Reviewing Effects of ICT in Primary Healthcare Services: A Public Value Perspective

Full Paper

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Abstract

Use of information and communication technology (ICT) in healthcare has increased dramatically over the past decades. A growing body of research illustrates both the practical and academic interest in the area. However, despite the rather massive focus, the research can be seen as a series of disconnected studies with only a handful of studies attempting to consolidate the field. Further, there is little agreement on how technology impacts sector values and of more general effects of technology in primary healthcare. To address this gap, we reviewed a carefully selected sample of existing research to investigate effects of ICT in primary healthcare and the impact ICT seem to have on sector values. Our findings include a comprehensive overview of effects of previous research and contradict much of existing literature in showing that a substantial amount of effects has actually been documented.

Keywords

Primary healthcare, effects, public values, telemedicine, telecare, telehealth.

Introduction

In both developed and developing countries, the proportion of people aged over 60 years is growing faster than any other age group. The global population of 60 years or older has doubled since 1980, and is expected to reach 2 billion by 2050 (World Health Organization 2014). This may be viewed as an indication of success of public health policies and socioeconomic development, but also as a major challenge to the capacity of healthcare systems, since the frequency of diseases and complexity of disease management increases with age (Barnett et al. 2012).

Responding to this challenge, the European Commission has included health, demographic change and wellbeing in the European Union framework for research and innovation, Horizon 2020 (European Commission 2014). Healthcare providers are seeking ways to support more people at home, and advances in technology have led to development of new devices that are integrated into healthcare to support people to cope with chronic diseases (Martin et al. 2008). As with many new technologies, the adoption of Information and Communication Technology (ICT) in healthcare often occurs without comprehensive evaluation of the health impact or a true understanding of the added value of ICT to health services (World Health Organization 2005).

Martin et al. (2008) aimed to determine what effect smart home technologies have on people, but found no studies testing their effectiveness and concluded that the effects of smart technologies to support people in their homes are not known. A focus on cost-effectiveness is important for adoption of new
Reviewing Effects of ICT in Primary Healthcare Services

technology in healthcare, but despite all enthusiasm, a synthesis concluded that almost nothing is known about the cost-effectiveness of telemedicine in chronic disease management, and that the evidence of the value is weak and contradictory (Wootton 2012). The lack of documentation regarding benefits and effects from use of technology should be regarded as a moral problem, as it is rapidly adopted into many countries’ healthcare services (Hofmann 2013).

The organization of healthcare systems has implications for implementation and utilization of new technology. Even if projects are reported as being successful, implementations may be obstructed by incentive systems that favors old working methods and work processes (Lanestedt and Bygstad 2009). Thus, factors that characterize a successful ICT project have changed from looking at technical solutions and functionalities, into how the project could fit in workflows and how the system could be used. ICT solutions should be closely aligned with workflow and organization. There can be substantial potential benefits, but also considerable costs associated with ICT-investments in healthcare. Although authorities have been hesitant in making benefits realization approaches a requirement, they are eager to better understand the potential benefits and how to produce such benefits (Flak 2012).

As a consequence of expected demographical changes, more healthcare services must be delivered by primary healthcare providers in the patient’s home. In summary, there is a need for research to document if or how ICT contribute to better healthcare, and how healthcare providers can work to realize the full potential of the technology. Furthermore, there is a need for an improved understanding of the costs and side effects that may be experienced from implementation of such technologies.

The objectives of this study are therefore to:

• provide an overview of the effects of introducing ICT in primary healthcare
• describe to what degree the reported effects of ICT in primary healthcare are documented

Background and Theory

Theory is used for two purposes in our study. First, we introduce the field of ICT in healthcare as context. Second, literature on public values is presented, and we describe how this is used as an analytic lens in our literature study.

ICT in Healthcare

In research, there is a conceptual confusion regarding the terminology related to ICT and healthcare (Martin et al. 2008). An analysis of the concept “telecare” reveals that terms like telemedicine, telecare and telehealth are used interchangeably (Solli et al. 2012).

Various definitions of the above-mentioned concepts exist (Grigsby 2002; Solli et al. 2012; Wootton 2012). With regards to trialing new services and technologies, England and the UK in general are said to have taken the lead among European countries (Clark and Goodwin 2010). The Department of health in the UK (2009, p. 5-6) use the following definitions for telecare and telehealth:

• Telecare: Services that "uses a combination of alarms, sensors and other equipment to help people live independently. This is done by monitoring activity changes over time and will raise a call for help in emergency situations, such as fall, fire or a flood”.

• Telehealth: Services that "uses equipment to monitor people's health in their own home... (monitoring) vital signs such as blood pressure, blood oxygen levels or weight”.

Even though the term “telecare” is much used in practice, no MeSH-term has been established for use when searching online library databases. The term “telehealth” is included in the MeSH-term “telemedicine” (among other concepts like eHealth). In a bibliometric analysis (Fatehi and Wootton 2012) the trends in the use of the different terms; "telemedicine", "telehealth" or "eHealth" were examined. The term “telemedicine” was most common and referred to in documents from 126 countries.

The European Commission (2008, p. 3) use the following definition of telemedicine: “Telemedicine is the provision of healthcare services, through use of ICT, in situations where the health professional and the patient (or two health professionals) are not in the same location. It involves secure transmission of
medical data and information, through text, sound images or other forms needed for the prevention, diagnosis, treatment and follow-up of patients.”

Given the varying use of terminology related to ICT in healthcare, we adopt the three different definitions to cover the broad area of the field.

A limited number of review articles focus on subsets of ICT in healthcare (e.g. (Martin et al. 2008; Wootton 2012)). However, we have not seen any study providing a comprehensive overview of effects of ICT in primary healthcare. Given the considerable focus on the theme and the existing body of research on the topic, we consider it timely to provide such an overview.

**Public Values**

Research from management studies and information systems has typically focused on organizational and financial impact from ICT. However, healthcare benefits include societal values such as quality of life and absence of disease, in addition to traditional benefits such as cost reductions and increased efficiency (Sherer 2014).

Implementation of ICT in the public sector is likely to have implications for public values. Different ICTs may impact different sets of values, in different ways (Bannister and Connolly 2014). Following Sherer’s (2014) argument of multiple values and diverse stakeholders, a public values framework is considered suitable for categorizing and analyzing effects of ICT in healthcare.

In literature, there is a lack of research focusing on both the subject of ICT and public sector values (Bannister and Connolly 2014), and value creation in the public sector (Pang et al. 2014). Defining value or performance in public sector and measuring “non-market” values such as democracy and transparency is suggested to be difficult (Pang et al. 2014).

For the purpose of studying effects on performance of ICT in public sector, little theory has been developed (Pang et al. 2014). There is a theoretical basis in the information system (IS) literature on IT business value built on e.g. the resource based view, but this does not fit the public sector very well (Bannister 2001; Pang et al. 2014). Public sector do not need to achieve competitive advantage, and it does not fit with the multi-dimensionality of values in public organizations (Pang et al. 2014).

Three concepts have emerged as key criteria in public sector for performance evaluation, and they are often called the three Es; efficiency, effectiveness and economy. When these criteria are combined optimally, it will deliver “value for money” (Bannister 2001). As earlier mentioned, in public sector there is a more diverse group of stakeholders (e.g., politicians, citizens, media) with diverse demands and interests than in private sector. “Value-based conflicts” can occur when the values governments work for, conflict each other. With limited resources, it is difficult to balance different interests often representing contradictory values (Pang et al. 2014).

A handful of frameworks for public values have emerged over the past years (e.g., Bannister and Connolly 2014; Codagnone et al. 2006). The framework from Rose et al. (2015) (Figure 1), offers a well-developed framework for understanding public values that we consider useful in addressing our research.

![Figure 1. Rival value positions for eGovernment (Rose et al. 2015, p. 46)](image-url)
For this review, the three value positions (administrative efficiency, service improvement and citizen engagement) and the belonging keywords are used as an analytic lens to investigate what values the literature of ICT in primary healthcare reports.

**Research Approach**

A literature review can enable theoretical progress and contribute to establishing firm foundations for an emerging field (Webster and Watson 2002). This fits well with the state of the eHealth area and our ambitions of establishing a foundation of possible effects from introducing ICT into primary healthcare services. In this study, we adopted the guidelines of Webster and Watson (2002) on how to carry out a literature review with the purpose of understanding and establishing a foundation of effects of ICT in primary healthcare services.

We searched two major library databases, Scopus and Ebsco Medline, as these cover a wide range of information systems and health ICT outlets, combining the following search phrases with no limitation regarding year of publication or outlet:

- Technology, using additional search phrase: Telemedicine OR Ambient assisted living OR Telecare
- Impact, using additional search phrase: Effects OR Evaluation
- Context, using additional search phrase: Primary healthcare OR Community health services

The search ended in February 2017 and resulted in 419 articles. There was some overlap between the two database searches. When duplicates were removed, the sample consisted of 284 unique articles.

One of the authors scanned the titles and abstracts once and divided the articles in three categories: relevant, irrelevant and unsure. The following inclusion criteria were applied: explicit technology focus, clearly stated effects and primary healthcare context. Papers only related to a hospital context were excluded. All three authors then discussed papers in the “unsure” and "irrelevant" categories, and ended up with 165 papers that met the inclusion criteria. Another 27 articles were excluded from the sample due to non-English or Scandinavian language (5), no mention of effects (10), technology not part of study (2), only focus on hospital (2), no mention of health (2), no full-text version available (1), or that articles for other reasons were difficult to map (5). This left 138 papers for analysis, published in 80 different outlets. In general, there were 1-3 papers meeting our criteria per outlet. Table 1 lists the three outlets with 8 or more papers in our sample.

<table>
<thead>
<tr>
<th>Journal</th>
<th>Search field</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Telemedicine and e-Health</td>
<td>Full text</td>
<td>19</td>
</tr>
<tr>
<td>Journal of Telemedicine and Telecare</td>
<td>Full text</td>
<td>14</td>
</tr>
<tr>
<td>Journal of Medical Internet Research</td>
<td>Full text</td>
<td>8</td>
</tr>
</tbody>
</table>

**Table 1. Literature sample overview**

Analysis was done in two iterations. First, we analyzed titles and abstracts to get an overview. We used two concepts from different strands of existing literature to guide our analysis. These concepts were: *technology* and *effects*. Table 2 provides the basis of our concept matrix, as suggested by Webster and Watson (2002).

<table>
<thead>
<tr>
<th>Concepts</th>
<th>Reference to literature</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td>Several studies (Martin et al. 2008; Solli et al. 2012)</td>
<td>Telecare, Telecare, Telehealth, Telemedicine, Other</td>
</tr>
<tr>
<td>Effects</td>
<td>Rival value positions for e-Government, Figure 1 (Rose et al. 2015)</td>
<td>Administrative efficiency, Service improvement, Citizen engagement, Other</td>
</tr>
</tbody>
</table>

**Table 2. Concepts and dimensions**

Units (e.g. documented or expected effects) and impacts (e.g. positive or negative) were added to every dimension (e.g. administrative efficiency) of the concept *Effects*. The different units and impacts used in the analysis are illustrated in Table 4.
After the initial analysis, we analyzed the full-text of each article according to the same criteria and further developed our concept matrix. While the initial iteration of analysis provided a rich overview according to our concepts, the second round completed the picture as we discovered additional items for our concepts, and also revised some of the initial mapping.

## Results

This section outlines the results from our analysis to address the objectives of the study:

- provide an overview of the effects of introducing ICT in primary healthcare
- describe to what degree the reported effects of ICT in primary healthcare is documented

The results are presented in Tables 3, 4 and 5. The findings are discussed in relation to the objectives in the next section.

Table 3 provides an overview of the number of papers containing the different dimensions of public values. Every dimension can potentially be found in every paper. Out of 138 papers, service improvement is the one of the public values with highest prevalence in our sample (121 papers), and administrative efficiency had the second highest prevalence (79 papers).

<table>
<thead>
<tr>
<th>Dimensions (public values)</th>
<th>Number of papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administrative efficiency</td>
<td>79</td>
</tr>
<tr>
<td>Service improvement</td>
<td>121</td>
</tr>
<tr>
<td>Citizen engagement</td>
<td>9</td>
</tr>
<tr>
<td>Other</td>
<td>6</td>
</tr>
</tbody>
</table>

Table 3. Number of papers containing the different dimensions of public values

In relation to the different units used in the analysis, a paper can report 1) documented, and/or 2) reported but not documented and/or 3) expected effects. The different units can give several combinations due to the impacts included in the analysis. The number of papers containing the dimensions of public values with different combination of units and impacts are illustrated in Table 4.

<table>
<thead>
<tr>
<th>Public values</th>
<th>Administrative efficiency</th>
<th>Service improvement</th>
<th>Citizen engagement</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Documented</td>
<td>Reported, not documented</td>
<td>Expected</td>
<td>Documented</td>
</tr>
<tr>
<td>Positive</td>
<td>49</td>
<td>9</td>
<td>17</td>
<td>92</td>
</tr>
<tr>
<td>Negative</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>No difference</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Inconclusive</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 4. Number of papers containing public values with different units and impacts

Table 4 provides numeric findings from our analysis in relation to our concept matrix. For addressing the first objective of our study, there is also a need to elaborate the results with qualitative data. This is illustrated in Table 5. Due to space limitation, only one reference is provided to illustrate each combination of dimensions, unit and impact.
<table>
<thead>
<tr>
<th>Dimension</th>
<th>Unit</th>
<th>Impact</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administrative efficiency</td>
<td>Documented</td>
<td>Positive</td>
<td>• Effective chronic condition management (Salisbury et al. 2015)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Negative</td>
<td>• Telemedicine model of initiated phone calls by a health-care provider had a negative effect on resource use (Berkhof et al. 2015)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No difference</td>
<td>• No difference in length of consultation (telemedicine/in-person) (Agha et al. 2009)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Negative</td>
<td>• Telemedicine model of initiated phone calls by a health-care provider had a negative effect on resource use (Berkhof et al. 2015)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inconclusive</td>
<td>• Responses were divided regarding whether or not Florence helps clinicians save time and whether adoption of Florence telehealth is cost-effective (Cottrell et al. 2015)</td>
</tr>
<tr>
<td></td>
<td>Reported, not documented</td>
<td>Positive</td>
<td>• Use of videoconferencing for psychiatric consultation has a viable option for an integrated, community-based mental health service (Doze et al. 1999)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Expected</td>
<td>• Fully developed, with a large-scale networking of primary care centers involved in teleconsulting, telemedicine should be cost-effective (Made et al. 1999)</td>
</tr>
<tr>
<td>Service improvement</td>
<td>Documented</td>
<td>Positive</td>
<td>• There were significant improvements in the primary outcome measures; pain (44%), stiffness (37%) and physical function (38%) (Wong et al. 2005)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Negative</td>
<td>• No significantly difference (face-to-face/technology) in adherence outcomes and depression outcomes (Kalapatapu et al. 2014)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inconclusive</td>
<td>• The studies provided variable and inconclusive results for outcomes such as psychological measures (Currell et al. 2000)</td>
</tr>
<tr>
<td></td>
<td>Reported, not documented</td>
<td>Positive</td>
<td>• With daily monitoring via the telehealth technology, care coordinators may have been able to identify subtle health changes, assist patients in managing their health problems, and resolve these problems before they became serious enough (Barnett et al. 2006)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Negative</td>
<td>• Patients with limited experience with the internet and information technology, who worked out of town, or who had an outdoor hobby would not be able to benefit from such a service (Abdullah et al. 2016)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Expected</td>
<td>• IT can be used to support identification of at-risk individuals, cardiovascular disease risk assessment and management, care planning, patient self-management, and evaluation of improvements (Wells et al. 2010)</td>
</tr>
<tr>
<td>Citizen engagement</td>
<td>Documented</td>
<td>Positive</td>
<td>• Using asynchronous communication in healthcare may be an important instrument to increase patient participation leading to self-management (de Jong et al. 2014)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Negative</td>
<td>• Patients less engaged (less talkative) and more likely to take on a passive role during Telemedicine consultations (Agha et al. 2009)</td>
</tr>
<tr>
<td></td>
<td>Reported, not documented</td>
<td>Positive</td>
<td>• Facilitates empowerment of patients in their own health (Wilhelmsen et al. 2014)</td>
</tr>
</tbody>
</table>
|                            |                             | Expected       | • Telemedicine-based ulcer follow-up can positively influence patient competence and involvement in diabetes self-management, including using preventive strategies to avoid or delay new foot ulcers (Iversen et al. 2016)
| Other                      | Documented                  | Positive       | • Increase women’s decision-making, social status and access to health resources. Can influence gender relations in meaningfully positive ways by providing new modes for couple’s health communication and cooperation (Jennings and Gagliardi 2013) |
|                            |                             | Negative       | • Human dimension is a possible problem area when using medical information systems (Burghgraeve and De Maeseneer 1995)               |
|                            | Inconclusive                |                | • Change in patient-reported adherence to BP medications, physical activity, salt intake, alcohol use, and weight did not have significant mediating effects on change in SBP, even though medication adherence and salt intake improved in the intervention group (Margolis et al. 2015) |
|                            | Reported, not documented,    | Positive       | • A change in evaluation methodology, from a strictly technical approach to a more comprehensive one, would result in better and less biased decision making in connection with the introduction of IT in healthcare (Burghgraeve and De Maeseneer 1995) |
|                            |                             | Expected       | • The magnitude of change (over 1000 steps per day or approximately half a mile) is clinically meaningful and, if continued, is expected to result in long-term health benefits such as reduced cardiovascular and diabetes risk (Glynn et al. 2014) |

Table 5. Examples of effects of ICT in primary healthcare in a public value perspective.
Discussion

In this section the findings from our analysis will be discussed and used as a basis for answering the stated objectives of our study:

- provide an overview of the effects of introducing ICT in primary healthcare
- describe to what degree the reported effects of ICT in primary healthcare is documented

As shown in Table 4 and 5, our analysis reveals a wide variety of effects from use of ICT in healthcare. The analysis showed that the identified effects could be mapped to the public value framework by Rose et al. (2015). Our analysis demonstrates that “Service improvement” is the most commonly found value among the three different value positions. Across the three value positions, most of the papers reported effects which were positive and documented (146 occurrences), but some of them are also reported negative, documented effects (17 occurrences), no difference with/without technology, documented (14 occurrences) or inconclusive (7 occurrences). The analysis also shows that there are many studies that report positive effects that are either expected (47 occurrences) or reported, but not documented (22 occurrences).

The emphasis on service improvements is interesting, as use of ICT in general is often motivated as a means to increase (administrative) efficiency. Further research should investigate if this is characteristic for the health context.

Previous research (Hofmann 2013; Martin et al. 2008; Wootton 2012) states a lack of documented effects from ICT in healthcare. Interestingly and surprisingly, the results from this review indicate the opposite. We identified a wide variety of documented effects related to ICT in primary healthcare from the literature. Hopefully, Table 5 can be used as a tool to get some examples of the effects of ICT in primary healthcare related to public values.

Table 5 provides an overview of the distribution of effects from ICT in primary healthcare at an aggregated level. Space constraints limit us from providing the full details behind the aggregation. However, the positive effects related to administrative efficiency were typically related to improved work processes and improved access to expert assistance (Barton et al. 2011). Negative effects in this category were typically related to increased workload and perceived negative changes in professional roles (MacNeill et al. 2014). In the area of service improvement, positive effects were typically related to improved access to service, increased user satisfaction and improved health condition (Bassilios et al. 2014). Negative effects in the same category were often related to technical and usability issues (Verwey et al. 2014). Positive effects related to citizen engagement were related to patient empowerment and participation (Fairbrother et al. 2013). Negative effects in this category were related to security risks related to confidentiality and negative impact on engagement due to technology reservation (Chang et al. 2013).

While we were able to map effects from the papers to the public value framework in Figure 1, we did experience challenges in doing so. Distinguishing between administrative efficiency and service improvements was experienced as relatively straightforward. However, the distinction between service improvement and citizen engagement was, at times, challenging. E.g. effects related to increased participation and patient empowerment, were classified as belonging to the citizen engagement category. However, this can also be seen as a variation of service improvement. On the other hand, we categorized effects related to access to service as service improvement. Also here, arguments could be made that this relates to citizen engagement. The boundaries between the two categories are seen as somewhat blur when applied in our context, and future research should aim at increasing the conceptual clarity of the framework.

Our analyses did not include an in-depth investigation of the size and quality of the studies in our sample. One can expect variations in both areas and a more careful sample selection could have affected the results. While we acknowledge that this is a potential weakness of the study, we argue that our results are valid and interesting, particularly in light of our sample size and the exploratory nature of our work.
Conclusion

This study has investigated a carefully selected sample of literature to understand effects from ICT in primary healthcare, whether or not effects mentioned in the literature are documented.

Our structured review of the literature was guided by The rival value propositions for eGovernment framework (Rose et al. 2015, p. 46).

Our results are summarized in Tables 3, 4 and 5 and show a vast variety of effects from ICT in primary healthcare. Interestingly and rather surprisingly, we found that a substantial amount of effects has actually already been documented in the literature. Further, we found no overweight of effects related to the value category "Administrative efficiency", but rather overweight of effects related to "Service improvement".

Implications

Our study has implications for both theory and practice.

Previous research (Hofmann 2013; Martin et al. 2008; Wootton 2012) states a lack of knowledge about effects and values of ICT in healthcare. This review provides an overview of the effects of ICT in primary healthcare and to what degree the effects are documented. Our findings suggest that the level of known, and also documented, effects are substantially greater than what has been suggested in the literature. Our analyses constitute a promising start of a mapping of effects from ICT in primary care that should be extended into a more comprehensive overview of potential effects. Future studies should corroborate the overview and provide additional details concerning the nature of the effects. Both research and practice can utilize such an overview. Our results can be used as a starting point for further theory development, e.g. in developing theoretical models of relationships between constructs like public values and effects.

Our analysis was based on the existing framework; Rival value positions for eGovernment (Rose et al. 2015). Whilst theoretically sound, the framework has had substantial empirical grounding. Our study illustrates that this framework proved useful as analytic tool for generating descriptive knowledge, and thus contribute to validation of this framework.

Our findings may be helpful as guidance for decision-makers when planning and implementing ICT in primary healthcare services. The extensive overview of potential effects can provide insights into what can be expected from investments in eHealth.

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