Usefulness of a Regional Health Care Information System in primary care
A case study

Marianne C. Maass\textsuperscript{a,∗}, Paula Asikainen\textsuperscript{b}, Tiina Mäenpää\textsuperscript{a}, Olli Wanne\textsuperscript{a}, Tarja Suominen\textsuperscript{c}

\textsuperscript{a} Satakunta Central Hospital, Department of Administration, Sairaalantie 3, 28500 Pori, Finland
\textsuperscript{b} Satakunta University of Applied Sciences, Department of Social and Health Care Technology, Finland
\textsuperscript{c} University of Kuopio, Department of Nursing Science, Finland

A B S T R A C T

The goal of this paper is to describe some benefits and possible cost consequences of computer based access to specialised health care information. A before–after activity analysis regarding 20 diabetic patients’ clinical appointments was performed in a Health Centre in Satakunta region in Finland. Cost data, an interview, time-and-motion studies, and flow charts based on modelling were applied. Access to up-to-date diagnostic information reduced redundant clinical re-appointments, repeated tests, and mail orders for missing data. Timely access to diagnostic information brought about several benefits regarding workflow, patient care, and disease management. These benefits resulted in theoretical net cost savings. The study results indicated that Regional Information Systems may be useful tools to support performance and improve efficiency. However, further studies are required in order to verify how the monetary savings would impact the performance of Health Care Units.

© 2008 Elsevier Ireland Ltd. All rights reserved.

1. Introduction

Today, the adoption of Regional Health Care Networks is a top priority in the field of medical and health care informatics [1–3]. There are a great number of diverse Information Systems in use, the goal of which is improved efficiency of health care services. There is an urge for standards and interoperability of systems in countries which have in the recent decades gradually adopted Information Systems [4,5]. Regional Networks strive towards the shared use of Regional Information Systems by networking entire regional administrative areas, such as Health Care Districts. The goal is to support seamless care and patient care chains throughout primary, secondary and tertiary care, and within the home care section by providing timely, high quality care, based on the most recent diagnostic data. Health Centres offer primary care services. Secondary and tertiary care is provided by Central Hospitals and University Hospitals, respectively. There is a need for integrated Information Systems, and for a comprehensive information infrastructure at intra-hospital, regional and national level. In fact, the Finnish Ministry of Social and Health Affairs promotes efforts towards building Regional Information Networks based on a reference registry [6].
The recurrent lack of diagnostic information is generally recognised [7]. On the other hand, the quality of care has been connected with the level of communication between primary and secondary care units [8]. Information Systems may offer efficient alternatives to support trans-institutional co-operation, to reduce the use of written documents, paper processing and telephone calls [9], and to reduce operating costs [10]. There are studies which suggest that timely availability of diagnostic information not only improves patient care, but also brings about cost savings [11]. Furthermore, the effectiveness of the use of Information Systems compared with traditional activity has been established, i.e. that costs were lower and medical benefits were greater [12]. The adoption of Health Information Systems including Electronic Health Records has progressed slowly; consequently the expected benefits have not been fully realised [13]. Some 15 years ago, it was foreseen that the transition to fully electronic activity might take up to three decades in some medical specialties [14]. Currently, this seems to be applicable to many Information System efforts.

It has been established that Health Information Systems may improve the performance of medical personnel, as well as diagnostic quality, disease management, and patient outcome, although the relationship between these systems and the benefits remain understudied, and methods and results are inconsistent [15]. The diversity of clinical settings, the variety of study methods, and the general immaturity of the research field challenge the comparison of results [16,17]. The relative newness of the field, the absence of a sufficient, adequate and compact research community, and lack of funding have all prevented the achievement of solid results. However, there is general consensus that widespread use and networking of Health Information Systems could eventually induce cost savings, especially in the area of preventive medicine and chronic disease [18]. In fact, it has been demonstrated that the use of Information Systems supports clinical performance and preventive care [19], and there are indications that the improved performance may enhance the revenue of a health care unit [20].

Diabetes may be regarded as an information intensive disease. Therefore it may be regarded an excellent study target to explore the usefulness of Information Systems. As a chronic, advancing disease its outcome depends on preventive medicine, follow-up programmes, and timely procedures embracing specialities such as amputation surgery, cardiology, clinical physiology, endocrinology, eye imaging, foot care, internal medicine, nephrology, nutritional therapy, ophthalmology, radiology, specialised nurse services, or venal surgery. Furthermore, diabetes is increasing rapidly; its total cost exceeded one billion euros already at the beginning of the 21st century [21]. It has been established that the quality of care connected with proper management of the diabetic care continuum may provide a means to control the outcome and cost of the disease [22]. There were 7585 medicated diabetic patients in the Satakunta Hospital District [23]. Primary care was provided by Health Centres, and secondary care was available in Satakunta Central Hospital.

Satakunta Central Hospital has adopted a Regional Health Care Information System service, the aim of which was to enable all Health Centres of the region to have access to secondary care diagnostic information regarding all patients. The study included a typical Health Centre serving approximately 20000 inhabitants, which represented nearly 10% of the total population of the region. The Health Centre has organised a follow-up programme for the treatment of its 461 diabetic residents [23]. A more comprehensive study including four Health Centres was performed [24].

The goal of this paper is to highlight the possible usefulness of the Regional Health Care Information System. The concept of usefulness is applied, in the sense of the possible costs and benefits of having real time access to the most recent diagnostic data. The following particular questions are addressed:

- Does access to real time diagnostic information change workflow?
- Does access to real time diagnostic information change patient care?
- Does access to real time diagnostic information change disease management?
- Does the use of the Regional Health Care Information System induce net savings?

2. Methods and materials

In 2005 a before–after activity analysis regarding the clinical appointments of twenty diabetic patients was conducted. The study setting consisted of two Health Care Units, namely Satakunta Central Hospital, and a Health Centre located in the Satakunta region. The Regional Health Care Information System (Fujitsuulvia Ltd./Finnish Post Ltd., Itella) enabled access through a reference register to any entered patient data [6], and each local Information System automatically created a reference to the register [25,26].

In the preparatory phase of the study a semi-structured thematic interview was conducted. The physician in charge of diabetes care was interviewed for background information for 90 min. The interview was tape recorded and transcribed. The goal of the interview was to ensure that the study would be focused on relevant issues, and that the staff would be involved in the study. In addition, its aim was to provide the non-medical researchers’ with a comprehensive understanding of the health care delivery system of this particular region, and of the work procedures of these particular health care units. The themes of the interview included medical aspects of providing primary care for diabetic patients at general level, cross-organisational co-operation with secondary care, patient care and diagnostic information needs. In addition, the following themes came under scrutiny: the patient flow between primary and secondary care; procedures triggered by unavailable diagnostic information; and the impact on patient care, organisation and personnel working conditions.

Time and motion studies were applied to study the clinical appointments. A stopwatch was used in order to determine the crucial work processes, and their duration. The time-and-motion studies were performed by an independent researcher, starting when the patient was called in, and ending when the patient left the examination room. The researcher could later ask questions about both the logic and the reasons behind
each action, in order to check her understanding and interpretation of the role of the Information System in patient care. Based on the results of the clinical observations, the interview and the time and motion studies, the before–after flow charts were drawn by using a modelling software (QPR Finland Ltd.).

The total cost of the Regional Information System project was calculated based on information given by the projects’ financial manager. The cost consequences at communal level were estimated based on information retrieved from the Financial Statements and Report of Activities of the Health Centre [28]. Cost savings were estimated based on the assumption that unsuccessful appointments, and consequently repeated visits and tests would be reduced. During time and motion studies those appointments were determined, which without the use of the Regional Information System would have been unsuccessful due to unavailability of most recent diagnostic information. The cost of one clinical appointment was determined based on its length and the cost of wage of medical personnel. The cost of tests was determined by using the price of the less costly test, such as a simple blood test [23,27–29].

### 3. Results

The consequences of the computer based access were 100% availability of latest diagnostic information, based on which it was estimated that redundant clinical appointments and/or testing could be eliminated in the future. Missing information was requested by telephone, fax orders, or tests were repeated. The patient was rescheduled for a new appointment, or given a phone call reception time, usually some two weeks later. The unavailability of information prolonged treatment, led to redundant appointments and testing, causing extra workload, uncertainty and discomfort (Fig. 1).

Workflow and patient care changed when the Regional Health Care Information System was used (Fig. 2). Access to Regional Health Care Information System reduced the number of work processes. The time and motion study revealed that workflow was simplified and accelerated in 4 of the 20 cases followed. Availability of the latest diagnostic data assisted in concluding successfully these clinical appointments. The treating physician felt that the result reflected the quotidian reality. The treatment was shortened by one

<table>
<thead>
<tr>
<th>DURATION OF WORK PROCESSES</th>
<th>DAY BEFORE CLINICAL APPOINTMENT</th>
<th>DAY OF CLINICAL OUTPATIENT APPOINTMENT</th>
<th>20 MINUTES</th>
<th>APPROXIMATELY 5 MINUTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEALTH CENTRE</td>
<td>PATIENT RECORD IS DELIVERED TO THE EXAMINATION ROOM</td>
<td>DOCTOR SIGNS-IN TO THE LOCAL INFORMATION SYSTEM</td>
<td>EXAMINATION RESULTS ARE REVIEWED</td>
<td>PATIENT CONSENT IS STAND</td>
</tr>
<tr>
<td>SATAMUNTA CENTRAL HOSPITAL</td>
<td>PATIENT IS REFERED TO SATAMUNTA CENTRAL HOSPITAL</td>
<td>HEALTH CENTRES LOCAL INFORMATION SYSTEM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>INFORMATION ARCHIVING MEDIA</td>
<td>HEALTH CENTRES LOCAL INFORMATION SYSTEM</td>
<td>HEALTH CENTRES LOCAL INFORMATION SYSTEM</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Fig. 1** – Flow chart showing the traditional “before” work processes. There was a parallel use of traditional and electronic records. Several work processes had already taken place before the arrival of the patients. Approximately seven days before the appointment patients had undergone blood sample tests. The physician became acquainted with the patient history, and called in the patient. Home care follow-up cards were checked. Treatment decisions and possible new treatment guidelines were entered to the Information System when the appointment was due.

**Fig. 2** – Flow chart showing the new “after” work processes. Work processes were reduced, because the physician now had access to the latest diagnostic information located in the secondary care Information System.
to two weeks. The access to real-time information assisted in providing adequate, high-quality patient care. The prerequisites for the improvement of patient safety and care were also enhanced. The Information System allowed in situ decision-making which encouraged confidence, and increased professional performance. There was no longer confusion arising from the absence of required documents, which previously had triggered several procedures. However, the use of the Information System prolonged the individual appointments by an average of four minutes, from 22 min to 26 min (Table 1).

### 3.1. Patient case 2

A patient presented with cardiac symptoms. The patient was not aware of what procedures had been carried out in Satakunta Central Hospital. The discharge summary was unavailable. With the patients’ consent the physician retrieved the latest examination results from the Information System: these together with the symptoms indicated, that the patient was in need of an urgent intervention. The patient’s care was accelerated.

### 3.2. Patient case 14

A patient had had eye imaging performed in Satakunta Central Hospital. The imaging results were lacking; nor had these results been sent by mail to the Health Centre. The physician signed in to the Information System, and reviewed the imaging results, as well as the latest treatment guidelines. There was no need to order a copy of the imaging related information, and thus a redundant appointment or a repeated examination was avoided.

### 3.3. Patient cases 16 and 17

The physician received these patients who possessed outdated health insurance cards, no longer covering the compensation of medication costs. In order to write accurate and valid reports the most recent illness history data was retrieved from the Information System. The necessary documents were completed during the appointment, and the compensation process was accelerated. There was no need to order the latest test results from the Satakunta Central Hospital, or to repeat the tests, or to reschedule new appointments.

Disease management was related to information management. There is a great need for information exchange concerning the diabetic patient, in order to prevent sporadic or irreversible worsening of the disease. Data is created, stored, and sent back and forth between treating physicians, specialists of several fields, archives, wards and clinics, and even between different organisations. It was inferred that computer access was more crucial in complicated patient cases the than in straightforward cases. The study indicated that timely decision-making enabled better and faster care practice. Access to latest diagnostic information might also provoke fewer errors.

Availability of the discharge summaries was regarded as critical. It should be delivered to the treating physician as a standard procedure. The arrival of the summaries officially returns the care of the patient to the Health Centre, and is necessary for appropriate care.

The Regional Health Care Information System allowed a focussed search for the precise information required (Fig. 3). Access to medical speciality related data by computed selection was rapid and convenient, whereas paper documents must be read from beginning to end, which is time consuming.

The total cost of the project to the Satakunta Central Hospital was some 800 000 €. The estimated net saving for the Health Centre was over 60 000 000 €, a sum which represented 10% of the total primary care cost. Satakunta Central Hospital charged for access to the Information System 41 000 €. The net savings were calculated based on the results of the activity analysis—the finding that 20% of the tests and clinical appointments were redundant. There were 200 000 labora-

<table>
<thead>
<tr>
<th>Patient no.</th>
<th>Medical problem</th>
<th>Quality of diagnostic information</th>
<th>Use of IS</th>
<th>Description of benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ordinary check-up</td>
<td>Sufficient</td>
<td>No</td>
<td>Increased personnel confidence</td>
</tr>
<tr>
<td>2</td>
<td>Cardiac symptoms</td>
<td>Insufficient</td>
<td>Yes</td>
<td>Faster treatment decision</td>
</tr>
<tr>
<td>3</td>
<td>Ordinary check-up</td>
<td>Sufficient</td>
<td>No</td>
<td>Increased personnel confidence</td>
</tr>
<tr>
<td>4</td>
<td>Ordinary check-up</td>
<td>Sufficient</td>
<td>No</td>
<td>Increased personnel confidence</td>
</tr>
<tr>
<td>5</td>
<td>Ordinary check-up</td>
<td>Sufficient</td>
<td>No</td>
<td>Increased personnel confidence</td>
</tr>
<tr>
<td>6</td>
<td>Ordinary check-up</td>
<td>Sufficient</td>
<td>No</td>
<td>Increased personnel confidence</td>
</tr>
<tr>
<td>7</td>
<td>Ordinary check-up</td>
<td>Sufficient</td>
<td>No</td>
<td>Increased personnel confidence</td>
</tr>
<tr>
<td>8</td>
<td>Ordinary check-up</td>
<td>Sufficient</td>
<td>No</td>
<td>Increased personnel confidence</td>
</tr>
<tr>
<td>9</td>
<td>Ordinary check-up</td>
<td>Sufficient</td>
<td>No</td>
<td>Increased personnel confidence</td>
</tr>
<tr>
<td>10</td>
<td>Ordinary check-up</td>
<td>Sufficient</td>
<td>No</td>
<td>Increased personnel confidence</td>
</tr>
<tr>
<td>11</td>
<td>Ordinary check-up</td>
<td>Sufficient</td>
<td>No</td>
<td>Increased personnel confidence</td>
</tr>
<tr>
<td>12</td>
<td>Ordinary check-up</td>
<td>Sufficient</td>
<td>No</td>
<td>Increased personnel confidence</td>
</tr>
<tr>
<td>13</td>
<td>Ordinary check-up</td>
<td>Sufficient</td>
<td>No</td>
<td>Increased personnel confidence</td>
</tr>
<tr>
<td>14</td>
<td>Ordinary check-up</td>
<td>Insufficient</td>
<td>Yes</td>
<td>Latest eye imaging results were accessed</td>
</tr>
<tr>
<td>15</td>
<td>Ordinary check-up</td>
<td>Sufficient</td>
<td>No</td>
<td>Increased personnel confidence</td>
</tr>
<tr>
<td>16</td>
<td>Ordinary check-up</td>
<td>Insufficient</td>
<td>Yes</td>
<td>Latest disease state-of-art results accessed</td>
</tr>
<tr>
<td>17</td>
<td>Ordinary check-up</td>
<td>Insufficient</td>
<td>Yes</td>
<td>Latest disease state-of-art results accessed</td>
</tr>
<tr>
<td>18</td>
<td>Ordinary check-up</td>
<td>Sufficient</td>
<td>No</td>
<td>Increased personnel confidence</td>
</tr>
<tr>
<td>19</td>
<td>Ordinary check-up</td>
<td>Sufficient</td>
<td>No</td>
<td>Increased personnel confidence</td>
</tr>
<tr>
<td>20</td>
<td>Ordinary check-up</td>
<td>Sufficient</td>
<td>No</td>
<td>Increased personnel confidence</td>
</tr>
</tbody>
</table>
Fig. 3 – Computer interface of the Regional Health Care Information System. The monitor view is simple. There is a list of patients' speciality related sheets in alphabetical order beginning with physiatry (Fysiatria), and followed respectively by physiotherapy, surgery, imaging, laboratory, nutritional therapy, rheumatology, ward treatment, and clinical appointments. The number of data references is on the right. The user may click the box next to the information desired, and the speciality data sheet arrives within seconds.

tory tests, and over 40 000 appointments during the year 2004 [28]. Each appointment was assigned 20 min of the physicians' working time. The savings in wage cost were over 80 000 €, or the equivalent of 1.2 labour years [29]. The estimated yearly cost savings resulting from the redundant testing were calculated by multiplying the number of the estimated unnecessary tests with the cost of the less costly test, which was 4 €.

4. Discussion

Today, there is general consensus about the need to create seamless care and health care service chains, and to move towards patient-, rather than organisation-centred activity. Late treatment decisions may lead to the deterioration of the illness, and successful treatment of diabetes includes the avoidance of irreversible damage. The results indicated that overall disease management may improve. This might hinder the worsening of the disease and thus lead to further considerable cost savings. Updated information was required for insurance purposes in two out of four cases, which is not insignificant from the disease management point of view. It may be argued that patients are more prone to use medication when the costs are compensated. Thus, availability of diagnostic information for bureaucratic purposes might be regarded as one aspect of disease management. The Regional Information System enhanced the quality of decision-making and professional confidence. Work processes diminished and became simpler; as a consequence working satisfaction might improve. Redundant tests and appointments were avoided, which might provide a possibility for the allocation of increased resources to patient care.

The findings indicate that it is possible to achieve net cost savings by networking the Health Care Information Systems. The consequences of the widespread use of the Regional Health Care Information System might induce further cost savings, or increased efficiency, and possibly enhanced performance. These findings do not contradict the previous study findings of other authors. The use of the Information System did not induce additional costs in other areas of the Health Centres activity. The Central Hospital was responsible for the risks and for all managerial, adoption-related, developmental, and financial issues of the undertaking, which was a benefit for the Health Centre. The end-user was merely committed to purchasing the electronic access cards. The parallel use of paper suggested that the full potential of Information Systems was still not fully exploited. Further reduction of the use of paper documents would introduce further cost savings through the modification of work processes. The use of paper-based discharge summaries might be reduced by introducing electronic discharge letters. Moreover, the computer interface could be designed in such a way that uncompleted patient cases remain in a pending list, as a reminder for the treating physician.

Access to specialised health care information improved workflow, a fact which might at first sight indicate the possibility of achieving cost savings. The use of the Information System reduced unnecessary returns to the Health Centre—a
benefit for all parties involved. In some patient cases the access to updated diagnostic information may be urgent, and a matter of life and death. Unnecessarily rescheduled patients represent an obstacle to efficient care. Updated, ubiquitously and simultaneously accessible diagnostic information is a prerequisite for providing efficient care. In fact, there was a waiting-list of several months for appointments at the diabetes clinic. However, rather than monetary benefits, there might merely be an increase in the performance rate, or reduced queuing. This would have to be verified by the following years’ Financial Statements and Report of Activities. On the other hand, the use of the Information System prolonged the individual appointments by an average of 4 min. It is to be expected that this time will be reduced as users become more familiar with the system behaviour.

The aim of the study was to increase understanding of the benefits by describing the consequences of the use of the Information System. The interaction of changes in patient care, costs, workflow, information flow, disease management, and Information Systems, is complicated, and the consequences are manifold. It is challenging to describe parallel and simultaneous phenomena, which might have different outcomes in different clinical settings. Even a relatively superficial description of different health care services delivery systems and practice of medicine would be a research project per se. The before–after layout of the study did provide reliable indications of changes in workflow. The study outline did not embrace negative results; in fact also none emerged, either in the interview, or in the activity analysis. The number of observed clinical appointments was low, but the intensive interview and the presence of researchers at the studied site added to the credibility of the results. The study was both quantitative and qualitative. The qualitative approach does imply subjectivity, and therefore a parallel use of quantitative methods was included in order to increase the applicability of the results to other similar systems. In fact the results of a more comprehensive cost-benefit analysis performed in the region gave identical percentages regarding redundant appointments and tests.

5. Conclusions

The access to the Regional Health Care Information System was useful. Improvements in workflow, patient care and disease management were observed. These benefits resulted in theoretical net savings. The results may be applicable to other patient groups suffering from chronic multi-symptom diseases with complicated treatment procedures, where up-to-date specialty-related information is of the utmost importance in order to provide the best possible care. It has been estimated that 20% of the population consume most of the health care resources. The improvement of the entire treatment chain for regular health care consumers might have a more beneficial effect on performance than in the case of average health care consumers.

The study embraced economics, human sciences and health informatics. The planning and execution of proper clinical trials still face scientific, economic, and organisational challenges. The research target is becoming more familiar, although new applications are introduced regularly. Further research is justified in order to guide technological development in a favourable direction through the creation of user-friendly interfaces which will assist personnel to adapt work processes in order to promote interorganisational paperless cooperation. It may be assumed that when changes in activity are made, work processes will also change. Access to information will assist personnel in their work processes, and allow the development of care chains. In the future there should be a set of valid criteria which may be applied to evaluate the usefulness of Health Care Information Systems—they should be measurable and unambiguous, and preferably internationally applicable. These criteria could include qualitative as well as quantitative assessment.

Acknowledgements

The implementation project (Salpahanke) manager Terttu Luuukoski, along with her team members, as well as the Department of Administration and Statistics, the Health Centres’ physicians and the technology service providers – Fujitsu Invia and the Finnish Post Ltd., Itella – are warmly thanked for fruitful co-operation.

References


[23] Satakunta Central Hospital Statistics, Department of Administration, Pori, 2005.


[27] Financial Statements and Report of Activities of Satakunta Hospital District, Satakunta Central Hospital, Pori, 2005, pp. 1–76.
