

1-1-2010

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Recommended Citation

Dawson, Linda L.; Plummer, Virginia; Weeding, Stephen; Harlem, Terri; Ribbons, Bob; and Waterhouse, David: Building a system for managing clinical pathways using digital pens 2010, 32-36.
<https://ro.uow.edu.au/infopapers/1471>

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Abstract

Background: A research team from Monash University and Peninsula Health, Victoria is undertaking a trial of digital pen and paper technology for clinical pathway management. Digital pen and paper allows for the capture of images of handwritten documents using an embedded camera in the pen which is matched with special patterns of dots on the paper. These digitised images can be uploaded to a database for analysis. **Objectives:** Clinical pathways have been adopted in most Australian hospitals to document and manage multidisciplinary care across a variety of acute care environments. Analysis of the information collected in paper-based clinical pathway documents is often time-consuming. This project seeks to streamline the collection and analysis of this data by developing a Digital Clinical Pathway Management System (DCPMS) based on digital pens and a customised database. **Method:** The DCPMS will be developed as part of a two year proof of concept project at Peninsula Health's Frankston Hospital. The goals are to: 1. Implement digital pen and paper technology on selected wards; 2. Analyse data collected by the DCPMS for usefulness in clinical decision-making; 3. Identify potential contributions to resource management for bed access, HR management and strategic planning; 4. Utilise clinical and managerial variance analysis from the DCPMS for resource planning in a casemix environment. **Implications:** This paper discusses the potential of a DCPMS in a hospital setting and the possible adoption of digital pen technology for other point of care data collection and analysis.

Keywords

Building, System, for, managing, clinical, pathways, using, digital, pens

Disciplines

Physical Sciences and Mathematics

Publication Details

Dawson, L., Plummer, V., Weeding, S., Harlem, T., Ribbons, R. & Waterhouse, D. (2010). Building a system for managing clinical pathways using digital pens. HIC 2010: proceedings; 18th Annual Health Informatics Conference: Informing the Business of Healthcare (pp. 32-36). Melbourne: RMIT Publishing.

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Building a system for managing clinical pathways using digital pens

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Abstract.

Background

A research team from Monash University and Peninsula Health, Victoria is undertaking a trial of digital pen and paper technology for clinical pathway management. Digital pen and paper allows for the capture of images of handwritten documents using an embedded camera in the pen which is matched with special patterns of dots on the paper. These digitised images can be uploaded to a database for analysis.

Objectives

Clinical pathways have been adopted in most Australian hospitals to document and manage multidisciplinary care across a variety of acute care environments. Analysis of the information collected in paper-based clinical pathway documents is often time-consuming. This project seeks to streamline the collection and analysis of this data by developing a Digital Clinical Pathway Management System (DCPMS) based on digital pens and a customised database.

Method

The DCPMS will be developed as part of a two year proof of concept project at Peninsula Health's Frankston Hospital. The goals are to: 1. Implement digital pen and paper technology on selected wards; 2. Analyse data collected by the DCPMS for usefulness in clinical decision-making; 3. Identify potential contributions to resource management for bed access, HR management and strategic planning; 4. Utilise clinical and managerial variance analysis from the DCPMS for resource planning in a casemix environment.

Implications

This paper discusses the potential of a DCPMS in a hospital setting and the possible adoption of digital pen technology for other point of care data collection and analysis.

Introduction

Clinical pathways have been adopted in most Australian hospitals to document and manage multidisciplinary care across a variety of acute care environments. Currently, clinical pathways are mostly paper-based and so analysis of data is often time-consuming and cumbersome. This paper describes a collaborative research project for using digital pens and paper at the point of care to gather clinical pathway data so that analysis of the results can be made available to clinicians and hospital administrators in a timely manner. Other benefits of this system are that digital pen and paper provides both paper-based and digital records of clinical pathway data that can be used in a variety of ways in patient care and resource management. The system under development is a digital clinical pathway data management system (DCPMS).

From a research perspective, the primary aim of the proposed project is to investigate how patient care can be improved using available and new technology not currently implemented in hospitals. The secondary aim is to investigate how bed management can be enhanced using electronic clinical pathways.

The project has the following goals, to:

- Implement and investigate digital pen and paper technology for the collection of clinical pathways data at the point of care;
- Assess and analyse data collected from the point of care, using the technology, and investigate its usefulness in clinical decision making;
- Identify from the research results clinical and managerial variance analysis for resource planning, bed management and access decision-making at executive level and Casemix funding applications; and
- Clinical and managerial variance analysis for resource planning in a Casemix environment.

The 'front-end' technologies of digital pens-paper will help collect variances in patient care that can be used by management to better manage consumption of health service resources and for discharge planning to manage length of stay (LOS). The big issue is time critical, resource efficient, best practice in acute in-patient care. As a proof of concept project, the aim is to build a fully integrated information system (albeit prototypical), not just another proprietary database. It is envisaged that this project will show that in the future there is potential for integrating digital pen technology with other clinical systems using Australian and international standards. The system will ultimately provide time critical clinical pathway information

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which can be used for clinical decision support and resource management for bed access, HR management and strategic planning.

Background

Clinical pathways are designed as multidisciplinary care guidelines for the purposes of providing evidence-based, cost effective care of appropriate duration in appropriate settings. They are similar to care maps or plans and most pathways have a nursing focus as nursing is the reason people are admitted to hospital (Plummer, 2005). Clinical pathway analysis uses forms to collect clinical pathway data and has been widely used as a way to control costs and to improve the quality of medical care (Grimshaw and Russell, 1993 and Capuano, 1985) and are particularly relevant in Casemix funded environments where there is a focus on the length of stay (LOS). Clinical pathways data collection can be quite minimal because it is ‘charting by exception’, that is staff only chart the variances from the clinical pathway during the delivery of patient care. There is evidence that utilisation of clinical pathways improves patient outcomes (Hanna et al., 1999; Jacavone, Daniels, & Tyner, 1999); and reduces LOS ((Hanna et al., 1999; Hwang, Wilkins, Lowery, & Gentile, 2000; Jacavone et al., 1999; Johnson, Blaisdell, Walker, & Eggleston, 2000; Warner, Kulick, & Stoops, 1998). And there is further evidence that clinical pathways improve staff satisfaction (Kinsman & James, 2004, Herring, 1999; Fujihara-Isosaki & Fahndrick, 1998); according to Kinsman & James (2004), the process of design and implementation of clinical pathways influences their use.

The ‘front-end’ technologies in this project – digital pens, digital paper, (and wireless networks) are already proven technologies used in other areas of health care, such as in cancer specialist rooms (Brophy et al, 2006) and mobile ward environments with a particular research focus on patient management (Dawson, Fisher, Weeding, Heslop, and Howard, 2009; Heslop, Weeding, Dawson, Fisher, and Howard, 2009; Fisher, Dawson, Weeding, and Heslop, 2006; Dawson, Fisher and Heslop, 2005), however, their use with ‘back-end’ technologies, such as a web-browser enabled proprietary database, in a hospital setting have yet to be explored. Currently, the collection of clinical pathway data is carried out manually on paper forms and subsequent and important variance analysis based on those paper forms has a significant manual component which is time consuming for hospital management to produce. This manual analysis is able to provide a limited amount of service utilisation information but is unable to provide this information in appropriate and useful timeframes or in the different formats required for various decision-making tasks in both the short and long term required by public hospital management.

The aim of this project is to provide real-time data capture and retrieval of clinical pathway information at the point of care which can be used for clinical decision making and resource management.

The overall contribution of this project is to provide:

- A better understanding of how electronic clinical information made immediately available, can aid in decision making by the multi-disciplinary team (i.e. Registered Medical Officers (RMO), Nurses, Allied Health Staff, etc.); and
- A better understanding of how electronic management information, made immediately available to hospital management, can improve hospital management outcomes.
- A DCPMS may provide the technological solution to the design and implementation barriers which have been influential in restricting this type of innovative software in the past (refs). If a DCPMS can improve staff satisfaction, it is more likely to increase utilisation of clinical pathways, make a positive impact on health outcomes, cost of care, quality of care and LOS; the influence of these leading indicators enhance bed management and access. For public hospital management these outcomes are critical in an environment of increasing utilisation of health services as evidenced, for example, by the increasing frequency of Emergency Department (ED) ambulance bypass (because the ED and acute care have a lack of available beds) and the growth in public hospital surgical waiting lists; again this is a beds issue that is related to LOS.

Part of the proof of concept project is to create a working prototype of a “back-end” web-browser enabled proprietary database to help facilitate the storage and delivery of electronic clinical pathway information to and from the point of care. The key difference is the real time application of the data at multiple levels of clinical and health service management. The success of this proof of concept proprietary database would elevate its status to that of an innovative and unique asset directly value-adding the digital infrastructure supplied by the partner organisations; thus allowing it to be licensed to every Health Service / tertiary hospital around Australia that wants to digitise the data in their clinical pathways in order to provide information to multi-disciplinary teams. The proprietary database can be bundled with or licensed separately to the digital infrastructure and could provide residual annual income to Monash University in licensing fees. Also, the proprietary database has the potential to be exported around the world to other health organisations and hospitals if the basic and minimum infrastructure were available.

Significantly, and because of differences in the nursing industrial relations environment across different states and countries, the introduction of traditional digitised clinical pathway data management system (DCPMS) software for clinical pathways data collection and resource management reporting may not be

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successful; this is where the ‘front-end’ digital pen-paper technology has an advantage and would be seen as a viable alternative. The timeliness of the information impacts on the capacity to manage clinical pathway variances which extend the length of stay. Paper based pathways may take up to 6 months to be analysed, long after the patient is discharged and the reasons for the variance have the potential to be repeated multiple times over in the intervening period. The DCPMS has the potential for immediate analysis, intervention, management and educative response. *“Hospitals that achieve higher output have the ability to achieve more government revenue, hence the shortened length of stay becomes a high priority”* (Barracough & Gardner, 2008: 246)

The digital pen-paper technology also has another advantage over traditional DCPMS software as it does not require any significant amount of retraining of staff; the only training required is how to dock a pen to transfer information, how not to lose it and if it does get lost how to get another one. Conversely, traditional DCPMS software would require substantially more extensive planning, implementation and training costs in time, money and hospital human resources; it would also be perceived industrially as a threat to the status quo of human resource management.

This proof of concept research project is overall significant because the research is investigating technologies not currently used in hospitals and is overall innovative because of the approach to the use of clinical pathways for management of hospital resources.

Research Approach

The research approach is a three stage proof-of-concept project utilising Action Research and Design Science approaches. In action research, researchers and participants work together to make changes in an organisational setting. For the participants a problem is solved and a new work environment is created; and for the researchers a greater understanding of the work environment and work practices is gained (McKay & Marshall, 2001). In a design science approach the outcome of the research is a specific artifact. The design science approach *“... seeks to create innovations that define the ideas, practices, technical capabilities, and products through which the analysis, design, implementation, management, and use of information systems can be effectively and efficiently accomplished. ... In the design-science paradigm, knowledge and understanding of a problem domain and its solution are achieved in the building and application of the designed artifact.”* (Hevner, March, Park, & Ram, 2004, p 75-76).

Stage 1: Analysing current clinical pathway management

The first stage of this project will lay the groundwork for the second and third stages by building a conceptual model (framework) of current practice in clinical pathway data management grounded both in practice and in the literature.

The conceptual framework will be developed from practical and theoretical perspectives:

- Practice: A model of current clinical pathway management at the research site will be developed by conducting interviews with key personnel and examining documents at the research site. The purpose is to describe and provide an understanding of how current clinical pathway data is collected analysed and reported; and
- Theory: A theoretical framework will be developed based on an in-depth review of the current literature on accepted clinical pathway management practices and infrastructure, and any literature describing the introduction of similar digital approaches in similar settings.

Stage 2: Development of digital pen based infrastructure for clinical pathway management

Based on the framework developed in Stage 1, in consultation with industry partner experts in the ‘front-end’ digital pen-paper technologies, an appropriate ‘back-end’ web-browser enabled proprietary database will be designed and integrated to create a digital clinical pathway management system (DCPMS). The ‘front-end’ digital pen-paper technology allows users to simultaneously record data on special paper-based forms while capturing and authenticating that data in digital form which can be uploaded to computer systems using wireless technology for checking, processing and reporting. The ‘front-end’ database is essentially an interpretation engine that recognises handwriting and converts it into digital letters and numbers (and words); it also creates an exact copy of the hand written document and stores it as a picture file (jpg) or pdf file. This software and subsequent data is stored in a pre-defined directory on a secure computer (server) of choice – that is where it ends. Images and data are converted to eXtensible Markup Language (XML) format for transfer to a digital repository such as ‘back-end’ web-browser enabled proprietary database. XML ‘is a simple, very flexible text format derived from SGML (ISO 8879). Originally designed to meet the challenges of large-scale electronic publishing, XML is also playing an increasingly important role in the exchange of a wide variety of data on the Web and elsewhere.’ (W3C, 2008). Digital pen-paper technology working in real time can be integrated with the existing mobile digital data management environment. This technology seeks to address the issue of time spent entering paper-based data into computer systems, timely access to data collected at the bedside and providing data to assist in auditing and resource management. It is expected that there will be a continuation in the use of paper records (to be determined by hospital management) to ensure the hospital maintains its ability to meet any existing and ongoing statutory obligations.

As part of the design and development of this system, the role of e-health standards associated with the technology will be explored. This project is in line with the National E-Health Transition Authority (NEHTA) e-health initiative (NEHTA, 2010) in that it is a move away from paper-based systems to the use of electronic access, transmission and recording of health information. Similarly, this technology will provide a prototype of end-to-end integrated e-health with the potential long-term benefits of:

- streamlining the secure delivery of healthcare information
- removing repetitious and inefficient processes
- improving patient healthcare outcomes
- providing more secure, convenient and co-ordinated interactions across the many different parts of the health system

Stage 3: Implementation, evaluation and review of the digital clinical pathway management system (DCPMS)

The third stage of this project adopts a participatory action research approach where researchers, industry partners and hospital staff are involved in developing a system in an organisational setting – in this case a DCPMS in a hospital ward setting. This will involve the implementation of the DCPMS on a single ward. This will be followed by a cycle of evaluation based on feedback from staff and reconfiguring based on learning, iteration by iteration. That is the process in Stage 3 is the typical action research approach where learning and reflection where each iteration affects change in the next iteration.

Once the proof of concept shows that the DCPMS technology can be used reliably in a tertiary hospital, providing service utilisation data as information in a variety of user-friendly ways (PC, Laptop, PDA, etc.) and for ongoing (time-reduced) clinical pathway auditing and other management reporting (for example using Crystal Reports), then the technology can be ‘rolled out’ for all clinical pathways (which is beyond the scope of this proof of concept project). The multidisciplinary team will be surveyed to measure resource consumption and identify perceptions of clinical decision support and outcomes of care using both traditional paper based systems and the DCPMS on similar patient cohorts, for comparison and evaluation.

Potential Implications

Reliable clinical pathways data can provide:

- evidence to support appropriate nursing resource reimbursement;
- potential to build future workflow processes for costing and coding of nursing procedures and practices;
- potential to integrate a range of clinical decision support and workflow process tools (clinical pathways) within existing hospital information technology systems;
- Potential to export the Australian model and technology to the many other international health care systems that are increasingly turning to Casemix hospital funding models;
- Enhancement of DCPMS as an enabling technology to contribute to national productivity and growth; and
- Smart use of Australian technology to enhanced financial and nursing resource management.

The development of a ‘proof of concept’ digital clinical pathways management system (DCPMS) would provide a demonstration of the potential significant benefits to the Australian healthcare system in improving the efficiency of clinical pathway management. These benefits include improved outcomes of care arising from a better match of patient requirements to nursing care and other health resources and better management of resources where savings can be re-directed into front-line patient care. This Australian innovation could then be exported to international health systems that are increasingly turning to hospital funding models that utilise clinical pathway information.

- It is vital for hospital management to improve resource management, for example, by gaining a better understanding of hospital beds utilisation and management and how it relates to LOS of individual patients, hospital management can directly affect the level of Casemix funding it attracts from Government. Continuing the example, if patients are not being discharged when medically ready and are staying in hospital longer than medically necessary then their individual LOS increases and potentially reduces the funding available to hospitals under Casemix funding. Many public hospitals do not have the resources to efficiently collect service utilisation data in a timely and readily available format; so the management of these hospitals would be extremely interested in any tool that can easily help provide service utilisation data in an efficient and timely manner particularly data derived from clinical pathways.

Conclusion

This paper has outlined a research project currently in progress which is investigating the use of new technologies (digital pen and paper) as a way of improving and enhancing patient care by digitising clinical pathway data for timely analysis and feedback.

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The lessons learnt from this project will be applicable to other uses of digital pen and paper for data collection at the point of care and the use of digitised clinical pathway data for supporting clinical decision making and resource management. Clinical pathways have been adopted in most Australian hospitals and we expect great interest in a system for digitising hospital data using the DCPMS after the proof of concept project is completed.

Acknowledgements

This project is supported by an Australia Research Council (ARC) Linkage Grant (LP0989160). The authors wish to acknowledge the support of Peninsula Health and Frankston Hospital Victoria, NEC Australia, the Print Media Group and Monash University.

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