Literature review brief

The background to this review is the link between nurse staffing, in terms of hours and skill mix, and certain patient outcomes which have been identified as most sensitive to nursing care. These outcomes, known as nurse-sensitive outcomes, or outcomes potentially sensitive to nursing, were explored by Needleman, Buerhaus, Mattke et al (2001). Needleman and colleagues developed algorithms to apply to hospitalised patient data concerning diagnosis related groups, International Statistical Classification of Diseases codes, secondary diagnoses and procedures to identify cases that had developed particular complications, or adverse outcomes, while in hospital. Such complications are considered to be potentially preventable as they are defined as arising after admission, implying that they could have been avoided under better nursing surveillance and care circumstances.

The brief for this review was to find out whether there was any evidence that the cost of these nurse-sensitive adverse outcomes could be quantified.

Overview

The idea of costing hospital experiences is not a new one, especially in the United States, where health insurers such as Medicare and Medicaid require the itemisation of costs for billing purposes. However, recently there has been an interest in identifying the costs associated with inpatient complications which can lead to additional interventions or treatment and a longer length of stay (LOS). The main focus of this review is on the costs associated with a set of nurse-sensitive patient outcomes. The review located little relevant information, but the handful of articles that have been published suggest that the costing process is possible, mainly through the use of software systems designed to assign costs to resources such as consumable and reusable materials and staff time. In most costing models the costs of an adverse event were calculated by comparing costs between similar patients; costs of a routine inpatient stay were contrasted with those associated with an inpatient stay during which complications developed. The difference between these two amounts was then considered to be the cost of the adverse event(s). Use of costing systems was found in Canada, the United States and Australia (links to relevant websites are provided in footnotes throughout this review).

As this review uncovered limited information relating to costs of nursing-related adverse events, its scope was broadened to encompass some of the literature on the costing of adverse events in general, which revealed a similar picture. In this more general sense, some authors have focused solely on the increase in LOS associated with an adverse event, and have estimated costs by comparing LOS for cases with and without an adverse event. More recently there has been an effort to cost more accurately, with the use of sophisticated costing systems. A case study of the costs of pressure sore treatment is included as an example.
Literature review

Introduction

The purpose of this review arises from Needleman, Buerhaus, Mattke et al’s 2001 report ‘Nurse staffing and patient outcomes in hospitals’. Based on the premise that nurse staffing, encompassing nursing hours and the skill mix of nursing personnel, is linked to patient outcomes, this research made use of patient discharge data from 799 hospitals in 11 states in the United States, and developed algorithms to identify cases in which patients had developed an outcome potentially sensitive to nursing (OPSN). Outcomes defined as OPSN had either been established in previous research (for example urinary tract infections (UTIs), skin pressure ulcers, hospital-acquired pneumonia and deep vein thrombosis/pulmonary embolism) or were newly defined in the 2001 study (for example upper gastrointestinal bleeding, central nervous system complications, sepsis, shock/cardiac arrest and, in surgical patients only, surgical wound infection, pulmonary failure and metabolic derangement). Results demonstrated an association between nurse staffing and urinary tract infections, pneumonia upper gastrointestinal bleeding and LOS, as well as shock in medical patients.

Since 2001 there have been numerous attempts to research the link between nursing and patient outcomes, but several authors have pointed out the difficulty involved in drawing causal links between the two (Aiken 2008; Kane, Shamliyan, Mueller et al, 2007), for example in terms of the problems inherent in disentangling nurses’ contributions from those of other health professionals and the broader system (Naylor 2007). The preventability of certain adverse events is being taken seriously, however. In 2008 the Centers for Medicare and Medicaid Services (CMS) in the United States introduced regulations refusing insurance payments for eight ‘never conditions’ – thus named because the CMS had determined that they should never occur. The eight conditions included pressure ulcers, falls with injury, catheter-associated UTIs, vascular catheter-associated infections, certain surgical site infections, objects being mistakenly left inside surgical patients, air emboli and blood incompatibility reactions – the first four of which have been definitively linked with nurse staffing (Buerhaus, Donelan, DesRoches, et al 2009).

A press release disseminated in Canada on 8 June 2010 demonstrates the current interest in calculating the costs of adverse events or outcomes. The release announced financial support from the Canadian Patient Safety Institute for research into the true costs of adverse outcomes. The project is entitled ‘The Economic Burden of Patient Safety’. The researchers, Drs Etchells and Mittman, propose to carry out the following:

1) systematic review of the patient safety (PS) economic literature;
2) development of guidelines for the conduct of economic evaluations in PS;
3) determine the economic burden of PS issues to the Canadian health care system;
4) estimate the value of improving PS using economic analysis; and
5) determine priority target areas for economic evaluations in the area of PS.1

Method

This review represents an attempt to identify the way in which costs associated with patients developing OPSNs have been calculated so far. A range of information sources were searched for information pertaining to the key terms ‘cost’, ‘outcomes potentially sensitive to nursing’, ‘nurse-sensitive outcomes’, ‘adverse events’ and ‘patient safety’.

Google and Google Scholar were used, alongside PubMed (Medline), PubMed Central and the Cumulative Index to Nursing and Allied Health Literature (CINAHL). The following journals were also searched: Nursing Economics, Journal of Advanced Nursing, Policy, Politics, and Nursing Practice and the Journal of Nursing Administration. Relevant articles having been identified, any possibly relevant articles cited within them were also investigated, along with others arising from PubMed’s ‘related citations’ facility.

Findings

The review identified very little relevant literature. This first section summarises the small set of articles that were found. Due to the limited nature of the available literature, the scope of the review was broadened to include a portion of the considerably larger body of literature on the costing of adverse events in general. Information presented in such articles is typically quite technical and not easy to summarise: consequently, this review quotes excerpts directly where relevant.

Some literature, although appearing (on the basis of title) to be relevant to this review, did not entail any specific method of calculating the cost of patient outcomes. For example, although Aiken’s 2008 article on the economics of nursing discusses the association between patient outcomes and specific qualities of the nursing workforce, such as registration, education, staffing hours and practice environment, it only goes so far as to describe adverse patient outcomes and patient care expenses as ‘costly’, and able to be offset by investment in nursing resources, providing no further monetary detail. Similarly, Davis, Lay-Yee, Bryant, et al’s 2002 study of adverse events in New Zealand hospitals concludes that:

The findings suggest that adverse events are as significant a problem in New Zealand as they are in Australia, the UK, and the United States. In essence, about one in eight admissions to a hospital are associated with adverse events (which may have occurred within or outside public hospitals). The majority of such incidents have a relatively minor impact on patients (though there is a significant proportion who suffer permanent disability or death), but their effects on hospital workload, and thus costs to the health system, are substantial.

Cost of nurse-sensitive adverse events

The main focus of the few relevant articles identified by this review was the costs of employing or increasing the employment of registered nurses in relation to cost savings associated with the prevention of adverse events.
Dall, Chen, Seifert, et al’s 2009 article synthesised the literature linking nursing resources to patient outcomes in order to calculate potential savings in terms of preventable adverse events associated with increasing nurse hours per patient day. It then applied these findings to 2005 hospital discharge data from the United States Agency for Healthcare Research and Quality (AHQR)’s Healthcare Cost and Utilization Project’s Nationwide Inpatient Sample (NIS) to estimate the incidence and costs of nurse-sensitive patient outcomes. In order to calculate costs, ‘charges were converted to cost with hospital-specific cost-to-charge ratios. The risk adjustment variable was average cost associated with the [diagnosis related group (DRG)]’ (page 98). As the NIS only contains hospital-related costs, the authors sought expert medical opinion regarding hospital and post-discharge costs for each nurse-sensitive outcome. They based their calculations on four assumptions: firstly that an average hospital visit to a doctor/other clinician costs around $100; secondly that patients who experience a fall receive one clinician examination; thirdly that during each additional day in hospital following emergence of a complication, patients receive a visit from their doctor and possibly from a specialist; and finally that some complications require post-discharge visits and treatment. The article acknowledged that there was little information available on which to calculate the costs of nursing care during the outcome-related length of stay.

The estimated increase in LOS and the costs associated with a range of nurse-sensitive outcomes (NSO) were as follows.

<table>
<thead>
<tr>
<th>NSO</th>
<th>Length of stay</th>
<th>Medical costs (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Medical</td>
<td>Surgical</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urinary tract infection</td>
<td>1.68</td>
<td>4.58</td>
</tr>
<tr>
<td></td>
<td>1628</td>
<td>4770</td>
</tr>
<tr>
<td>Pressure ulcer</td>
<td>4.19</td>
<td>6.59</td>
</tr>
<tr>
<td></td>
<td>5177</td>
<td>5484</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>2.79</td>
<td>4.48</td>
</tr>
<tr>
<td></td>
<td>5837</td>
<td>8511</td>
</tr>
<tr>
<td>Deep vein thrombosis</td>
<td>3.09</td>
<td>5.65</td>
</tr>
<tr>
<td></td>
<td>5281</td>
<td>10,349</td>
</tr>
<tr>
<td>Upper gastrointestinal bleeding</td>
<td>1.37</td>
<td>2.64</td>
</tr>
<tr>
<td></td>
<td>2809</td>
<td>5862</td>
</tr>
<tr>
<td>[Central nervous system] complications</td>
<td>0.80</td>
<td>2.99</td>
</tr>
<tr>
<td></td>
<td>1102</td>
<td>3584</td>
</tr>
<tr>
<td>Sepsis</td>
<td>5.51</td>
<td>9.30</td>
</tr>
<tr>
<td></td>
<td>11,259</td>
<td>20,398</td>
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<tr>
<td>Shock/cardiac failure</td>
<td>0.56</td>
<td>1.36</td>
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<tr>
<td></td>
<td>5584</td>
<td>9247</td>
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<tr>
<td>Postoperative infection</td>
<td>N/A</td>
<td>8.14</td>
</tr>
<tr>
<td></td>
<td>N/A</td>
<td>14,571</td>
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<tr>
<td>Pulmonary failure</td>
<td>N/A</td>
<td>4.51</td>
</tr>
<tr>
<td></td>
<td>N/A</td>
<td>15,138</td>
</tr>
<tr>
<td>Adverse drug event</td>
<td>3.80</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7789</td>
<td></td>
</tr>
<tr>
<td>Fall</td>
<td>2.39</td>
<td></td>
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<tr>
<td></td>
<td>7118</td>
<td></td>
</tr>
</tbody>
</table>

(This table appeared as Table 5 in Dall, Chen, Seifert, et al 2009.)

2 According to the AHQR website, ‘This inpatient care database includes all patients, regardless of payer – including people covered by Medicare, Medicaid, private insurance, and the uninsured. The data can be weighted to produce national estimates, allowing researchers and policymakers to use the NIS to identify, track, and analyse national trends in health care utilisation, access, charges, quality, and outcomes.’ In 2008 the NIS included details of approximately 8 million hospital stays based on all patient discharges from 1056 hospitals in 42 states.
Cho, Ketefian, Barkauskus, et al (2003) investigated the effect of nurse staffing on adverse events, mortality, morbidity and costs. Based on Cho’s 2001 model of nurse staffing and patient outcomes, the authors hypothesised that while there are no direct effects of staffing on mortality, morbidity and costs, nurse staffing is indirectly influential via adverse events. The study used existing Californian financial and inpatient databases and focused on 11 DRGs and seven adverse events: falls/injuries, pressure ulcers, adverse drug events, pneumonia, UTIs, wound infections and sepsis. In calculating medical costs, the authors converted charges to costs by using hospital level ratios of costs-to-charges. This ratio was calculated, using financial data from the Office of Statewide Health Planning and Development, by dividing total operating expenses by gross patient revenue. Individual patient costs were estimated by multiplying charges and the hospital-specific cost-to-charge ratio.

Pappas (2008) acknowledged the need to calculate the ‘actual hospital cost of complications that relate to the quality and quantity of nursing care’ (page 231). Previously she had reviewed the history of costing nursing and patient expenses, noting that the prevalent way of quantifying costs took into account nursing salaries, costs per hospital patient day and ratio of costs to charges (Pappas 2007). The objective of her 2008 research was to develop a methodology for measuring actual patient costs and identifying relationships between nurse staffing, adverse events and costs. Two acute-care hospitals in the United States were the focus of the project, providing data on staffing, patient acute care episodes and outcomes, and care costs. The financial and staffing data came from a cost accounting system, Eclipsys TSI, which enables the calculation of cost per case. The resulting standardised costs were actual costs associated with each patient’s hospital stay. The clinical outcomes measured were those considered to be associated with nursing care, including medication errors, UTIs, patient falls, pneumonia and pressure ulcers. Incidences of these adverse events were identified through incident reports and discharge diagnoses from medical records. The average cost of adverse events per case was estimated to be $1000, but when this was broken down by type of event it ranged from approximately $300 to $2400, medication errors and falls being the least costly and UTIs, pressure ulcers and pneumonia the most costly.

Unruh’s 2008 review of nurse staffing and patient, nurse and financial outcomes stated that ‘relatively few studies have investigated the relationship between nurse staffing levels and hospitals’ financial outcomes’ (page 68), and described their results as inconclusive. Unruh identified four approaches to research in this area, one being an exploration of how changes to nurse staffing levels impact on rates of adverse events, and consequently on cost savings. In this context Unruh cited five articles. One of these (McCue, Mark and Harless 2003) investigated the link between nurse staffing, quality and financial outcomes in United States hospitals between 1990 and 1995, but focused only on mortality rates as a predictor of quality care. Another (Rothberg 2005) also concentrated on mortality and LOS as factors influenced by nurse staffing.
Shamliyan, Kane, Mueller, et al (2009) conducted a simulation exercise to predict the cost savings associated with increasing registered nurse staffing in acute-care hospitals. They used data from the NIS, which they stated ‘provides the dollar value per case of nurse-sensitive adverse events in subgroups of patient age, income, residency and hospital location, bed size and teaching status’ (page 306). The following excerpt outlines the costing procedures used in the study (page 306):

Calculations for an average of hospital charges per discharge (Healthcare Cost and Utilization Project & United States; Agency for Healthcare Research and Quality, 2000; Soucienct, 2005) for patient adverse events were based on International Classification of Diseases codes (Centers for Disease Control and Prevention & National Center for Health Statistics, 2000) (see Tables 3 & 4) (Needleman, 2001). The database of the Healthcare Cost and Utilization Project provides the dollar value per case of nurse-sensitive adverse outcomes in subgroups of patient age, income, residency and hospital location, bed size, and teaching status. We simply calculated average hospital charges for [International Classification of Diseases] codes of nurse-sensitive adverse events in each of these categories.

A study carried out by Rothschild, Bates and Franz in 2009 looked at the costs and savings associated with prevention of adverse events by critical care nurses in the critical care unit (CCU) of a tertiary care academic hospital in New England. Costs were calculated as follows (page e3):

... we determined the costs of care and length of stay (LOS) from the hospital billing systems. We then determined the incremental costs and LOS for patients with adverse events matched to patients without events (controls) based on unit, pre-event LOS, and pre-event unit costs (as a proxy for matching on pre-event severity of illness). We used a random effects linear regression model to regress patient costs incurred from the day of the event to either the day of an additional event or the day of unit discharge controlling for covariates such as age, sex, race, mortality, Diagnosis related group (DRG) weight, and APACHE II (Acute Physiology and Chronic Health Evaluation) and Charlson scores. For this study, we only used the CCU AEs [adverse events]. We matched 52 CCU patients having at least one AE with 183 CCU control patients. We found an AE cost $3857 (P = .023) and resulted in a 1.08-day increase in the LOS (P = .003).

In the United States context, Needleman and colleagues have written a series of articles linking hospital data to nursing resources and reviewing literature addressing the same issue (Needleman, Buerhaus, Mattke, et al 2001; Needleman, Buerhaus, Mattke et al 2002; Needleman, Buerhaus, Stewart, et al 2006; Needleman, Kurtzman and Kizer 2007; Needleman 2008). However, the only articles in which they describe costing processes provide little detail. Needleman, Buerhaus, Stewart, et al (2006) state that (page 205):

Discharge abstracts and nurse staffing data were obtained from the states; data on hospital size, location, teaching status, from the American Hospital Association (AHA) annual survey; and cost-to-charge ratios, from Medicare cost reports.

Begley and Brennan (2009) conducted a systematic review of evidence determining the impact of Magnet designation on nursing and patient outcomes. (Magnet status is awarded by the American Nurses’ Credentialing Center, an affiliate of the American Nurses Association, to hospitals satisfying a set of criteria designed to measure strength and quality of nursing.) While they identified three areas of impact – nurse variables, patient variables and financial impact – they were apparently only able to identify one article addressing financial consequences (Tuazon 2007). This article compared profit ratios of Magnet and non-Magnet institutions in New Jersey in 2002/2003, and found that Magnet status was profitable. However, the article provided no breakdown of specifics.
**Costs of nursing**

One of the costs associated with adverse events is that of the nursing time required when patients are in hospital longer than initially expected. In 2008 Finkler reviewed two articles concerned with measurement of nursing care intensity, and pointed out that it has been possible to measure differential use of nursing resources since the 1970s via patient classification systems such as GRASP (acuity and nursing workload software) and Medicus. However, Finkler also pointed out that interpreters of data produced by these systems should be careful to consider to what purpose the information would be put, and be sure that potential gains outweigh the costs of implementing the information-collecting exercise.

The next section considers some of the literature associated with adverse events more broadly.

**Costs of adverse events**

Of the larger body of literature, only a little considers preventable events such as OPSNs. In 2009, Hoonhout, de Bruijne, Wagner, et al concluded their literature review with the statement that ‘except for one study which took place over a decade ago, no data on costs of preventable AEs (adverse events) are available.’

Some authors have calculated costs of adverse events solely according to their impact on LOS (Ackroyd-Stolarz, Guernsey, MacKinnon, et al 2009; Williams, Olsen, Crichton, et al 2008; Vincent, Neale and Woloshynowycz 2001). For example, Vincent, Neale and Woloshynowycz counted adverse events and estimated costs based on extra LOS multiplied by the average cost of a medical (£171) or surgical (£282) bed. No other charges were taken into account, and no detail was provided concerning types of adverse events, beyond designating them as medical, surgical, orthopaedic or obstetric.

Others have attempted to identify more specific costs. For example Ehsani, Jackson and Duckett (2006) used adjacent DRGs to calculate differences in costs between those cases with and without complications. Two methods were used to determine cost, as follows (page 552; footnotes have been removed):

First, the mean cost was calculated for cases with and without a recorded adverse event for each [adjacent DRG (adjDRG)]. Second, an analysis of the combined effect of age, comorbidity and the presence of an adverse event on the cost of an episode of care was calculated using coefficients from a linear regression model, with the total cost of the admitted episode as the dependent variable. The length of stay variable was excluded from the model, as it is both a predictor and outcome of an adverse event.

The 10 adjDRGs contributing the greatest dollar value attributable to adverse events were identified by establishing the mean difference between episodes with and without adverse events, and multiplying by the number of cases in each group. The incremental cost of adverse events in these individual adjDRGs was also estimated using linear regression, adjusting for age and pre-existing comorbidity, with the total cost of the episode as the dependent variable.

The adjustment for presence and severity of pre-existing comorbidities was calculated using the [International Classification of Diseases, Tenth Revision, Clinical Modification] mapping of the Charlson index by Sundararajan et al, a validated and widely accepted measure of comorbidity. C-prefixed diagnosis codes were excluded from this analysis to ensure that the Charlson index adjusted for comorbidities present on admission and not complications arising during the episode of care.
Hoonhaut, de Bruijne, Wagner, et al (2009) estimated the medical costs associated with adverse events in 21 Dutch hospitals by way of a retrospective record review. They estimated cost in terms of extra days in hospital and medical expenses associated with adverse events. Two independent physicians estimated the proportion of each hospital stay generated by the adverse event, and their estimates were averaged and rounded up. Where the additional LOS could not be calculated, the difference between the expected and observed LOS was used. The costing process was outlined as follows (references have been removed):

The excess LOS and the excess medical procedures were multiplied by unit costs to estimate the total excess direct medical costs. Dutch guideline prices of 2003 were used to estimate the costs of one hospital day of standard or intensive care in a university and general hospital. Prices were corrected with price-indices for 2004. No unit costs for tertiary medical teaching hospitals were available; therefore the guideline prices for general hospitals were used. The unit costs include costs of a standard hospital day, medical and nursing staff, medication, material, equipment, housing and overhead. The costs of procedures and interventions were not included in these costs. The costs of the excess medical procedures were estimated by multiplying the number of procedures by standard price tariffs used for insurance companies, maintained by the Dutch Healthcare Authority.

This study estimated costs of a general hospital day to be €341 and an intensive care day to be €1704. The authors note that medical interventions were not always listed (for example, the casting of a broken leg), so medical costs were an underestimate. Surgical adverse events generally resulted in a longer additional LOS than medical adverse events, leading to higher costs. The estimated additional LOS for preventable adverse events was 10.3 days on average. The authors concluded from their estimates that total adverse events increased annual Dutch medical costs by €355 million and that preventable adverse events increased such costs by €161 million, representing 2.4 percent and 1.11 percent of the national health care budget respectively.

Hemmila, Jakubus, Maggio, et al (2008) considered costs of complications among patients admitted to hospital following trauma. The 512 study patients were divided into three groups: those with no complications (64 percent), those with one or more minor complications (such as a UTI or decubitus ulcer; 10 percent) and those with one or more major complication (such as pneumonia or myocardial infarction; 25 percent). Costs were calculated as follows (footnotes have been removed):

Cost accounting data were obtained from the University of Michigan Health System Data Warehouse (HSDW). The cost accounting data from each patient encounter is entered into the HSDW using a detailed cost-accounting system, Transitions Systems Inc. (TSI). The TSI cost accounting system tracks the use of all resources and assigns estimates of costs. These estimates are based on direct acquisition costs for supplies and time-and-motion studies for labor costs. Financial data obtained included hospital charges, net payment, direct costs, indirect costs, and total margin for the inpatient trauma encounter. We also obtained the primary payer data and placed them into appropriate categories for analysis.

(The TSI system, also known as Eclipsys, was referred to above in the context of Pappas’ 2008 article: see http://www.eclipsys.com/)

Results suggested that both minor and major complications significantly increased LOS. Presence of a minor complication added to hospital charges, net payment and hospital costs, but when considered per day did not significantly add to the total cost margin. Major complications did, however: adding an average of $1070 per day to hospital costs.

8 | P a g e

Calculating Outcomes Potentially Sensitive to Nursing
An article published by Mello, Studdert, Thomas, et al in 2007 makes the following observation (page 836):

Over the past several years, patient safety advocates have sought to persuade hospital leadership that the costs of medical malpractice lawsuits, and of adverse events more generally, constitute a strong business reason to invest in safety improvements. Sometimes called the ‘business case for patient safety,’ this argument posits that in addition to meeting the ethical and public health imperative to minimize patient injuries, health-care organizations that invest in systems improvements to reduce adverse events will reap a financial return.

Mello and colleagues make the case for acknowledging that the consequences of adverse events go far further than hospital expenses: they can include lost income/household production, pain and suffering, burial costs, disability payments, future medical costs and lawsuit expenses. This article’s analyses of data associated with adverse events in Utah and Colorado in 1992 (Studdert, Thomas, Zbar, et al 1997) suggest that hospitals only pick up about 22 percent of the total expenses generated by adverse outcomes. The authors conclude that ‘the direct costs of adverse events do not fall on hospitals to a significant enough extent to create strong economic incentives for safety improvement’ (page 838).

Zhan and Miller (2003) estimated costs of medical events using data from the NIS. Having identified cases in which an adverse medical event was involved, they matched each case with up to four control cases according to hospital, DRG, ethnicity (white/non-white), age within 10 years, sex and co-morbidity. Excess length of stay, charges and mortality rates were then calculated by comparing each case with the corresponding mean for the four control cases. While the patient safety events addressed by Zhan and Miller were not specifically nursing-related, some had previously been identified as being potentially sensitive to nursing. For example, Zhan and Miller reported decubitus ulcers to result in an average excess LOS of 3.89 days and a cost of US $10,845; post-operative pulmonary embolism/deep vein thrombosis in an excess LOS of 5.36 days and a cost of $21,709; post-operative sepsis in an excess LOS of 10.89 days and a cost of $57,727; and post-operative physiologic and metabolic derangement in an excess LOS of 8.89 days and a cost of $54,818.

Zhan and Miller’s study extended the procedure used by Bates, Spell, Cullen, et al (1997) and Classen, Pestotnik, Evans, et al (1997). The Bates study used patient data from two tertiary care hospitals in Boston. Cases experiencing adverse drug events were identified via incident reporting, discussions with staff and daily record reviews. Event information was then subjected to independent review by two physicians, who decided whether or not there had been an incident, and if so whether it had been avoidable. Cases were matched with non-incident cases according to DRG, sex, race, age, illness severity and co-morbidity (using the Charlson index, which predicts one-year mortality for patients with a range of co-morbid conditions: 22 in total). According to the authors, ‘Information on length of stay and charges was obtained from billing data, and costs were estimated by multiplying components of charges times hospital-specific ratios of costs to charges.’ Costs and length of stay were compared across matched pairs. The Classen study was based at LDS Hospital in Salt Lake City. Similarly to the Bates study, the focus was on differences between pairs of cases matched on a range of variables including admission period, age (within 10 years), sex, acuity and DRG. In explaining their calculations of cost, the authors state (footnotes have been removed):
Cost outcomes were determined from a transaction-based microcosting system called the standard cost manager (SCM), a microcomputer software system designed and developed by Intermountain Health Care, Inc, and Ernst and Whinney. This system is a cost-based accounting system that uses time and motion studies to estimate the actual costs of all aspects of hospital care, updated each year, and is used widely throughout US hospitals.

Rigby and Litt (2000) focused on the difference between adverse and iatrogenic events; the former defined as ‘unavoidable or unpredictable events that occur during the appropriate application of best practice’ and the latter ‘events that arise as a result of incomplete or inappropriate diagnosis or therapeutic interventions’ (page 216). Using data from the Quality in Australian Health Care Study and the Utah Colorado Study, the authors calculated the costs of 25 specific iatrogenic events. Their description of calculation of costing in their study is as follows (footnotes have been removed):

An average direct acute care cost per category using Australian disease related groups (AN-DRG version 3) data was calculated per 10 000 discharges. Principal diagnosis cost weights were used except in the case of warfarin related injuries, inadequate manipulation of fractures, and unnecessary operations. The heterogeneous nature of these latter categories required more refined costings using secondary diagnoses. The costing data were further adjusted to reflect age, sex, and related co-morbidity. The cost of preventable injuries provides an indirect measure for potential cost savings.

An Australian study (Justin, Hanson, Fan, et al 2006) explored the possibility of linking incident reporting (using the AIMS system for incident reporting and management)\(^4\) with a clinical costing system (PowerHealth Solutions)\(^5\) in order to gain an understanding of the true costs of adverse events. The project was based at the Children’s Hospital at Westmead, where researchers focused on drug-related adverse events. Episodes of care that involved an adverse event were compared to those that did not in order to calculate cost differences. Results suggested that adverse events entailed an average cost increase of 20–85 percent, depending on the severity of the event. This translated into total costs of around $6 million over the initial six-month study period.

The only New Zealand information this review located was an estimation of the cost of adverse events in hospitals as part of the New Zealand Quality in Healthcare Study by Brown, McArthur, Newby, et al (2002). The authors considered costs of clinical procedures and additional bed days associated with adverse events and valued them according to amounts charged to overseas patients for use of health care resources. Their conclusions suggested that adverse events cost an average of $10,264 per patient.

\(^5\) http://www.powerhealthsolutions.com/products/PPM/CostManager/
Pressure ulcers – a case study of the costs of a specific adverse event

Schuurman, Schoonhoven, Defloor, et al published an article on the costs associated with pressure ulcer care in 2009. In reviewing the extant literature, they concluded that only a few attempts had been made to calculate such costs, and that all had been based on expert opinion rather than actual data. Their own study itemised care costs including staff time involved in repositioning, mobilising and wound care (based on average wage costs per minute for specific categories of staff) and the costs of resources (such as special mattresses and beds, dressings, nutritional supplements and ointments). While they did not specify exactly how they calculated proportions of costs for reusable resources such as beds and mattresses, they provided estimates for mattresses ranging from €2 (foam mattresses) to €54 (air fluidised mattresses) per day. Staff cost estimates ranged from €0.47 (for a daytime nurse) to €2.40 (for a medical specialist) per minute. Two hospitals were used in the analyses, one focusing more on the human approach to prevention and treatment (such as repositioning or mobilisation) and the other placing a greater emphasis on the technical approach (such as special beds and mattresses). Estimated total mean costs of pressure ulcers ranged from €423 for a grade 1 ulcer to €1287 for a grade 4 ulcer in the ‘technical approach’ hospital (€47–99 per day) and from €352 for a grade 1 ulcer to €1722 for a grade 4 ulcer in the ‘human approach’ hospital (€32–123 per day).

Conclusion

This brief review suggests that costing of nurse-sensitive adverse events is possible, and is generally done through the use of a hospital accounting system. Costs are calculated for individuals developing an adverse outcome, and these costs are compared to costs incurred by similar individuals who did not develop the outcome. However, costing using this method would appear to be a time-consuming and not entirely accurate process, which has thus far been carried out for research purposes only, and with a relatively small sample of patients. Accounting systems appear to be improving, and are now widely used in Canada and the United States.
References


Naylor MD. 2007. Advancing the science in the measurement of health care quality influenced by nurses. Medical Care, Research and Review 64(2 Suppl): 144S–69S.


