



KAROLINSKA INSTITUTET Medical Management Centre

9 October 2009

*The costs of poor quality and adverse
events in health care
- A review of research*

Dr John Øvretveit jovret@aol.com
Director of Research, and
Professor of Health Innovation and Improvement,
The Medical Management Centre,
The Karolinska Institutet, Stockholm.

Sara Tolf sara.tolf@ki.se
Researcher, The Medical Management Centre,
The Karolinska Institutet, Stockholm,

Reference citation: Øvretveit, J and Tolf, S 2009 The costs of poor quality and adverse events in health care - A review of research for the Swedish healthcare compensation insurance company (Landstingens Omsesidiga Forsakringsbolag (LoF)), The Medical Management Centre, The Karolinska Institutet, Stockholm.

Contents

SUMMARY	4
PURPOSE	4
THE NUMBER OF AVOIDABLE EVENTS CAUSED BY HEALTHCARE WHICH HARM PATIENTS	4
THE COSTS OF ADVERSE EVENTS	5
THE CONSEQUENCES OF ADVERSE EVENTS	7
IMPLICATIONS – PRACTICAL AND SCIENTIFIC	7
1.1.1 <i>Practical implications</i>	7
1.1.2 <i>Scientific implications</i>	8
PART 1: INTRODUCTION, OBJECTIVES AND METHODS	9
2 INTRODUCTION	9
2.1.1 <i>Background</i>	9
3 OBJECTIVES AND METHODS.....	9
AIMS AND OBJECTIVES	9
METHODS	10
3.1.1 <i>Search for previous reviews</i>	10
3.1.2 <i>Search for specific studies</i>	10
3.1.3 <i>Assessing strength of evidence</i>	10
3.1.4 <i>Selection summarizing and synthesis</i>	11
3.1.5 <i>Limitations of the review</i>	11
DEFINITIONS	12
DEFINITIONS USED IN THIS REVIEW	12
LIMITATIONS OF THIS OVERVIEW	13
PART 2: FINDINGS	14
4 EVIDENCE OF THE NUMBER AND TYPES OF QUALITY PROBLEMS.....	14
GENERAL STUDIES	15
4.1.1 <i>Poor quality waste</i>	15
4.1.2 <i>Overuse, underuse, misuse under-coordination and waste</i>	16
ADVERSE EVENTS.....	16
5 EVIDENCE OF THE COST OF POOR QUALITY	18
GENERAL COSTING STUDIES	18
SPECIFIC ADVERSE EVENT COST, BY TYPE OR SERVICES	20
5.1.1 <i>Adverse drug events (ADEs)</i>	20
5.1.2 <i>Hospital acquired infections (HAIs)</i>	22
5.1.3 <i>Adverse events in surgical care</i>	22
5.1.4 <i>Pressure Ulcers</i>	23
5.1.5 <i>Patient falls</i>	23
5.1.6 <i>Adverse events associated with “failure to rescue”</i>	24
5.1.7 <i>Communication and coordination failure</i>	24
5.1.8 <i>Hospital discharge communications</i>	24

PART 3: DISCUSSION AND CONCLUSIONS	26
6 DISCUSSION.....	26
COMMENTS ON THE RESEARCH	26
EVIDENCE OF EFFECTIVE INTERVENTIONS	26
7 CONCLUSIONS.....	26
CONCLUSIONS: COSTS OF POOR QUALITY AND ADVERSE EVENTS.....	26
THE CONSEQUENCES OF ADVERSE EVENTS.....	28
IMPLICATIONS – PRACTICAL AND SCIENTIFIC	28
7.1.1 <i>Practical implications</i>	28
7.1.2 <i>Scientific implications</i>	29
8 REFERENCES	30

Summary

Purpose

This report presents a review of evidence of the number, cost and consequences of poor quality and adverse events (AEs) in healthcare. Not all poor quality results in an adverse event experience by a patient. There are differing views and evidence about how many adverse events are avoidable. This report follows the conventional definition of adverse events as avoidable events that harm patients or healthcare providers and are caused by healthcare, not by the patients illness. Some result from failures to provide treatments known to be effective (one type of poor quality), such as failure to provide timely antibiotics before surgery to reduce post surgical infection. Medical errors may or may not result in an adverse event - even if they are not detected and corrected, they may not cause harm.

The number of avoidable events caused by healthcare which harm patients

The review found strong evidence of a large number of adverse events for hospital patients in Sweden and in many other western health systems. National studies using patient journal review methods (medical records) show many different types of adverse events, but studies differ in how they categorise these. The Swedish study using this method shows similar rates to the UK and Denmark with 12.3% of hospital patients experiencing an adverse event, but more in the Swedish study were judged to be preventable (70% of rather than 37 - 51%), and on average 6 additional days stay for each. There is little strong evidence of differences between countries in specific types of adverse events, largely because of differing reporting systems or study methods.

The most common hospital AEs reported in one US study are classified as:

1. Adverse drug events (ADEs, ADRs)
2. Iatrogenic infections (or Hospital Acquired Infections (HAIs))
 - post-operative deep wound infections
 - urinary tract infections (UTI)
 - lower respiratory infections (pneumonia or bronchitis)
 - bacteremias and septicemias
3. Pressure injuries (pressure ulcers)
4. Mechanical device failures
5. Complications of central and peripheral venous lines
6. Deep venous thrombosis (DVT) / pulmonary embolism (PE)
7. Strength, agility and cognition (patient falls, injuries and restraints)
8. Blood product transfusion
9. Patient transitions

An Australian study reported the following AEs in ranking of frequency in a 120 bed community hospital: wound infections; pressure sores; urinary tract infections; inadequate manipulation of fractures; pulmonary embolism; unnecessary operations; falls admitted; warfarin related; bleeding due to non-steroidal anti-inflammatory drugs; deep vein thrombosis; postoperative nausea and vomiting; and pneumothorax. It estimated that the cost of these “12 preventable iatrogenic injuries is significant and accounts for 2-3% of the annual budget” (Rigby & Litt 2000).

Apart from the medical records reviews, most studies at the hospital level focus on one type of adverse event (eg hospital acquired infections) or one service (eg surgical services), rather than reporting evidence of all adverse events occurring in the hospital over a period of time. Categorisation systems for adverse events are under-developed, and mix categories of events experienced by patients (eg adverse drug reaction) with categorise of ideas about causes of events (eg adverse event due to communication failure).

There is little research into adverse events outside of hospitals in primary care, nursing homes or home care health services. There are reports of a high number of adverse events due to poor communication and coordination between services, but little strong evidence of this apart from adverse drug events due to failures in communication.

The costs of adverse events

Far little evidence is available about the cost of poor quality or adverse events, either for single types, or for a hospital overall, or nationally. There are few empirical costing studies, and most studies are estimates based on extrapolations, with assumptions which only allow for approximate assessments of costs. However, the available evidence does show a high cost of adverse events to providers, the healthcare system employers and the national economy. There are no studies of the costs to patients or relatives, or to individual providers such as a nurse involved in a serious adverse event.

There evidence of a considerable volume of adverse events and poor quality represents potential savings to a health service or a health system. There is almost no evidence of the costs of poor quality or adverse event costs outside of hospitals, or due to poor quality transfers between services.

The highest costs for which there is evidence are for overuse of certain treatments, and underuse, leading to higher cost care later, and for hospital acquired infections, adverse drug events, complications in surgery, and hospital “failure to rescue” before arrest or respiratory failure. There is probably a high cost of poor quality as a result of misdiagnosis and poor coordination and communications.

The following summarises the research findings and estimates, for the USA and then the UK. Rates and potential savings in Sweden may be significantly different.

US estimates are that,

- 73 studies give evidence of overuse, misuse and underuse of medical procedures including, underuse of influenza vaccine and beta blockers, overuse of antibiotics, and misuse of antidepressant medications.
- 15% of appendectomies in 1997 were assessed as unnecessary (15.3%) costing \$740 million annually.
- 25% of hospital days and clinical procedures are inappropriate, and 40% of medications unnecessary.
- “outmoded and inefficient medical procedures” cost \$390bn
- a likely high cost of error in diagnosis and prescribing, especially outside of hospitals.
- avoidable postoperative sepsis can cost up to \$57,700 per patient; reopening of a surgical incision (\$40,300 excess charges), and “selected infection due to medical care” \$38,700.
- 10% of prescriptions contain errors, account for 25% of claims; 19% of all AEs are ADEs, and 58% are preventable, 28% were due to negligence.
- cost to a hospital of each ADE is \$2,000 per event and about \$3.8 m per hospital per year (\$1 m preventable). Another study found ADEs cost \$3,244 per patient or \$2.8 million a year for a 700 bed teaching hospital,
- 1.9 million ADEs /yr in 1.6 million nursing home residents, 40% preventable and 86,000 life-threatening or fatal ADEs, 70% preventable. 20% of preventable adverse drug events in elderly patients in ambulatory settings.
- inappropriate prescribing can be up to 40% for nursing home residents and 21% for patients at their own homes over 65.
- cost of wasted medications in an outpatient population of older people (n=73) averages \$30 per prescription
- 24 extra days stay for the 8% of surgical patients who experienced “serious error” reported in one study
- one in-hospital complication found in 10.8% of hospital patients costs between \$9,239 to \$30,896 for each patient,
- one hospital pressure ulcer on average cost in 1999 was \$37,288 (nationally a cost of \$2.2 to \$3.6 bln),

UK estimates are that

- hospital acquired infection cost \$1.6bn a year (about 1.4% of the total NHS budget, “15%-30% preventable”)
- costs of ADEs are £0.6 bln ("The problem is that nobody really knows the extent of the problem").
- 25% of radiological procedures not necessary
- one patient fall causing a fractured neck of femur costs £11,452
- pressure ulcers occurred in 4-10% of patients admitted to a UK district hospital in 1991, (with estimated cost in Sweden for 600 bed hospital of over \$1m every year)

The consequences of adverse events

There is little empirical research into other consequences of adverse events apart from costs and extra treatments required. Studies of patient claims have not systematically explored consequences. One study has examined empirically the effect on care providers. Potential consequences which could be studied to assess significance and frequency are effects of higher adverse events on hospital or individual provider indemnity insurance, for provider reputation and income, and how important this information is for patients for their choice of provider, or for healthcare workers in deciding whether to apply for a position in a healthcare service.

Implications – practical and scientific

1.1.1 Practical implications

The practical implications of the evidence of a significant number of adverse events in healthcare are,

For patients: a significant epidemic of unnecessary suffering, caused by trusted institutions of society, at a time when a person is at their most vulnerable, and where they have no access to information which they might use to protect themselves and their relatives. Increasing anxiety before going into hospital from dramatic media coverage of extreme cases. High financial costs through lost employment income, extra treatments, and travel for healthcare to restore health. A need for information to help the patient play their part to reduce risks when receiving a service

For individual healthcare workers: potential loss of confidence, and defensiveness as the evidence becomes more known, and a need for information about actions they can take to reduce adverse events. A need to support colleagues involved in medical error or adverse events.

For health service provider organisations: protection and encouragement to healthcare workers to “speak out” when they see a potential error and to report errors, training to health workers to reduce adverse events, support systems to reduce the likelihood of errors, support for providers adversely effected by their involvement in a safety event, and a programme of actions to improve safety including data collection and reporting.

For purchasers: changes to current payment systems which financially reward poor quality, consideration of a “no pay for never events” scheme and collecting data to identify these adverse events, action to agree cost and savings sharing between parties for improvements which a provider makes which may not save the provider money under current payment system.

For regulators: better use of existing routinely reported data to identify poor providers, initiatives to encourage actions to reduce poor quality, standards defining systems and

processes required for measuring reporting and taking action to reduce poor quality, effective sanctions for unsafe performance.

For national or local government: Stronger leadership to encourage the use of strategies found to be effective elsewhere, allocation of resources to allow better data collection and comparison, support units to help services improve safety and quality, and penalties for unsafe services including publication of safety performance.

Research funding bodies: a programme to develop Swedish non-clinical practical research and researchers, focusing on finding, testing and developing practical solutions and strategies.

1.1.2 Scientific implications

The limitations of the evidence are a challenge to the research community to direct more attention to this area of high public concern. There is a need for a network of researchers in Sweden and the Nordic countries to build knowledge and experience of methods and theories to study this area and to move away from current reliance on US and UK research in the field which is only partially transferable to the Nordic health systems.

More, and better, research is required, especially into,

- Adverse events in ordinary Swedish county hospitals, using different sources and methods and an agreed classification to establish the number and costs for different parties.
- Adverse events outside of hospitals, and also as a result on deficiencies on communication or cooperation between providers.
- The costs of preventative interventions, and the savings or losses for different interest groups, and how these costs and savings are distributed over time.

Part 1: Introduction, objectives and methods

2 Introduction

This report presents the findings of a review of published research into the costs and consequences of poor quality in healthcare, and its implications for the Swedish health system. Part 1 describes the background and methods. Part 2 gives the findings of the search and review. Part 3 discusses the findings and draws conclusions for practical actions and for research.

2.1.1 Background

In 2005, a review of research was undertaken to provide Landstingens Omsesidiga Forsakringsbolag (LoF) with information about which interventions are being used to improve patient safety, and about any evidence of the results. The aim was for LoF to use this in two ways:

- to give providers help for improving patient safety, by offering the most up to date review of research based evidence on the subject
- to decide which, if any, interventions to recommend for Swedish health care and whether to use financial incentives to encourage their use.

Part of this 2005 review considered the evidence of adverse events. The report below both draws on and updates the section on “cost of poor quality” given in the 2005 review.

3 Objectives and methods

Aims and objectives

The aims were to present research evidence of the number, consequences and costs of adverse events in health care, paying particular attention to Swedish evidence or evidence relevant to Sweden.

The objectives were to

- find, assess, and summarise the best evidence from research on the above subjects,
- present the findings in an easy to understand way so as to be useable by practitioners, managers and policy makers to consider priorities for action and for research, and by researchers to inform their studies of patient safety

- comment on the research, including the limitations.

Methods

3.1.1 Search for previous reviews

The method used to identify relevant research was first, to search for reviews already undertaken into poor quality, adverse events and their costs. A search was made using the Pubmed data base, and in the search indexes in the Journals of Quality and Safety in Healthcare and The Joint Commission Journal on Quality and Safety, as well as articles and books on quality and safety subjects collected by the author since 1985. No reviews were discovered on this subject since Øvretveit 2004, so this review aimed to update the 2004 review.

3.1.2 Search for specific studies

Other searches were then made in Pubmed and on internet search engines for research and reports which had become more widely referred to or used since published reviews. These were identified, assessed for strength of evidence and the most relevant were summarised.

3.1.3 Assessing strength of evidence

The review concentrated on studies with valid and reliable evidence. In the absence of strong evidence, for example, about costs and consequences, the most relevant studies were selected.

An initial overview of the literature showed few primary studies on the cost of adverse events or studies which had estimated costs as part of a primary study on the quantity of adverse events. Excluding studies which did not use systematic health economics methods would have ruled out a considerable amount of research. Thus, costing studies were also included which had not used rigorous health economic methods but were judged to meet “acceptable standards of evidence” for validity and reliability.

Studies were excluded where the reviewer judged that the conclusions did not follow from the empirical evidence, or the methods were invalid or unreliable. Studies where no evidence was reported to support the propositions were only included where the discussion gave relevant hypotheses for testing, or useful frameworks.

After assessment, some studies which did not meet the “strength of evidence” criteria were retained because no other evidence was available and/or their strong relevance to the questions. Examples were detailed self reports by managers, or conceptual articles which provide useful frameworks for future research.

Literature was excluded if it was, a) not relevant (not about poor quality, adverse events or costs, or did not include this subject as part), b) did not meet basic scientific

criteria of evidence in this field, c) did not engage in “significant” conceptual analysis. The exclusion criteria were thus: not relevant to the questions, or speculative or exhortative opinion literature which did not cite evidence.

3.1.4 Selection summarizing and synthesis

Abstracts and papers were selected according to whether empirical research on the intervention was reported, or whether “significant” conceptual discussion or experiential reports was likely to be presented. A set of abstracts were selected and of these full papers were retrieved. In addition, a manual search was made of the author’s library of English language quality and safety books and papers. Selection using the same criteria yielded 5 books and 8 papers.

Each study selected was summarised in terms of: title, author, journal reference, key findings, and method used. A note was made about which costs the study estimated: ie narrowly defined as the cost of wasted health care provider materials and time, or included costs of litigation, or more broadly to include costs to the wider health system or the patient (eg travel, lost income from inability to work), or society generally (eg including lost income tax revenue).

To decide how to present the research, the categories of different subjects studied were noted while the studies were being summarised. They were then refined to create the structure of headings used in the report below.

3.1.5 Limitations of the review

The review was systematic, but did not followed systematic review procedures used in biomedical reviews (Mulrow & Oxman 1997). Although reasonably comprehensive, the review could have missed some empirical studies relevant to the questions, in part because of the wide range of literature in different disciplines which could not be fully searched and reviewed in the time available.

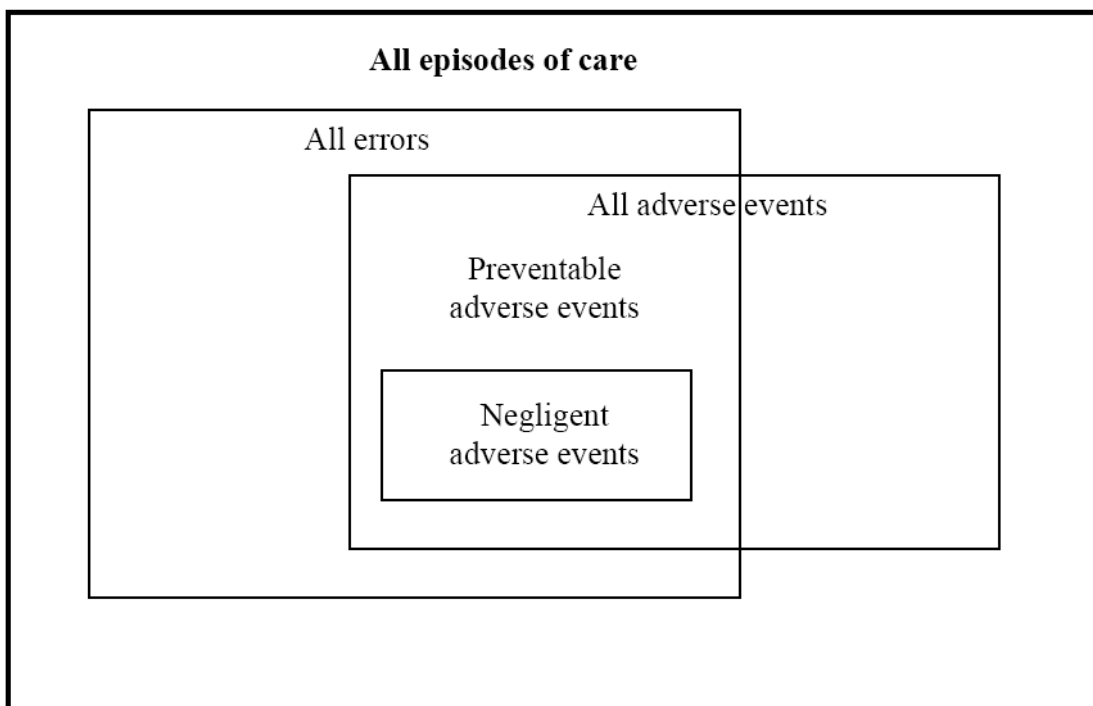
Space and time did not permit a full description of the research methods of each study, which would have allowed the reader independently to judge the validity and reliability of the study and strength of evidence.

As regards combining findings from different studies, this can allow more reliable and valid answers than would be possible from the findings of one study. However, combining findings from different countries or from studies using different methods can sometimes lead to misleading conclusions, so in these cases a range was reported (eg 14%-26%).

As most of the research is from the USA, we cannot assume the same findings for Sweden.

Definitions

In the USA IOM report (Kohn, Corrigan, & Donaldson 2000), “safety” is freedom from accidental injury, and an “adverse event” is an injury caused by medical management, rather than by the underlying disease or medical condition of the patient. A “preventable adverse event” is an adverse event attributable to error. A “negligent adverse event” is a preventable adverse event meeting legal criteria used to decide negligence (often whether the care provided failed to meet the standard of care reasonably expected). The overlap in these definitions is summarized in the diagram below:



This review follows these IOM definitions, but it should be noted that, using these definitions, negligence is not possible without an adverse event. For many people, negligence is failing to meet the standard of care reasonably expected, regardless of whether an adverse event occurs. In the Swedish compensation scheme, harm can be caused and compensation awarded without needing to prove negligence.

Definitions used in this review

Patient injury: harm caused to a patient as a result of their healthcare and which could have been avoided.

Adverse event (“AE”) “undesired events, causing patients harm, not by the underlying disease, but as a consequence of examination, treatment or care”, or “an unintended injury or complication which results in disability, death or prolonged hospital stay and is caused by healthcare management (rather than a patient’s disease)” (Wilson et al (1995)).

Other definitions are: UK NHS “times when things go wrong in the NHS that did or could harm a patient”. The Harvard Medical Practice Study defined an adverse event as “...an injury that was caused by medical management (rather than the underlying disease) and that prolonged the hospitalization, produced a disability at the time of discharge, or both”,(Brennan, et al 1991) p.370) a preventable adverse event as an adverse event caused by an error, and a negligent adverse event as an adverse event caused by “..failure to meet the standard of care reasonably expected of an average physician qualified to take care of the patient in question.”(Leape, et al 1991) p.377)

Medication error: a mistake in writing prescriptions, dispensing or administering drugs.

Adverse drug event (“ADE”) an injury resulting from medical intervention relating to a drug.

Near miss (“NM”): an occasion where an error was narrowly avoided. Or “an event where the error was detected and intercepted before harm was done” (Orser et al., 2000). There is evidence from one US study that there are seven times as many near misses as adverse events (Bates et al., 1995).

Overuse, Underuse and Misuse. “Overuse” (providing a treatment when its risk of harm exceeds its potential benefit), “underuse” (failing to provide an effective treatment when it would have produced favorable outcomes), and “misuse” (avoidable complications of appropriate care) (Chassin, 1991; Chassin et al., 1998).

Risk : the chance of disaster or loss (OED).

Safety intervention, method or strategy: any action taken to prevent or minimise harm to a patient. The term is used generically to describe actions taken at the clinical, organisational and national level by different actors. In this review “safety method” rather than “intervention” is more often used to describe methods for collecting, analysing and acting on safety data, and risk assessment. “Strategy” is more often used to describe a collection of activities or interventions carried out by an organisation or a national body.

For other definitions, see USA Veterans Health Administration glossary, at <http://www.va.gov/ncps/glossary.html>

Limitations of this overview

The limitations of this review need to be noted to help readers to assess the scientific validity of conclusions, and to judge the implications for action.

First, the studies reviewed below vary considerably, not only in how they define costs, but also in how they assess “avoidability” of an adverse event. Cost of injuries are different to costs of avoidable injuries: some injuries are assessed as unavoidable, even though the term “injury” suggests avoidability. There is some uncertainty and subjective judgment in defining whether an injury is avoidable, and studies vary in the method and the validity of their assessments. The review has already noted the different terms used around the subject of injury, harm, error, adverse event. It highlights in the text where definitions used in different research studies are significantly different, as these have different implications for the costing estimates used in the study.

Second, costs, injury incidence, (and savings) in Sweden are likely to be different to those in the research summarized. Most of the research was carried out in the USA, and some of the calculations included costs of lost business and legal and insurance costs.

Third, from an economic perspective, both the cost of the injury and the cost of the solution need to be considered in prioritising action – this review did not consider the costs and effectiveness of solutions, which were considered in two other reviews (Øvretveit 2005, 2009b). As regards the economics of quality action, the second part of the equation after the cost of the problem is the cost and ease of implementation of a solution. The cost to prevent an injury may be higher than the cost of the injury. But some interventions are lower cost than the cost of the injury, and thus spending on the intervention would save money. However the Øvretveit 2009 review shows that savings may come to the purchaser or another party rather than to the provider, who typically spends money on the solution.

Overall, for practical decisions about quality investments and actions, the size and cost of a quality problem is irrelevant if the costs of a solution are unknown. The Øvretveit 2005 and 2009c reviews revealed little research on the effectiveness of interventions to reduce poor quality, and even less about the costs of these interventions. Further, the costs and effectiveness of the solutions are likely to be context-specific, depending on the organisation's culture and other variables. Studies elsewhere may not give a good guide to what could be expected in Sweden. The lack of evidence of the effectiveness and cost of interventions is a hindrance to investment planning to reduce the cost of poor quality.

As regard the comprehensiveness and thoroughness of the overview, there are also limitations. Some studies were not discovered and some which were identified were not summarised because they were not assessed to contribute sufficiently to the needs of the research users or the objectives of the study.

Part 2: Findings

4 Evidence of the number and types of quality problems

The review revealed a growing body of research in healthcare which reports quality problems and quantifies the size of the problem. Most recent research is about “adverse events” to patients, rather than about quality problems which includes` `wasted materials or personnel time which may not directly harm patients. However, there is little research which has systematically assessed the costs of each quality problem, or the total costs to an organisation of a range of quality problems.

The following first reports some of the research on the volume and costs of quality problems in general. Then it reports research on the number of adverse events, which

gives some indication of the possible high cost of poor quality in health care. Then it reports studies which have costed poor quality.

General studies

The most comprehensive systematic review of research into poor quality found in the search was that undertaken for the IOM (2000) report. This reported 73 studies with evidence of overuse, misuse and underuse of medical procedures including overuse of antibiotics, misuse of antidepressant medications and underuse of influenza vaccine and beta blockers.

One systematic search of studies for enhancing safety in primary care found 31 relevant articles (Wilson & Sheika (2002)). Studies reported included one finding a high number of diagnostic errors in a self-report study, and most often involving asthma, cancer, dermatological conditions, substance misuse and depression; one finding “problems” with 3-5% of all primary care prescriptions a third of which were “major safety concerns”; one finding 24% of people over 65 living at home were prescribed a contraindicated drug (21% of which were in nursing homes); a study finding 4% of drugs dispensed by a pharmacy were incorrect, and particular safety concerns for non-steroidal anti-inflammatory drugs, lithium, warfarin, corticosteroids and antidepressants.

4.1.1 Poor quality waste

Examples of poor quality waste reported in the research include scheduled patients failing to attend appointments; failing to continue treatment because of their dissatisfaction with the quality of the service; and dissatisfied patients telling others about their experience, leading to lost referrals and income to a service, and to time used dealing with complaints.

If the complaints process does not lead to a peaceful outcome, then there may be court and compensation costs. One US health system calculated that the cost of unresolved patient complaints was \$4m a year for a service with 88,000 patient discharges. The costs of litigation, most of which are related to adverse events, is considered under a later sub-heading on adverse events.

Other poor quality reported representing waste, includes the time wasted due to patient journals missing; patients telling the same story to different personnel; test results not used because there is a delay in getting them to the ordering clinician, and delay in treatment due to late test results. Errors in cancer screening in the UK have led to many patients being recalled, re-tested, and high compensation for mistreatment or failure to treat. Other poor quality includes illegible and incomplete prescriptions that take up technician, nurse, and pharmacist time; hospitalization of patients with diabetes,

asthma and other chronic diseases who did not get preventive care; patient falls and pressure ulcers, wrong surgery and other adverse events discussed below.

4.1.2 Overuse, underuse, misuse under-coordination and waste

The categories of overuse, underuse and misuse of treatments and tests (Chassin 1991) covers many quality problems which sometimes results in adverse events, but this section considers the problem in general and the cost implications. “Appropriate” treatment is where the expected benefits are greater than the expected harm.

There is evidence of different types of waste categorised under these headings in clinical areas. The UK Royal College of Radiologists estimated that 25% of radiological procedures were not necessary. Early Rand corporation studies in the USA estimated that 25% of hospital days and clinical procedures were inappropriate, and 40% of medications were unnecessary. A later study by the US Juran Institute (2003) estimated costs of poor quality in the USA due to “outmoded and inefficient medical procedures” to be \$390bn or \$1700 to \$2000 per employee covered by insurance.

Flum and Koepsell (2002) estimated that 15.3% appendectomies in the USA in 1997 were not necessary. Wide variations in the utilisation of procedures have been found which suggest over-treatment in some areas of the USA (Chassin et al (1986)). Sweden has half the rate of hip revisions (re-replacements) as any other country as a result of a data base and research which found certain prostheses and cement fixation had reduced reoperations. More recently the “evidence based medicine movement” has shown that many procedures continue to be used many years after research has found them to be ineffective.

A recent UK trial of patient reported medical outcome questionnaires (PROMs) may also indicate possible overuse, or at least defensive medicine, where there are potential cost savings, although this study is controversial. The study raised the question of whether surgical procedures were needed for patients reporting no problems before surgery, and for those with no change or worse after surgery for groin hernia, varicose veins hip and knee replacement (West 2009). The OHE study director Professor Nancy Devlin is reported as saying, “*If a PCT is responsible for a budget and has a third of patients not reporting a problem before surgery, you have to wonder whether it is defensible*”.

Adverse events

“Adverse events” are “undesired events, causing patients harm, not by the underlying disease, but as a consequence of examination, treatment or care”. Medical errors, overuse, misuse or underuse may or may not result in an adverse event. Serious adverse events cause death or disability lasting more than three months or prolonging hospital stay more than a week. Research estimates between 48,000 and 98,000 people

a year die from adverse events in US health care. One of the most common are adverse drug events (2% of hospitalized patients suffer preventable ADEs (overdoses; allergic or idiosyncratic reactions; drug-drug interactions; or errors in route, rate, timing or patient (James, IHC, 2007).

One research method is to review patient records and assess them for adverse events. The largest early study using this method – the Harvard Medical Practice Study – documented frequencies of adverse events of 3.7 % after reviewing 30,000 randomly selected records of patients discharged in 1984 from 51 hospitals (Leape et al (1991), Brennan et al (1991)). The study estimated 58% of the adverse events were preventable. 2.8% of adverse events were classified as causing longer-term moderate impairment, 3.9% as causing permanent impairment (<50% disability), 2.6% permanent impairment (>50% disability) and 13.6% as leading to death. 25.4% of the adverse events classified as negligent lead to death. By specialty, the highest rates of adverse events occurred in vascular surgery (16.1%) and thoracic and cardiac surgery (10.8%).

A similar later study in Utah and Colorado of 15,000 records of patients discharged in 1992 reported a rate of adverse events of 2.9% of hospitalizations (Thomas et al (1999), Gawande et al (1999)), with surgical events accounting for 45% and ADEs the most common non-operative event. Using similar methods, an Australian study found adverse events in 16% of hospital admissions, 51% of which were “highly preventable” (Wilson et al (1995)). The different findings are thought to be because of different definitions of adverse event, in medical records data recording, but also in real differences in injury rates (Weingart et al (2000)).

As regards the overall rate of “adverse events”, most European research on this subject has been undertaken in the UK, with a public healthcare system similar in some respects to that of Sweden. Patient records studies in UK and Danish hospitals report adverse events rates of 11.7% and 9%, respectively. In Australia it was 16.6 (Wilson et al 1995); New Zealand 12.9 (Davies et al 2002); and Canada 7.5 (Baker et al 2004).

One UK study found that 45% of patients experienced some medical mismanagement and 17% suffered errors that led to a longer hospital stay or more serious problems (Andrews et al (1997)). A recent review of research found “The reported rates of AEs vary remarkably (0.0037-39.0%) because of different detection methods used, the different definitions applied and different health care settings studied”(von Laue et al (2003)).

Another way of estimating adverse events is to use voluntary reporting systems, but these do not document most injuries (one study found 1 in 100-150 injuries were reported (James, IHC, 2007)). The latter study found that 80% of the time clinical teams do not associate patient symptoms with the treatments causing them and suggested that

a more accurate assessment of sources of injury can significantly change intervention strategies.

The research above is in and about AEs in hospitals, and in the USA. One of the few studies considering AEs outside of hospital was a New Zealand study which found 20% of the AEs identified from hospital record reviews occurred before admission to hospital (from 12.9% of all patients who were admitted (Davies et al 2002)).

One study of AEs after leaving hospital found 20% discharged medical patients experienced an AE within a month, 33% of which were preventable (Forster et al 2003). One study estimated 12% of US nursing home residents (total 1.6 million) were receiving warfarin on a chronic basis and that adverse events related to warfarin therapy—primarily bleeds—were “very common”. The study estimated that nearly 34,000 fatal, life-threatening, or serious adverse warfarin-related events per year (Gurwitz et al 2000 and 2005).

A systematic search of studies for enhancing safety in primary care found 31 relevant articles (Wilson & Sheika (2002)). Studies reported included one finding a high number of diagnostic errors in a self-report study, and most often involving asthma, cancer, dermatological conditions, substance misuse and depression; one finding problems with 3-5% of all primary care prescriptions and a third as “major safety concerns”; one finding 24% of people over 65 leaving at home (21% of which were in nursing homes) were prescribed a contraindicated drug; particular safety concerns for non-steroidal anti-inflammatory drugs, lithium, warfarin, corticosteroids and antidepressants; and a study finding 4% of drugs dispensed by a pharmacy were incorrect. These are studies of error, which may or may not have resulted in a patient experiencing an adverse event.

5 Evidence of the cost of poor quality

There is little research which has systematically estimated the cost of poor quality or of adverse events in healthcare. The validity of the evidence varies between studies, especially where provider financial data are used.

General costing studies

One report stated that research shows that poor health care quality is the third leading cause of death in the USA, increases annual health care costs by \$450 billion, and costs employers \$225 billion a year in lost productivity. But there are many different estimates: Thomas et al (1999) estimated \$37.6 billion for all USA adverse events (4% of all national health expenditures in 1996) and \$17 billion for preventable adverse events. The AHRQ 2000 report on medical errors estimated the possible savings from eliminating all avoidable errors in the USA to be \$17 billion per year. Another study

estimated between \$5 billion to \$10 billion a year for all avoidable errors during hospitalization in the USA (Zhan & Miller 2003).

A study by the US Juran Institute (2003) estimated costs of poor quality in the USA due to “outmoded and inefficient medical procedures” to be \$390bn or \$1700 to \$2000 per employee covered by insurance. These costs were estimated from data on “unnecessary administrative activity” (the largest waste); overuse of hysterectomy, cardiac catheterization, antibiotics, tranquillisers, sedatives, cardiac enderectomy, cardiac pacemakers, upper gastrointestinal endoscopy, and non-steroidal anti-inflammatory drugs; and from data on underuse of tests for patients with heart attacks, diabetes and congestive heart failure, flue and pneumonia vaccine, and screening tests for depression and breast cancer. Flum and Koepsell (2002) estimated that 39,901 of the 261,134 appendectomies performed in the USA in 1997 were unnecessary (15.3%) - the total cost of these misdiagnosed cases could be \$741.5 million annually.

One of the few studies into the lifetime health care costs of an injury was undertaken by Johnson et al. 1992. This study interviewed 794 patients experiencing AEs in the Harvard Medical Practice Study estimated the total costs of all AEs in New York State would be \$21.4 billion a year (\$2.5 billion was future earnings losses, \$3.4 billion lost household production, and \$14.5 billion expected lifetime medical care costs).

Rigby & Litt (2000) use the data from an Australian study (Wilson et al 1995)) together with data about costs from Australian disease related groups. They concluded that “the cost of just 12 preventable iatrogenic injuries is significant and accounts for 2-3% of the annual budget of a 120 bed community hospital”. The study did not give predictions of possible savings because it did not calculate the costs of effective interventions. The injuries were, in ranking of frequency: wound infections; pressure sores; urinary tract infections; inadequate manipulation of fractures; pulmonary embolism; unnecessary operations; falls admitted; warfarin related; bleeding due to non-steroidal anti-inflammatory drugs; deep vein thrombosis; postoperative nausea and vomiting; and pneumothorax.

Brown et al (2002) estimated that, in New Zealand, each adverse event cost an average of \$NZ 10,264 per patient, with a total cost of \$NZ 870 million or 30% of total public hospital expenditure, of which \$NZ 590 million was associated with preventable adverse event.

Vincent et al (2001) estimated the additional costs associated with the 119 adverse events they identified (Vincent, Neale, & Woloshynowych 2001). These adverse events accounted for 999 extra bed days, of which 460 bed days (46%) were judged preventable. Each adverse event led to an average of 8.5 additional days in hospital, giving a total additional cost of £290,268 to the two hospitals in the study. Extrapolating to England and Wales suggested an additional three million bed days and additional costs to the NHS of £1bn.

The UK Department of Health report 2000 (“An organization with a memory”) built on the Vincent et al 2001 and other studies to estimate 850,000 inpatient episodes involved adverse events in NHS at a total cost of £2 billion in additional bed-days.

Specific adverse event cost, by type or services

The following presents evidence about the cost of adverse events for specific services (eg surgery) or by type (eg adverse drug event or hospital acquired infection).

5.1.1 Adverse drug events (ADEs)

Adverse drug events have probably been the most well studied AE, because of the high costs and that most can be avoided. ADEs generate costs to the patient, costs to the hospital though treating the effects of the ADE, and sometimes costs of medical negligence claims. A UK study estimated the costs of ADEs to be \$0.8 bln or approximately 1.5% of the UK NHS annual budget (Audit Commission (2001)). It also suggested that ADEs are increasing. The reports author commented that, "The problem is that nobody really knows the extent of the problem". Only one hospital that was visited had a comprehensive system for reporting errors.

Medication errors, which can result in an ADE, were reported in a study of 2% to 14% of patients admitted to a sample of US hospitals (Leape (1994)). Another study estimated that the average hospital administers 1-2 million prescriptions a year: 10% of prescriptions contain errors, and account for 25% of claims. The New York study above found 19% of all AEs were ADEs, that 58% were preventable, and 28% were due to negligence. According to this study, antimicrobial drugs were the class of agents most commonly associated with adverse drug events (Wilf-Miron et al 2003).

In a study of 424 randomly selected visits to a hospital emergency department, 47% of visits resulted in the patient receiving a prescription for a medication (Beers et al (1990)). In 10% the new medication could potentially harm the patient due to an avoidable drug-drug interaction. In all of these cases, a medication history had been recorded and available to the prescribing physicians.

“Based on the literature, there was a strong consensus that errors around the administration of drugs were the most critical problem contributing to adverse events. These can result from any mix of incorrect writing of prescriptions by physicians, illegibility of the written orders, the prescribing of inappropriate meds, the incorrect interpretation/transcription of written orders by nurses, or the incorrect administration and documentation of the meds”.

Chief of Surgery at Toronto UHN, quoted in Anderson et al 2006.

Studies of adverse drug events have found that they are the cause of 5% of hospital admissions, and occur in 10-20% of hospital in-patients (Pirmohamed et al (1998)). One US study found adverse drug reactions in 2.5% of patients resulting in an average of 1.9 days longer in hospital and a cost of \$2262 per patient (Classen et al (1997)). Another study reported 6.5%, and estimated 28% were preventable (Bates et al (1997)).

The strongest evidence from the early studies is from a study which assessed costs for 109 patients at one US hospital (Schneider et al. 1995). Costs included extra laboratory tests and treatments, noninvasive procedures, and invasive monitoring or procedures, increased length of stay, and intensive care. The mean cost varied from \$95 for additional laboratory tests to \$2,640 for intensive care. The next most costly outcomes were increased length of stay and invasive monitoring or procedures.

A probability model was used in one study to estimate the total cost of drug-related morbidity and mortality in the US. The data input into the model came from 32 published studies and other data (Johnson & Bootman 1995). The estimate was a total likely cost of \$76.6 billion a year in ambulatory care (range of \$30.1 billion - \$136.8 billion).

Some of the best evidence in this field of research was provided by a matched case control study by Classen et al (1997). In the US over in four years between 1990-1993, 2.43 ADEs per 100 admissions were discovered. Using regression analysis to control for all matching variables, the study reported an extra 1.91 days in hospital with an increased cost of \$2,262, as well as an increased risk of death and for severe ADEs \$3634. (Classen et al. 1997).

The US study of ADEs noted above originally estimated that the cost to the hospital of each ADE was \$2,000 per event and about \$3.8 m per hospital per year and that \$1 m was preventable. One of the studies with the strongest evidence used three methods to identify ADEs over six months in 11 units in two US teaching hospitals: nurses and pharmacists were asked to report incidents to nurse investigators; a nurse investigator visited each unit twice daily on weekdays to solicit information; the nurse investigator reviewed patient journals at least daily (Bates et al (1995)). The study found 247 ADEs and 194 potential ADEs which represents 6.5 ADEs and 5.5 potential ADEs for every 100 admissions. Of all ADEs, 1% were fatal, 12% life-threatening, 30% serious and 57% significant.

28% were preventable and 43% were intercepted before the drug was given. Errors resulting in preventable ADEs occurred most often at the stages of ordering (56%) and administration (34%) - transcription and dispensing errors were uncommon. Errors were more likely to be intercepted if they occurred early in the process - 48% at the ordering stage but none at administration of the drug. A later study found that patients stayed an additional 2.2 days with an increased cost of \$3,244 per patient. The extrapolated costs would be \$2.8 million a year for a 700 bed teaching hospital, notwithstanding the human cost (Bates et al (1997)).

The rate of ADEs was highest in medical intensive care units (19 per 1,000 patient-days) and similar in surgical intensive care and medical and surgical general care units (9 - 11 per 1,000 patient-days).

Over 50% of all ADEs were associated with the use of analgesics (30%) or antibiotics (24%). No single drug accounted for more than 9% of ADEs. Analgesics were the leading drug class associated with preventable ADEs, and half of these involved misuse or malfunction of infusion pumps or devices (epidural catheters or patient-controlled analgesia). (UK data from a trial audit of errors and near misses in the UK NHS found infusion pump incidents were common with 30 to 35 different devices in any one hospital).

As with other AEs, non-hospital evidence is scarce. One review of research into inappropriate prescribing for older people found 11 studies (Liu, & Christensen 2002). Either observational or claims data methods were used, revealing a rate of inappropriate prescribing from a high of 40% for nursing home residents to 21% for patients at their own homes over 65. No research was reported in this paper which costed the consequences of inappropriate prescribing. However, one study was found which estimated the cost of wasted medications in an outpatient population of older people (n=73) (Morgan 2001). The study found an average waste cost of \$30.

Overall estimates made by Gurwitz et al 2000 and 2005 were of 1.9 million ADEs /yr in the 1.6 million US nursing home residents, 40% of which were preventable and 86,000 life-threatening or fatal ADEs, 70% which were preventable. Another study estimate 20% of preventable adverse drug events among elderly patients in ambulatory settings are due to patient-related errors, including problems with medication adherence (Forster et al 2003). Many of these incidents of poor quality may be caused by communication and coordination failures, considered later.

5.1.2 Hospital acquired infections (HAIs)

A report by a parliamentary committee in the UK estimated 100,000 cases of hospital acquired infection in England, causing 5000 deaths and costing \$1.6bn a year. Estimates vary about how much could be prevented, from 15%-30% (HCPAC(2000)).

One study used patient safety indicators to identify “medical injuries” in 7.5 m discharge abstracts from 994 hospitals in 28 states in 2000 (Zhan & Miller (2003)). Of these AHRQ indicators, postoperative sepsis was found to be the event leading to highest mortality (22% of all mortalities) the longest extra stay (10.9 days) and the highest excess charges (\$57,700). The second most serious was postoperative wound dehiscence (reopening of a surgical incision) (9.6% of all mortalities, 9.4 extra days, and \$40300 excess charges), and the third, “selected infection due to medical care” (4.3% mortalities, 9.6 days, \$38,700).

5.1.3 Adverse events in surgical care

Some of the AEs in this category are HAIs associated with surgery. The earliest empirical research found in the review which costed adverse events is Couch et al

1981. Thirty six AEs were found in 5612 surgical admissions over one year in a US hospital, 11 of which caused death. The total costs associated with the 36 AEs was estimated at \$1,732,432.

Another more recent US study used an observer's record, journals and other data to identify "adverse events" in surgical care (Krizek (2000)). It found 46% of patients experienced adverse event (2183 errors, 21% serious), 18% experienced serious events ("potentially life or limb-threatening") and a 32-days stay average for serious error cases, compared to a normal 8.8 days.

The additional costs for surgical complications during or after major surgery was estimated in one study by using routine administrative data on 372,684 discharges from 404 Californian acute-care hospitals (Kalish et al. 1995). With one in-hospital complication for 10.8% of patients the costs were estimated to be \$9,239 to \$30,896 from 5.4 -13.5 extra days length of stay.

Venous thromboembolism (VTE) occurs in 40-60% of orthopaedic surgery patients, with the risk of pulmonary embolism in hip fracture surgery patients as 7.5%, which can be fatal. It can be prevented with pre-surgical drug prophylaxis. Bullano et al 2005 found post discharge treatment of recurrent VTE cost on average \$12000, mainly from the need for hospital readmission, which was found to occur in 2.4% of all hip and knee replacement patients. Up to 40% of at risk surgical patients were found not to receive guideline-recommended prophylaxis.

5.1.4 Pressure Ulcers

Pressure ulcers occurred in 4-10% of patients admitted to a UK district hospital in 1991 was the finding of one study. Another study estimated that failure to prevent bed sores causes unnecessary suffering and costs a 600 bed hospital over \$1m every year (Øvretveit 2004). The mean cost per US hospital admission for patients who develop a pressure ulcer in 1999 was reported to be \$37,288 (Allman 1999) giving a cost of \$2.2 to \$3.6 billion for US acute care settings (Beckrich & Aronovitch 1999).

Most cases are avoidable by regular turning and repositioning of the patient and by using special mattresses and covers for patients at risk. One study concludes that, given the high costs of this quality problem, and the relatively low cost and effective remedies which could be implemented easily, it is likely that a hospital or health organisation could save considerable amounts of its annual budget a year with a programme to reduce pressure ulcers sores in hospitals by 50% from current rates (Øvretveit 2004).

5.1.5 Patient falls

One UK study estimated the costs associated with a patient fall which had resulted in a fractured neck of femur to be £11,452, from an extra cost per day of £234 for geriatric

and rehabilitation care, and orthopaedic and theatre costs of £584 per day (Walsh & Antony (2009).

5.1.6 Adverse events associated with “failure to rescue”

The most common are in-hospital cardiac- or respiratory arrests which could have been prevented by risk assessment, monitoring and timely action. Estimates vary, but some indication comes from studies of avoidable admissions to ICU, which McQuillan et al 1998 found to be between 4.5% and 41% (see also Hillman et al 2001, Kause et al 2004 and Goldhill 1999).

5.1.7 Communication and coordination failure

The most common cause of poor quality is failures in care communication and coordination, often due to failures in management systems to ensure this. That is evidence from this reviewer’s practical experience as a clinician and in leading and studying improvement since 1985, and from the Joint commission analysis of sentinel events (JC 2007). These failures include many I have witnessed and grouped under communication with patients, between work-shifts, between professions, between internal services, and between care facilities and external services. But what is the research evidence?

There is no systematic review of all the above types of poor quality. Different studies attribute the cause of an adverse event differently and may or may not define the cause as communication or coordination failure. A full review of this subject was outside the scope of this review, but some key studies and their findings relevant to this review are described in Bodenheimer 2008.

“The most dangerous period for the patient is the handover between one clinical team and another”

Professor Michael Thick Clinical director UK “connecting for health” IT programme. (quoted in Carlise 2009).

5.1.8 Hospital discharge communications

Jones & Mitchell 2006 report one study by Bolton hospital which found 250 communications hand-off between personnel to discharge one patient with complex care needs.

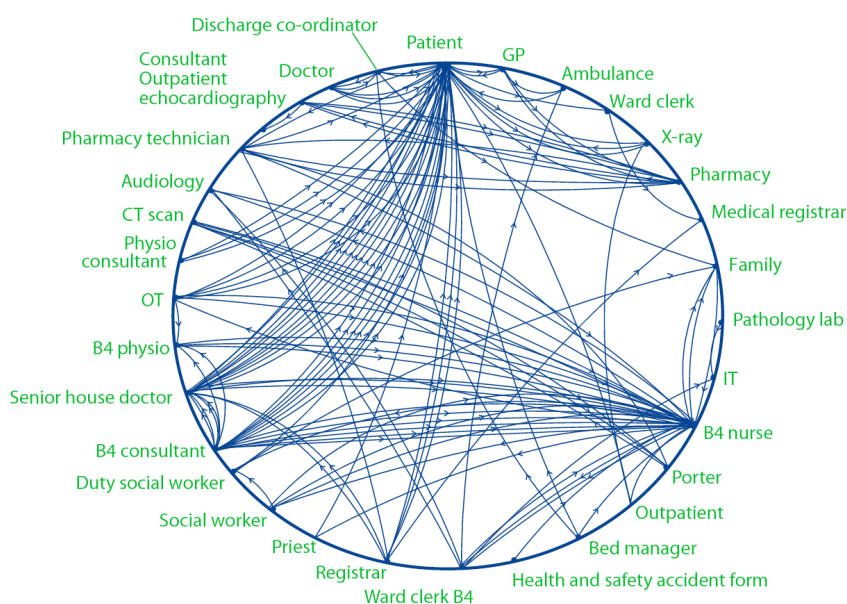


Figure: Communications hand-off between personnel to discharge one patient with complex care needs

The 2007 UK NHS Alliance survey of 500 GPs found 70% of GPs reported late discharge summaries “often” or “very often”, and of these 90% reporting it “compromised clinical care” and 68% “compromised patient safety”. One summary arrived 11 years late, and many were incorrect, illegible, with unknown acronyms, and no patient name or diagnosis or changes in medication. The 2008 survey was similar, but made more note of the financial costs, “one doctor estimates she spends half a day a week chasing up information from the hospitals which was not provided...further costs are incurred due to readmissions”. Financial penalties are being introduced by purchasers for discharge summaries 5 or 3 days late, with some using the summary with coding information included as a proxy invoice.

One US survey study found 59% of surgical and medical residents reported one or more patients had been harmed during their most recent clinical rotation because of poor handoffs, 12% reporting that this harm had been “major” (RR 68% of 238 surveyed). 37% reported that one or more interruptions during the receipt of handoffs occurred either most of the time or always. The study notes that information was often missing, incomplete, or inaccurate but that “*Many best-practice recommendations for handoffs are not observed, although the extent to which improvement of these practices could reduce patient harm is not known*” (Kitch et al 2008).

Part 3: Discussion and Conclusions

6 Discussion

Comments on the research

Most research into poor quality has been carried out in the USA and into hospital care. The last 5 years has seen more research in Europe, but there is very little research into poor quality and even less on quality costs in Sweden. It is possible that there are a significant number of adverse events outside of hospital caused by other types of healthcare or when patients transfer between service, but very little is known about this.

Recent analysis has found that the costs of poor quality are distributed in time, and between different stakeholders within healthcare, and affect other parts of the social care system (Øvretveit 2009b).

Evidence of effective interventions

Whilst there is mounting evidence of the amount and cost of poor quality, this evidence is of little practical use unless there are effective interventions for reducing poor quality, or such interventions can be created. Many of these interventions were reviewed in AHRQ 2001 and Øvretveit 2007 and 2009b. These review found few studies which had also estimated the “spend costs” of the interventions or the savings, and few estimates were based on empirical data.

7 Conclusions

Conclusions: costs of poor quality and adverse events

There is strong evidence of a considerable volume of adverse events and poor quality, which includes failure to provide effective treatments. This represents potential savings to a health service or a health system. There is less evidence of their costs. There is little evidence of the rates of poor quality or resultant costs outside of hospitals, or due to poor quality transfers between services.

The highest costs for which there is evidence are for overuse of certain treatments, and underuse leading to higher cost care later, and for hospital acquired infections, adverse drug events, complications in surgery, and hospital “failure to rescue” before arrest or respiratory failure. There is probably a high cost of poor quality as a result of misdiagnosis and poor coordination and communications.

The following summarises the research findings and estimates, for the USA and then the UK. Rates and potential savings in Sweden may be significantly different.

US estimates are that,

- 73 studies give evidence of overuse, misuse and underuse of medical procedures including, underuse of influenza vaccine and beta blockers, overuse of antibiotics, and misuse of antidepressant medications.
- 15% of appendectomies in 1997 were assessed as unnecessary (15.3%) costing \$740 million annually.
- 25% of hospital days and clinical procedures are inappropriate, and 40% of medications unnecessary.
- “outmoded and inefficient medical procedures” cost \$390bn
- a likely high cost of error in diagnosis and prescribing, especially outside of hospitals.
- avoidable postoperative sepsis can cost up to \$57,700 per patient; reopening of a surgical incision (\$40,300 excess charges), and “selected infection due to medical care” \$38,700.
- 10% of prescriptions contain errors, account for 25% of claims; 19% of all AEs are ADEs, and 58% are preventable, 28% were due to negligence.
- cost to a hospital of each ADE is \$2,000 per event and about \$3.8 m per hospital per year (\$1 m preventable). Another study found ADEs cost \$3,244 per patient or \$2.8 million a year for a 700 bed teaching hospital,
- 1.9 million ADEs /yr in 1.6 million nursing home residents, 40% preventable and 86,000 life-threatening or fatal ADEs, 70% preventable. 20% of preventable adverse drug events in elderly patients in ambulatory settings.
- inappropriate prescribing can be up to 40% for nursing home residents and 21% for patients at their own homes over 65.
- cost of wasted medications in an outpatient population of older people (n=73) averages \$30 per prescription
- 24 extra days stay for the 8% of surgical patients who experienced “serious error” reported in one study
- one in-hospital complication found in 10.8% of hospital patients costs between \$9,239 to \$30,896 for each patient,
- one hospital pressure ulcer on average cost in 1999 was \$37,288 (nationally a cost of \$2.2 to \$3.6 bln),

UK estimates are that

- hospital acquired infection cost \$1.6bn a year (about 1.4% of the total NHS budget, “15%-30% preventable”)
- costs of ADEs are £0.6 bln (“The problem is that nobody really knows the extent of the problem”).
- 25% of radiological procedures not necessary
- one patient fall causing a fractured neck of femur costs £11,452

- pressure ulcers occurred in 4-10% of patients admitted to a UK district hospital in 1991, (with estimated cost in Sweden for 600 bed hospital of over \$1m every year)

For prioritisation and action to reduce this suffering and costs, knowledge is needed about effective solutions, the spend cost of these, and how the costs and savings are distributed between different parties and over time. The latter is needed in order to devise payment and financing systems and savings sharing arrangements which provide incentives to improve safety rather than rewarding poor quality which the current system does. A review of research describes these spend costs and savings (Øvretveit 2009b)

The consequences of adverse events

There is little empirical research into other consequences of adverse events apart from costs and extra treatments required. Studies of patient claims have not systematically explored consequences. One study has examined empirically the effect on care providers. Potential consequences which could be studied to assess significance and frequency are effects of higher adverse events on hospital or individual provider indemnity insurance, for provider reputation and income, and how important this information is for patients for their choice of provider, or for healthcare workers in deciding whether to apply for a position in an healthcare service.

Implications – practical and scientific

7.1.1 Practical implications

The practical implications of the evidence of a significant number of adverse events in healthcare are,

For patients: a significant epidemic of unnecessary suffering, caused by trusted institutions of society, at a time when a person is at their most vulnerable, and where they have no access to information which they might use to protect themselves and their relatives. Increasing anxiety before going into hospital from dramatic media coverage of extreme cases. High financial costs through lost employment income, extra treatments, and travel for healthcare to restore health. A need for information to help the patient play their part to reduce risks when receiving a service

For individual healthcare workers: potential loss of confidence, and defensiveness as the evidence becomes more known, and a need for information about actions they can take to reduce adverse events. A need to support colleagues involved in medical error or adverse events.

For health service provider organisations: protection and encouragement to healthcare workers to “speak out” when they see a potential error and to report errors, training to health workers to reduce adverse events, support systems to reduce the likelihood of

errors, support for providers adversely effected by their involvement in a safety event, and a programme of actions to improve safety including data collection and reporting.

For purchasers: changes to current payment systems which financially reward poor quality, consideration of a “no pay for never events” scheme and collecting data to identify these adverse events, action to agree cost and savings sharing between parties for improvements which a provider makes which may not save the provider money under current payment system.

For regulators: better use of existing routinely reported data to identify poor providers, initiatives to encourage actions to reduce poor quality, standards defining systems and processes required for measuring reporting and taking action to reduce poor quality, effective sanctions for unsafe performance.

For national or local government: Stronger leadership to encourage the use of strategies found to be effective elsewhere, allocation of resources to allow better data collection and comparison, support units to help services improve safety and quality, and penalties for unsafe services including publication of safety performance.

Research funding bodies: a programme to develop Swedish non-clinical practical research and researchers, focusing on finding, testing and developing practical solutions and strategies.

7.1.2 Scientific implications

The limitations of the evidence are a challenge to the research community to direct more attention to this area of high public concern. There is a need for a network of researchers in Sweden and the Nordic countries to build knowledge and experience of methods and theories to study this area and to move away from current reliance on US and UK research in the field which is only partially transferable to the Nordic health systems.

More, and better, research is required, especially into,

- Adverse events in ordinary Swedish county hospitals, using different sources and methods and an agreed classification to establish the number and costs for different parties.
- Adverse events outside of hospitals, and also as a result on deficiencies on communication or cooperation between providers.
- The costs of preventative interventions, and the savings or losses for different interest groups, and how these costs and savings are distributed over time.

8 References

- AHRQ (2000) Medical Errors: The Scope of the Problem. Fact Sheet. Rockville, MD: Agency for Healthcare Research and Quality; 2000. Publication no. AHRQ 00- P037. Accessed at www.ahrq.gov/qual/errback.htm on 7 December 2004.
- AHRQ (2001) Making Health Care Safer. A Critical Analysis of Patient Safety Practices: Summary. AHRQ Publication No. 01-E057. Agency for Healthcare Research and Quality, Rockville, MD. <http://www.ahrq.gov/clinic/ptsafety/summary.htm>
- AHA (2004) Partnering With Patients to Reduce Medical Errors (Guidebook for Professionals), Rockville, Ill: American Hospital Association, 2004
- AHRQ Patient Safety Network, <http://psnet.ahrq.gov/index.aspx>
- AHRQ PSNet Patient Safety Network Glossary - Patient safety. <http://psnet.ahrq.gov/glossary.aspx#P>. Accessed October 20, 2007.
- AHRQ's Patient Safety Initiative: Building Foundations, Reducing Risk. Interim Report to the Senate Committee on Appropriations. AHRQ Publication No. 04-RG005, December 2003. Agency for Healthcare Research and Quality, Rockville, MD. <http://www.ahrq.gov/qual/pscongrpt/>
- Aletras V, Jones A, Sheldon T. Economies of scale and scope. In: Ferguson B, Sheldon T, Posnet J (eds.). Concentration and choice in healthcare. London, Financial Times Healthcare, 1997.
- Allman R: The impact of pressure ulcers on healthcare costs and mortality. *Adv Wound Care* 11(3 Suppl):2, May–Jun. 1998.
- Amalberti R Auroy, Y Berwick, D Barach, P 2005 Five System Barriers to Achieving Ultrasafe Health Care *Ann Intern Med.* 2005;142:756-764.
- Anderson et al 2006 The business case for patient safety, *Healthcare Quarterly special issue* 10; 20-26.
- Andreen Sachs, M & Lind, M (2009) Quality costing and savings (presentation report at the 2009 European Quality Forum, Berlin, March 2009.
- Andrews L, Stocking C, Krizek T, Gottlieb L, Krizek C, Vargish T Siegler M (1997), “An alternative strategy for studying adverse events in medical care”, *The Lancet*, 349: 309-313.
- Arah, A Klazinga N How safe is the safety paradigm? *Qual Saf Health Care* 2004;13:226–232
- Atkinson AB. Atkinson review of government output and productivity for the national accounts: final report. Basingstoke: Palgrave Macmillan, 2005.
- Audit Commission (2001) A spoonful of sugar, Audit commission publications, PO Box Wetherby LS23 7JA (author, Mapstone, N)
- Australian report 1999: Implementing safety and quality enhancement in health care. Australian Resource Centre for Healthcare Innovations [website]. <http://www.archi.net.au> (accessed Sep 2007).
- Bagian J.P., et al. (2002) VA’s root cause analysis system in action. *Jt Comm J Qual Improv* 28:531–545, Oct. 2002.
- Bagian JP, Lee C, Gosbee J, DeRosier J, Stalhandske E, Eldridge N, et al. (2001) Developing and deploying a patient safety program in a large health care delivery system: you can't fix what you don't know about. *Joint Commission Journal on Quality Improvement* 2001;27(10):522-532.
- Baker GR, Norton PG, Flintoft V, Blais R, Brown A, Cox J, Etchells E, Ghali WA, Hébert P, Majumdar SR, O’Beirne M, Palacios-Derflingher L, Reid RJ, Sheps S, Tamblyn R. 2004 The Canadian Adverse Events Study: the incidence of adverse events among hospital patients in Canada. *CMAJ.* 2004 May 25;170(11):1678-86.
- Baker, G. R., Norton, P. (2001). “Making Patients Safer! Reducing Error in Canadian Healthcare.” *Healthcare Papers* 2(1): 10-31.
- Baker, G. R., Norton, P. (2002) “Patient Safety and Healthcare Error in the Canadian Healthcare System: A Systematic Review and Analysis of Leading Practices in Canada with Key Initiatives Elsewhere.” Report to Health Canada. .
- Balck, N Borwn, J and Carins, J 2006 Health care productivity, *BMJ* 2006;333:312-313
- Banning et al (1993) Reduction of errors in laboratory test reports using CQI, *Clin Lab Man rev*, 7 424-36.
- Bassham, J 2005 Redesigning Care Fact Sheet Streaming in the Emergency Department (ED), from Flinders medical centre web site.
- Batalden, P and Davidoff, F 2007 What is “quality improvement?” and how can it transform healthcare? *Qual Saf Health Care* 2007;16:2–3.
- Bates et al (1998) DW, Leape LL, Cullen DJ, Laird N, Petersen LA, Teich JM, et al. Effect of computerized physician order entry and a team intervention on prevention of serious medication errors. *JAMA.* 1998;280:1311-6.

- Bates, D Spell, N Cullen, D et al (1997) "The cost of adverse drug events in hospitalised patients" *Journal of the American Medical Association*, Vol. 277, No 4, pp 307-311.
- Bates, D. W., Boyle, D. L., et al. (1995). "Relationship between medication errors and adverse drug events." *Journal of General Internal Medicine*. 10(4): 199-205.
- Beckrich K., Aronovitch S. Hospital-acquired pressure ulcers: A comparison of costs in medical vs. surgical patients. *Nurs Econ* 17:263–271, Sep.–Oct. 1999.
- Beers MH, Munekata M, Storrie M. The accuracy of medication histories in the hospital medical records of elderly persons. *J Am Geriatr Soc* 1990;38(11):1183-7.
- Ben-Tovim D, 2007 Seeing the picture through "lean thinking" *BMJ* 2007;334:169 (27 January).
- Ben-Tovim D, Bassham J, Bennett D, Dougherty M, Martin M, O'Neill S, et al. Redesigning care at the Flinders Medical Centre: clinical process redesign using "lean thinking". *Medical Journal of Australia* 2008;188 (6 Suppl):S27-S31.
- Bent, P Bolsin, S Creati, B Patrick A, Colson M Professional monitoring and critical incident reporting using personal digital assistants *MJA* 2002, 177: 492-97.
- Berte, L & Nevalainen, D (1997) Quality pays – in every business" *Transfusion science*, 18, 4: 589-596.
- Berwick, D M (1996) "Improving healthcare", *British Medical Journal* ; 312: 605-18.
- Berwick, D.M. 1989. Continuous Improvement as an Ideal in Health Care. *New England Journal of Medicine* 320(1):53–56.
- Bevan, G Airoidi, M Morton, A Olivera, N 2007 Estimating health and productivity gains in England from selected interventions, London, Health Foundation.
- Bigelow B & Arndt M 1998 Reengineering: deja vue all over again *Health Care Management Review* 23 3 1998 58-66.
- Bigelow B & Arndt M 2000 The more things change the more they stay the same, *Health Care Management Review* 2000 25 (1) 65-72
- Bigelow, B & Arndt, M Total quality management: Field of dreams?" *Health Care Management Review*, 1995;20 (4):15-25.
- Birkmeyer CM, Lee J, Bates DW, Birkmeyer JD. Will electronic order entry reduce health care costs? *Effective Clinical Practice*. 2002;5:67-74.
- Birkmeyer JD, Birkmeyer CM, Wennberg DE, Young M (2001) Leapfrog patient safety standards: The potential benefits of universal adoption. 2001. Washington, DC, The Leapfrog Group.
- Birkmeyer JD, Dimick JB. 2004 Leapfrog safety standards: potential benefits of universal adoption. The Leapfrog group. Washington, DC: 2004.
- Bisognano, M & Nolan, T Finding the balance between quality and cost, *Health care financial management association*, April 2006, cover story.
- Black N, Browne J and Cairns J (2006). 'Health care productivity'. *British Medical Journal*, vol 333, pp 312–13.
- Boaden, R Harvey, G Moxham, C Proudlove, N 2008 *Quality Improvement: Theory and Practice in Healthcare*, National Library for Health, NHS Institute for Innovation and Improvement; University of Warwick www.institute.nhs.uk/qualityimprovement
- Bodenheimer T. Coordinating care—a perilous journey through the health care system. *The New England Journal of Medicine* 2008 Mar 6; 358(10):1064-71.
- Bogner M, editor.(1994) *Human error in medicine*. Hillsdale, NJ: Lawrence Erlbaum Associates. 1994.
- Borbas C, Morris N, McLaughlin B, Asinger R, Gobel F The role of clinical opinion leaders in guideline implementation and quality improvement *Chest*. 2000 Aug;118(2 Suppl):24S-32S.
- Bradley EH, Holmboe ES, Mattern JA, Roumanis SA, Radford MJ, Krumholz HM. The roles of senior management in quality improvement efforts: what are the key components? *J Healthc Manag*. 2003 Jan-Feb;48(1):15-28.
- Brennan T, Leape L, Laird N, Hebart L, Loralio A, Lawthers A Newhouse, Weiler, & Hiatt (1991) Incidence of adverse events and negligence in hospitalised patients", *New England Journal of Medicine*, 324: 370-6, 1991.
- Brennan, T. A., Localio, A. R., et al. (1990). "Identification of adverse events occurring during hospitalization. A cross-sectional study of litigation, quality assurance, and medical records at two teaching hospitals." *Annals of Internal Medicine*. 112(3): 221-6.
- Brilli, Richard J.; Sparling, Karen W.; Lake, Michael R.; Butcher, John; Myers, Sarah S.; Clark, Marta D.; Helpling, Alma; Stutler, Mary E. 2008 The Business Case for Preventing Ventilator-Associated Pneumonia in Pediatric Intensive Care Unit Patients *Joint Commission Journal on Quality and Patient Safety*, Volume 34, Number 11, November 2008 , pp. 629-638(10)

- Brown C, Hofer T, Johal A, Thomson R, Nicholl J, Franklin B, Lilford R: An epistemology of patient safety research: a framework for study design and interpretation. Part 1. Conceptualising and developing interventions. *Qual Saf Health Care* 2007, 17:158-162.
- Brown, P., McArthur, C., Newby, L., Lay-Yee, R., Davis, P., & Briant, R. 2002, "Cost of medical injury in New Zealand: a retrospective cohort study", *J.Health Serv.Res.Policy*, vol. 7 Suppl 1, p. S29-S34.
- Buetow S, Kiata L, Liew T, Kenealy T, Dovey S, Elwyn G. Patient error: a preliminary taxonomy. *Ann Fam Med*. 2009;7:223-231.
- Bullano et al 2005 Long term evaluation of health plan costs per Venous thromboembolism events, *J manag care pharm*, 2005 11,8, 663-675
- Burton, R (1995) Reductions in unwanted complications and lengths of inpatient stay by use of "dynamic guidelines" *Physician Executive Journal of Management*, Vol 21, No 11, pp 19-21.
- Cabana D, Rand C, Powe N, Wu A, Wilson M, Abboud P, & Rubin H Why Don't Physicians Follow Clinical Practice Guidelines?: A Framework for Improvement *JAMA*, Oct 1999; 282: 1458 - 1465.
- Caplan RA, Posner KL, Cheney FW (1991) Effect of outcome on physician judgments of appropriateness of care. *JAMA*. 1991;265:1957-1960.
- Carlisle, D 2009 Lost for words, *HSJ* 20 Jan 2009, 18-21.
- CBO 2004 An Analysis of the Literature on Disease Management Programs, Oct 13, 2004. USA Congressional Budget Office. from www.cbo.gov
- Chaix-Couturier C, et al (2000). Effects of financial incentives on medical practice: results from a systematic review of the literature and methodological issues. *Int J Qual Health Care* 2000;12:133.
- Chang et al 2004 Interventions for the prevention of falls in older adults: systematic review and meta-analysis of randomised clinical trials, *BMJ* 328 20 MARCH 2004, 680.
- Chassin, M Brook, R Park, J et al 1986 Variations in the Use of Medical and Surgical Services by the Medicare Population, Santa Monica: Rand.
- Christianson J, Leatherman S, Sutherland K. Financial Incentives, Healthcare Providers and Quality Improvements. A Review of the evidence. London: The Health Foundation, 2007
- Classen DC, Evans RS, Pestotnik SL, Horn SD, Menlove RL, Burke JP. The timing of prophylactic administration of antibiotics and the risk of surgical-wound infection. *N Engl J Med* 1992; 326:281-286.
- Classen, D. C., Pestotnik, S. L., et al. (1997). "Adverse drug events in hospitalized patients. Excess length of stay, extra costs, and attributable mortality." *Journal of the American Medical Association*. 277(4): 301-6.
- Clemmer, Terry P., Spuhler, Vicki J. Developing and gaining acceptance for patient care protocols. *New Horiz* 1998; 6(1):12-19 (Society of Critical Care Medicine).
- Clemmer, Terry P., Spuhler, Vicki J., Oniki, Thomas A., Horn, Susan D. Results of a collaborative quality improvement program on outcomes and costs in a tertiary critical care unit. *Crit Care Med* 1999; 27(9):1768-1774.
- CMMS 2008 Centers for Medicare & Medicaid Services: Medicare Program: Changes to the hospital inpatient prospective payment systems and fiscal year 2009 rates; payments for graduate medical education in certain emergency situations; changes to disclosure of physician ownership in hospitals and physician self-referral rules; updates to the long-term care prospective payment system; updates to certain IPPS-excluded hospitals; and collection of information regarding financial relationships between hospitals; final rule. *Fed Regist* 2008, 73:48434-49083. OpenURL
- CMS 2006 Premier Hospital Quality Incentive Demonstration, http://www.cms.hhs.gov/HospitalQualityInits/35_hospitalpremier.asp
- Coleman K, Reiter KL, Fulwiler D. The impact of pay-for-performance on diabetes care in a large network of community health centers. *J Health Care Poor Underserved* 2007;18:966-83
- Couch, N. P., Tilney, N. L., Rayner, A. A., & Moore, F. D. 1981, "The high cost of lowfrequency events: the anatomy and economics of surgical mishaps", *N.Engl.J.Med.*, vol. 304, no. 11, pp. 634-637.
- Cretin, S., S. M. Shortell, and E. B. Keeler. 2004. "An Evaluation of Collaborative Interventions to Improve Chronic Illness Care. Framework and Study Design." *Evaluation Review* 28 (1): 28-51.
- Crosby PB. *Quality is Free: The Art of Making Quality Certain*. New York, New York: NAL Penguin, Inc., 1979.
- Cutler TW, Palmieri J, Khalsa M, Stebbins M. Evaluation of the relationship between a chronic care management program and California pay-for-performance diabetes care cholesterol measures in one medical group. *J Manag Care Pharm* 2007;13:578-88
- D'Angelo & Zarbo (2006?) The Henry Ford Production System: Measures of Process Defects and Waste in Surgical Pathology as a Basis for Quality Improvement Initiatives *American Journal of Clinical Pathology*
- Danish health care act 2003, Act on patient safety in the Danish health care system; Danish parliament act 429, of 10/06/2003).

- Davies et al 2001 (Davis P, Lay-Yee R, Briant R, et al. Adverse events in New Zealand public hospitals: principle findings from a national survey. Occasional Paper No 3. Wellington: Ministry of Health; 2001)
- Davis D, Evans M, Jadad A, et al. The case of knowledge translation: shortening the journey from evidence to effect. *BMJ* 2003; 327: 33-35.
- Davis P, Lay-Yee R, Briant R, et al. Adverse events in New Zealand public hospitals: principle findings from a national survey. Occasional Paper No 3. Wellington: Ministry of Health; 2001
- Davis, D. A., Thomson, M. A., et al. (1995). "Changing physician performance. A systematic review of the effect of continuing medical education strategies." *Journal of the American Medical Association*. 274(9): 700-5.
- DeBrantes et al 2004 Financial Incentives for Adoption of Health Information Technology by Healthcare Deliverers, E health initiative foundation www.bbriefings.com/pdf/1251/deBrantes.pdf
- DeBusk RF, Miller NH, Parker KM, Bandura A, Kraemer HC, Cher DJ, et al. Care management for low-risk patients with heart failure: a randomized, controlled trial. *Ann Intern Med*. 2004;141:606-13.
- Deming, WE. *Out of the Crisis*. Cambridge, MA, MIT Center for Advanced Engineering Study, 1986.
- Department of Health. *Healthcare output and productivity: accounting for quality change*. London: Department of Health, 2005.
- Devers, K Pham, H Liu, G 2004 What Is Driving Hospitals' Patient-Safety Efforts? *Health Affairs* 2004 23 (2): 103-115.
- Dhillon, B (2003) Methods for performing human reliability and error analysis in health care" *International Journal for Health Care Quality Assurance* 2003 Vol 16 No 6&7: 306-317.
- DiGioia A, Greenhouse P, Levison T. Patient- and family-centered collaborative care: An orthopaedic model. *Clinical Orthopaedics and Related Research*. 2007;463:13-19.
- DOH 2000 National Health Service. *An organisation with a memory: A report of an expert group on learning from adverse events in the NHS*. London: Department of Health, 2000.
- DOH 2000 National Health Service. *An organisation with a memory: A report of an expert group on learning from adverse events in the NHS*. London: Department of Health, 2000.
- DoH 2005 *Healthcare output and productivity: accounting for quality change*. London: Department of Health, 2005.
- Donchin Y, Gopher D, Olin M, et al (1995) A look into the nature and causes of human errors in the intensive care unit. *Crit Care Med* 23 (2):294-300,
- Dopson, S., Fitzgerald, L., Ferlie, E., Gabbay, J. and Locock, L. No magic targets. Changing clinical practice to become more evidence based. *Health Care Management Review* 2002; 37: 35-47.
- Dudley RA, Frolich A, Robinowitz DL, et al (2004) Strategies To Support Quality-based Purchasing: A Review of the Evidence. Summary, Technical Review Number 10. AHRQ Publication Number 04-P024, July 2004. Agency for Healthcare Research and Quality, Rockville, MD. <http://www.ahrq.gov/clinic/epcsums/qpurchsum.htm> (accessed July 22, 2005)
- ehealth (2003) *Financial Incentives: Innovative Payment for Health Information Technology*, from www.ccbh.ehealthinitiative.org. (accessed July 22, 2005)
- Ehman, A. J. (2003). "Saskatchewan first with mandatory reporting of medical errors." *Canadian Medical Association Journal* 168(4): 471.
- Ehsani, J., Jackson, T., and Duckett, S. (2006) The incidence and cost of adverse events in Victorian hospitals 2003-04, *Medical Journal of Australia*, vol, 184, no. 11, pp 551-555.
- EPOC 2009 Cochrane Effective Practice and Organisation of Care Group [<http://www.epoc.cochrane.org/en/scope.html>]
- Evans RS, Pestotnik SL, Classen DC, Burke JP. Development of an automated antibiotic consultant. *M.D. Computing* 1993; 10:17-22.
- Evans RS, Pestotnik SL, Classen DC, Clemmer TP, Weaver LK, Orme JF, Lloyd JF, Burke JP. A computer-assisted management program for antibiotics and other anti-infective agents *N Engl J Med* 1998; 338:232-238 (22 Jan).
- Evans RS. The HELP system: a review of clinical applications in infectious diseases and antibiotic use. *M.D. Computing* 1991; 8:282-288, 315.
- Ferlie EB, Shortell SM: *Improving the Quality of Health Care in the United Kingdom and the United States: A Framework for Change*. *Milbank Q* 2001, 79:281-315.
- Fillingham, D 2008 *Lean Healthcare: Improving the Patient's Experience*, Kingsham Press, Chichester.
- Fisher ES, Wennberg DE, Stukel TA, Gottlieb DJ, Lucas FL, Pinder EL. The implications of regional variations in Medicare spending, Part 1: The content, quality, and accessibility of care. *Annals of Internal Medicine*. 2003 Feb 18;138(4):273-287.
- Fisher ES, Wennberg DE, Stukel TA, Gottlieb DJ, Lucas FL, Pinder EL. The implications of regional variations in Medicare spending, Part 2: Health outcomes and satisfaction with care. *Annals of Internal Medicine*. 2003 Feb 18;138(4):288-298.

- Flum, D. R. & Koepsell, T. 2002, "The clinical and economic correlates of misdiagnosed appendicitis: nationwide analysis", *Arch.Surg.*, vol. 137, no. 7, pp. 799-804.
- FMC 2009 Flinders medical centre lean programme
<http://www.flinders.sa.gov.au/redesigningcare/pages/overview/6863/>
- Forster A.J., et al.: The incidence and severity of adverse events affecting patients after discharge from the hospital. *Ann Intern Med* 138:161–167, Feb. 4, 2003.
- French, B et al 2009 What can management theories offer evidence-based practice? A comparative analysis of measurement tools for organisational context *Implementation Science* 2009, 4:28 doi:10.1186/1748-5908-4-28
- Gebhart F. (1999) VA facility slashes drug errors via bar-coding. *Drug Topics*;1:44.
- Getting evidence into practice. NHS Centre for Reviews Dissemination *Effective Health Care Bulletin* 5 (1) 1999.
- Glickman SW, Ou F-S, DeLong ER, et al. Pay for performance, quality of care, and outcomes in acute myocardial infarction *JAMA* 2007;297:2373–80
- Goldhill DR, White SA, Sumner A. Physiological values and procedures in the 24 h before ICU admission from the ward. *Anaesthesia* 1999; 45: 529–34.
- Goldratt EM. *Theory of constraints*. New York: North River, 1999. <http://www.coba.usf.edu/departments/accounting/faculty/jozsi/presentations%20fall06/TOC.pdf> (accessed Sep 2007).
- Gosbee J (2004) Introduction to the Human Factors Engineering Series Joint Commission on Quality and Safety *Journal* April 2004 Volume 30 Number 4 215-219.
- Gosbee J and Anderson T (2003) Human factors engineering design demonstrations can enlighten your RCA team, *Qual. Saf. Health Care* 2003; 12: 119-121.
- Gosbee John W. Conclusion: You Need Human Factors Engineering Expertise to See Design Hazards That Are Hiding in "Plain Sight!" *Joint Commission Journal on Quality and Patient Safety*, December 2004, vol. 30, no. 12, pp. 696-700(5)
- Gosden T, Forland F, Kristiansen IS, et al.(2001) Impact of payment method on behaviour of primary care physicians: a systematic review. *J Health Serv Res Policy* 2001;6:44–55.
- Gosfield, A. G. (2004). The doctor-patient relationship as the business case for quality. *Journal of Health Law* 37, 2, 197-223. Available at www.gosfield.com/PDF/DrPatientRelationship.pdf.
- Gosfield, A. G. & Reinertsen, J. L. (2003). Doing well by doing good: Improving the business case for quality. Available at www.uft-a.com.
- Gosfield, A. G. & Reinertsen, J. L. (2004, January 22). Paying physicians for high quality care. *New England Journal Medicine*. <http://222.uft-a.com/PDF/NEJM%20Epstein%20letter.pdf>.
- Gosfield, A. G. 2004 "Contracting for Provider Quality: Then, Now and P4P," in Gosfield, (Ed.), *Health Law Handbook*, 2004 edition, West Group, pp. 103-183, available at <http://www.gosfield.com/PDF/ch3PDF.pdf> (accessed July 22, 2005)
- Gray, A 2003 Adverse events and the National Health Service: an economic perspective- a report to the National Patient Safety Agency, Health Economics Research Centre Department of Public Health, University of Oxford, November 2003.
- Greenhalgh T, Robert G, Bate P, Kyriakidou O, Macfarlane F, Peacock R. A systematic review of the literature on diffusion, dissemination and sustainability of innovations in health service delivery and organisation. London, NHSSDO Programme, 2004. www.sdo.lshtm.ac.uk
- Grimshaw J McAuley M Bero L et al Systematic reviews of the effectiveness of quality improvement strategies and programmes, *Quality and Safety in Health care*, 2003; 12:298-303.
- Grimshaw JM, Thomas RE, MacLennan G, et al. Effectiveness and efficiency of guideline dissemination and implementation strategies. *Health Technology Assessment*, 2004, Vol 8, No6.
- Grol R Wensing M (2004) What drives change? Barriers to and incentives for achieving evidence based practice. *Medical Journal of Australia*, 2004; 180: s57-s60.
- Gurwitz J.H., et al. 2000 Incidence and preventability of adverse drug events in nursing homes. *Am J Med* 109:87–94, Aug. 1, 2000.
- Gurwitz J.H., et al. 2005 The incidence of adverse drug events in two large academic long-term care facilities. *Am J Med* 118:251–258, Mar.1, 2005.
- Halm, E Lee, C Chassin, M 2002 Is volume related to outcome in health care? A systematic review and methodologic critique of the literature, *Annals of internal medicine*, 2002, 137:511-520.
- Haycox, M & Bagust, A (1999) Clinical guidelines: the hidden costs *BMJ* 1999; 318:391-393.
- HCPAC(2000) Management and control of hospital acquired infection in Acute NHS Trusts in England, UK House of Commons Public Accounts Committee, www.publications.parliament.uk/pa/cm/cmpubacc.htm

Hebert, P. C., Levin, A. V., et al. (2001). "Bioethics for clinicians: 23. Disclosure of medical error." *Canadian Medical Association Journal*. 164(4): 509-13.

HF (2004) Briefing: Making healthcare safer for patients, London: Health Foundation , www.health.org.uk

HFMA 2006 Managing the Margin: a business case for patient safety, Healthcare Financial management association Newsletter, December 2006.

Hibbard JH, Stockard J, Tusler M. Does publicizing hospital performance stimulate quality improvement efforts? *Health Aff (Millwood)* Mar-Apr 2003;22(2):84-94.

Hickson GB, Altemeier WA, Perrin JM. Physician reimbursement by salary or fee-for-service: effect on physician practice behavior in a randomized prospective study. *Pediatrics* Sep 1987;80(3):344-50.

Hillman AL, Ripley K, Goldfarb N, Weiner J, Nuamah I, Lusk E. The use of physician financial incentives and feedback to improve pediatric preventive care in Medicaid managed care. *Pediatrics* Oct 1999;104(4 Pt 1):931-5.

Hillman KM, Bristow PJ, Chey T, et al. Antecedents to hospital deaths. *Inter Med J* 2001; 31: 343-48.

Hoonhout et al 2009 Direct medical costs of adverse events in Dutch hospitals, *BMC Health Services Research* 2009, 9:27

Hunt, D RB Haynes, SE Hanna, K Smith. (1998) Effects of computer-based clinical decision support systems on physician performance and patient outcomes. *JAMA* 280: 1339-1346.

Iles, V Sutherland, K. (2001) *Managing Change in the NHS, Organisational Change*. London: National Co-ordinating Centre for NHS Service Delivery and Organisation R & D, 2001.

Institute of Medicine. (1990). *Medicare: A strategy for quality assurance volume II*. K. N. Lohr (Ed.). Washington, DC: National Academy Press, 116-139.

Ioannidis, J. P. & Lau, J. 2001, "Evidence on interventions to reduce medical errors: an overview and recommendations for future research", *J.Gen.Intern Med*, vol. 16, no. 5, pp. 325-334.

IOM (2000) Institute of Medicine, Committee on Quality of Health Care in America. (2001). *Crossing the quality chasm: A new health system for the 21st century*. Washington, DC: National Academy Press.

IOM (2000) *To err is human: Building a safer health system*. By L. T. Kohn, J. M. Corrigan, & M. S. Donaldson, (Eds.). Washington, DC: National Academy Press, Institute of Medicine, Committee on Quality of Health Care in America.

IOM 2003 *Priority Areas for National Action: Transforming Health Care Quality*, Institute of Medicine, National Academy Press, Washington.

Jakobsen, K et al 2002, Estimation of the relation between quality and productivity at vascular departments at Danish hospitals. *Annu Meet Int Soc Technol Assess Health Care Int Soc Technol Assess Health Care Meet*. 2002; 18: abstract no. 163.

James BC. Quality improvement in the hospital: managing clinical processes. *The Internist* 1993; 34:11-13, 17.

James, B Baley, B 2006 *Cost of Poor Quality or Waste in Integrated Delivery System Settings*, Report to AHRQ Rockville Maryland. <http://www.ahrq.gov/research/costpqids/cpqidsappa.htm>

James, B Savitz, L & Baley, B 2007 *Framework for Estimating the Cost of Waste and Poor Quality in Health Care*, Unpublished manuscript, Intermountain health care, Utah.

James, B 2007. *Managing Patient Safety*. Intermountain Health Care. Institute for health care delivery research, 2007. <http://www.intermountainhealthcare.org/qualityimprovement/research/HealthTech6.pdf>

JC 2007 *The joint commissions report on quality and safety: Sentinel Event Root Cause and Trend Data*, Oak Brook Illinois: Joint commission for Accreditation of Health care organisations, 2007.

JCAHO (2002). "Sentinel event policy and procedures." Joint Commission on the Accreditation of Healthcare Organizations.

Johnson, J. A. & Bootman, J. L. 1995, "Drug-related morbidity and mortality. A cost-of illness model", *Arch.Intern Med*, vol. 155, no. 18, pp. 1949-1956.

Johnson, W. G., Brennan, T. A., Newhouse, J. P., Leape, L. L., Lawthers, A. G., Hiatt, H. H., & Weiler, P. C. 1992, "The economic consequences of medical injuries. Implications for a no-fault insurance plan", *Journal of the American Medical Association*, vol. 267, no. 18, pp. 2487-2492.

Johnston G et al. Reviewing audit: barriers and facilitating factors for effective clinical audit. *Quality in health care*, 2000, 9:23-36

Jones, D & Mitchell A 2006 *Lean thinking for the NHS*, NHS confederation: London.

Juran Institute (2003) *Cost Management Update*, Sigma Issue No 140, The Cost Management Group of the IMA from www.juran.com, also reported in *BMJ News*, Medical errors kill almost 100000 Americans a year. *BMJ* 1999 319: 1519.

- Kahn KL, Keeler EB, Sherwood MJ, et al. Comparing outcomes of care before and after implementation of the DRG-based prospective payment system. *JAMA*. Oct 17 1990; 264(15):1984-8.
- Kairy et al 2009 A systematic review of clinical outcomes, clinical process, healthcare utilization and costs associated with telerehabilitation *Disability and Rehabilitation*, 2009; 31(6): 427-447
- Kalish, R. L., Daley, J., Duncan, C. C., Davis, R. B., Coffman, G. A., & Iezzoni, L. I. 1995. Costs of potential complications of care for major surgery patients", *Am.J.Med Qual.*, vol. 10, no. 1, pp. 48-54.
- Kaplan HS, Battles JB, Van der Schaaf TW, Shea CE, Mercer SQ (1998) Identification and classification of the causes of events in transfusion medicine. *Transfusion*. 1998;38:1071-78.
- Karsh, T Beyond usability: designing effective technology implementation systems to promote patient safety, *Qual Saf Health Care* 2004;13:388-394.
- Kause J, Smith G, Prytherch D, et al. A comparison of antecedents to cardiac arrests, deaths and emergency intensive care admissions in Australia and New Zealand, and the United Kingdom—the ACADEMIA study. *Resuscitation* 2004; 62: 275-82.
- Kaushal, R., Shojania, K. G., & Bates, D. W. 2003, "Effects of computerized physician order entry and clinical decision support systems on medication safety: a systematic review", *Arch.Intern Med*, vol. 163, no. 12, pp. 1409-1416.
- King DL, Ben-Tovim DI, Bassham J. Redesigning emergency department patient flows: application of Lean thinking to health care. *Emerg Med Australas* 2006;18:391-7.
- Kirkland, K. B., Briggs, J. P., Trivette, S. L., Wilkinson, W. E., & Sexton, D. J. 1999, "The impact of surgical-site infections in the 1990s: attributable mortality, excess length of hospitalization, and extra costs", *Infect.Control Hosp.Epidemiol.*, vol. 20, no. 11, pp. 725- 730.
- Kitch et al 2008 Handoffs causing patient harm, *Joint Commission Journal on Quality and Patient safety*, Oct 2008 34,10, pp563-570.
- Kristensen, S Mainz, J and Bartels, P 2007 Vocabulary and Indicators, *Simpatie Work package 4*, ESQH office Aarhus, Denmark, <http://www.simpatie.org/Main/pf1175587453/wp1175588035/wp1176820943>, accessed 14th March 2009.
- Krizek TJ. Surgical error: ethical issues of adverse events. *Arch Surg*. 2000;135(11):1359-1366
- Krizek TJ. Surgical error: ethical issues of adverse events. *Arch Surg*. 2000;135(11):1359-1366
- Kuperman, G. J., Teich, J. M., et al. (2001). "Patient safety and computerized medication ordering at Brigham and Women's Hospital." *Joint Commission Journal on Quality Improvement*. 27(10): 509-21.
- LA Times (2003) "Cedars-Sinai Medical Center suspends use of computerized physician order entry system. *Los Angeles Times*. 22 January 2003:B.1.
- Leape LL, Brennan TA, Laird N, Lawthers, Localio, Barnes, Hebert, Newhouse, Weiler, & Hiatt (1991) The nature of adverse events in hospitalized patients: Results of the Harvard Medical Practice Study II. *N Engl J Med* 1991;324:377-84.
- Leape LL. Reporting of adverse events. *N Engl J Med* 2002;347:1633-8.
- Leape, L Error in Medicine *Journal of the American Medical Association* 1994;(272)23: 1851-57.
- Leape, L Kapcenell et al (2000) Reducing adverse drug events: lessons from a breakthrough series collaborative, *Joint commission journal on quality improvement*, 26, 6 ;321-331.
- Leape, L. L., Bates, D. W., et al. (1995). "Systems analysis of adverse drug events. ADE Prevention Study Group.[comment]." *Journal of the American Medical Association*. 274(1): 35-43.
- Leape, L. L., Cullen, D. J., Clapp, M. D., Burdick, E., Demonaco, H. J., Erickson, J. I., & Bates, D. W. 1999, "Pharmacist participation on physician rounds and adverse drug events in the intensive care unit", *Journal of the American Medical Association*, vol. 282, no. 3, pp. 267-270.
- Leatherman, S., Berwick, D., Iles, D., Lewin, L. S., Davidoff, F., Nolan, T., & Bisognano, M. 2003, "The business case for quality: case studies and an analysis", *Health Aff.(Millwood.)*, vol. 22, no. 2, pp. 17-30.
- Leatherman, S., D. Berwick, et al. (2003). "The business case for quality: case studies and an analysis." *Health Affairs*. 22(2): 17-30.
- Lewis Q Fletcher M Implementing a national strategy for patient safety: Lessons from the National Health Service in England *Qual. Saf. Health Care* 2005;14:135-139
- Liu, C., et al. 2008. "Organizational Cost of Quality Improvement for Depression Care." *Health Services Research*. DOI: 10.1111/j.1475-6773.2008.00911.x.
- Liu, G & Christensen, D The continuing challenge of inappropriate prescribing in the elderly: an update of the evidence, *Journal of the American Pharmaceutical Association* 2002; 42(6):847-857.

- Marshall M Harrison S (2005) It's about more than money: financial incentives and internal motivation *Qual. Saf. Health Care* 2005;14;4-5
- Martin LA, Neumann CW, Mountford J, Bisognano M, Nolan TW. *Increasing Efficiency and Enhancing Value in Health Care: Ways to Achieve Savings in Operating Costs per Year*. IHI Innovation Series white paper. Cambridge, Massachusetts: Institute for Healthcare Improvement; 2009. (Available on www.IHI.org)
- Martin, S Smith, P Leatherman, S 2006 Value for money in the English NHS Summary of the evidence, London, Health Foundation.
- Marx D. (2001) "Patient safety and the "just culture": A premier for health care executives." *Columbia University Mayo Alumni* (1995) "Can we be doing better", Fall issue, p 7.
- McAlister FA, Lawson FM, Teo KK, Armstrong PW. A systematic review of randomized trials of disease management programs in heart failure. *Am J Med.* 2001;110:378-84.
- McGlynn et al 2003; "The Quality of Health Care Delivered to Adults in the United States," *New England Journal of Medicine*, vol. 348, no. 26 (June 26, 2003), pp. 2635–2645.
- McNulty, T & Ferlie, E *Reengineering health care: the complexities of organizational transformation*, Oxford University Press: Oxford, 2002.
- McQuillan P, Pilkington S, Allan A, et al. Confidential inquiry into quality of care before admission to intensive care. *BMJ* 1998; 316: 1853–58.
- McRae et al 2009 The Australian health care system: the potential for efficiency gains a review of the literature, Australian Government.
- Meredith, L. S., P. Mendel, M. Pearson, S. Y. Wu, G. Joyce, J. B. Straus, G. Ryan, E. Keeler, and J. Unutzer. 2006. "Implementation and Maintenance of Quality Improvement for Treating Depression in Primary Care." *Psychiatric Services* 57 (1): 48–55.
- Merry, A., McCall, S. A. (2001). "Errors, medicine and the law." Cambridge, Cambridge University Press.
- Michie, S, Johnston, M Abraham, C Lawton, R Parker, D Walker, A Making psychological theory useful for implementing evidence based practice: a consensus approach *Qual. Saf. Health Care* 2005;14;26-33
- Mikel H. Mikel Harry on six sigma in healthcare. Interview by Carole S. Guinane. *J Healthc Qual* 2006; 28: 29-36.
- Miller, D, (Ed) (2005). *Going Lean in Healthcare*. In Institute for Healthcare Improvement (Ed.), *Innovation Series*. Cambridge, MA: Institute for Healthcare Improvement.
- Miller, D, (Ed) (2005). *Going Lean in Healthcare*. In Institute for Healthcare Improvement (Ed.), *Innovation Series*. Cambridge, MA: Institute for Healthcare Improvement.
- Milstein, A Galvin, R Delbanco, S Salber, P Buck, C *Improving the Safety of Health Care: The Leapfrog Initiative, Effective Clinical Practice*, 2000.
- Mission, J (2001) A review of clinical risk management *J. Qual. Clin. Practice* 2001, 21, 131–134
- Mitchell PH, Lang NM. Nurse staffing: a structural proxy for hospital quality? *Med Care.* Jan 2004;42(1):1-3.
- Mitchell, J 2006 Chapter 1 Defining patient safety and quality of care, in *National Quality Forum. Standardizing a patient safety taxonomy: a consensus report*. Washington, DC: National Quality Forum; 2006.
- Morgan, T The economic impact of wasted prescription medication in a outpatient population of older adults, *The Journal of Family Practice* 2001;50(9):779-781.
- Mulrow C & Oxman A (1997) *How to conduct a Cochrane systematic review*, Cochrane Collaboration: San Antonio, 1997.
- Mutter, M (2003) One Hospital's Journey Toward Reducing Medication Errors Source: *Joint Commission Journal on Quality and Patient Safety*, June 2003, vol. 29, no. 6, pp. 279-288(10)
- National Coalition on Healthcare (NCH) and Institute for Healthcare Improvement (2000) *Reducing medication errors and improving patient safety: success stories from the front lines of medicine*, Washington DC, National Coalition on Healthcare.(<http://www.nchc.org/>).
- National Coalition on Healthcare (NCH) and Institute for Healthcare Improvement (2002) *Curing the System: Stories of Change in Chronic Illness Care*, Washington DC, National Coalition on Healthcare.(<http://www.nchc.org/>).
- Needleman, J Kurtzman, E and Kizer, K 2007 *Performance Measurement of Nursing Care: State of the Science and Current Consensus*, *Med Care Res Rev* 2007; 64: 10S-20S.
- Needleman, J., P. Buerhaus, S. Mattke, M. Stewart, and K. Zelevinsky. 2001. *Nurse Staffing and Patient Outcomes in Hospitals*. Boston, MA: Harvard School of Public Health.
- Needleman, J., P. Buerhaus, S. Mattke, M. Stewart, and K. Zelevinsky, 2002. Nurse-staffing levels and quality of care in hospitals. *New England Journal of Medicine* 346 (22): 1415-1422.

- NHCPI (2001) *The Growing Case for Using Physician Incentives to Improve Health Care Quality*, Washington: National Health Care Purchasing Institute, 2001.(from www.nchpi.net)
- NHS (2001) *Building a safer NHS for patients*, London: department of health, 2001.
- NHS Centre for Reviews Dissemination (1999) *Getting evidence into practice*. NHS Centre for Reviews Dissemination Effective Health Care Bulletin 5 (1) 1999.
- NHSE, 1993 *Risk management in the NHS*, London:HMSO,1993
- NHSMa 2004 *10 High Impact Changes for service improvement and delivery: a guide for NHS leaders*, NHS Modernisation Agency, Leicester.
- NHSNorthWest. 2008 *A North West Health System Approach to Advancing quality*. Manchester: NHS North West Strategic Health Authority, 2008. http://www.dh.gov.uk/en/Publicationsandstatistics/Lettersandcirculars/Dearcolleagueletters/DH_090444.
- NIII 2006 *Delivering quality and value: focus on productivity and efficiency*, NHS Institute for Innovation and Improvement, www.institute.nhs.uk
- NQF 2003 *Safe practices for better healthcare*, Washington: National Quality Forum, 2003 (accessed May 30, 2005, www.qualityforum.org)
- NQF 2006, National Quality Forum: *Standardizing a Patient Safety Taxonomy*. 2006. (and in Theme Issue: *Towards an International Classification for Patient Safety*. *Int J Qual Health Care*. 2009;21:1-26.
- NSCPS 2002, National Steering Committee on Patient Safety *Building a Safer System: A National Integrated Strategy for Improving Patient Safety in Canadian Health Care*
- OHE Commission Report of the Office of Health Economics Commission on NHS Outcomes, Performance and Productivity. London: Office of Health Economics, 2008
- ONS 2004, *Public service productivity: health*. London: Office of National Statistics, October 2004.
- ONS 2006 *Public service productivity: health*. London: Office of National Statistics, February 2006.
- Orser, B. A., Chen, R. J., et al. (2001). "Medication errors in anaesthetic practice: a survey of 687 practitioners." *Canadian Journal of Anaesthesia*. 48(2): 139-46.
- Øvretveit, J (1992), *Health Service Quality*, Blackwell Scientific Press, Oxford
- Øvretveit J (2003a) "What is the best strategy for improving quality and safety of hospitals – a review and synthesis of the evidence" WHO, Copenhagen. Also from WHO web page - the top question on the page:http://www.euro.who.int/eprise/main/WHO/Progs/HEN/Syntheses/20030820_1
- Øvretveit J (2005a) "What are the advantages and disadvantages of different quality tools– a review and synthesis of the evidence" WHO, Copenhagen. (<http://www.euro.who.int/hen>) http://www.euro.who.int/eprise/main/WHO/Progs/HEN/Syntheses/QualityTools/20051006_13
- Øvretveit J and Gustafson D. (2003) "Evaluation of Quality Improvement Programmes" *British Medical Journal*,vol 326, pp 759-761.
- Øvretveit J, Andreen Sachs M. 2005 *Brister i patientsäkerhet och övrig kvalitet - hur minska kostnaderna?* *Läkartidningen* 2005;102:232-4. (How can we estimate and reduce the cost of poor quality in our service?)
- Øvretveit J, Andreen Sachs M. *Brister i patientsäkerhet och övrig kvalitet - hur minska kostnaderna?* *Läkartidningen* 2005c;102:232-4. (How can we estimate and reduce the cost of poor quality in our service?)
- Øvretveit, J (2000) "The economics of quality - a practical approach", *International Journal of Health Care Quality Assurance*, Vol 13, No 5, pp 200-207.
- Øvretveit, J (2002) *Action Evaluation of Health Programmes and Change A handbook for a user focused approach*, Radcliffe Medical Press, Oxford.
- Øvretveit, J (2003b) *Grading evidence for decision-makers: Issues and methods in assessing the scientific quality of research and summarizing strength of evidence for public health research reviews*, Discussion Document for WHO Health Evidence Network, Copenhagen, available from Karolinska Institutet, Medical Management Centre, Stockholm.
- Øvretveit, J (2004a) *The cost of poor quality in health care - A review of research*, for Stockholm County Council, available from Karolinska Institutet, Medical Management Centre, Stockholm.
- Øvretveit, J (2004b) *Framework for Quality Improvement Translation: Understanding the Conditionality of Interventions*, Joint Commission Journal on Quality and Safety, Global supplement, 2004 ;August:15-24 online: <http://www.jcrlinc.com/subscribers/journal.asp?durki=32>
- Øvretveit, J (2007) *Economics and effectiveness of interventions for improving quality and safety of health care- A review of research*, available from Karolinska Institutet, Medical Management Centre, Stockholm.
- Øvretveit, J 2005b *Research and knowledge about the effectiveness of interventions to improve patient safety, A review of research and guidance for LoF*, Stockholm: Karolinska Institute Medical Management Center, 2005.

- Øvretveit, J 2009a Effective leadership of improvement: a review of research, London: Health Foundation.
- Øvretveit, J 2009b Does improving quality save money? A review of evidence of which improvement to quality reduce costs for health service providers, The Health Foundation, London. www.health.org.uk; http://www.health.org.uk/publications/research_reports/does_quality_save.html.
- Øvretveit, J (2009c) Leading evidence informed value improvement in health care, Kingsham Press, Chichester, UK. www.akdpress.com
- Øvretveit, J 2009d Which interventions are effective for improving patient safety? A synthesis of research and policy issues, WHO HEN, Compenhagen and MMC, Karolinska,
- Øvretveit, J and Granberg, C (2006) Testing quality costing models: A report of the 16-month experience of 5 projects, available from Karolinska Institutet, Medical Management Centre, Stockholm.
- Øvretveit, J and Bisognano, M (2009b) The Business case for quality (presentation report at the 2009 European Quality Forum, Berlin, March 2009). from http://internationalforum.bmj.com/multimedia/wednesday-18-march-2009?portal_status_message=Changes%20saved.
- Pappas, S 2008 The Cost of Nurse-Sensitive Adverse Events, JONA 2008 Volume 38, Number 5, pp 230-236.
- Paradis, A et al 2006 Appendix B: Excess Cost and Length of Stay Associated with Voluntary Event Reports in Hospitals, from AHRQ <http://www.ahrq.gov/research/costpqids/cpqidsappb.htm>
- Perrow C (1999) Normal accidents : Living with High-Risk Technologies. With a New Afterword and a Postscript on the Y2K Problem. Princeton, NJ: Princeton University Press. 1999.
- Pestotnik SL, Classen DC, Evans RS, Burke JP. Implementing antibiotic practice guidelines through computer-assisted decision support: clinical and financial outcomes. *Ann Intern Med* 1996; 124:884-890.
- Pestotnik SL, Evans RS, Burke JP, Gardner RM, Classen DC. Therapeutic antibiotic monitoring: surveillance using a computerized expert system. *The American Journal of Medicine* 1990; 88:43-48.
- Pittet D, Hugonnet S, Harbarth S, Mouroug P, Sauvan V, Touveneau S, et al. (2000) Effectiveness of a hospital-wide programme to improve compliance with hand hygiene. *Lancet* 2000;356:1307-12.
- Plowman, R., Graves, N., Griffin, M. A., Roberts, J. A., Swan, A. V., Cookson, B., & Taylor, L. 2001, "The rate and cost of hospital-acquired infections occurring in patients admitted to selected specialties of a district general hospital in England and the national burden imposed", *J.Hosp.Infect.*, vol. 47, no. 3, pp. 198-209.
- Posnett, J. Is bigger better? Concentration in the provision of secondary care. *British medical journal*, 1999, 319:1063-1065.
- Pronovost P, Holzmueller, C (2004) Partnering for Quality, *Journal of Critical Care*, 2004 19(3):121-29.
- Pronovost P, Waters H, Dorman T (2001) The Economic Impact of the Leapfrog Group intensive care unit physician staffing standard, in Birkmeyer J, Birkmeyer C, Skinner J, (eds): *Economic Implications of the Leapfrog Safety Standards*. Washington, DC, The Leapfrog Group, 2001
- Pronovost P, Weast B, Bishop K, et al: Senior executive adopt-a-work unit: A model for safety improvement. *Jt Commission Joint Commission Journal on Quality and Safety* 30: 59-68, 2004.
- Pronovost PJ, Jenckes MW, Dorman T, et al: Organizational characteristics of intensive care units related to outcomes of abdominal aortic surgery. *JAMA* 1999, 281:1310-1317,
- Pronovost, P., Needham, D., Berenholtz, S., Sinopoli, D., Chu, H., Cosgrove S., et al. (2006). An intervention to decrease catheter-related bloodstream infections in the ICU. *New England Journal of Medicine*, 355(26), 2725-2732.
- QQIP 2009 Quest for Quality and Improved Performance [<http://www.health.org.uk/quip/>]
- QuIC (2000) Doing What Counts for Patient Safety: Federal Actions to Reduce Medical Errors and Their Impact, Report of the Quality Interagency Coordination Task Force To the President (QuIC), Agency for Healthcare Research and Quality., (www.Quic.org)
- Raschke, R et al.(1998) A computer alert system to prevent injury from adverse drug events. Development and evaluation in a community teaching hospital. *JAMA* 280: 1317-1320.
- Rasmussen J.(1990) Human error and the problem of causality in analysis of accidents. *Philos Trans R Soc Lond B Biol Sci.* 1990;327:449-460.
- Reinertsen, J L (2006) Interview with Gary Kaplan, *Quality and Safety in Health Care*, 15 (3): June 156-158
- Resar, R Pronovost, PHaraden, C Simmonds, T Rainey, T Nolan, T Using a Bundle Approach to Improve Ventilator Care Processes and Reduce Ventilator- Associated Pneumonia *Joint Commission Journal on Quality and Safety* 2005 31 (5):243-251.
- Rex JH, Turnbull JE, Allen SJ, Vande Voorde K, Luther K. (2000) Systematic root cause analysis of adverse drug events in a tertiary referral hospital. *Jt Comm J Qual Improv.* 2000;26:563-
- Rich MW, Beckham V, Wittenberg C, Leven CL, Freedland KE, Carney RM. A multidisciplinary intervention to prevent the readmission of elderly patients with congestive heart failure. *N Engl J Med.* 1995;333:1190-5.

- Rich MW. Heart failure disease management programs: efficacy and limitations *Am J Med.* 2001;110:410-2.
- Rigby, K & Litt, J (2000) Errors in care management: what do they cost? *Quality in Health Care*, 9 216-21.
- Roberts HV, Zangwill WI. *Quality Improvement through Waste Reduction*. Chicago, IL: University of Chicago; June, 1993.
- Rosenthal, M. B., Fernandopulle, R., Song, H. R., & Landon, B. (2004). Paying for quality: Providers' incentives for quality improvement. *Health Affairs* 23 (2): 127-141.
- RTI International. *Cost of Poor Quality or Waste in Integrated Delivery System Settings, AHRQ Final Report* submitted to Cynthia Palmer, AHRQ TOO, Contract No. 290-00-0018, RTI Project No. 0207897.011; August 2006.
- Rubenstein L, Chang B, Keeler E, et al. 1992 Measuring the quality of nursing surveillance activities for five diseases before and after implementation of the DRG-based prospective payment system. Paper presented at Patient outcomes research: examining the effectiveness of nursing practice, 1992; Bethesda, MD.
- Rubenstein, L. V., L. E. Parker, L. S. Meredith, A. Altschuler, E. dePillis, J. Hernandez, and N. P. Gordon. 2002. "Understanding Team-Based Quality Improvement for Depression in Primary Care." *Health Services Research* 37 (4): 1009-29.
- Rubenstein, L., J. McCoy, D. Cope, P. Barrett, S. Hirsch, K. Messer, and R. Young. 1995. "Improving Patient Quality of Life with Feedback to Physicians about Functional Status." *Journal of General Internal Medicine* 10 (11): 607-14.
- Runciman W (2002) Lessons from the Australian Patient Safety Foundation *Quality and Safety Health Care* 2002;11:246-251.
- Runciman WB, Sellen A, Webb RK, Williamson JA, Currie M, Morgan C, et al. (1993) The Australian Incident Monitoring Study. Errors, incidents and accidents in anaesthetic practice. *Anaesth Intensive Care.* 1993;21:506-519.
- Runciman, B., Merry, A., et al. (2001). "Improving patients' safety by gathering information. Anonymous reporting has an important role." *British Medical Journal.* 323(7308): 298.
- Runciman, W. B., Merry, A. F., et al. (2003). "Error, blame, and the law in health care—an antipodean perspective.[comment]." *Annals of Internal Medicine.* 138(12): 974-9.
- Santry, C 2009 Email warns clinicians of suspension over hygiene, *HSJ* 21 May 2009, p 8.
- Savitz, L 2007 Cost of waste/poor quality" presentation of research at AHRQ Annual Meeting, September 27, 2007 Bethesda, Maryland
- Schiøler T, Lipczak H, Pedersen BL, Mogensen TS, Bech KB, Stockmarr A, Svenning AR, Frølich 2001 A; Danish Adverse Event Study. *DSI Institut for Sundhedsvaesen, Ugeskr Laeger.* 2001 Sep 24;163(39):5370-8.
- Schneider, P. J., Gift, M. G., Lee, Y. P., Rothermich, E. A., & Sill, B. E. 1995, "Cost of medication-related problems at a university hospital", *Am.J.Health Syst.Pharm.*, vol. 52, no. 21, pp. 2415-2418.
- Schwartz WB, Mendelson DN. Eliminating Waste and Inefficiency Can Do Little to Contain Costs, *Health Affairs* 1994;224-238.
- Schuyve, P An Interview with Lucian Leape, *Joint Commission Journal on Quality and Safety*, 2004;30 (12): 653-58.
- SCIP 2009 Surgical Care Improvement Project Measures: Available at: <http://www.qualitynet.org/dcs/ContentServer?level3=Measures&c=MQParents&pagename=Medqic%2FMeasure%2FMeasuresHome&cid=1137346750659&parentName=TopicCat>.
- Scott T, Mannion R, Davies HTO, Marshall MN. *Organisational culture and performance in the NHS: a review of the theory. instruments and evidence.* York: Centre for Health Economics; 2001.
- Scott, T, Mannion, R, Davies, H & Marshall, M (2003) *The Quantitative Measurement of Organizational Culture in Health Care: A Review of the Available Instruments.* *Health Services Research* 38 (3), 923-945.
- Severens JL. Value for Money of Changing Healthcare Services? *Economic Evaluation of Quality Improvement.* *Qual Saf Health Care* 2003;12:366-371.
- Smetzer, J (2005) Reducing at risk behaviours, *Joint Commission Journal on Quality and Safety*, 2005, 31(5): 294-299.
- Solberg L, Brekke M, Fasio J, et al. Lessons from experienced guideline implementers: attend to many factors and use multiple strategies. *Jt Comm J Qual Improv* 2000;26:171-88.
- Sorensen, J Safety culture: a survey of the state of the art, *Reliability Engineering and System safety* 2002; 76:189-204.
- Spath PL, Nash DB 2004 *A guide to involving patients in error prevention and the role of hospital leadership.* Chicago, Illinois: American Hospital Association; 2004.
- Spooner A, Chapple A, Roland M. What makes British general practitioners take part in a quality improvement scheme? *J Health Serv Res Policy* 2001;6:145-50.
- Stalhandske E, Bagian, J Gosbee, J (2002) Department of Veterans Affairs Patient Safety Program *Am J Infect Control* 2002;30:296-302.

- Stalhandske E, Bagian, J Gosbee, J 2002 Department of Veterans Affairs Patient Safety Program Am J Infect Control 2002;30:296-302.
- Stanhope N, Crowley-Murphy M, Vincent C, et al. An evaluation of adverse incident reporting. J Eval Clin Pract 1999;5:5-12.
- Terry Y et al 2004 Using industrial processes to improve patient care BMJ 2004;328:162-164
- Thomas EJ, Peterson LA (2003) Measuring errors and adverse events in health care. J Gen Intern Med 2003;18:61-7.
- Thomas, E Studdert, D Newhouse, J Zbar, B Howard, K Williams, E and Brennan, T (1999) Costs of medical injuries in Utah and Colorado, Inquiry, 36(3) 255-64.
- Thompson, D N, Wolf, G A, Spear, S J (2003) Driving Improvement in Patient Care: Lessons From Toyota, Journal of Nursing Administration, 33 (11): 585-595
- Thompson, R McElroy, H Kazandjian, V (1997) "Maryland hospital quality indicator project in the UK", Quality in Health Care, 6,1, 49-55.
- Thor, J., Lundberg, J., Ask, J., Olsson, J., Carli, C., Pukk Härenstam, K. and Brommels, M. (2007) "Application of statistical process control in healthcare improvement: systematic review", Quality and Safety in Health Care, 2007;16:387-399
- Tourangeau AE, Cranley LA, Jeffs L. Impact of nursing on hospital patient mortality: a focused review and related policy implications. Qual Saf Health Care Feb 2006;15(1):4-8.
- Trowbridge, R & Wachter, R (2001) Legislation, Accreditation, and Market-Driven and Other Approaches to Improving Patient Safety Ch55 in AHRQ 2001, Making Health Care Safer. A Critical Analysis of Patient Safety Practices: Summary. AHRQ Publication No. 01-E057. Agency for Healthcare Research and Quality, Rockville, MD. <http://www.ahrq.gov/clinic/ptsafety/summary.htm>
- van den Heuvel J, Does RJ, Bogers AJ, Berg M. 2006 Implementing Six Sigma in The Netherlands. Jt Comm J Qual Patient Saf. 2006 Jul;32(7):393-9.
- Van der Schaaf T. (1992) Near miss reporting in the Chemical Process Industry [Doctoral thesis]. Eindhoven, The Netherlands: Eindhoven University of Technology. 1992.
- Vincent C, Ennis M, Audley RJ (1993) Medical accidents. Oxford ; New York: Oxford University Press. 1993.
- Vincent, C. (2001). "Clinical risk management: Enhancing patient safety." London, British Medical Journal Publishing Group.
- Vincent, C. A. and A. Coulter (2002). "Patient safety: What about the patient?" Quality & Safety in Health Care. 11(1): 76-80.
- Vincent, C., Neale, G., & Woloshynowych, M. 2001, "Adverse events in British hospitals: preliminary retrospective record review", British Medical Journal, vol. 322, no. 7285, pp. 517-519.
- Vincent, C., Taylor-Adams, S., et al. (1998). "Framework for analysing risk and safety in clinical medicine." British Medical Journal. 316(7138): 1154-7.
- VMS 2004: Hospital lab uses Six Sigma to reduce turnaround time and improve quality. ValuMetrix Services case study. Raritan, NJ: Ortho-Clinical Diagnostics, Inc.; 2004. Available at: [http://www.valumetrixservices.com/pdf/WHC_CaseStudy\(final\).pdf](http://www.valumetrixservices.com/pdf/WHC_CaseStudy(final).pdf).
- von Laue NC, Schwappach DL, Koeck CM. (2003) The epidemiology of medical errors: a review of the literature. Wien Klin Wochenschr. 2003;115(10):318-25.
- Wachter, R Shojania, K The Faces of Errors: A Case-Based Approach to Educating Providers, Policymakers, and the Public About Patient Safety, Joint Commission Journal on Quality and Safety in Health Care, 2004 30 (12): 665-673.
- Wagner EH. Deconstructing heart failure disease management. Ann Intern Med. 2004;141:644-6.
- Wallace, C. J Savitz, L 2008 Estimating waste in frontline health care worker activities. LETTER TO THE EDITOR Journal of Evaluation in Clinical Practice. 14(1):178-180, February 2008.
- Wallace, J, Savitz, L 2007 Estimating Waste in Frontline Health Care Workers. Journal of Evaluation in Clinical Practice, 2007.
- Walley, P Rayment, J Cooke, M 2006 Clinical Systems Improvement in NHS Hospital Trusts and their PCTs - a snapshot of current practice, University of Warwick/NIHL, 2006.
- Walsh, K & Antony, J (2009) An assessment of quality costs within electronic adverse event and recording systems, IJHCQA, 22 (3) 203-20.
- Walshe, K Shortell, S What happens when things go wrong: how healthcare organisations deal with major failures in care Health Affairs May 2004, 23, 3: 103-11.
- Walston, S & Kimberly, J Reengineering hospitals: experience and analysis from the field, Hospital and health service administration, 42 2:143-63.

- Walton RT, H. E. D. S. F. N. 2002, Computerised advice on drug dosage to improve prescribing practice (Cochrane Review)., Update Software, Oxford, The Cochrane Library, 1, 2002: CD002894.
- Wang (1998) (also Wang et al. 2003).Leape et al (1999) Ioannidis and Lau (2001).
- Wang, S. J., Middleton, B., Prosser, L. A., Bardon, C. G., Spurr, C. D., Carchidi, P. J., Kittler, A. F., Goldszer, R. C., Fairchild, D. G., Sussman, A. J., Kuperman, G. J., & Bates, D. W. 2003, "A cost-benefit analysis of electronic medical records in primary care", *Am.J.Med*, vol. 114, no. 5, pp. 397-403.
- Wanzel, K. R., Jamieson, C. G., et al. (2000). "Complications on a general surgery service: incidence and reporting.[comment]." *Canadian Journal of Surgery*. 43(2): 113-7.
- Weeks WB, Bagian JP: Developing a culture of safety in the Veterans Health Administration. *Eff Clin Pract* 3:270-276, 2000.
- West, D (2009) "Patient reports cast doubt on the need for large numbers of procedures" *HSJ*, 14thmay2009; p4-5.
- Westwood, N, Silvester, K (2007) Eliminate NHS losses by adding Lean and some Six Sigma, *Operations Management*, 33 (5): 26-30
- Wilf-Miron R, I Lewenhoff, Z Benyamini, and A Aviram From aviation to medicine: applying concepts of aviation safety to risk management in ambulatory care *Qual. Saf. Health Care* 2003; 12: 35-39.
- Wilson T & Sheika, A (2002) Enhancing patient safety in primary care, *BMJ* 324; 584-7.
- Wilson, R Runciman, W Gibberd, B Harrison, B Newbury, L & Hamilton, J (1995) "The quality in Australian healthcare study", *Medical Journal of Australia*, 163 (9): 458-71.
- Wilson, W. (2002). "To Catch an Error: Without Good Protective Legislation Reporting Medical Mistakes is Risky. So Safety Experts Are Focusing on Close Calls And Other Techniques To Cut Medical Errors." *Medical Post*. 38(29): 45.
- Womack J Jones D 2007 *Lean Solutions : How Companies and Customers Can Create Value and Wealth Together*, Simon & Schuster.
- Womack J, Jones D. 1998 *Lean thinking. Banish waste and create wealth in your corporation*. London: Simon and Schuster, 1998.
- Wong J & Beglaryan H (2004) *Strategies for Hospitals to Improve Patient Safety: A Review of the Research*, Ontario; The Change Foundation, 2004
- Young MP, Gooder VJ, Oltermann MH, Bohman CB, French TK, James BC. The impact of a multidisciplinary approach on caring for ventilator-dependent patients. *International Journal for Quality in Health Care* 1998; 10:15-26.
- Zhan & Friedman 2006, Medicare payments and costs *Health Affairs*, September/October 2006 pp 1386-93.
- Zhan, C & Miller, M (2003) Excess length of stay, charges, and mortality attributable to medical injuries during hospitalization, *JAMA*, 290 (14), 1868-74.