SIMULATION OF A MULTIMEDIA PATIENT RECORDS SYSTEM

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ABSTRACT

The paper highlights the need for, and the benefits of using, simulation during the development and implementation of modern healthcare systems. Whilst healthcare establishments already utilise information systems in a wide variety of disciplines, the majority of systems are currently isolated, with patient records largely based upon manual methods. As such, it is envisaged that the establishment of composite, multimedia-based patient records would considerably aid care delivery. After a brief discussion of the advantages that this would bring, the paper proceeds to highlight how simulation can be employed to aid system design and development in a number of areas (including the user interface, records structure, security, networking requirements and the profiling of future application demands). The discussion is based upon work currently being conducted by the authors within a practical research project.

INTRODUCTION

During the past twenty or more years computerised information systems have gradually been introduced to, and utilised within, a large number of Health Care Establishments (HCEs). Modern medical care requires the use of computerised systems to process, visualise and store vast amounts of information. The data produced by these more advanced medical systems consists of not only simple textual data but also digital images, full motion video, audio and visualised graphics (Nelson and Todd Elvins 1993). The use of computerised systems, both centralised and departmental, has resulted in HCEs being able to offer ever more complex and comprehensive medical care.

INFORMATION TECHNOLOGY IN MODERN HEALTHCARE

Computers now form an integral part of the process of administering and monitoring patient care. Additionally, computerised systems have also enabled a wide range of complex scanning and diagnostic procedures such as Computer Tomography (CT), Magnetic Resonance Image (MRI) and Ultrasonic Imaging to be offered (with the information gained then being utilised in the planning and delivery of further medical procedures). The increased use of information technology has resulted in clinicians being able to collect, generate, analyse and interpret ever greater amounts of patient data. The availability and quality of this data then enables the clinicians to prescribe and administer the most appropriate healthcare programme for the patient.

However, at present, within many HCEs there are growing problems associated with the management and organisation of the rapidly proliferating amounts of both patient data and management / administrative information. Due to the fragmented development and implementation of the HCE information systems, there tends to be little or no integration or exchange of data between systems. The lack of information organisation, in conjunction with the sheer volume of data, can often result in decreased clinical efficiency, as more time is spent attempting to search for and retrieve data from different systems. Thus the benefits offered by the availability of increasingly comprehensive patient data are diminished and, therefore, in order to improve the situation data needs to be made more portable, accessible, comprehensible, and appropriately structured.

It is widely envisaged that these problems could be overcome by the adoption of composite patient healthcare records, based around multimedia technology (Treves et al. 1992).

ADVANTAGES OF A MULTIMEDIA-BASED HEALTHCARE RECORD

The use of multimedia patient data in healthcare has already begun and will inevitably increase as more clinicians are afforded the opportunity to produce and utilise high quality data at a relatively low cost. There are currently two developmental paths to the production and utilisation of multimedia data within healthcare. The first is that offered by the ability to obtain "raw" data via advanced techniques such as MRI and CT, which can then be visualised, manipulated, rendered and animated by powerful workstations, to generate the desired end result. At present this route is expensive due to the data collection and manipulation tools required, although it is already implemented in larger HCEs. The other path is that offered by the PC, where technological advancement is now reaching the point where clinicians can produce high quality multimedia data (including video, audio, graphics, images and text) both easily and relatively inexpensively.

Thus the way is clear for clinicians to be able to create and utilise multimedia clinical data. A composite multimedia record would improve the provision of patient care, as clinical decisions would be made with all the multimedia patient data available on one system, in the most easily comprehensible and informative manner.

The ability to view patients records easily will in turn enable clinicians to more comprehensively assess patient needs, responses to treatments, and on-going progress and may aid clinical decision making. Thus the patient will benefit from the use of multimedia data, in that they will be prescribed the most appropriate care plans. In addition, the healthcare providers benefit from the comparative cost reductions facilitated by the administering of the most suitable patient care.

The proposed system would ideally be able to integrate with any existing systems holding patient data, meet the desired user requirements, be secure against malicious or accidental intrusion, facilitate data communications within and between HCEs and be able to accommodate future medical advances and changes in working practices (Orozco-barbosa et al. 1992).

However, the introduction and implementation of multimedia patient records may prove to be problematic if there are not accompanying advances and improvements in the structuring, integration, portability, accessibility and comprehensibility of the data generated.

DEVELOPMENT OF A SIMULATION-BASED PROTOTYPE SYSTEM

This section examines practical work that is being undertaken by the research team to help realise the composite multimedia healthcare record concept. The general background is discussed, followed by a description of the simulation aspects involved.

Project Aims and Background

The remit of the project was to establish where the use of multimedia would be most applicable in healthcare and to define the structure, content and interfaces required for a multimedia-based records system. Additional considerations were the definition of most effective systems working practices, with the procedures required for the creation, appending, manipulation and management of the patient data.

The systems development was based at Derriford Hospital, a major HCE local to the research team. In terms of information systems, this establishment is similar to numerous others in the UK. Apart from a centralised Patient Administration System (PAS - which is accessible from all departments), a few independent departmental systems and a number of specialised stand-alone machines, the majority of patient data is generated and maintained manually.

It was established through interviews (described below) that the use of computers is alien to the majority of hospital personnel, with a worrying (and widely held) perception that computers will not form part of the future for healthcare. This view was generally based upon the belief that the computerisation of many operations and working practices would be costly and offer no real advantages. These factors suggested that the development of a simulation-based prototype would be the best way for the project to proceed, as this would allow an opportunity to demonstrate the future possibilities and benefits that would be offered, breaking down the resistance of the users.

Research Methodology

The task of developing a composite, multimedia records system is obviously immense. For this reason the scope of the study was limited, with a single department being selected to act as the "base" for the project. It was considered that the base should be a department in which there would be a number of opportunities for the introduction and use of multimedia patient data and one in which the patients are often referred to and between a number of closely associated departments over long treatment periods. As such, the Ear Nose and Throat (ENT) department was selected, with Radiology, Speech Therapy, Plastics, Microbiology, Dental Specialities and Maxillo-Facial departments as peripheral or closely associated referral departments.

The research method selected was that of performing discursive interviews throughout the selected departments. A range of staff were covered, from consultants to secretaries, so that the full scope of the departmental operations could be assessed. The data obtained was then used to create a prototype system which would then undergo recursive refinements. The desired system requirements and established working practices, along with user and departmental data exchanges and paths, were then abstracted and modelled from the interview results.

A significant issue in the design of the system was ensuring integration with current, and possible future, clinical practices. To this end, clinical staff were asked to identify "core non-flexible" and "core flexible" clinical and administrative practices and procedures. The "core non-flexible" practices and procedures were those which it would be impractical to change to any extent and which must, therefore, be maintained whether the patient records system was computerised or not. The "flexible" practices were those which could be re-engineered so long as the desired end result was still achieved.

The "non-flexible" practices tended to be made so by being either time sensitive (e.g. the requirement for immediate clinical reporting of results within the Radiology department, as delays could potentially compromise patient health) or a matter of established medical convention or clinical practice (e.g. that departmental appointments are always made internally). As such, the departments involved would find it impractical to perform them in any other way.

The "flexible" practices were those which could be made easier by the computerisation of the Patient Records System. These included the ordering and tracing of patient notes, the appending of data, and the searching for clinical details.

The interviews also established where it would be clinically appropriate to generate the multimedia data which would be used within the proposed records system. The selected departments each considered where, within their clinical discipline, it would desirable to obtain multimedia patient data (for instance, when would it be desirable to have video data of the patient, and what were the practicalities of generating it ?).

Uses of Simulation

Having used the interviews to establish the basic system requirements, the study could proceed to consider prototype implementation.

It is envisaged that once an initial prototype is developed and in-place at the hospital, simulation will form the core of its future development. A cross section of users will initially simulate the typical everyday use of a small number of demonstration multimedia patient records. From this the desired systems interface can be established. A number of different records structure styles can be offered, with the users then determining which is easiest to use. Different clinical scenarios will be simulated, which will require the records to be manipulated in a number of different ways.

From the record usage simulations a comprehensive range of individual record search options will be defined. These will indicate and define those data items and criteria (such as previous surgery, previous treatments, current and past medication, family history, noted medical conditions, etc.) by which the records need to be searched.

Once the use of individual records has been simulated, the project will move on to simulate a system dealing with a number of records, defining the functionality required with respect to multiple records. The users will be able to define the searches, and other functions, which the system must be able to perform between separate multimedia patient records. Thus at the end of the record usage simulation stage the preferred user interface, record structure, and intra and inter-record functionality will have been defined.

The next stage will be to simulate record creation and maintenance. Simulation in a real clinical environment will enable the clinicians to determine where, and when, it is practical to obtain multimedia patient data. The data collection processes must not intrude upon, or compromise, clinical working practices. The staff must then simulate the editing of the patient data, and the record appending practices required, again in a manner which integrates with other working practices.

Simulation will, therefore, enable the users to define and develop the most suitable practices for the collection, processing and maintenance of the multimedia patient record data. If these procedures can be made as simple and easy as possible then users, both clinical and administrative, will be far more inclined to pursue the use of multimedia in healthcare. The simulation environment may then be extended beyond this to consider other important aspects relating to multimedia records system implementation, including security, network requirements and additional functionality.

The requirements for data security can be considered and various approaches simulated. It is envisaged that the multimedia context will require an approach to security that is as transparent as possible, so as not to unnecessarily detract from the otherwise user-friendly nature of the environment (Furnell et al. 1995).

As an example, whilst user authentication could principally be based around a traditional password approach, it might be desirable to evaluate more friendly (and secure) methods within the context of the simulation environment. Alternatives could include the use of smart cards, real-time supervision systems (verifying identity by analysing factors of user behaviour such as typing styles and application usage) and / or various biometric identification techniques that might be feasibly implemented using existing multimedia hardware (e.g. faceprint or voice recognition). Through the simulation study, appropriate techniques or combinations could be established as required by different user groups.

There will also be a need for security restrictions at the departmental and user levels to control access, modification and deletion of different aspects of the overall records.

Once the security aspect has been simulated, the study can move on to define aspects of the systems network requirements and possible additional functionality. The users will continue to simulate the everyday use of the system, but it will be extended to include additional features. These will include a range of departmental administrative, clinical audit, and management functions. A number of the proposed functions will reference the patient records data, whilst others will reference other data sources, some localised and some remote.

At this point the prototype simulation will not only be defining the desired additional system functionality, but will be helping to determine the systems integration and network requirements. By simulating the additional system functionality, the simulation will be able to establish those existing, or proposed, hospital systems from which data will need to be accessed. Thus the system integration requirements will be defined. The systems networking requirements will also be eluded to by the simulation of the additional functionality. From the use of the prototype it will be possible to determine the quantities of non-localised data required by the users, the data types required over the networks, and the acceptable system data throughput and response times, as well as the types and quantities of data transmitted by the users. Hence the simulation will give an indication of the systems network requirements. Security of data communications could also be considered here, with the simulation study considering various techniques that may be appropriate to ensure the confidentiality and integrity of transmitted data, as well as requirements for non-repudiation services (AIM SEISMED 1994).

The system simulation will also provide a valuable insight into the systems usage patterns with respect to the user types and help to determine the optimum working practices and duty ranges, for the different user types within the base department. Different systems operational modes may be simulated, in which the different user groups have subtly varying roles and duty ranges. From the simulation results the departments optimal operational mode can be established, thereby maximising systems and departmental efficiency.

CONCLUSIONS

At the end of the project, after the use of simulation as a development technique, in conjunction with the progressive implementation, extension and refinement of the prototype system, the users will obtain not a fully defined system but one which a least starts to address and overcome the numerous problems associated with the development of a multimedia healthcare records system.

A simulation study as described would allow time for end users to become more familiar with the technology involved and would hopefully result in the development of a system which is of real benefit to them. The experimental period would also enable the clinicians to determine where, and to what extent, the use of multimedia patient data is most advantageous. The in-place use of a simulated prototype appears to be the only real option for the development of suitable systems as it is only through such an approach that the desired end result will be achieved.

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BIOGRAPHY

Nichola Salmons graduated in 1991 with a BSc. in Applied Chemistry from the then Polytechnic South West (now University of Plymouth). This was followed by a PgD. in Computer Technology and Software Applications from the University of Central Lancashire in 1992, and an MSc. in Telecommunications Technology from Aston University in 1993. She is currently working towards her PhD at the University of Plymouth, the aim of which is to develop a “Composite Multimedia Healthcare Record”. Steven Furnell is currently collaborating in this work, which is being supervised by Peter Sanders and Colin Stockel.