The cost of Hospital Acquired Infections

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Background

Hospital Acquired Infections occur when a micro-organism invades a hospitalised patient. The common sites of HAI are the urinary tract (UTI), lower respiratory tract (LRTI), surgical wound (SWI), bloodstream (BSI) and the skin. Patients can acquire infection in more than one site and these are known as multiple infections.

It has been suggested that approximately one in ten patients admitted to hospital suffer from one or more HAIs at any one time (DH/PHLS, 1988). There is however variation in the prevalence rates of hospital infection for different categories of patient. Patients in intensive care beds consistently have the highest rates and rates are higher in surgical than in medical patients. Because prevalence studies record the proportion of patients with an HAI at a specific point in time, outbreaks or seasonal variation might bias the estimates upwards. The incidence of HAI is a more useful measure as it illustrates the number of patients that acquire a HAI during a defined time period such as a year and rates may be expressed as a percentage of total discharges. A study in England of surgical patients by Coello et al. (1993) found the incidence of HAI to be 7.2 per cent and a recent study by Plowman et al. (2001) of patients admitted to medical and surgical specialities reported an overall rate of 7.8 per cent.

HAI also has an impact on mortality. Applying the assumptions from a study of mortality in the US (Haley, 1986) to England suggests that 5,000 deaths are directly attributable to HAI and a further 15,000 partially attributable (Plowman et al., 1997). Care should be taken interpreting these findings as many patients might have died from other causes, regardless of HAI.

Cost implications

The costs of HAI are distributed between many different agents. As these infections cause the patient to spend longer in hospital, resources such as consumable items, the time of health care professionals and the capacity of capital equipment and infrastructure are used to provide the appropriate care. A patient with a hospital infection might occupy a bed for three days longer than normal during which time nursing and medical staff might administer antibiotics and care for the patient. As these resources could have been used for the care of alternative patients an opportunity cost is incurred. Following discharge patients who suffered a hospital infection might consult primary and community care services, such as general practitioners or district nurses more frequently. An opportunity cost would arise because had the infection not occurred then primary and community care resources would have been available for alternative uses.

In addition to the opportunity costs incurred by the health sector there might be private costs incurred by the patient and those who provide informal care for them. These costs could be financial, such as additional medications, travel costs or child care costs, or they could be non-financial, such as physical pain and emotional stress. Finally, if the infection delays patients or informal carers access to their usual activities, be they paid or un-paid, then productivity losses could accrue. Figure 1 is a schematic representation of all costs.

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Figure 1 – A schematic representation of the costs associated with HAI

(I) Opportunity costs to health services

Hospital services

Inpatient stay (inpatient days, investigations, treatments)
Outpatient consultations (consultations, investigations, treatment)

Primary care services

General Practitioner (consultations, investigations, treatment)
District nursing and other (nursing care, investigations, treatments)

(II) Private costs to patients and informal carers

Out of pocket expenditures (travel, medicines, miscellaneous expenses)
Other consequences (death, anxiety, pain/discomfort)

(III) Other costs to society

Production losses due to morbidity and caring activities

Adapted from Plowman et al. (1997)

To provide a comprehensive picture of the burden of HAI all costs should be considered. Researchers working in the area of HAI rarely include costs that fall outside the hospital sector. Haley (1992) argues this is because researchers perceive hospital administrators as the group to be convinced that scarce hospital resources are being unnecessarily employed by HAI. The importance of including costs that fall on health services other than the in-patient sector, and so representing the true economic cost of hospital infection, is rarely acknowledged.

There is a wide and varied international literature on the costs imposed by HAI; the results of some key studies published between 1977 and 2000 are summarised in Table 1.

Patients with UTI and SWI were studied more frequently than other sites of HAI, possibly due to the higher incidence of these two sites of infection (Coello et al., 1993, Plowman et al., 1999). UTIs appear to be the least costly per case, more expensive are SWIs followed by BSIs, pneumonias, LRTIs and the most costly are patients with multiple infections.

However, generalisations need to be made with care for a number of reasons. The numbers of HAIs included for each study is low, due to the large number of patients that have to be recruited in order to identify HAI. As a consequence patients selected may not be representative of the wider population from which they were drawn. Moreover, generalising results from one country to other parts of the world, where the characteristics of patients, clinical practice and health care systems differ, should be undertaken with care. But of most relevance here, the methodology for identifying costs and the scope of costs included in the estimates varies between the studies.

Table 1 - Findings of studies of the costs of HAI by type of infection, length of stay and extra hospital costs or charges 1977-2000

Site of HAI	Reference	Patients studied	Number of HAIs	Country	Extra days in hospital	(£) extra cost per case +
UTI	(Coello et al., 1993)	general surgery, orthopaedic and gynaecology	36	England	3.6	576
	(Haley et al., 1981)	all admissions	177	US	1	1,031
	(Rubenstein et al., 1982)	general surgery and orthopaedics	30	US	5.1	756
	(Plowman et al., 1999)	medical, surgical, orthopaedics, urology, gynaecology, elderly care, ENT & obstetrics	107	England	5	1,122
	(Scheckler, 1978)	all admissions	38	US	0.6	361
SWI	(Davies and Cottingham, 1979)	orthopaedic	29	England	17	2,015
	(Rubenstein et al., 1982)	general surgery and orthopaedics	19	US	12.9	1,912
	(Mugford et al., 1989)	caesarean section	41	England	2.1	1,170
	(Coello et al., 1993)	general surgery, orthopaedic and gynaecology	12	England	10.2	1,798
	(Poulson et al., 1994)	surgical patients	291	Denmark	5.7	
	(Plowman et al., 1999)	medical, surgical, orthopaedics, urology, gynaecology, elderly care, ENT & obstetrics	38	England	7	1,594
	(Scheckler, 1978)	all admissions	16	US	7.5	3,400
	(Green and Wenzel, 1977)	surgical patients: appendectomy, cholecystectomy, bowel resection, total abdominal hysterectomy, caesarean section, coronary artery bypass graft.	51	US	6.0	1,452
Pneumonia	(Scheckler, 1978)	all admissions	10	US	3.7	1,866
	(Kappstein et al., 1992)	intensive care unit	34	Germany	10.13	6,405
Multiple	(Rubenstein et al., 1982)	general surgery and orthopaedics	8	US	18	2,668
	(Plowman et al., 1999)	medical, surgical, orthopaedics, urology, gynaecology, elderly care, ENT & obstetrics	57	England	29	8,631
	(Coello et al., 1993)	general surgery, orthopaedic and gynaecology	9	England	26.2	4,154
	(Liu-yi and Shu-qun, 1990)	cardiac surgery	43	China	25	1,254
LRTI	(Freeman et al., 1979)	all admissions	27	US	8.7	
	(Plowman et al., 1999)	medical, surgical, orthopaedics, urology, gynaecology, elderly care, ENT & obstetrics	48	England	8	2,080
	(Haley et al., 1981)	all admissions	75	US	6	8,639
BSI	(Haley et al., 1981)	all admissions	8	US	7	5,326
	(Plowman et al., 1999)	medical, surgical, orthopaedics, urology, gynaecology, elderly care, ENT & obstetrics	4	England	4	6,209
	(Pittet et al., 1994)	surgical intensive care	86	US	14	26,034
All Infections	(Girard et al., 1983)	neonates	61	France	6.7	1,294
	(Liu-yi and Shu-qun, 1990)	cardiac surgery	60	China	14	433

+ All costs have been converted into sterling using the OECD ‘Health data database’ (1996) and have been adjusted to 1999/00 prices by using a factor series that takes into account hospital input cost inflation in England.

Methods of cost estimation

The simplest approach to estimating the cost of HAI is to identify patients with HAI and estimate by how many days their hospital stay is prolonged. Haley (1992) suggests such estimates are used to create political urgency and raise awareness of the problem rather than provide accurate estimates of the additional resources employed. Two more sophisticated approaches are the concurrent and comparative methods.

The concurrent method requires professionally qualified staff to estimate the additional resources that should be attributed to HAI. For example, Wakefield et al. (1987) used specially trained staff who worked to carefully prepared protocols that assessed each day of the patient's hospital stay according to whether it was: attributable to the reason for admission; jointly attributable to the reason for admission and the HAI; or attributable to the HAI alone.

The comparative method requires that data are collected on resources used by patients with and without infection and the level of resource use is compared between the two groups. As these patient groups may have quite different characteristics, which might impact on resource use, infected patients are matched with uninfected controls on key characteristics such as sex, age, diagnosis, treatment procedures and co-morbidities. This requires a large sample of controls and there may well be bias from omitting patients for whom no match can be found (Haley, 1991).

In order to minimise this bias Hyryla and Sintonen (1994) and Plowman et al. (2001) adopted an approach that analysed a prospective cohort of patients admitted to hospital. The infection status and costs of each patient were used in regression models, alongside a number of control variables, to identify the marginal effect of HAI on cost outcome. This statistical approach is a more rigorous method for matching in which all patients are included and has the added advantage of providing confidence intervals around the estimates of additional cost due to HAI.

Quite apart from the difficulties in identifying the pure effect of HAI on costs there are issues over how the baseline patient costs should be estimated. The most common approach is to use the same cost for each day of the hospital stay. This method assumes that all bed days attract equal resource use regardless of the diagnosis, age, speciality or infection status of the patient. The only way to discriminate between the cost of patients is by their length of stay, which might conceal the real pattern of resource use.

The most rigorous approach, known as *micro-costing,* was recommended by Haley (1991) who suggested that data are collected on all the components of care supplied to the patient and cost estimates are derived in conjunction with the individuals who supply the components of care. A recent study (Plowman et al., 1999) used micro-costing to determine the cost of resources used by patients during their hospital stay. Data were collected on all the resources used by patients, including information on: all investigations the patient received such as x-rays, laboratory tests, endoscopies or cardiac tests; all medical and surgical procedures such as surgical interventions, insertion of intra-vascular catheters, insertion of urinary catheters; all drugs and infusions administered; and all care administered by nursing staff and other health care professionals. The economic cost of using these resources was estimated and attributed to the patients. The economic cost of using part of the capacity of the hospital overheads, management function and capital assets were also assessed and attributed to patients. All the methods used were derived from economic theory with the aim of reflecting the opportunity cost of using hospital resources.

Hospital and community health service costs

Plowman and colleagues reported and valued the costs that fell both in and outside of the in-patient hospital sector. In total the authors estimated that HAI cost the NHS £986.36 million (Plowman et al., 2001). Most of this cost, £930.62 million was borne by in-patient services. Confidence intervals were estimated for inpatient costs and indicated that we could be 95 per cent certain that inpatient costs lay between £780.26 and £1080.97. Substantial costs, £55.74 million, were also incurred after the patient had left hospital. General Practitioners costs were valued at £8.49 million, hospital out-patients departments £26.83 million and district nursing services £20.51 million. Including costs incurred outside of the hospital sector sets this study apart from much of the existing literature. However, estimates only included patients admitted to medicine, surgery, orthopaedic, urology, gynaecology, care of the elderly, ENT and obstetrics. Such admissions reflect 70 per cent of all in-patient admissions. If patients admitted to all specialities were included the estimate may be considerably higher.

Although understanding the cost of infection is important it does not provide guidance to policy makers on whether or not investments should be made in infection control programmes. However, estimates of the cost of infection, if appropriately estimated, might reflect the economic benefits of preventing an infection. For example, an infection control programme might lead to the avoidance of 20 infections and if these infections would have imposed a cost of £1,000 each one might argue that the infection control programme was worth £20,000. If the programme cost less than £20,000 then net benefits will accrue and the programme is worth implementing. With the development of high quality cost benefit models those responsible for resource allocation can make better decisions about what investments to make in infection control activities.

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