

BMJ Open A systematic review of the cost and cost-effectiveness of electronic discharge communications

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ABSTRACT

Background The transition between acute care and community care can be a vulnerable period in a patients' treatment due to the potential for postdischarge adverse events. The vulnerability of this period has been attributed to factors related to the miscommunication between hospital-based and community-based physicians. Electronic discharge communication has been proposed as one solution to bridge this communication gap. Prior to widespread implementation of these tools, the costs and benefits should be considered.

Objective To establish the cost and cost-effectiveness of electronic discharge communications compared with traditional discharge systems for individuals who have completed care with one provider and are transitioning care to a new provider.

Methods We conducted a systematic review of the published literature, using best practices, to identify economic evaluations/cost analyses of electronic discharge communication tools. Inclusion criteria were: (1) economic analysis and (2) electronic discharge communication tool as the intervention. Quality of each article was assessed, and data were summarised using a component-based analysis.

Results One thousand unique abstracts were identified, and 57 full-text articles were assessed for eligibility. Four studies met final inclusion criteria. These studies varied in their primary objectives, methodology, costs reported and outcomes. All of the studies were of low to good quality. Three of the studies reported a cost-effectiveness measure ranging from an incremental daily cost of decreasing average discharge note completion by 1 day of \$0.331 (2003 Canadian), a cost per page per discharge letter of €9.51 and a dynamic net present value of €31.1 million for a 5-year implementation of the intervention. None of the identified studies considered clinically meaningful patient or quality outcomes.

Discussion Economic analyses of electronic discharge communications are scarcely reported, and with inconsistent methodology and outcomes. Further studies are needed to understand the cost-effectiveness and value for patient care.

BACKGROUND

The transition between acute care and community care can be a vulnerable period

Strengths and limitations of this study

- A comprehensive systematic review of six databases was completed using best practices.
- To our knowledge this is the first systematic review on this topic.
- Research is timely as many institutions are facing adoption decisions surrounding eHealth tools.
- The review only identified four studies on this topic, and other studies may not be publicly available.
- Of the discharge tools being analysed, all may be considered out of date.

during patient care due to the potential for postdischarge adverse events. Recent studies have estimated the incidence of adverse events to range from 19% to 23% within 2–5 weeks postdischarge.^{1 2} Of these events, 21% of patients required additional physician visits, 17% required hospital readmission and 12% presented to the emergency department.^{1 2} These events constitute a costly and potentially avoidable resource use.

The vulnerability of this period has been attributed to three main factors all related to the miscommunication between in-hospital and community-based physicians,³ including: (1) failure to reconcile medications, (2) giving the patient or patient's family the responsibility of relaying essential discharge information to the primary care physician and (3) failure to transfer crucial information between hospital and primary care physicians.³ Electronic communication tools have been proposed as one option to bridge this communication gap by providing an immediate link between acute care and primary care physicians. This is in contrast to traditional discharge systems where a discharge summary is prepared by a physician either by hand or using a dictation tool,

the summary is then signed by the physician and sent to the family doctor using fax or mail systems.

A 2011 systematic review examined the efficacy of electronic discharge communications, identifying eight randomised control trials and four quasi-experimental studies.⁴ While the reported outcomes varied across included studies, the overall conclusions from the systematic review recommended implementation of computer-based discharge tools; however, due to the lack of rigorous evidence, organisations were encouraged to incorporate formal evaluation protocols.⁴

Along with the efficacy of these tools, the associated financial costs must be considered prior to implementation. This is particularly true for the public sector, which has a limited budget and where implementation will require the reallocation of funds. The cost-effectiveness of these tools remains unknown and, to our knowledge, there are no pre-existing systematic reviews examining this evidence. By considering the costs and benefits of these electronic tools, in comparison with other uses of resources, decision makers can optimise the health impact of scarce healthcare resources. The objective of this study was to establish the cost and cost-effectiveness of electronic discharge communications compared with traditional discharge systems for individuals who have completed care with one provider and are transitioning care to a new provider by reviewing the economic and health economic literature.

METHODS

A prespecified review protocol was developed and followed for all methods (LKS, RE, KT, DLL, PR, MJ and FC). Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) reporting guidelines were used.⁵

Search strategy

MEDLINE, Embase (Excerpta Medica Database), EconLit, PubMed, National Health Services Economic Evaluation Database and Web of Science were searched from database inception until October 2015. A detailed search strategy was developed by a Master of Library and Information Science librarian. For all databases, terms/keywords were combined from the following three themes: (1) economic; (2) discharge and (3) electronic/computerised. Medical subject headings (MeSH) terms used included: medical economics, hospital economics, Markov chains, patient discharge, patient discharge summaries and electronics. The initial search strategy was developed for use in MEDLINE and then adapted for the other databases. No limitations on year, language or human populations were used. Hand searching reference lists of studies included was also conducted. Full details are available in appendix 1.

Study selection

Titles and abstracts were reviewed independently by two investigators (LS and RE). The reviewers were not

blinded to the study journal or authors. This initial screen was broad, and citations were excluded if they were not an economic evaluation or cost-analysis, did not use a discharge intervention or used a non-electronic intervention. Electronic communications were defined as being at least one of the following three statements: automatic population of a discharge document by computer database(s) (apps included), transmission of discharge information via computer technology or computer technology providing a 'platform' for dynamic discharge communications.⁴ Discharge was defined as *completion* of care with one provider and transitioning care to another provider, in order to differentiate discharge from referrals to medical specialists. No further restrictions on population, comparison and economic study design were used. Titles/abstracts identified by either reviewer were included in the full-text review. Agreement among reviewers was quantified using the kappa (κ) statistic.

Full-text articles were retrieved and reviewed in duplicate by the same two investigators (LS and RE). Articles were excluded if they were published in abstract form only, not an economic evaluation or cost analysis, the intervention was not discharge related, the intervention was not a summary tool or if the intervention was not electronic. The same definitions of discharge and electronic communications used in the abstract review were also used during the full-text review. No further restrictions on population, comparison and economic study design were used. Agreement (κ statistic) was also calculated at this stage.

Data extraction and analysis

The primary outcomes of interest were cost-effectiveness, cost-utility, cost-benefit, and costs. Specifically, outcomes of interest from the cost-effectiveness studies included cost per readmission avoided and cost per life saved. The outcome of interest from the cost-utility analysis was cost per quality adjusted life year.

Data were extracted in duplicate by two investigators (LS and RE). This included: year, population, outcomes, intervention, comparator, model details (time horizon, discount rate and currency) and results (net present value, incremental cost-effectiveness ratio, costs and so on). All differences in data extraction were resolved through review of source documents.

Study quality and risk of bias was assessed using the Consensus Health Economic Criteria (CHEC) list, a checklist that can be used to critically appraise published economic evaluations.⁶ This 19-point checklist includes reporting standards for economic model characteristics (population, time horizon, perspective, discount rate and so on), identification and valuation of costs and outcomes, discussion points, conclusions as well as funding and conflicts of interest. The CHEC list was completed in duplicate (LS and RE) with differences resolved through consensus and review of source documents.

A component-based analysis was used to describe and synthesise the included studies. Specifically, tabulation

methods were used to report on study characteristics, outcomes and costs.

Patient involvement

No patients were involved in the design or conduct of this study, nor were they involved in analysis of the results. There are no plans to involve patients in the dissemination of this research.

RESULTS

The literature search identified 1000 unique citations. Of these, 943 abstracts were excluded when both reviewers agreed that they were not relevant to the systematic review, 57 full-text articles were assessed for inclusion. Four unique articles met final inclusion criteria ($\kappa=1.000$). The reference lists of the four identified articles were hand searched. An additional three articles were identified; all were excluded (figure 1).

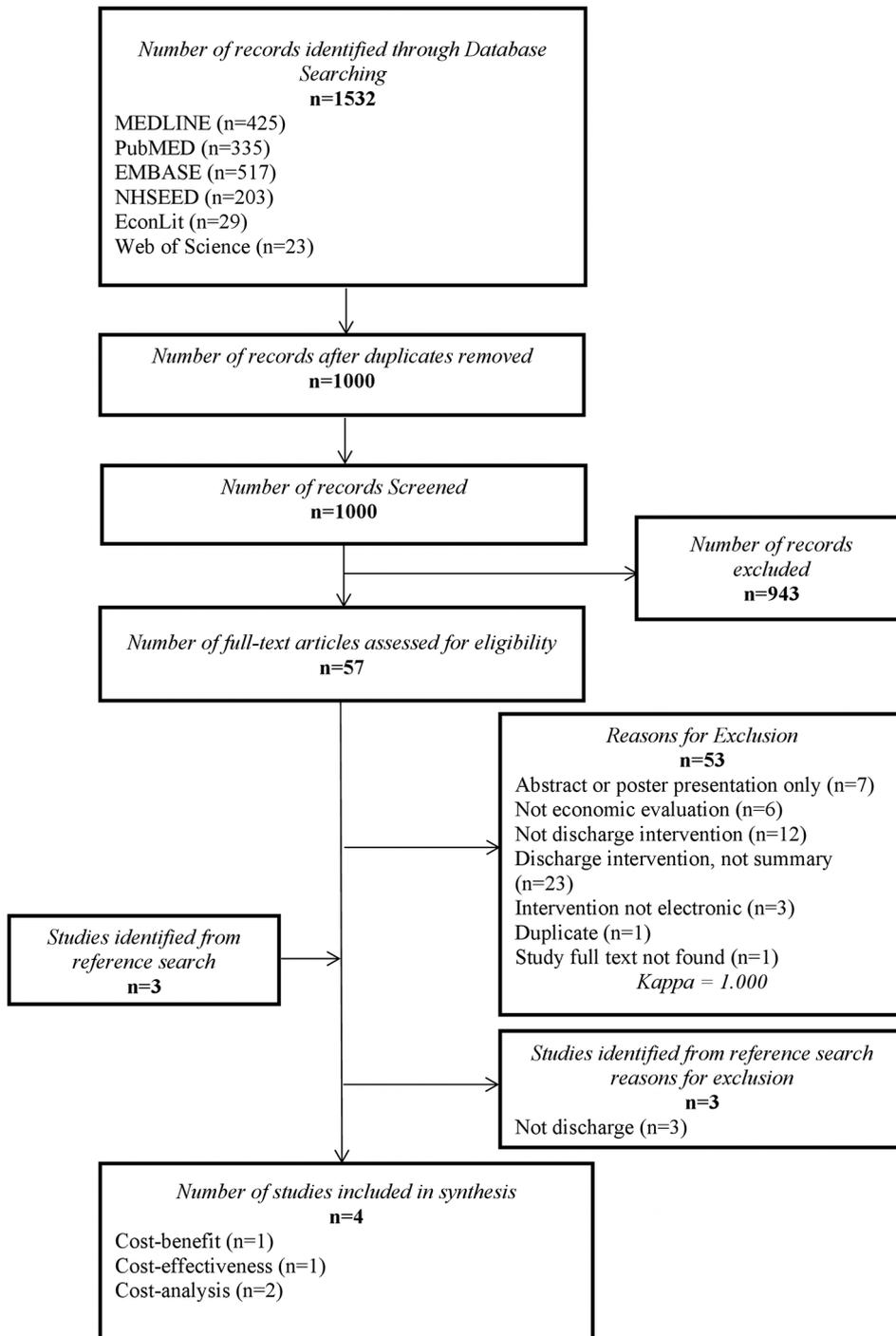


Figure 1 Summary of study inclusion

Table 1 Characteristics of included studies by year

Study: authors (year)	Country	Methodological approach	Population	Intervention	Comparator	CHEC* score
Kopach <i>et al</i> (2005) ⁷	Canada	Cost-effectiveness	Automation of medical documentation for entire hospital discharge	Speech recognition technology—signatures generated electronically, final documents sent through email or e-fax	Dictation through telephone used to create voice file to be transcribed—paper based signatures and traditional mailing	18
Colsman <i>et al</i> (2009) ⁸	Germany	Cost-analysis	Dermatology department including four physicians and three typists	Electronic medical record system combining laboratory, experimental findings, nursing performance indicators—separate text editor used for writing discharge letters	Typists used to create discharge document	10
Aanesen <i>et al</i> (2010) ⁹	Norway	Cost-benefit	10 hospital departments and nine primary care physicians	Discharge summary created electronically and sent electronically	Paper-based discharge	12
Mourad <i>et al</i> (2011) ¹⁰	USA	Cost-analysis	600 bed quaternary care academic institution	NoteWriter with both free-text and autopopulated fields. Separate software tracks signatures and automatically triggers dissemination	Orally dictated discharge notes	7

*Consensus Health Economic Criteria list.

Included studies

In total, one cost-benefit, one cost-effectiveness and two cost-analysis studies were identified.⁷⁻¹⁰ All four studies were conducted in different countries with publication dates ranging from 2005 to 2011. Direct translation from German to English was used for one article.⁸ All four studies focused on the transition from hospital to community care, with one study specifying intervention use in a dermatology department.⁷⁻¹⁰ One study focused on a dictation tool, which generated signatures electronically and used electronic dissemination,⁷ two studies generated electronic discharge letters through autopopulation by medical records^{8,10} and one used an electronic platform.⁹ Table 1 provides a summary of study characteristics.

Study quality

Only one study was of good quality with a score of 18 out of 19.⁷ The other three studies were of low quality, with scores ranging from 7 to 12 out of 19 (appendix 2). All of the clearly described the study population and competing alternatives, while also having a well-defined research question. However, only one of the studies reported standard economic analysis components in a consistent manner.⁷ None of the studies appropriately discussed ethical and distributional issues as they relate to the study population. Furthermore, possibly due to the nature of their study design, the two cost analyses did not report a time horizon or a discount rate. In the results section,

only one study fully described their study parameters and completed a sensitivity analysis.⁷

Primary objectives and outcomes

All of the included studies varied in their primary objective (table 2). Kopach *et al* focused on the cost-effectiveness of dictation,⁷ Colsman *et al* focused on time savings due to autopopulation,⁸ Aanesen *et al* looked at decreased value of a system due to late adoption⁹ and Mourad *et al* presented a business case for the implementation of electronic discharge communications.¹⁰

All studies also varied greatly in their reported primary outcome (table 2). Kopach *et al* was the only study to report a cost-effectiveness ratio.⁷ Specifically, authors noted that spending an additional \$0.331 per discharge decreased the average note completion time by 1 day.⁷ The other three studies reported costs per discharge page for the intervention and the comparator,⁸ dynamic net present value (used to determine optimal investment policy¹¹) of the intervention⁹ and costs associated with the comparator.¹⁰ Two studies acknowledged that electronic discharge would be more costly compared with traditional dictation,^{7,8} and might not be beneficial to all users.⁸ Moreover, one study showed that the cost per page per discharge letter was cheaper using the intervention (€9.51 compared with €10.71 using the control).⁸ The study by Aanesen *et al* showed that 5-year adoption had a dynamic net present value of €31.1 million, which was greater than 10-year implementation that had a dynamic

Table 2 Conclusions and findings of included studies by year

	Primary objective	Primary outcome	Conclusions
Kopach <i>et al</i> (2005) ⁷	Compare the automation of medical discharge notes for in-patients to a current medical documentation system and determine if it is cost-effective.	Incremental cost-effectiveness ratio of \$0.331 (in 2003 \$C)	Automated documentation system costs more but reduces document completion time. Spending an additional \$0.331 per discharge, average time of note completion decreased by 1 day.
Colsman <i>et al</i> (2009) ⁸	Determine the extent to which a hospital information system for patient data supports the creation of a discharge report	Total cost per page per discharge letter in the comparator is €10.71. Total cost per page per letter in the intervention is €9.51.	Creation of discharge letter in an isolated text editor is advantageous for typists but not for physicians. To be beneficial for clinicians, it is necessary to improve user experience and expand imports of medical data.
Aanesen <i>et al</i> (2010) ⁹	Examine the consequences of maintaining an old working procedure when a new technology has been implemented	Dynamic net present value (DNPV) for 5-year implementation of electronic message exchange in hospitals and primary care units is €31.1 million. DNPV for 10-year implementation is €24.6 million.	Greater DNPV for faster implementation of electronic discharge tools
Mourad <i>et al</i> (2011) ¹⁰	Present the business case for the implementation of an electronic discharge summary	Yearly costs of discharge using current system is \$496 400. Cost of a 14-day delay in billing is \$107 000–\$215 000.	Investing in e-discharge has real-time benefits in the impact on patients, system improvements, qualitative benefits and return on investment

net present value of €24.6 million.⁹ Finally, the business case reported that the yearly cost of discharge using their current system was \$496 400.¹⁰

Costs reported

A list of relevant costs to consider when adopting electronic discharge communications was determined through variables identified in the literature (table 3).^{7–10} Only the study by Kopach *et al* reported on the costs of the intervention and the comparator.⁷ The other three studies either reported time savings ratios,^{8,9} or only considered the potential costs savings by reporting the expenses associated with traditional paper-based discharge.¹⁰ None of the studies considered all infrastructure, personnel and system maintenance costs. Specifically, none of the studies reported costs of network connectivity, server capacity, interface with current records systems, physician training and computer and network maintenance.

DISCUSSION

In summary, this review identified four studies.^{7–10} The component-based analysis indicated that these studies varied with respect to economic analysis methodologies, primary objectives, primary outcomes and costs reported. Three of the studies were considered to be of low quality using the CHEC list.

To our knowledge, this is the first systematic review conducted to examine the state of the evidence on the costs and cost-effectiveness of electronic discharge communications. The only previously published systematic review on the efficacy of electronic discharge tools

identified that there is support for the implementation of computer-based discharge tools.⁴ The authors of this review stated that it was uncertain if widespread implementation of these tools would be beneficial without the consideration of efficacy, local context, stakeholder input, patient outcomes and cost-effectiveness.⁴ The findings of our work demonstrate that the cost-effectiveness is not often reported and, when it is reported, with many important aspects of costs excluded. This would lead to duplication of effort as individual organisations would be required to develop their own business cases with no readily available template or comparator.

Some studies did report attractive economic findings, particularly as they relate to faster implementation and decreases in time delays. However, the primary outcomes reported make it difficult to compare across tools and to justify the expenditure required for these tools in the greater healthcare system context. All of the studies also used differing levels of electronic input (dissemination, autopopulation and platform) and are not representative of all electronic discharge systems. Future studies should consider presenting the costs of the intervention in a disaggregated format such that different centres will be able to select costs depending on their current systems and required development process.

Three of the four studies focused on some measure of time savings with respect to the cost analysis.^{7–9} None of the studies measured meaningful health-related patient or quality outcomes including: patient satisfaction, physician satisfaction, readmission rates or mortality associated with the implementation of electronic discharge.

**Table 3** Summary of costs reported for included studies

	Kopach <i>et al</i>⁷		Colsmann <i>et al</i>⁸		Aanesen <i>et al</i>⁹		Mourad <i>et al</i>¹⁰	
	Intervention	Control	Intervention	Control	Intervention	Control	Intervention	Control
Infrastructure	+	N/A						
Software/licencing	+	N/A						
Hardware	+	N/A						
Network connectivity								
Server capacity for backup system								
Interface with current electronic medical records								
Personnel								
Physician champion								
Physician training								
Computer programmer								
Transcription	+	+	+	+				+
Deficiency tracking								
Notification	N/A	+						
Postage/dissemination	+	+						
Maintenance	+	+						
Computer/printer maintenance								
Network maintenance								
Software add-ons and updates								
Time savings	+	+	+	+	+	+		
Time delays						+	+	+

+, included in paper.

N/A, not applicable.

Furthermore, the studies did not measure patient safety outcomes such as the avoidance of adverse events, which could potentially decrease with the implementation of these tools. Notably, only one study identified as a cost-effectiveness study, which in healthcare typically provide a cost per clinical benefit. Because this study did not measure meaningful clinical outcomes, it is difficult to ascertain the true cost-effectiveness of electronic discharge tools. This is particularly concerning for publicly funded healthcare systems that must make tradeoffs in order to work within a constrained health budget. Moreover, studies that measure clinically meaningful outcomes such as the cost per adverse event avoided or cost per readmission avoided could present a stronger case for tool adoption. Outcomes like the cost per decrease in time delay may not be readily understood by decision makers and may not be comparable across eHealth tools and healthcare sectors. Future cost-effectiveness studies should ultimately include hard clinical endpoints such as mortality and readmissions. Available reporting guidelines should be followed to improve overall quality.

Besides time savings, most of the studies reported on the costs of transcription.^{7 8 10} However, none of the

studies reported on critical costs surrounding network connectivity, server capacity, interface with current medical records, physician training, computer programmers, computer and network maintenance and software updates. All of these costs are essential infrastructure, personnel and maintenance costs, which must be considered in order to ensure the success of implementation and continued use of electronic discharge communication tools. Future studies in this area should focus on addressing all relevant costs while using patient safety and quality outcome measures.

Our understanding of the cost-effectiveness of electronic discharge communication tools is limited by the literature available. Importantly, we suspect many of the large healthcare systems who have adopted electronic discharge communication tools have developed business cases, yet due to the proprietary nature, this important information is unlikely to be publicly available.

The timeliness of the interventions also limits the relevance of the published work. The most recent study (Mourad *et al*) was published in 2011, which is already 4 years old.¹⁰ For the information technology industry, this is a significant period of time over which technologies

can change. In fact, Kopach *et al* in 2005 identified that their system would be irrelevant in 3 years due to ever-changing technology.⁷ This may also be a deterrent for future studies, given that researchers will have to rapidly complete and publish their appraisals, in order for an evidence-informed adoption decision to be made. Healthcare systems should be encouraged to rapidly publish their business cases in order to enable other systems to make evidence-informed decisions about their electronic tool adoption.

Another factor that may be impacting the literature available is the large amount of data and infrastructure required for these tools. For instance, tools that are autopopulated by external data sources such as pharmaceutical and diagnostic platforms require extensive hardware, interface systems, maintenance and updates. Systems that have already implemented components of this eHealth infrastructure may be too invested to change their adoption decisions based on the results on a health economic study. This makes a case for pilot studies in systems with modest adoption. These systems would be able to assess eHealth tools, while also taking the results into consideration during their full adoption decision. However, within this context, timeliness will also be a major hurdle.

The outcomes measured in the studies were all different, and studies were of low to moderate quality. This makes it challenging to generalise the results of these studies to other settings or contexts. A component-based analysis and tabular format were used in an attempt to synthesise results and findings from the included studies. Lastly, it is possible that studies may have been missed in the search strategy; however, this is unlikely as we followed standardised systematic review protocols and consulted with a librarian.

CONCLUSIONS

Despite the focus of implementing electronic discharge communication tools in healthcare systems, there is a limited amount of information on their cost-effectiveness, and the cost-effectiveness of electronic discharge communication tools cannot be drawn from this review. Future work in this area should focus on conducting research to collect the evidence to support the cost-effectiveness of electronic discharge tools. For decision makers and policy makers that are planning on acquiring electronic discharge communication and tools, cost must be a factor in evaluating which electronic discharge tools to adopt. This becomes even more important during challenging fiscal constraints that healthcare systems continue to face.

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Contributors Design of the study (LKS, RE, KT, DLL, PR, MJ and FC); collection of data (LKS and RE); management of data (LKS and RE); analysis of data (LKS, RE and FC); interpretation of the data (LKS, RE, KT and FC); preparation of manuscript (LKS, RE, KT and FC); review of manuscript (LKS, RE, KT, PR, MJ, MS, WAG and FC); approval of manuscript (LKS, RE, KT, PR, MJ, MS, WAG and FC).

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Data sharing statement This systematic review did not include any primary research, and there is no additional unpublished data associated with this study. All data are publicly available in published literature, cited within the main document. A full search strategy is attached in the supplemental file.

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