1. Introduction

The purpose of this paper is to discuss the cost implications of adverse events (AEs) experienced by patients. While the human harm to patients resulting from adverse events is acknowledged, the discussion in this paper is concerned with highlighting the cost implications pressurising health service budgets. Such economic data could guide organisations in patient safety improvement strategies.

Availability of reviews of the costs of patient safety
Overall, a high level search of the literature for systematic reviews and overviews of the costs of patient safety revealed relatively few studies compared with the level of international interest in the topic. Most literature is concerned with individual case studies in specific healthcare settings or with priority healthcare concerns such as healthcare associated infection.

A search of the literature found a limited number of cost studies on AEs in the UK with more studies done in the US, Canada, Australia and other European countries.
countries. However, the AEs experienced by patients in these countries are similar to those in the UK, thus the discussion will draw on these studies to inform the financial implications of patient safety incidents.

**Introduction to patient safety and impact on health service costs**

The World Health Organisation (WHO) has defined patient safety as “freedom for a patient from unnecessary harm or potential harm associated with health care”.\(^2\)

In Scotland, the Scottish Patient Safety Programme (SPSP) is aware of the complexities involved in delivering modern healthcare and has designed a standardised approach to improving selected areas of patient care. Factors such as weak legal and regulatory oversight of health service delivery, inappropriate infrastructure including outdated or overused technologies, insufficiently distributed and trained personnel and uninformed patients/customers will usually converge in various proportions towards the occurrence of safety failures.\(^2\)

Unforeseen/unwanted events might take place in all settings where healthcare is delivered (primary, secondary and tertiary care, community care, social and private care, acute and chronic, including palliative). A summary profile of safety for patients in healthcare settings is included at Appendix II, and contains additional contextual information for the AE cost discussion presented in this paper.

Adverse events are a notable component of patient safety costs to health services. Other costs can include associated clinical negligence claims. The costs of patient safety will reflect the definition of patient safety (for example, some definitions of patient safety include timeliness to treatment and this area also has considerable cost implications).

Research into adverse events has drawn attention to the need to improve patient safety.\(^1\) AEs in hospitals have been linked with direct medical costs, as indicated by a number of studies outside Europe which have impacted on health budgets.\(^3\) The average excess length of stay (LOS) shown in the studies ranges from six to
8.5 days for all AEs. For the NHS Trusts in England, this translates into a cost of some £2 billion a year in additional hospital stays alone.

The remainder of this paper presents a summary of patient safety costs from example studies.

2. Cost Measurement Examples
A variety of methods are used to calculate the costs related to AEs and preventable AEs, partly reflecting the availability of patient safety and cost data, or proxy data. These costs can be inclusive of the costs to society and economy.

A study focusing on the economic measurement of medical errors used claim data to identify that the cost of medical errors in the US was $19.5 million in 2008. These costs included the direct increase in medical costs of providing inpatient, outpatient, and prescription drug services to individuals who were affected by medical errors. An increase in indirect costs of approximately $1.4 billion related to increased mortality rates among individuals who experienced medical errors was also identified, as well as $1.1 billion for lost productivity due to related short-term disability claims.

In another study carried out in the Netherlands, only direct medical costs were taken into account due to limited cost data associated with AEs. Additional medical procedures during the excess LOS as a consequence of the AE were used to assess the direct medical costs attributable to AEs. According to this study, the cost driver for direct medical costs was found to be excess LOS in hospital. Unit price of intensive care unit stay, surgical AEs and age influence the impact of the direct medical costs. Even though it is often assumed that patients who die have no or low excess costs, the Dutch study showed that excess costs
related to (preventable) AEs in patients who die in hospital are still substantial both for excess LOS and extra interventions.

Kaushal et al. (2007) carried out a study to demonstrate the costs of AEs associated with intensive care units. Costs of care and LOS were identified from hospital billing systems for patients in medical and cardiac intensive care units to establish the main outcome measures. Incremental costs and LOS for patients with AEs were compared with patients without AEs while in intensive care units. The study concluded that patients who require intensive care are especially at risk for AEs, and the associated costs with such events are substantial. Recommendations for further investment in prevention strategies are justified by the costs of AEs.

Appendix I provides a summary of some cost studies associated with AEs in different countries.

3. Patient Safety, Medication Errors and Costs

Health services around the world have underestimated the scale of unintentional harm or injury experienced by patients as a result of incidents caused by medication errors. In the UK, it has been acknowledged that it is the interaction between human and system factors with the complex process of prescribing, dispensing and administering drugs that results in unintended and potentially harmful outcomes.

A UK study carried out to assess litigation related to medical errors (including blood) and allergic reactions to drugs in anaesthesia, classified drug related errors as follows:

- Administration of wrong drug
- Drug administered in the wrong dosage
- Drug administered in the wrong order
Drug administered through the wrong route

The study revealed that such drug-related medical errors cost the NHS Trusts in England £4,915,452 from 1995 to 2007. Out of the 93 relevant claims, 61 (7%) alleged patient harm directly by drug administration, one alleged harm due to errors that include drug omission, and 31 (4%) alleged harm by an allergic reaction.

4. Patient Safety, Acute Care Adverse Events and Costs

The study from the Netherlands carried out in the hospital setting showed that medical procedures attributable to AEs (mainly re-operations) accounted for approximately 15% of the medical costs attributable to AEs. The total cost of preventable AEs in university hospitals rose substantially even though the number of preventable AEs was lower than in general hospitals. It was further found that the excess LOS (5.6 days to 16.8 days), and consequently the excess costs of €2979 to €6649 (approx. £2,617 - £5,541), of preventable AEs increased when the impairment or disability was more severe (with hospital deaths, in which readmissions were impossible, the average costs of AEs were somewhat lower than in discharged patients). Surgical AEs resulted in longer excess LOS, resulting in higher excess costs than non-surgical AEs. Surgical and medication related AEs were considered to be the most expensive type of AEs. The Dutch study further showed that costs attributable to AEs were higher for older, surgical patients compared with non-surgical patients and for several diagnostic groups.
In another study carried out in Germany, deep vein thrombosis, wound healing and haematoma were found to be the most common adverse events for surgical patients, such as in total knee arthroplasty.\textsuperscript{8}

Doctors who unintentionally leave medical equipment in patients during an intervention cost the NHS £9m in medical negligence compensation over a five year period.\textsuperscript{7} Incidents where equipment is accidentally left inside a patient following surgery happens on average twice a week in England. The average compensation for such incidents is up to £18,000. In 2008, the highest figure paid out was £115,000 after the tip of a needle was not removed. In one incident a settlement of £75,000 was made after a patient later found a surgical clip, and on another occasion £60,000 was paid in compensation to someone who still had ‘packaging material’ inside them after an operation.

5.  Healthcare Associated Infections and Costs

Healthcare associated infections (HAIs) have been a quality of care issue for several decades, and continue to be an important topic in medical care involving the risk of infectious complications (surgery, intensive care, grafts, etc.) being delivered to populations with increasing susceptibility to infection (e.g. those who are of advanced age and those who are immunodeficient).\textsuperscript{9} The consequences of HAIs are likely to create a burden for patients and their care-givers and result in costs to diagnose and treat them.\textsuperscript{10, 11} It has been noted that about 15% of these HAIs are avoidable.\textsuperscript{12}

Studies have been carried out on the economic impact of HAIs using different methods.\textsuperscript{10, 11} These methods are often flawed by their inability to accurately distinguish between the type and amount of resources specifically associated with treating HAI and those incurred by the principal clinical cause for which the patient was admitted, and used average total cost.
A report by the National Audit Office (NAO) estimated that a reduction in the rates of MRSA bloodstream infections saved the NHS in England between £45 million and £59 million in treatment costs between 2003/4 and 2008/09. Similarly, by reducing the rate of C. difficile infections, between £97 million and £204 million was saved in treatment costs between 2006/07 and 2007/08.\(^{14}\)

The argument for the economic rationale for the prevention of HAIs has centred on the following:\(^{15}\)

- hospital-acquired infections take up scarce health sector resources by prolonging patients’ hospital stays;
- effective infection control strategies release these resources for alternative uses.

At least one in 10 hospitalised patients will acquire an infection after admission which results in substantial economic cost.\(^{15}\) The direct cost is that patients with HAIs increase their hospital stay during which time they occupy scarce bed-days and require additional diagnostic and therapeutic interventions. Cost estimates of these infections at 2002 prices suggest that the annual economic costs are $6.7 billion per year in the US and £1.6 billion in the UK.

A study in the UK found that HAIs occurring in surgical patients (surgical, orthopaedic, gynaecology, urology and ENT (ear, nose and throat) patients) were estimated to cost the hospital sector £363 million.\(^{11}\) The study suggests that crude national estimates of gross benefits of prevention will translate into a 15% reduction in HAIs, making it possible to release £140 million of resources.
6. **Summary from our high level review of adverse events and costs to health services**

Improvements in technology have created a complex healthcare system which still faces the challenges of reducing harm to patients. This paper has highlighted limited examples of AEs and associated costs.

Research in this area has revealed that patients can face unintentional harm at different points during their patient journey due to failures in technology, administration processes, medication errors, and infections. An increasing number of AEs are reported while patients are in acute care rather than primary care.

Costs associated with AEs are mainly attributed to additional days spent in hospital or accessing healthcare resources. A review of the literature has shown there is a lack of consensus on how to calculate the costs associated with AEs. Some studies have used litigation costs whereas others have sourced cost data from various hospital sources. Using litigation costs limits the costs to only those AEs where patients have taken legal action, thus excluding patients with AEs who have not taken legal action.

It is important to highlight that when compared to the United States and Australia, the UK has limited information on AEs, resulting in a relatively limited picture of the financial costs to the health service. The general consensus by researchers is that excess LOS is the main cost driver of medical costs. Patients who experience AEs are likely to either stay longer in the hospital or continue to access healthcare as a result of the AE. Examples given are those who acquire HAIs, surgical patients who may suffer injuries, or misdiagnosis of illness; and medical costs can include in-house ambulatory services, diagnostic services, operating rooms and pharmacological treatment.
In Scotland, the principles that drive the enhancement of safety in NHS Scotland were set out in *Learning from Experience* issued by the Chief Medical Officer in 2001. This agenda has included recognising that patient safety has cost implications:

For example, an economic model is being developed by the SPSP to evaluate the national outcomes associated with the implementation of the Ventilator Acquired Pneumonia (VAP) and Central Line bundles in terms of associated costs benefits and bed days saved. This is based on using the ‘deviation from the ideal’, i.e. the cost per day in ICU/HDU for every extra day caused by infection. The current cost of ICU is £2,000; HDU is £700 per day for all NHS Scotland. Using this cost information, and assuming that VAP extends stay by 6.10 days, the cost per infection would be £12,200. Central line infections based on 7 LOS, split 3.5 days in ICU at £2,000 per day and 3.5 days HDU at £700 per day, translates into £9,450 per infection (costs based on two US studies).

As awareness of the human implications for patient safety is raised, the costs associated with poor patient safety should also be highlighted.
## Appendix I

### Summary of studies indicating costs of Adverse Events

(Working draft)

<table>
<thead>
<tr>
<th>Study title (including focus country of study)</th>
<th>Cost details (cause)</th>
<th>Estimated cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adverse events and the National Health Service: an economic perspective (UK) Alastair Gray, 2003&lt;sup&gt;ii&lt;/sup&gt;</td>
<td>850,000 (estimated) inpatient episodes annually in which adverse events occur</td>
<td>£2 billion/year (cost of additional bed-days)</td>
</tr>
<tr>
<td>Cost of prescribed NSAID-related gastrointestinal adverse events in elderly patients (Canada) Rahme et al., 2001</td>
<td>Gastrointestinal-related adverse events</td>
<td>CA $2,916,121 (total cost over 2 years)</td>
</tr>
<tr>
<td>Cost-effectiveness of pressure-relieving devices for the prevention and treatment of pressure ulcers (UK) Fleurence, 2005&lt;sup&gt;iii&lt;/sup&gt;</td>
<td>Total cost of pressure ulcer care costs</td>
<td>£1.4 billion – £2.1 billion/year</td>
</tr>
<tr>
<td>The Effects of Nurse Staffing on Adverse Events, Morbidity, Mortality, and Medical Costs (US) Cho et al., 2003</td>
<td>Per average patient with hospital-acquired pneumonia: Increase in length of stay Increase in costs</td>
<td>5.1 – 5.4 days $22,390 – $28,505</td>
</tr>
</tbody>
</table>

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<sup>ii</sup> Gray, A. Adverse events and the National Health Service: an economic perspective (A report to the National Patient Safety Agency) 2003

Appendix II

A Profile of Safety for Patients in Healthcare

While it can be argued that improved technologies, medicines and treatments have resulted in improved healthcare, this has also resulted in a more complex healthcare delivery system. Medical errors can happen at different stages during the patient journey, such as during prevention, diagnostics, treatment and follow-up. Errors include communication failures, equipment failures and other system failures. The practical view of patient safety can be seen as the mechanisms, tools, underlying resources and actions required to reduce and ultimately avoid unintentional harm to patients. This may cover any aspect of care, including organisational factors, health-care personnel, the systems and environments that are likely to contribute to a safety breach.

The role of human error and poor clinical judgment and systems failures have been identified as the main causes of risks to patient safety. Incidents causing harm to patients are likely to lead to a range of costs such as inpatient and outpatient expenses, lost income, future medical expenses, burial costs for fatal injuries and non-economic losses (e.g. pain and suffering).

Hospital charts in various countries have shown that 2.9% - 16.6% of patients in acute hospitals have experienced one or more AE. Adverse events of around 10% are estimated to occur on admission or at a rate of an estimated 850 000 per year. As highlighted already for the NHS Trusts in England, this translates into a cost of approximately £2 billion a year in additional hospital stay alone. Reviews of adverse events and errors have indicated that even though human

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iv For example, the prevalence of health-care infections, diagnostic and medication errors, addressing more specific risks associated with certain treatments, medicines or devices, etc.

v A set of interdependent elements (people, processes, equipment) that interact to achieve a common aim.
fallibility is a contributor, incidents mainly occur as a result of systems lacking in-built patient safety checks.¹⁹

In the UK, unlike the United States and Australia, little is known about adverse patient events and cost implications. A preliminary study of adverse events at two London hospitals found that 10.8% of patients had experienced AEs, with an overall rate of 11.7% including multiple events.¹³ A third of the events resulted in moderate or severe impairment, and around half were judged preventable. The estimated cost of additional bed days for the preventable events was over £290,000, resulting in an estimated bill of approximately £1bn per year for NHS Trusts in England.
Reference List


