DEVELOPING RESEARCH AND PRACTICE

Citation classics in patient safety research: an invitation to contribute to an online bibliography

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Background: There has been a documented massive increase in published papers on patient safety over the past 20 years or so.

Aims: To ascertain the most influential papers over these last two decades.

Method: We obtained citation counts on papers which seemed to have been the most important in influencing opinion and practice. Our original source of papers were based on a systematic review of patient safety literature carried out by Shojania and colleagues and supplemented by other papers that we had come across in the course of our work directing the Department of Health Patient Safety Research Programme.

Results: We have listed 62 papers on our full report found on our website (http://www.pcpoh.bham.ac.uk/publichealth/psrp/PS_review.htm) and present the top 10 most highly cited papers here.

Conclusion: We are aware that the results were influenced by our subjective assessment and therefore invite readers to send us their favourite papers so we can include them in our interactive bibliography.

There has been an explosion of interest in patient safety in the last decade and a half (fig 1). Governments have responded to concerns over safety with major initiatives such as the formation of the Natural Patient Safety Agency for England and Wales. Here, we report on the results of a search for the most influential papers that have initiated and sustained this movement. We also invite readers to visit our website (see below) to nominate their own candidates for inclusion.

METHODS

We set out, in the first instance, to identify studies that had been most influential in changing how people think and act in the context of patient safety. It was impossible to analyse and carry out citation counts on all potentially relevant articles as the number of papers indexed under "patient-safety" is vast, with over 2000 papers for the year 2005 alone.

Figure 1 Growth of citation counts of papers coded in Medline under the terms "patient safety", "quality in healthcare" and "medical/medication errors" from 1966 to 2005. Each graph was normalised by taking the data for the year 2005 as 100% ("patient safety" 2472; "quality in healthcare" 21 870; "medical/medication error" 7867).

An initial list of papers that we judged influential was drawn from a systematic review of the patient-safety literature.¹ This was augmented by articles encountered by the authors in the course of their duties in directing the Patient Safety Research Programme for the Department of Health (England). A long list of 62 articles that appeared influential or important was drawn up, and a citation count (total and per year) was obtained for each article from the ISI Web of Science database. We also obtained citation counts using Google Scholar and Scopus. Correlations of rank order between the three citation counters were all close (>0.93).

The full listing of citation counts is provided in our paper "Patient safety—an unsystematic review and bibliography" available on the internet at http://www.pcpoh.bham.ac.uk/publichealth/psrp/PS_review.htm. As the articles selected were based on subjective personal selection, we have provided a facility for others to insert their favourite articles and to state why these have influenced them. Here, we provide an account of the top 10 most highly cited papers on the topic of patient safety (table 1), along with a few others that have not yet had time to accrue high citations, but are following a rapid upward trajectory. We classify papers into those describing the epidemiology of harm and error, those dealing with the underlying psychology and sociology, and those evaluating interventions to improve patient safety. In essence we cover three questions:

1. How common is the problem?
2. What are the underlying causes?
3. What can be done about it?

RESULTS

Epidemiology

Four of the top 10 papers describe the epidemiology of error in healthcare. The two most highly cited papers disseminated the results of the Harvard Medical Practice Study.^{2 3} These were the first major studies to show that medical care causes a large number of injuries to patients, many of which are preventable. As a result of this study, Wilson *et al*⁴ conducted the Quality in Australian Health Care Study published in 1995, also in our list of the 10 most highly cited articles.

Table 1 The 10 highest-cited patient safety papers

Principal author	Year	Web of Science Citations 16 August 2005	Average citations per year	Summary
Brennan TA	1991	890	64	The results of the Harvard Medical Practice Study I. A retrospective record review, showing that 3.7% of patients in New York hospitals experience disabling injuries as a result of medical treatment and that 28% of these are caused by negligence, in the sense that they were probably preventable.
Leape LL	1991	715	51	The second part of the Harvard Medical Practice Study Results, elaborated on the results of the first part, including the procedures resulting in adverse events, whether related to an operation—for example, a wound infection, or not, as in cases with diagnostic mishaps. This paper stated that patients ≥65 years old experience adverse events twice as frequently as those <65.
Bates DW	1995	630	63	A study of the incidence of ADEs and potential ADEs in 4031 patients who spent a total of 21 412 days in hospitals. 247 ADEs (28% preventable) and 194 potential ADEs (incidents with potential for injury related to a drug, 43% of which were prevented before drug administration) were identified.
Leape LL	1994	563	51	A study of the causes of errors and the ways in which they may be prevented. Leape examines various different theories of cognition and the physiological and psychological factors that may affect performance. He suggests that the current “blame culture” in the medical system is destructive in that it means that errors are not reported and so cannot be learnt from.
Fischhoff B	1975	559	19	A study of the effect of outcome knowledge on judgement under uncertainty. Patients were told of an unfamiliar historical event such as a war in India and given four possible outcomes. They were then asked to say how likely they thought each outcome was to have occurred. Some of the patients were told that one of the outcomes was “true”, and their responses to the likelihood of each of the outcomes were compared with the control group. The study showed that when people think they know of the outcome of an event, they are more likely to judge it as being “true”, but they are unaware of the effect that this outcome knowledge has on their perceptions.
McDonald CJ	1976	398	14	One of the earliest studies into the efficacy of protocol-based computer reminding systems. The results suggested that they are useful, but especially if they reflect a doctor’s actual decision-making logic.
Bates DW	1998	364	52	A classic study of the effect of POE and team interventions on the incidence of ADEs showed that the rate of non-intercepted serious medication errors was reduced by 55% by these interventions.
Wilson RM	1995	325	33	The Quality in Australian Health Care Study, based on the Harvard Medical Practice Study, reviewed 14 179 patient records and found 2353 adverse events (a rate of 16.6%). Over half of the adverse events were judged to have a high preventability rating.
Hunt DL	1998	316	45	A systematic review of the effectiveness of CDSSs. 68 studies that looked at CDSSs were selected and evaluated and the results of the studies were recorded. 15 of the studies looked at drug-dosing systems, with six finding them to be effective, two ineffective and the remaining seven concerned with warfarin dosing and giving inconsistent results. Five studies assessed CDSSs and only one found it effective. Of the 19 preventative care CDSSs, 14 provided a benefit. 29 studies looked at the role of CDSSs in other aspects of medical care and 23 were beneficial. Overall, 65% of the studies found that the CDSSs were effective.
Reason J	2000	201	40	Reason discusses the causes of errors, which are either human or system based. He examines approaches to error in high-reliability organisations such as Air Traffic Control and the nuclear power industry. He advocates a shift towards a systems-based approach to error in medicine.

ADEs, adverse drug events; CDSSs, computer-based decision support systems; POE, physician computerised orderentry.

Subsequent studies of this type, such as those by Vincent *et al*⁵ in the UK and Baker *et al*⁶ in Canada, are widely cited but do not make the top 10. However, a study completed by Bates *et al*⁷ in 1995 measured the incidence of adverse drug events of different types and showed that most medication errors occur at the drug-ordering stage.

Psychology and sociology

Two of our top 10 papers explore the cognitive basis of human error: “Models and management” by Reason⁸ and “Error in medicine” by Leape.⁹ These build on earlier work by Reason himself and the great Danish psychologist, Rasmussen, which show how errors can be classified—for example, into “skills-based” errors (slips that occur when

attention is diverted from a task that is under sub-conscious control), “rule-based” errors (slips that occur when the wrong rule is chosen during problem solving) and “knowledge-based” errors (where a mistake occurs because of lack of knowledge or misinterpretation of a problem). Both Reason and Leape build on these insights to argue for an emphasis on systems failure and a less hierarchical healthcare culture, and this chimes with the work of Helmreich and Merritt in aviation,¹⁰ which has been hugely influential in medical research, even though it does not make the cut into the top 10. Likewise, the study by Friedman *et al*¹¹ on the effect of sleep loss on the performance of junior doctors has “spawned a dynasty” despite not quite making the top 10. However, the immensely influential paper by Fischhoff on the pervasive

nature of what we would now call “hindsight bias” comes in at number five.¹² This has obvious relevance both for research and for safety practices, such as root cause analysis and confidential enquiries, which rely on retrospective judgements about the safety of care.

Interventions

Studies into interventions are less common than studies into the incidence and causes of medical errors, but three make the cut. A large body of patient safety literature exists on the effect of computer protocols and reminder systems, the most highly cited of which was the paper by McDonald.¹³ This article has had plenty of time to accrue citations, but two other top 10 papers from Bates *et al*¹⁴ and from Hunt *et al*¹⁵, both published in 1998, have registered even higher annual citation rates. Another important intervention that has been studied is the effect of reducing doctors’ working hours on the number of adverse events that occur in intensive care units. This study is a randomised trial by Landrigan *et al*¹⁶. It showed that the rate of serious errors can be reduced by more humane scheduling of junior doctors’ work hours. The study by Landrigan is too recent to make the top 10, but the paper has received 25 citations in <1 year.

DISCUSSION

Limitations to the study

The citation counters used did not permit us to determine the number of citations received by articles that were published in books. In consequence, some of the very important articles cited in our original paper may have been omitted from our hierarchy of most highly cited articles. Likewise, we fully concede that the selection of papers for citation analysis is subjective, which is why we invite readers to visit http://www.pcpoh.bham.ac.uk/publichealth/psrp/PS_review.htm to read the full text of our article and add their own opinions on the most important papers. In this way, we can all identify the intellectual heart of the patient safety movement and ultimately develop a consensus-based “reader in patient safety” analogous to similar reviews in health sociology.^{17 18}

A prize for patient safety research?

Who should be awarded the “Nobel prize” for safety research? On the basis of citations, there are two leading candidates, Lucian Leape and David Bates, each of whom contributed to three of the top 10 citation classics. James Reason is another contender, as he created many of the ideas we now take for granted in the safety movement. Perhaps we should award three prizes: Leape for measuring the size of the problem, Reason for understanding why there is such a problem and Bates for doing something about it. Once again, we invite readers’ views.

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