Evidence for Busines Intelligence in Health Care: A Literature Review

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Abstract. This paper outlines a systematic literature review undertaken to establish current evidence regarding the impact of Business Intelligence (BI) on health system decision making and organizational performance. The review also examined BI implementation factors contributing to these constructs. Following the systematic review, inductive content analysis was used to categorize themes within the eight articles identified. This study demonstrated there is little evidence based literature focused on BI impact on organizational decision making and performance within health care. There was evidence found that BI does improve decision making. Implementation success was found to be dependent on several factors, many of which relate to broader organizational culture and readiness.

Keywords. Business intelligence, health, decision making, analytics, outcomes

1. Introduction

Clinical information systems are improving healthcare delivery through legible documentation, improved information sharing, and alerts among other benefits[1]. In addition, access to real-time information from these systems can enable front line managers to make informed decisions to drive system improvements. This concept, referred to as Business Intelligence (BI) can be defined as *the use of specialized tools to collect, analyze, and present organizational data to operational leaders in user-friendly format(s) to support organizational objectives*. BI is an emerging focus within the health sector but has become an established management practice in other sectors such as business, manufacturing, and finance where BI is viewed as a key component of strategic and operational decision making[2,3].

In all sectors, being rich in organizational data does not correlate directly to good information and, despite best intentions, "the problem is that most companies are not succeeding in turning data into knowledge and then results"[4, p. 118]. While there are few empirical studies examining the impact of BI in the health sector, there are numerous articles identifying the anticipated benefits of BI reinforcing the need for study in this area[5]. Expected benefits include: easier access to data[6-8]; time savings[7]; improved decision making[6]; improved outcomes[7]; and improved financial performance[9].

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2. Review Objectives

This systematic literature review was undertaken to establish the evidence demonstrating the impact of BI on decision making and organizational performance and to identify success factors for BI implementation in the health care sector. The review focused on the following questions: 1) What evidence exists that use of BI improves nurse or other health system manager decision making in health care? 2) What evidence exists that use of BI improves organizational performance in health care? 3) What are implementation success factors for BI in health care?

3. Methodology

The PRISMA methodology was used to guide the selection of articles and to structure both the screening and qualitative/quantitative assessment of included papers[10,11]. Search terms included: health care *or* medicine; BI *or* business analytics *or* big data; decision making – manager *or* nurse manager; organizational performance *or* outcomes; and implementation success factors. Databases were selected in consultation with subject matter experts to identify those common to the health sector, business and informatics and searches were conducted in July 2015.

Inclusion criteria were intentionally broad and included: English text; publication year>=2000 to reflect mature underlying health information systems; evidence based or existing systematic review; and, health system management related. Exclusion criteria were: clinical decision support (tools for individual patient care decisions); general decision making that did not reference or consider the underlying information systems; secondary or retrospective analysis; and articles without a research basis. Of the latter, numerous articles indicated a case study methodology however these were excluded where formal methods or controls for bias were not described. In total, 10 databases and search engines were included (See Table 1).

Table 1. Databases and search engines.

Database	Number of Results Returned
CINAHL with full text EBSCO	391
Medline with full text EBSCO	962
PubMed	265
Business Source Complete EBSCO	70
Web of Science Core Collection	577
IEEE Xplore Digital Library	407
Science Direct	139
Health Technology Assessments EBSCO	14
ACM Digital Library	12
Total	**2,837**

3.1. Screening and Quality Assessment

Searches were imported into EndNote[TM] reference management software and databases were merged and duplicates (n=547) were removed resulting in 2,290 unique articles. Articles were screened by title and abstract by one author (LL) and the remaining 342 articles were reviewed in detail along with an additional 36 identified through hand searching. Reviews were then validated with the second author (AR) with final determination based on consensus between the reviewers.

3.2. Data Analysis

Included articles were reviewed for quality and underlying bias and then analyzed using qualitative inductive content analysis[12]. Findings were marked manually and then transcribed into a graphical format using brainstorming features of Visio. The quantitative results were descriptive and, for the most part, not directly attributed to the presence of BI thus, the analysis focused on general themes and did not differentiate between anticipated versus actual impacts.

4. Results

Following screening, eight articles met the inclusion criteria (see Figure 1). The articles were predominantly descriptive with subjects reporting anticipated versus actual benefits with BI systems.
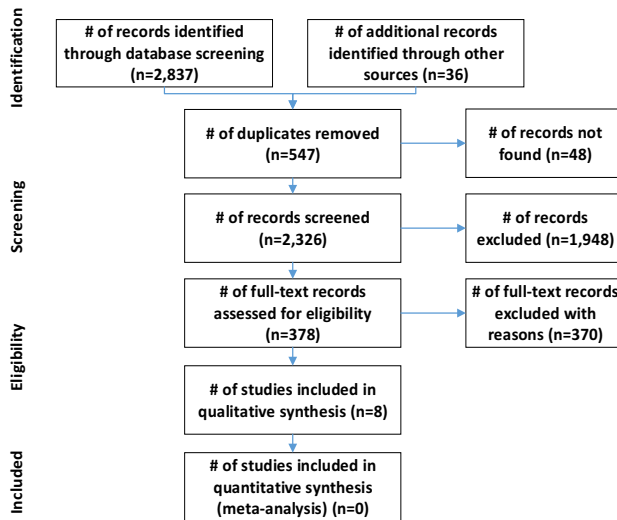
Identification

# of records identified through database screening (n=2,837)

# of additional records identified through other sources (n=36)

# of duplicates removed (n=547)

# of records not found (n=48)

Screening

# of records screened (n=2,326)

# of records excluded (n=1,948)

Eligibility

# of full-text records assessed for eligibility (n=378)

# of full-text records excluded with reasons (n=370)

# of studies included in qualitative synthesis (n=8)

Included

# of studies included in quantitative synthesis (meta-analysis) (n=0)

Figure 1. Search summary

Of the eight articles, seven directly examined health sector findings while one included health sector respondents among other service industries. Methods were predominantly qualitative and included: descriptive survey (n=1)[17], framework development methodology supported by case study (n=1)[18], mixed methods (n=2)[15,14], case study (n=3)[13,16,19], and systematic literature review (n=1)[20]. Four were published in 2014, and one in each of 2003, 2008, 2011 and 2015. Journals included: Communications of the Association for Information Systems; CIN: Computers, Informatics, Nursing; Journal of Ambulatory Care Management; Journal of Nursing Management; Journal of Oncology Practice; International Journal of Information Management (n=2); and International Journal of Accounting Information Systems.

Qualitative analysis of themes that presented in the articles resulted in six high level groupings: information needs/system indicators; information system quality; demonstrated/anticipated benefits; barriers to getting/using information; decision making impacts; and factors impacting BI adoption. While not all articles were

reflected in each of the theme groupings, each grouping contained concepts from at least four of the articles. Findings specific to each research question are summarized below (see Table 2).

Table 2. Summary of findings

Question	Findings
Evidence that use of BI improves manager decision making?	Manager reported improvements in decision making, economic awareness, ability to explain variances[14]
	Anticipated improvements if BI available: increased confidence in decisions, less subjective, more timely[13]
Evidence exists that use of BI improves organizational performance in health care?	Improved internal business processes (efficiency, customer intelligence) and ability to realize organizational objectives (enhanced profits, improved inventory turnover, partner relations) in all sectors although weaker in service sectors[15]
	Perception that organizational objectives such as length of stay were not being managed as effectively as they could be impacting quality of care and cost[13]
	Unit level improvements included reduced overtime and extra staffing hours (as compared with control units); managers reported better understanding of interrelated factors such as patient acuity, staffing and cost of care[14]
	Decreased morbidity and mortality, shorter wait times and length of stay and decreased cost[16]
Implementation success factors for BI in health care? *(often identified as gaps to address)*	Organizational: lack of skilled analytics resources[13,17,18]; leverage drivers such as external compliance or reporting mandates[17]; strong organizational vision[18]; address organizational silos[17]; and, address underlying care coordination factors[14,19]
	Technical: integration across multiple platforms[17,18]; and, need for a strong underlying technology platform[13,18]
	Data: underlying data quality and semantic interoperability systems[13,16,18]
	End user adoption: strong perceived usefulness and ease of use[14,19,20]; presentation of data that is meaningful and can be changed/controlled by end users[14,19,20]; and, ability to address fear of measurement and transparent reporting[14,19,20]

4.1. Discussion

The articles found through this search, while limited, do provide evidence for the research questions posed. The articles as a group suggest there is evidence that BI, when available to health system leaders and managers, would be used to inform decision making resulting in improved organizational performance. Given the prospective approach of several of the articles, it is worth noting the observation in Foshay and Kuziemsky[13] that there is a risk that managers may lack the skills to use the data for decision making even if it was available to them. The limited number of empirical articles found in this search on health sector BI is, in part, because the BI field itself is an emerging area[5].

4.2. Limitations

While the search terms were intentionally broad, it is still possible that articles were missed due to the emerging nature of work in this field and the potential that published research may be using alternative subject key words. The primary reviewer worked independently on the original reviews and may have missed key articles however, this is mitigated somewhat through the inclusion of new articles found through hand search and reference review.

5. Conclusion

These findings reinforce the need for research looking at BI impacts in the health care sector given the unique nature of health service delivery and its complex supporting organizational structures. The articles lend compelling arguments for the potential for BI to add value to health system manager practice. They also reinforce the need for research approaches that extend beyond implementation and user acceptance to look at organizational factors and the realization of organizational performance improvements.

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