

Health Informatics in Developing Countries: Systematic Review of Reviews

Contribution of the IMIA Working Group Health Informatics for Development

D. Luna¹, C. Otero², A. Marcelo³

¹ IMIA Health Informatics for Development Working Group Chair, and Chair of Health Informatics Department, Hospital Italiano de Buenos Aires, Argentina

² Oregon Health and Science University, USA, and Hospital Italiano de Buenos Aires, Argentina

³ IMIA Health Informatics for Development Working Group Co-Chair, National Telehealth Center, University of the Philippines Manila, Philippines

Summary

Objectives: An evidence-base is important for medicine and health informatics. Despite numerous publications showing the benefits of health informatics, the emergence of health information systems in developing countries has been slower than expected. The aim of this paper is to identify systematic reviews on the domain of health informatics in developing countries, and classify the different types of applications covered.

Methods: A systematic review of reviews was conducted. The literature search spanned the time period between 2000 and 2012 and included PubMed, EMBASE, CINAHL, Scopus, Cochrane Systematic Reviews, LILACS, and Google Scholar. The search term was 'systematic reviews of health informatics in developing countries', and transparent and systematic procedures were applied to limit bias at all stages.

Results: Of the 982 identified articles, only 10 met the inclusion criteria and one more article was added in a second manual search, resulting in a total of 11 systematic reviews for the analysis.

Conclusions: Although it was difficult to find high quality resources on the selected domain, the best evidence available allowed us to generate this report and create an incipient review of the state of the art in health informatics in the developing countries. More studies will be needed to optimize the results.

Keywords

Medical Informatics, developing countries, evidence-based medicine

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Introduction

Health informatics applications are intended to support healthcare providers and organizations in delivering the best care to patients. Their introduction can radically affect health care organization, service delivery and outcome. The use of modern information and communication technology (ICT) offers tremendous opportunities to support health care professionals and to increase the efficiency, effectiveness and appropriateness of healthcare [1]. ICT also has the potential to decrease unintended variation in practice and occurrence of medical errors [2].

Sacket defines Evidence-based Medicine as the 'conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patients' [3]. The term Evidence-Based Health Informatics (EBHI) was introduced subsequently [4], and was an adaptation of Sacket's original definition to health informatics. EBHI can be understood as the conscientious, explicit, and judicious use of current best evidence about introduction and operation of Information Technology (IT) into a given health care setting [1]. Also, it has been argued that this approach provides better support for information systems applied to healthcare [5].

The benefits of health information technology have been sufficiently demonstrated in first world countries where numerous public and private programs that encourage the development and diffusion of health informatics have been carried out. Devel-

oping countries on the other hand have had less success with the penetration of health informatics [6, 7]. The purpose of this review is to assess the state of the art health informatics in developing countries through a systematic review of reviews. While there is a large number of non-systematic narrative reviews in health IT, there are fewer systematic reviews and even less meta-analyses on this topic [8].

Objective

The aim of this work is to perform a systematic review to summarize the evidence on the state of health informatics in developing countries. This review also investigates what types of applications were covered in these papers and what factors contributed to their success or failures.

Methods

The authors performed a systematic review on health informatics in developing countries, and evaluated both quantitative and qualitative researches.

Data Source

Searches were performed for publication dates ranging from 2000 to 2012, from data sources such as PubMed, EMBASE, CINAHL, Scopus, Cochrane Systematic

Reviews, Latin American and Caribbean Health Science Literature Database (LILACS), and Google Scholar. Some additional relevant studies were identified in a second stage from related citations in articles evaluated in the first selection.

Review Selection

Two reviewers (DL, CO) independently examined titles and abstracts. Relevant review articles were obtained in full text, and assessed against the inclusion criteria. Inter-reviewers agreement on inclusion as assessed using kappa statistics and any disagreements were resolved through discussion.

Inclusion and Exclusion Criteria

Due to the importance to work with quality reviews, a paper was qualified to be included in this revision if it was made with an explicit and systematic question and if the search strategy was clearly explained. All languages were included but only papers pertaining to developing countries were analyzed. Duplicate references were excluded.

Data Analysis

Papers were analyzed according to the principal aim of the review. Categories were defined when saturation was reached. Publications were classified according to the following criteria related to the saturation effect in the review's analysis:

- Storage, retrieval, and data transmission / IT implementations
- Clinical decision making / Support systems / Disease management
- Remote Care / Telemedicine
- Mobile health (mHealth)

Search Strategy

A first stage included PubMed, EMBASE, CINAHL, Scopus, Cochrane Systematic Reviews and LILACS databases, as well as Google Scholar. The search was limited to systematic reviews in health informatics in developing countries from 2000 to 2012,

Table 1 Source databases and the corresponding query search used

Source Databases	Query Search	Limits
PubMed	"developing countries"[MeSH Terms] AND "medical informatics"[MeSH Terms]	Date From 2000/01/01 to 2012/12/31
EMBASE	'developing country'/exp AND 'medical informatics'/exp	Date From 2000/01/01 to 2012/12/31
CINAHL	(MH "Informatics") AND (MH "Developing Countries")	Date From 2000 to 2012
Scopus	(KEY(developing countries) AND KEY(medical informatics)) AND DOCTYPE(ar OR re	Date From 2000 to 2012
Cochrane Systematic Reviews	"developing countries" AND informatics	
LILACS	Query: mh:("Medical Informatics") AND db:("LILACS") AND fulltext:("1")	Date From 2000 to 2012
Google Scholar	allintitle: developing countries review „medical informatics“ OR "information technology" OR "information system" OR ehealth OR medical OR health OR mhealth OR mobile OR computer OR telemedicine OR ICT	Date From 2000 to 2012

taking into account the characteristics of the search engine for each source. In a second stage a new search was performed using the reference lists cited by the articles of the first set, and further searches using related articles functionality. The different search strategies used are specified in Table 1.

Results

The search yielded a total of 980 publications, 85 were removed because of duplication, and 875 were excluded for not meeting the inclusion criteria (Fig. 1). In a deep full text analysis of the 20 reviews selected in the first stage, 10 papers were excluded because they weren't systematic reviews (but since they included interesting data and taking into account the few quality resources available, the authors decided to comment the highlights of these articles in the discussion section). In a second stage, using the reference lists included in the first set of articles, further searches were made and one relevant publication was added, giving a total of 11 reviews to consider.

The inter-rater reliability (Kappa) for applying review selection criteria was 0.71 (95%CI: 0.61 to 0.80).

Review Characteristics

This section describes the relevant topics of each review (see Table 2 for the characteristics and classification criteria of the 11 reviews evaluated).

Five papers were related to the category storage, retrieval, and data transmission/IT implementation. In the last topic, Tomasi et al [9] evaluated 52 articles, in their review concluding in first instance, the difficulty to find quality studies in this domain. Authors recognized the publication bias that could exist when working with developing countries and highlighted the low adherence to health IT in primary care setting, even when physicians recognized the usefulness of computerized systems in primary health care, especially for promoting greater efficiency in management processes. In the same way Williams et al [10] recognized some limitations such as lack of human expertise and financial resources and challenges with the technical infrastructure. Blayas' review [11] concurs in the sense that developing countries are ripe for health IT implementation. Millard et al. [12] studied open-source point-of-care Electronic Medical Records (EMRs) for use in resource-limited settings without reliable internet access. Among the six open-source

EMRs that they found, none met the minimum requirements for a fully functioning EMR suitable for use in resource-limited settings. The authors recommended the necessity of an international body directly testing these products to determine their clinical functionalities and limitations. Concerning access to information of health care workers, Pakenham-Walsh et al. [13] found that information needs are varied and are constantly under the influence of multiple factors (professional, institutional, cultural and infrastructural).

Three reviews were focused on topics related to the category disease management and clinical decision support systems (CDSSs). The first one was related to diabetes [14] and found positive results in the patient's prognosis. The second one was related to HIV [15] and highlighted the effectiveness of IT in health care, but admitted that the system was not prepared for a whole implementation. The last review, focused on Africa, introduced another complexity in this setting: the difficulties of the environment such as electricity access and technical support.

Telemedicine is one of the biggest challenge in developing countries, and maybe, the most diffused topic in health informatics as there are few quality studies in this issue. Two reviews were found, one from Wootton et al. [16] and one from Rey

Moreno et al. [17]. Wootton concluded that telemedicine is still at a very early stage. There are very few publications in the peer-reviewed literature and most of them are in the nature of review articles or editorials. For Wootton, telemedicine will not help directly with infrastructure problems such as the provision of sanitation or drinking water. However, it may help indirectly, by improving the organization of health-care. Also comments that faults of telemedicine occurring in the industrialized world are occurring in telemedicine projects in developing countries. Such faults include: excessive expectations; unsustainable funding models; lack of trials and evaluation data; lack of published results and sharing of expertise. Rey Moreno agree with Wootton on the poor quality of papers, and that although many projects in Colombia (his setting for the review) seem to have had a positive effect, none of them had been rigorously evaluated, and therefore in the absence of scientific evidence no general recommendations can be made.

The last category analyzed for this review is the more recent topic discussed in health informatics: mobile health or mHealth. Two articles agree that new mobile technologies could show benefits in controlled settings like special diseases (chronic diseases for example) or specific populations, but there is a dearth of quality papers on this topic

and even less where clinical outcomes have been shown. Also, compared with the spread of mobile phones and personal devices, the development of mobile health applications has not been as high as expected [18, 19].

Evidence Synthesis

In summary, all the reviews agree that the papers evaluated are generally of poor quality. Even though the benefits of health informatics have been published and demonstrated in the literature among developed countries, developing countries have not exhibited the same behavior. Thus, authors agree on the publication bias of their review, considering the difficulty to publish, and the limited access to a peer review process for the medical informatics research teams of these countries. Even so, authors agree that the field is fertile, and the perception of health care workers is in favor of the computerization process. More quality researches are needed.

Discussion

Limitations: Some limitations inherent to the methodology of this systematic review need to be addressed. An important limitation is linked to the choice of key words and search strings. The concept of Medical Informatics covers a broad spectrum: the choice of MESH terms was difficult across all databases.

By incorporating developing countries as a descriptor in our inclusion criteria, some reviews that are more general in scope and have not been indexed with this term could have been lost. In the same way the use of Mesh Terms in our search strategy in PubMed could have omitted papers indexed differently. The authors felt this could be compensated with a search on Google Scholar.

The authors chose to be more restrictive in the Google Scholar search strategy in order to optimize results. The search strategy used keywords in the title for the purpose of improving the specificity of the search strategy.

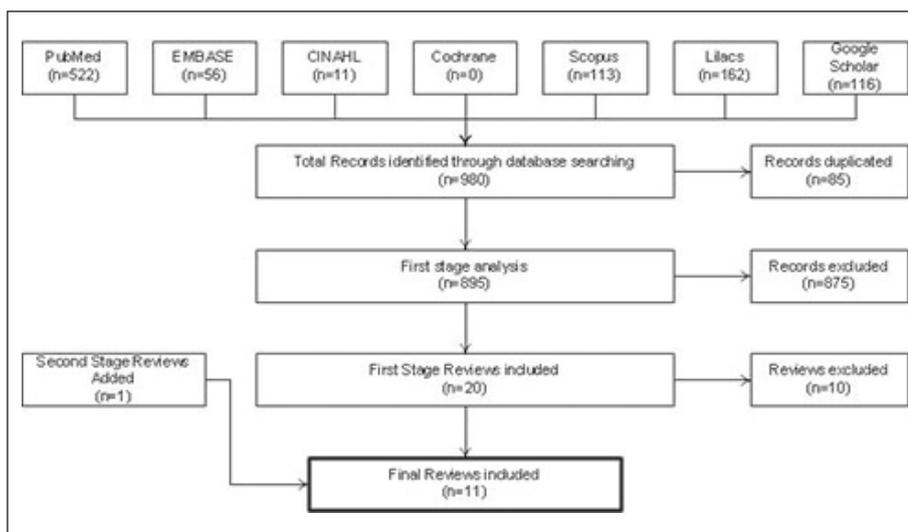


Fig. 1 Flow diagram of study selection

Table 2 Characteristics of the reviews evaluated

Topic	Author	Aim	Sources	Art.	Period covered	Key findings
Storage, retrieval, and data transmission / IT implementations	Tomasi et al. [9]	Explore the debate and initiatives concerning the use of IT in primary health care in developing countries.	Medline, Lilacs, Cochrane, Web of Science, EMBASE	52	1992-2002	There is a consensus concerning usefulness of computerized systems in primary health care, especially for promoting greater efficiency in management processes. In the consideration of CDSS, emphasis has been placed on quality and safety concerns.
	Williams et al. [10]	Examine Electronic Medical Record benefits to the patients, physicians and other care providers as well as its ultimate contribution to development of healthcare delivery in developing countries.	Medline, CINAHL, COMPENDEX, Academic Search Premier	23	Until 2007	In spite of challenges facing the developing world such as lack of human expertise and financial resource, most studies have shown feasibility to design and implement HIS into this environment.
	Blaya et al. [11]	Review evaluations performed on e-health systems in developing countries, assess their potential impact, and guide future implementations and evaluations.	Medline, EMBASE, Science Citation Index, Social Sciences Citation Index, the Cochrane Library, LILACS	45	Until 2009	Even when there are no quality studies, papers show positive effect evidence on e-health systems. This context could improve with the development of implementation plans and guidelines.
	Millard et al. [12]	Address the needs of clinicians from resource-limited settings without reliable internet access who are considering adopting an open-source Electronic Medical Record.	Medline, CINAHL, Google Scholar	19	1995-2010	Review of HCE, scope, pros and cons. Found positive evidence for the control of specific diseases, but limited for more widespread set.
	Pakenham-Walsh et al. [13]	Information and learning needs of health care providers in developing countries.	Medline	149	1996-2006	Developments which improves the availability and use of relevant, reliable health care information has enormous potential to radically improve health care worldwide.
Clinical decision making / Support systems / Disease management	Ali et al. [14]	Assess the quantifiable and qualitative impacts of combined Electronic Medical Records with Clinical Decision Support Systems tools on physician performance and patient outcomes and their applicability in developing countries.	Medline	33	Until 2010	In the context of limited resources, and lack of structured systems or trained human capital, this review reinforces the need for well-designed investigations evaluating the role and feasibility of technological interventions in clinical decision making.
	Oluoch et al. [15]	Effectiveness of combined Electronic Medical Records with Clinical Decision Support Systems tools on quality of HIV care and treatment in resource-constrained settings.	Medline, EMBASE, CINAHL, Global Health Library (GHL)	12	Until 2012	Technical infrastructure problems such as unreliable electric power and erratic Internet connectivity, clinicians' limited computer skills and failure by providers to comply with the reminders are key impediments to the implementation and effective use of CDSS.
Remote Care / Telemedicine	Wootton et al. [16]	What is known about the use of telemedicine in the developing world.	Medline	40	Until 2000	Telemedicine for the developing world is at a very early stage. There are few publications in the peer-reviewed literature. Most of the works are educational, and there is only limited clinical experience. Furthermore, the applications exhibit the problems well known in telemedicine generally, such as lack of long-term funding and an absence of quality control.
	Rey Moreno et al. [17]	Identify all the projects carried out in Colombia which provided services via telemedicine.	Medline, LILACS, Cochrane Library, Current Contents, CINAHL, CUIDEN, Telemedicine Information Exchange (TIE), IEEExplore.	43	Until 2009	Although many projects seem to have had a positive effect, none of them had been rigorously evaluated, and therefore in the absence of scientific evidence no general recommendations can be made.
Mobile Health	Deglise et al. [18]	Examine current practice for using SMS for disease prevention, surveillance, management and treatment compliance in developing countries.	PubMed, EMBASE, CINAHL, PsycINFO, Science Direct, Springer link, EBSCOhost, ABI/Inform, Cochrane, Google Scholar	31	1998-2009	Mobile health seems to be an interesting tool for specific diseases. The use of this technology could be useful in developing countries. Even when it could have a positive effect, this review did not find clinics outcomes in this study.
	Gurman et al. [19]	Determine how much evidence currently exists for mHealth in behavior change communication interventions in developing countries.	Scopus, PubMed, MEDLINE, LexisNexis, Google Scholar	16	Until 2011	Although Mobile Health is viewed as a promising tool with the ability to foster behavior change, more evaluations of current interventions need to be conducted to establish stronger evidence.

With a different strategy to mitigate this limitation, and without the limit of “developing country”, we would have to analyze much more papers, and we would have thus required more resources. Because of that, we decided to perform the search as described in the method.

Strengths: This systematic review was comprehensive, based on the most important indexed databases for medical informatics topics. Some publications from the grey literature have been probably covered since Google Scholar was included as a resource, because of its known coverage of peer-reviewed journals databases [20], and its ability to identify articles not indexed in PubMed [21].

Data sources: We performed some searches in LILACS in order to access Latin-Americans resources. This strategy included only full text. We used Cochrane too, like a recognized source of EBM resources, but no reviews related to developing countries were found. This is not surprising since the Cochrane Collaboration is focused on a limited number of systematic reviews related to IT interventions in health care, such as the review on CDSSs for neonatal care [22], or computerized advice on drug dosage [23], to name a few.

Some of the biggest challenges in this review dealt with the two principal topics of this analysis: Health Information Systems and Developing Countries. While there is no strict definition of the term ‘Health Information System’ that covers a disparate world of meanings, the term ‘Developing Countries’ includes a wide range of countries and regions. In reality, the diversity of so-called developing countries could be varied. Even so, this review tried to describe a general view of these topics.

Although large programs for health informatics implementation and research are being conducted in many developing countries, more information on the impact of these applications in terms of costs are still needed [24]. Considering that despite geographical and cultural differences, many of these countries share similar challenges and opportunities in the development of health informatics [25], such as limited power, poor network access, and distributed populations,

all requiring different designs and strategies in resource poor environments [26, 27].

A recent publication of WHO provides an overview of the status of health information systems (HIS) in developing countries. It showed that while there has been progress in several HIS areas, there are also major persistent gaps and virtually none of these countries has a full system of data sharing and transparent quality control in place [28]. The lack of interoperability is an evident difference in developing and developed countries [29], and for countries with scarce resources, a trial-and-error approach can be very costly. More comprehensive frameworks and practical tools to guide HIS implementers is needed [30, 31]. It is important to identify and develop the skills, training, and competencies, consistent with local cultures, languages, and health systems, that will be necessary to realize the full benefits of health informatics applications [32]. Several partnerships among academic institutions and public and private organizations, in areas such as sub-Saharan Africa, Haiti, and Peru, are leading the way [33].

As previously stated, some of the comments above are part of articles not incorporated in the review. However, we decided to summarize some interesting concepts they describe in this section.

Some important topics in health informatics have not been covered by our analysis. For instance, topics such as Personal Health Records (PHR), Picture Archiving and Communication System (PACS) or Laboratory Information System (LIS) have not been considered.

Conclusion

As is prevalent in other fields of medicine, Health informatics in developing countries lacks quality resources to develop a comprehensive review of the state of the art. Further research and development of methodologies, guidelines and tools are needed to advance Evidence-Based Health Informatics.

Collaborative efforts that allow sharing of experiences between developed countries and emerging regions will be needed in the near future. In the same way, educational programs that communicate the benefits of the

medical informatics and human resources formation can help to optimize resources and contribute in the growth of this discipline.

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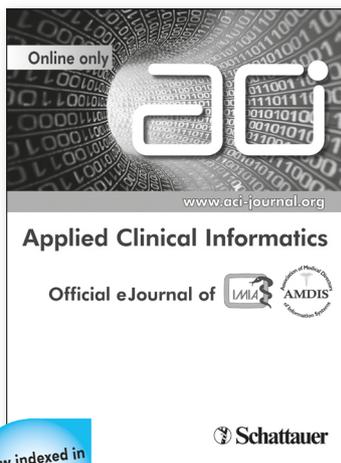
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Correspondence to:

Daniel Luna MD, MSc PhD cand.
 Health Informatics Department
 Hospital Italiano de Buenos Aires
 Gascon 450, CABA,
 Buenos Aires, Argentina (C1181ACH)
 Tel/Fax: +5411 4959 0507
 E-mail: daniel.luna@hospitalitaliano.org.ar

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