor effecting this interaction [32].

Nath [33] has argued that an externality occurs *wherever due to the nature of the present economic and social institutions, costs are imposed on others which do not have to be paid for, or benefits are bestowed on others, for which nonpayment is received. This definition points out 2 basic features of externalities.* First one is the necessity of imposing cost or benefit by any decision making unit to other units and the other one is, in return for the arising benefit or cost, the possibility of taking a price or finding a market where the compensation can be paid and not be effecting the payment without an intervention. Externality is used to express situations where the price mechanism removes the feature of giving information.

To be able to express a case as externality, two situations must have developed together. Those are (a) an individual affecting another individual with real variables of production and

consumer function and (b) the one causing the effect of granting a compensation or equalization of the cost or the benefit resulting from this effect. To be able to evaluate harmful or helpful effect as an externality, it is necessary that the cost caused by the aforesaid effect on third parties must be higher than the one of realizing it [34].

Externalities can be categorized as positive or negative externalities depending on their consequences. Positive externalities occur when the actions of economic decision makers deliver benefit to the other units and in such a case those who receive the benefits make a payment to those who perform the action. In positive externalities people evaluate the spillover effects positively [35]. Negative externalities occur when the action of economic decision units causes harm to the actions of the other economic units and therefore no payment is made to compensate the harm deriving from these actions.

At positive external economies, the vaccination made to minimize the risk of contagious diseases delivers a benefit not only to the person who receives the vaccination but also to the others. In positive externality, less production is made when compared with effective amounts [36]. Negative externalities are negative effects, which are unpredicted during the production or consumption period. In case of negative externality, there would be more production than the optimum level, due to the businesses not putting up with all the costs deriving from these activities. A patient developing an infection while receiving health services, but not receiving any payment from the hospital for the compensation of situation, can be given as an example for negative external economies.

Regarding resolving externalities namely interiorizing, the literature has developed different solutions [33-38]. The important part is not totally diminishing the externality but by equalizing the private and social costs/benefits ensure that the market functions effectively. Some economists promote government interference as a favorable solution in case of the failure of the market. This kind of interference can be made through direct government arrangements or by establishing tax subventions [37]. The instruments that governments utilize in the scope of externality regulations may include implements like taxes, subventions, fees, standards and pollution permissions. However, some economists [37] argue that a solution, which is produced by the negotiation of the parties, would be more effective for the market than interfering it directly. According to Coase, reaching an agreement on the property rights is clearly identified as a benefit for both of the persons who create the externalities and who also suffer from the externalities. There is motivation for both parties. While the first approach is studied both by theory and practice, the market approach is discussed more, theoretically.

Material and methods

The record series (called as NOSO list by the hospital) are held in an Excel platform with the purpose of entering the data to the UHESA system by the nurses of Düzce University Infection Control Committee. These series constitute the dataset of the study. Each of the infection attack of the patients who are diagnosed with HAIs, by the Committee, are recorded as a line. By using this dataset, each patient's registration number is pulled out and added to the dataset.

For the costs, a query program using SQL codes running on the patients' registry numbers is developed by the Hospital Information Processing Unit, as a part of the hospitals information management system. The data on the costs is obtained from this software. The costs are based on the date of the HAIs diagnose. For example, if a patient, who is hospitalized on 13th January 2012 for an orthopedic surgery, is diagnosed with HAIs on the 4th day of the hospitalization, then the hospital infection cost is calculated as of the 17th January.

Costs, services, medication and materials are collected in three items. This study employs genuine cost items rather than the invoice value of the Social Security Institutions reimbursements. For example, while the genuine cost due to HAIs of a gall bladder surgery patient outruns 22,000 TL, the amount paid by SGK for the invoice can be only 1,750 TL. Especially in surgical branches due to package rate, it is observed that the SGK is paying to the institution an invoice value lower than the genuine cost. Patients who were not discharged

Table 4. Cost value of the total labor loss of the patients with HAIs

	1	2	3 (2*W)
Years	A_{Ni}	A_{Di}	LTC_{HE}
2011	99	3,478	94,688.55
2012	78	2,712	82,580.40
2013	102	3,785	126,154.10

Note: Column 1 states the number of the patients with HAIs; Column 2 states Hospitalized days of the patients with HAIs in working age and Column 3 states cost value of the total labor loss of the patients with HAIs. Daily subsistence level (W) is 27,225 TL in 2001; 30.45 TL in 2012 and 33.33 TL in 2013. Total cost is 303,403 TL (between the years 2011-2013).

although they had more than one infection attack, who were gone ex or who were not transferred, were sorted through and the numbers of persons subject to the cost were identified annually.

As a final step, the number of patients who were re-hospitalized after some time for different reasons although they were discharged within the same year and developed hospital infection is also included to the total number of persons who are subject to the cost. So, the existing numbers of persons were few and were evaluated within the amount of persons subject to the cost as separate individuals. Regarding the hospital invoice process, it should be noted that there is no difference between the HAIs patients and the other patient groups.

A genuine approach comprising of four steps is developed for the calculation of the costs that derive from the infections developed during the delivery of health services and incurred to society and to the SGK.

The first step was to calculate the cost of HAIs to the SGK. All costs (a total cost consisting of service, material and medication cost) after HAIs diagnoses while receiving health services at the Düzce University Application and Research Hospital were calculated.

The additional cost undertaken by the SGK, due to the negative externality created by infections which develop during health services delivery, is calculated by following formula:

C_{SGK}: HAIs' cost to the SGK

N_i: The number of patients (person) with HAIs

D_i: Number of hospitalization days (day) of a HAIs patient

C_i: Total treatment expenses made for HAIs patients (TL)

C_{SGK} shows the additional treatment cost paid for patients due to hospital acquired infection. As this cost is undertaken by the SGK, it is accepted as an additional cost of the infection to the state. The monetary value of C_{SGK} is documented in Scheme 1.

Considering the above table, the total cost of treatment deriving from infection cost of SSI has reached to TL 5,832,167 in 2013. In the period of 2011-2013, the total cost is £ 10,726,693.

In the second step, the monetary value of the work power loss of the patients who developed an infection during the health service delivery was calculated. The patients who are included in the active work power and who receive treatment due to hospital infection at the Düzce University Application and research Hospital were included in the analysis. The potential magnitude, coming up if HAIs patients between the ages of 15-65 work on a minimum wage level during their treatment period, was calculated with the formula below:

$$LTC_{HE} = \sum [(A]_{Ni} * A_{Di}) * W$$

LTC_{HE}: Cost value of the total labor loss of the patients with HAIs (TL)

A_{Ni}: Number of the patients with HAIs in working age (person)

A_{Di}: Hospitalized days of the patients with HAIs in working age

W: Daily subsistence level (TL)

As a result of the calculations by using the above mentioned formula, working age of the patients with HAIs was used in the calculation of potential cost of lost labor. These costs and value creation opportunity cost of labor are provided. Calculation results are shown in **Table 4**.

In the third step of the study, the relative cost of HAI patients in relation to normal patient groups was calculated. As explained in the theoretic parts, the treatment costs of patients with infections are higher when compared to normal

Table 5. Proportional cost of the patients with HAI relatively normal patient

Year	1	2	3	4	5 (3-4)	6 (5/1)
	N_i	D_i	C_{SGK}	$[(A]_{Ni}*AC_{Ti})$	RTC_{HE}	$\frac{RTC_{HE}}{N_i}$
2011	285	11,611	3,761,043	293,909	3,467,134	12,165.38
2012	213	6,901	1,133,483	417,346	716,137.2	3,362.15
2013	249	10,584	5,832,167	476,748	5,355,419	21,507.70

Note: Column 1 gives the number of the patients with HAIs; Column 2 provides the number of days of hospitalized the patients with HAIs, Column 3 presents the cost of the HAIs to SGK; Column 4 shows the total cost for the normal patients; Column 5 provides the proportional cost of the patients with HAIs to relatively normal patients and Column 6 gives the total treatment costs for patients with HAIs.

Table 6. Social Cost of Patients with HAI

1	2	3	4	5	6 (1+2+5)
C_{SGK}	LTC_{HE}	Ex_{Ni}	PEx	$Ex_{Ni}*PEx$	HE_{pWC}
3,761,043	94,688.55	160	415	66,400	3,922,132
1,133,483	82,580.40	99	415	41,085	1,257,148
5,832,167	126,154.10	132	415	54,780	6,013,101

patients. This cost is changeable depending on the type of infection and the unit where the patient is hospitalized. The calculation was made as follows:

$$C_{SGK} = \Sigma(N_i * D_i) * C_i$$

$$RTC_{HE} = [(A]_{Ni} * AC_{Ti}) - \Sigma(N_i * D_i) * C_i$$

RTC_{HE}: Proportional cost of the patients with HAIs relatively normal patients

C_{SGK}: Cost of the HAIs to SGK (TL)

N_i: Number of the patients with HAIs (person)

D_i: hospitalized day number of the patients with HAIs

C_i: Total treatment costs for patients with HAIs (TL)

AN_i: Normal Patient Number (person)

AC_{Ti}: Mean treatment cost per patients (TL)

$[(A]_{Ni}*AC_{Ti})$: Total cost fort the normal patients (TL)

When **Table 5** is examined, especially between 2011 and 2013; treatment costs paid per patient are respectively 12,165 TL and 21,507 TL. The cost is higher for the patients with HAIs than the cost of normal patients. Patients with HAIs cause much more additional treatment costs due to the infection.

In the last step, the social cost of infections which developed during the delivery of health services is calculated. In this calculation, the funeral allowances for the HAI's resulted deaths are taken into consideration along with the calculation of the monetary value of work power loss due to HAIs and the above given calculation method for the monetary value of HAIs in the SGK. For the calculation of HAIs' societal cost, the three magnitudes' total value is taken. These are: HAIs' cost to the SGK, the monetary value work power loss due to HAIs and the funeral allowances paid for HAIs. In case of the funeral allowances only those with social security were included. The respective societal cost was calculated with the formula below:

$$HE_{pWC} = \Sigma(N_i * D_i) * C_i + \Sigma[(A]_{Ni} * A_{Di}) * W + [(Ex]_{Ni} * PEx)$$

$$HE_{pWC}=C_{SGK}+LTC_{HE}+[(Ex]_{Ni}*PEx)$$

HE_{pWC}: Social Cost of Patients with HAIs (TL)

LTC_{HE}: Cost value of the total labor loss of the patients with HAIs (TL)

RTC_{HE}: Proportional cost of the patients with HAIs relatively normal patient groups (TL)

C_{SGK}: Cost of the HAI to SGK (TL)

Ex_{Ni}: Number of Patients with HAIs result with mortality

PEx: Funeral Assistance for dead patients (TL)

When we analyze **Table 6**, it can be seen that the societal cost in 2013 of the HAIs patients is more than 6 million TL. It should be noted that those values are provided from the HAIs occurring only at the Duzce University Application and Research Hospital. This reflects how big the amount of societal cost of HAI would be when a general view is assumed.

Table 7. Turkey Projection (Social Cost of Patients with HAI)

	1	2	3	4	5 (4*3)	6 (5*[*HE*]$_i$*pWC*/1)	7 (6/5)
	N_i	TN_i	$\frac{N_i}{TN_i}$	$\sum H_i$	$\sum H_i * \frac{N_i}{TN_i}$	THE_{pWC}	HE_{pWC}
2011	285	18,336	0.015	11,436,781	177,764.10	2,446,365,597	13,762
2012	213	19,063	0.011	11,978,827	133,845.15	789,968.68	5,902
2013	249	21,085	0.012	12,765,247	150,749.18	3,640,442,057	24,149

Note: Column number 1 reflects the number of patients with HAIs, column number 2 provides the total number of patients, column number 3 shows the rate of infected patients among the number of total patients, column number 4 reflects the total number of patients in Turkey, column number 5 gives the total number of HAIs patients in Turkey and column number 6 reflects the communal cost of HAIs patients in Turkey. Note 2: The cost of the infected patients Turkey is calculated with the method of direct proportion with reference to the total cost of infection based on the infected patients' rate of estimated communal cost at Düzce University. For the calculation, the formula given below is used.

Table 8. Costs of HAIs patients and normal patients and hospitalization period of HAIs patients compared to normal patients

Year	Average hospitalization period of HI patients (day)	Normal patients average hospitalization period (day)	Average treatment cost of HI patients (TL)	Average treatment cost of normal patients (TL)	Hospitalization period of HI patients compared to normal patients	Treatment cost of HI patients compared to normal patients
2011	40.74	5	13,762	1,914.65	8.14	7.19
2012	32.39	4	5,902	1,959.37	8.09	3.01
2013	43	3	24,149	1,031.26	14.33	23.42

Based on the sample of the Duzce University Application and Research Hospital, the societal cost of HAIs patients in Turkey is estimated. If the percentile cut of HAIs patients' among normal patients is assumed to be adoptable for a Turkey in general, it is possible to reach the total number of infected patients in Turkey and accordingly, the loss of social welfare caused by HAIs patients. The Scheme regarding the said calculations is as follows.

$$THE_{pWC} = \frac{(\sum H_i * [\frac{N_i}{TN_i}) * HE]_{PWC}}{N_i}$$

$$social\ cost\ of\ HI\ in\ Turkey = \frac{THE_{pWC}}{(\sum H_i * \frac{N_i}{TN_i})}$$

THE_{pWC}:*social cost of HAI in Turkey* (TL)

$\sum H_i$: Total Patient Number in Turkey (person)

HE_{pWC}: *social cost of paitent with HAI* (per Patient (TL))

$$\text{HI'scomunal cost in Turkey} = \frac{T_{tl}\ \text{number of patients} * \text{HI Cost}}{\text{Number of HI patients}}$$

When **Table 7** is analyzed and a forecast is made for Turkey in general, it can be seen that in 2013 the communal cost of HAIs patients is 3,640,442,057 TL. The average communal cost of infected patients in Turkey is 172,655.53 TL per patient. Costs of HAIs patients and normal patients and hospitalization period of HAIs patients compared to normal patients shown in **Table 8**.

Discussion

This provides a genuine approach to the communal cost of infections acquired during health service delivery. Study is designed for the years between 2011 and 2013 and it is based on the data set of 749 patients registered as HAIs patients by the Infection Committee of Düzce University Research and Application Hospital. The cost of HI to the SGK, the total monetary value of work power loss of HI patients of working age, the relative cost of HI patients compared to a normal patients' group, HAIs patients communal cost (private hospital) and the communal cost (Turkey perspective) of HAIs patients to Turkey are all calculated. The obtained results are summarized as follows.

The total cost of HAIs to the SGK for the period of 2011-2013 is calculated as 10,726,693 TL (average of approximately 3.6 million TL per year). The monetary value of days which the active population with HAIs is not able to work is determined as 303,403 TL for 3 years. Within the three years period, a rounded value of 37,000 TL more is paid for HAIs patients when

it is compared with the payments for normal patients. The social cost of HAIs patients for 3 years is 11,192,381 TL. In the context of the projection made for the same period, the cost of HI patients to the whole population is calculated as 6,876,775,822 TL (average of 2,292,258,607 TL for each year).

Findings show that especially the HAIs costs of 2012 are less than the HAIs costs of the years 2011 and 2013. There are a few reasons for this. The average cost of randomly chosen persons who were in the 2012 control group were 3.5 times more than compared to the 2011 year control group. The number of patients in the year 2012 was lower than the years before and patients were determined who were included in the 2013 years cost items based on long term hospitalization although they were hospitalized in 2012.

A study made by Yalçın [7] estimated that the additional cost per HAIs patient is about 1,500 US dollars and the communal cost in our country varies between 500 million and 1 billion US dollars. When we compare our study's data with these rates, it is calculated that the additional cost per patient, based on US dollars, (considering that it is a 3rd step University hospital) is 7,284.43 $ for 2011, 1,867 $ for 2012 and 11,319 $ for 2013. The reasons for the additional costs being so high can be explained by two factors. Firstly when compared with the control group patients, patients with HAIs are longer hospitalized and secondly they are more and more often treated with medication.

It is seen that compared to normal patients, HAIs patients stay 8-14 times longer at the hospital. Also it is seen that the relative costs of HAIs patients compared to normal patients are 15 times higher, except for the year 2012. When these rates are compared with the literature (look **Table 1**) it can be seen that it produces similar results with Carmeli and Wiegand [20, 35]. Carmeli found 12,766 $ and Wiegand found 10,000 $ additional cost. The 2003 studies of Engeman (39,000 $), Foglia's study in 2007 and the study of NQF in 2009 (119,872 $) [6, 16, 17] was obtained from data belonging to American hospitals and the costs are higher than our costs, because the American private treatment costs are really higher than other countries. Also it is important to point out that the prices of Health Application Statement, which the SGK is using for the reimbursement system since 2007 are not overhauled. When the inflation in the mentioned period and the accrual is considered, it is evaluated that the cost of HAIs in Turkey would be higher.

When costs for the country in general are considered, Septimus [38] finds that the cost of HAIs is released as 9.8 billion $, while the amount according to Wong is 10 billion [39]. Our study finds that Turkey's cost of HAIs is released as 1,918,421 $. The increase of the hospitalization duration and the increase of the treatment costs bring a considerable additional burden to the SGK. When SGK's health expenses are examined, the number concretized with the projection corresponds to 7.2% of SGK's health expenses for the year 2013. For three years period, the average of obtained costs corresponds to 5% of the average SGK health expenses of 3 years [40-42].

According to the Global Budget agreement which is concluded every year between the Ministry of Health and the SGK, in 2013, the SGK has paid 19 billion 869 million TL for treatment expenses to the Ministry of Health [40]. In 2013, the estimates for Turkey show that the communal loss deriving from hospital infection is 3,645,872,600 TL. This amount corresponds to 18.3% of the Global Budget. When the communal costs related to HAIs are calculated within the context of negative externality, it is seen that they constitute a considerable part of the total health expenses. Some political arguments have been taking place regarding the emerging negative externality and the reduction of the communal cost of HAIs within the context of the obtained results. The source of communal costs which are caused by HAIs and the solution suggestions are explained in detail at the discussion part below.

As result, infections which may develop during the delivery of health services can be assessed as negative externalities. There are two approaches that dominate the attempts to overcome the negative externalities (internalization). The first approach is based on the management of subsidy and social intervention mechanisms with a special focus on taxes. In such a system, it is recommended that hospitals with low infection rates shall be paid the full amount on the basis of health application statement (SUT) prices, whereas the hospitals

with high infection rates shall get their payments with 5% deduction from the SUT prices. Publication of a list of safe hospitals based on the infection rates can serve as a motivation instrument among the hospitals, increasing the credibility of the ones with lower infection rates. Encouraging rates can be applied regarding the circulating capital shares of the physicians working at public hospitals. For the university and privately-owned hospitals that have an agreement with SGK and that enjoy low infection rates, a certain rate of discount can be applied on their invoice rates as an award mechanism. It is also possible to enact some punishment mechanisms for the hospitals with high infection rates. The second approach used for the internalization of externalities would be the Coase approach. It is based on agreements to be signed between the parties with the purpose of internalization of already mentioned externalities [34]. Based on this approach, it is expected that there may be agreements between private hospitals and patients where the infection acquirement risk is being reflected to the mentioned treatment costs.

When we analyze the theoretical and practical studies in the literature, it is obviously seen that 40 to 60% of hospital infections can be prevented by undertaking various measures [13, 25]. The application shows that leader and prestigious medical establishments have set a 0 (zero) hospital infection target and they have achieved it [41]. Within this context, it becomes clear that it is possible to reduce the communal cost of HAIs (3.645 billion TL) which is retrieved from our studies and it can be deducted about 40 to 60% with various measure packages. When the possibly obtained amounts are taken into consideration, which are about 1.458 billion TL with a 40% deduction and 2.187 billion TL respectively for 60%, it is seen that these are very important figures of attainable savings. According to the study of Umschied et al. on the preventability and the costs of HAIs types, there are different financial figures which may be obtained by the realization of several prevention measures. Those include BIP, 2.19-3.17 billion US dollars; AUTI between 115 million and 2.82 billion US dollars; CEA 166-345 billion US dollars. CLABSI 960 billion-1.82 billion US dollars. For the year of 2013, depending on the prevention level of 40 to 60%, financial savings which can be obtained in Turkey with the implementation of prevention measure packages, may lead to the amounts between 767,368 and 1,151,052 $.

There are necessary activities to be undertaken in order to reduce the HAIs costs and the harm done to the patients. Improvement of the clinical quality is a requirement above all. There should be compliance between the health service quality that the patient is receiving and the one that the patient should receive. In line with this, applications aiming at the type of infection based proof should be initiated. Guidelines published by leading organizations on this issue, namely CDC and WHO should be followed carefully and measures should be taken in order to keep the medical knowledge up-to-date. With clinical guidelines targeting at hand hygiene, 18 bundle (basic measure packages) applications and the maximum barrier measures, the HAIs can be reduced about 50%. By means of simple measure packages and hand hygiene targets, it is possible to obtain a communal saving up to 1 billion US dollars. Additional cost according to infection types, additional mortality, additional hospitalization days and prevention level are not covered by this study and remain as the priority areas to be studies under the scope of the cost research on HAIs. Especially in the area of special infection types, there is a need for specific studies, focusing on each infection individually. It must not be forgotten that for each of the infection type, a different measure should be to be taken.

With regard to the SGK and the Ministry of Health UHESA dataset, a fast cost study should be initiated. When the cost study is performed, a comparison with the patient data of the control group should be made. Comparative studies with the data obtained from Turkey and data attained from other studies should also be undertaken as to highlight and adopt effective and functioning prevention applications. The Ministry of Health should monitor the applications of all health institutions to prevent HAIs and should make policies and take actions highlighting the importance of this issue.

Disclosure of conflict of interest

None.

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