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Infiltrating IT into Primary Care: A Case Study

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Abstract

Web based approaches to tracking students on placement are receiving much interest in the field of medical education [1, 2] The work presented here describes a web-based solution to the problem of managing data collection from student encounters with patients whilst on placement. The solution has been developed by postgraduate students under the direction of staff of the health informatics diploma. Specifically, the system allows undergraduate students on placement or in the main hospital to access a web-based front end to a database designed to store the data that they are required to gather. The system also has the important effect of providing a rationale for the provision of electronic communication to the undergraduate students within the context of healthcare delivery. We believe that an additional effect will be to expose practicing healthcare providers to electronic information systems, along with the undergraduates who are trained to use them, and increase the skill base of the practitioners.

1. Introduction

A General Practice placement in the community is a compulsory part of the undergraduate medical curriculum at the Wellington School of Medicine, along with hospital-based placements. As part of their assessment students are expected to record information about the patients they have seen on placement. This information is used to allow the students to investigate some characteristic of the patient population they and their peers see in training. This forms the basis of a project presentation at the end of the fourth year. Current tools for this data collection and analysis exercise are inadequate. In addition, students have had little training in the use of electronic information and analysis tools. In order to support this aspect of the undergraduate curriculum better a system development project has been undertaken to provide a web-based method of recording information about patient encounters.

Since July 1998 the Information Science Department at the University of Otago in conjunction with the Wellington School of Medicine has been running a postgraduate diploma in Health Informatics. The postgraduate students involved in the system development project described in this paper are enrolled on the diploma. The setting up and management of this diploma are further described by Parry et al. [3-8]. The course is offered part time and at a distance. Students are mainly from general practice and nursing backgrounds. The particular cohort of students involved in the system development project have selected the health information systems paper which has two papers as prerequisites, these cover basic information management skills and an introduction to health informatics. Figure 1 illustrates the relationship between those developing and delivering the system and the users of the system.

Students on the post graduate diploma are well placed to appreciate the problems encountered by both general practitioners and medical students, since they are primary health care providers with a specific interest in health informatics, who did not receive training in the topic as part of their undergraduate studies. Thus they form the interface between practitioners in healthcare and academic knowledge in health informatics. As part of their diploma they can choose to undertake research leading to a system development project.

This paper describes a web based approach to tracking undergraduate medical students progress whilst they are on placement. It also explores how such an approach benefits the developers of the system, the staff involved, the undergraduate students and the staff at the students' placements. Section 2 describes the current situation with regard to Information Technology (IT) literacy amongst undergraduate medical students and practicing clinicians. Section 3 outlines how the development of a web based data entry system for undergraduate medical students can benefit all participants. This is described from the point of view of the postgraduate and the undergraduate students. Section 4 gives some technical detail on how the system was developed. Lessons learned from the project are described in the discussion in section 5 including how the project was managed and what obstacles were encountered. In section 6 the extent to which the wider aims of the project have been met are assessed.

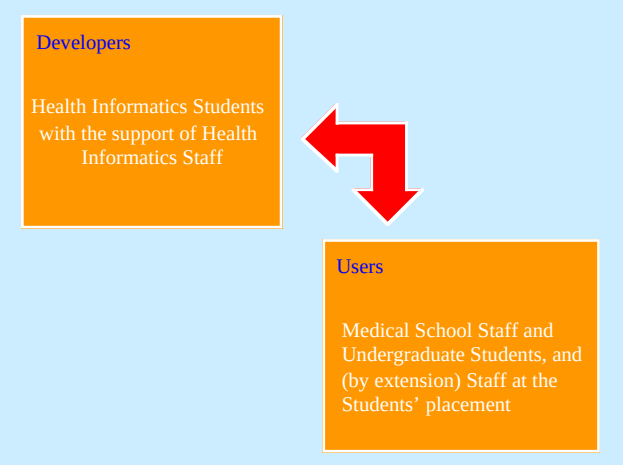

Figure 1 Developers and users of the web based reporting system

2. The problem

Whilst efforts are being made to incorporate IT in the undergraduate curriculum [1, 9], a greater challenge lies in bringing IT to practicing clinicians. This was identified by Coiera who stated that this group *"…will be expected to work for many decades in an environment in which IT illiteracy will become increasingly burdensome "* [10] page 319. The following section elaborates on the reasons behind this assertion and in this context, identifies the objectives of the current work.

2.1. Motivation for the work

It is important for primary health care providers to increase their informatics skill base in order to take advantage of services that can be added to the activities of a GP practice using desktop systems and the Internet. A number of these services were identified by Carlile and Sefton [9]. These are discussed below.

2.1.1. Prescription support and tracking and online access to pharmaceutical information. There are two advantages immediately apparent to the practitioner. First, it is possible to provide a means of checking misprescriptions, interactions and dosages, and second an audit can be kept on which drugs are prescribed and at what cost.

2.1.2. Links to international medical digital libraries and information reviews. It is possible to get online access to enormous numbers of abstracts from the medical literature via Medline [11]. Electronic versions of the major medical journals are increasingly available -such as the British Medical Journal [12]. Another example is the Cochrane Library [13], which is an electronic publication, designed to supply high quality evidence to inform people providing and receiving care.

2.1.3. Patient advisory services and web sites. As a critical mass of Internet users develop, it will soon be possible to use electronic communication between physicians and patients. This type of communication via e-mail and the Internet has profound implications for the patient-physician relationship. This is explored in [14]

2.1.4. Medical news groups and forums. Electronic discussion lists are used by many groups, including GPs, for communication and information sharing. The technology offers potential for formal learning and professional development. Various models have been proposed to describe the dynamics of such 'virtual' forums, these are described in [15]

2.1.5. Continuing medical education (CME) programs. These have been shown to improve the performance of primary health care providers [16]. Access to such programs via the Internet is desirable for clinicians in remote areas.

2.1.6 Electronic Claims for reimbursement

New Zealand is moving to a single patient identifier, which will be required for all reimbursement claims. The Intention is to have electronic access to this number for every health professional via a health intranet [17].

It was also identified in [9] that the level of IT competency among interns and residents is generally low. This is a common problem identified in [1]. In the current project and in the work of Maulitz et al [1], the greatest importance is placed on making computer skills and applications an integral part of the general practice placement. The specific requirements are for an easy to use database, which is accessed via the web and stores details of student patient encounters and reports on them both on an individual basis and statistically for the benefit of staff and other students.

3. A contribution to raising the IT skill base of clinicians

One approach to mitigating the problems identified above is to train practicing physicians to be IT literate by means of CME, and such courses as the postgraduate diploma. The approach described here aims to introduce greater IT awareness into physician's practices via the students that are on placement with them. By the time the students go on placement they are conversant in accessing digital libraries and information reviews online and have developed an understanding of the issues involved in managing health data. The effectiveness of the notion of "seeding" interest in IT has yet to be measured. However a working web based encounter management system has been developed, which will be accessed by the students on placement during office hours and is likely to raise awareness of the possibilities of the internet for accessing medical information and services. This system is described

from two perspectives in the following sections, firstly from the point of view of the undergraduate medical student and teaching staff and secondly in terms of providing a coherent program of study for the postgraduate diploma in the field of system development. Technical detail of the system implementation is given in section 4.

3.1. The undergraduate data collection exercise

The Wellington Medical School accepts students from their 4th year. During their 4th and 5th years, they study Health Informatics. Part of the 4th year study is a clinical data collection and analysis project.

The students are on clinical attachment in the following areas:

- Community (General) Practice
- Mental Health
- Emergency Medicine and Anaesthesia
- Internal Medicine and the Elderly
- Neurosensory (Neurology, Neurosurgery, Eye, ENT, Endocrine)
- Gastro-Intestinal (Gut)
- Clinical Skills (Medicine)

The students record data on 20 consecutive patients from each of two hospital-based runs, and 30 patients from the general practice based run. In 1998 the total number of encounters recorded by all students was in the order of 1500.

Before the development of the web based patient encounter system, the students on attachment used encounter sheets (see appendix 1) in a log diary to record patient data. They were issued with written instructions in the use and coding of this data in the log diary.

The data was then transcribed into a stand-alone Access database in the medical school computer facility that contained the same fields as the encounter form.

Each page of the log contained the written data for one patient (the "encounter form"). The student transferred this data to the computer daily, weekly or when and where access is available. In a situation where the student was away from the university for some time under this regime it was difficult for teaching staff to monitor individual student progress or identify problem areas to monitor their progress.

The data that the students collect is intended to be used to document morbidity patterns seen during the period of attachment and to record a commentary on the experience. It is used to compare data from patients attending a general practitioner with data from patients seen in hospital settings of various types.

Using the stand alone system, students could only enter data from encounter sheets into their own locally held database, in the university computer lab which meant Students were unable to view group or mass data

The new web based system is due to go into use in February 2000. It offers students the ability to enter data at their placement, and also view summary data of the encounters of other students. Tutors can also access the data to see that students are seeing the requisite number of patients in the right balance and are not falling behind.

3.2. Details of the system development project

The students of the health informatics diploma who choose the information system development stream are expected to develop an understanding of the issues involved in managing and coordinating large system development projects.

This course uses the skills the HEIN students have gained on earlier papers [5] and consolidates their systems analysis and design skills

For the purposes of this project HEIN postgraduate students are divided into three groups.

- Back-end designers - Responsible for table design, query writing triggers etc. along with production on the target machine
- Interface designers - Responsible for the look and feel of the web pages and their functionality
- User relations/business analysis/implementation - Responsible for obtaining the user needs- relations with the users, and documentation production

The teaching objectives of the project were to:

- Understand the potential of placing a database on the web
- Understand the organization of a large project
- Develop negotiation skills
- Develop the technical skills needed in the particular group they are in.

After an initial meeting with the clients (undergraduate medical teachers), each group had a meeting once a fortnight to discuss technical issues relating to their aspect of the project, there is also a meeting once a fortnight involving representatives from each of the groups. Thus there are intra-group meetings one week alternating with inter-group meetings the next. There are two deliverables, and access prototype and a fully operational web version. Emphasis is placed on managing these meetings and negotiating compromise in design and implementation appropriately.

Given that this is a distance learning course, meetings are conducted via the web using NetMeeting (Microsoft). NetMeeting operates with an OnLive server, which allows multipoint audio via a web interface, and H.323 server. Up to 25 people can participate in meetings simultaneously.

System development by geographically isolated teams presents some interesting challenges in itself. These are discussed at greater length in section 5.

A useful tool for managing project reports and documents is the web-based document sharing system BSCW (Basic Support for Co-operative Work). Students are conversant with the use of this system from experiences on earlier papers.

BSCW was developed by the German Institute for Information Technology [18, 19] BSCW is a series of Python scripts that run on an HTML server and allow secure file storage accessed via web pages. With a sophisticated access control system and a rich array of threading and versioning features group members can be presented only with those areas to which they should have access, i.e. discussion groups, a software archive and their project area. The teaching staff has access to all areas that include the definitive documents for the course production, student results and administrative areas.

4. Method

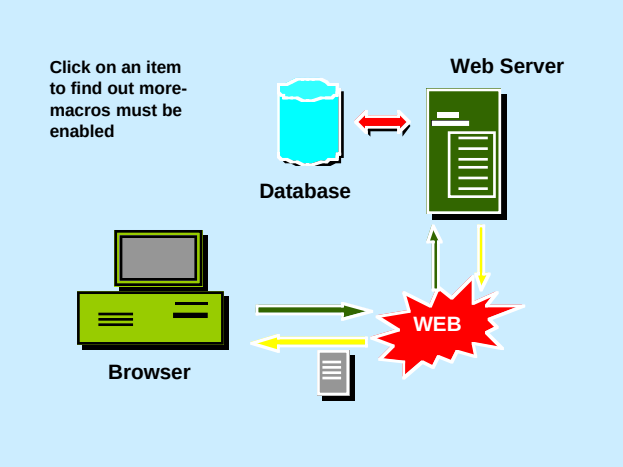

Figure 2 Architecture of the web based reporting system

Figure 2 illustrates the architecture of the reporting system developed here. The database holds all the student morbidity system data. Initially developed in Access, it is designed to run on SQL Server in production. The database includes all the tables, queries and other objects needed to allow students to add data to the database and view data and reports from it. The database is physically located on one of the servers at Otago.

The Web server handles the requests for web pages sent by the browser. When the user goes to an URL the web server checks to see if the file requested exists and whether the user is allowed access to it. If an HTML page has been requested then the web server sends the HTML file down to the browser. As the browser interprets the HTML page, if it finds tags that indicate that indicate images etc. are needed the browser requests them as well. Requests for data from the database are handled by the web server, which strips out the appropriate tags and passes the SQL statements through to the database. The data that the Database sends back is then inserted into the page, which is sent down to the browser

Information is transmitted over the web - this may be subject to interception or corruption so security must be considered. This is an important issue in medical practice, see, for example [20], and forms part of the Health Information Systems curriculum on the Health Informatics Postgraduate Diploma.

Web Pages, including active server pages, are created by a combination of HTML and data from the database. At it's simplest the browser sends requests for pages (the URL) and other files (from the tags within HTML files) see Figure 3. Data can also be posted by the browser to the web server, both for input into the database and construction of queries, see Figure 4.

In the first case (the report style) a defined report can be produced using a known value e.g. select firstname from names where surname = "cockcroft"

In the second case (the interactive style) parameters can be passed to the report by means of variables e.g. select firstname from names where surname = variable_name

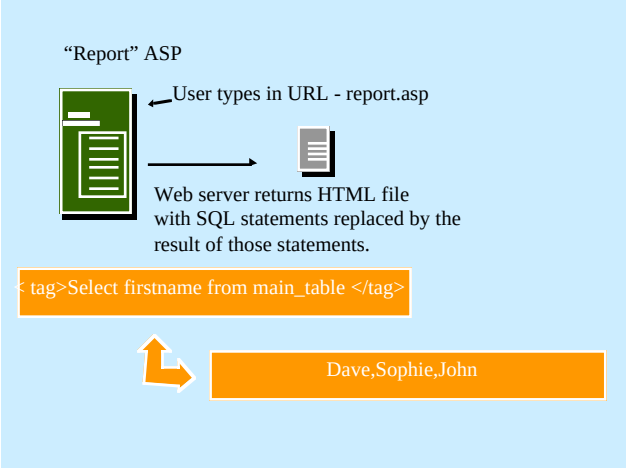

Figure 3 "Report" style active server page (ASP)

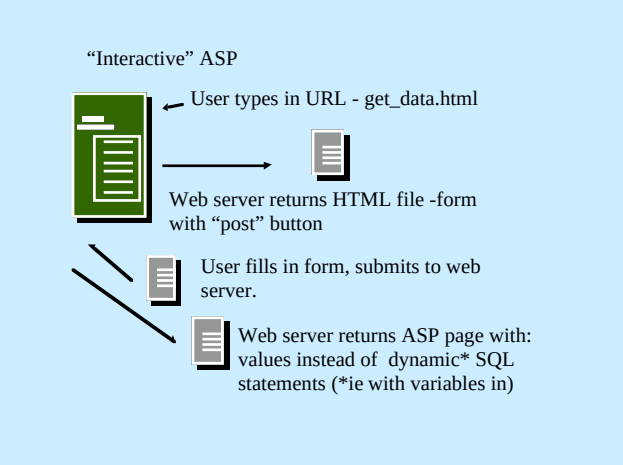

Figure 4 "Interactive" style active server page (ASP)

5. Discussion

The system development described in this paper is complete in prototype form and due to go into production in the first semester of 2000. In this section advantages of the system are described. Some challenges of carrying out the system development are also discussed.

5.1. Advantages of web based system to delivery of undergraduate program

This paper described the development of a web based system for recording patient encounters. The key issue here is that students can access the database from wherever their placement is, and also pull down reports of group and class activities for comparison. This is a major improvement on the existing system where students could not enter data immediately and were likely to fall behind. In addition tutors can monitor the progress of students and ensure that they are seeing the right number and balance of patients.

5.2. The challenge of system development by a geographically distributed team

Developing the web based encounter management system remotely has provided a number of distinct challenges. The importance of clear and unambiguous communication has been demonstrated. E-mail is inadequate for exchanging system documentation and code because of the danger of it not reaching all participants and a lack of version control. It has become evident that it is important to keep track of all change requests and actions in a central location. In both the above cases BSCW is a useful tool, but there has been some inertia is its adoption. Intergroup discussion via E-mail have led to conflict due to the permissive nature of the medium, and E-mail traffic has been extensive with a total of over 800 messages exchanged in the course of the project. It would be impossible to conduct a system development project without regular audio meetings to explain progress.

6. Conclusion

In this paper the larger problem of bringing informatics to primary health care providers, and incorporating it in the medical curriculum was described. Drivers for increased connectivity and use of IT are already in place, as described in section 2 but training of practitioners is still a major problem. The provision of the web-based database we have described will encourage the use of the technology in the primary sector by the undergraduates. These undergraduates in turn provide a reservoir of computer-literate people who can act as facilitators within the primary care environment, demonstrating a successful and useful application of IT. Effectively, we hope that the primary aim of increasing undergraduate medical students' knowledge of informatics will be followed by an infiltration of this knowledge into the general practice environment. At the same time the experience gained in developing this system will enhance the learning of the postgraduate students, and encourage the formation of a community of individuals with significant skills in this area. As this system has not yet been introduced, all these gains are speculative, but formal assessments of the impact of this system are planned.

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APPENDIX 1 - ENCOUNTER FORM

Student Number		**Group Number**		**Patient Number**	

Encounter Interviewer		**Responsible Doctor**	

Location		**Attachment**	

Date Seen	**Patient ID**	**Date of Birth**	**Sex**	**Consent**

Consultation Type	

Presenting Symptom 1	
Presenting Symptom 2	
Presenting Symptom 3	
Number Presenting Symptoms	

Diagnosis 1			
Diagnosis 2			
Diagnosis 3			
Number Diagnoses made			
Psychosocial Problem		Number of Psychosocial Problems	

INVESTIGATIONS		**DRUG TREATMENT**		**REFERRAL**	
Haematology		Antibiotic		Referral 1	
Bacteriology		Anti inflammatory		Referral 2	
Biochemistry		Analgesic		Referral 3	
Cytology Cervix		Anti asthmatic			
Cytology other		Contraception		**PROCEDURE**	
X-Ray straight		Gastrointestinal		Procedure 1	
X-Ray contrast		Anti hypertensive		Procedure 2	
Ultrasound		Cardiac other		Procedure 3	
Other investigation		Hypnotic/tranquilliser			
		Anti depressant			
		Insulin/hypoglycaemic		**FOLLOW UP**	
		Other Drug			

Number Investigations		Number of Drugs		**ADVICE**	

COMMENTS	

CONSULTATION TYPE		**ATTACHMENT**		**INVESTIGATIONS**	
Patient Initiated	1	Mental Health	1	No investigations	1
Follow up Acute Illness	2	Emergency Medicine & Anaesthesia	2	Haematology	2
Regular Exam Chronic Illness	3	Community (General Practice)	3	Bacteriology	3
Health Check	4	Internal Medicine & Elderly	4	Biochemistry	4
Obstetric Care	5	Neurosensory	5	Cytology cervix	5
Admission	6	Gastrointestinal (Gut)	6	Cytology other	6
Other	7	Clinical Skills	7	X-ray straight	7
ENCOUNTER INTERVIEWER		**DIAGNOSES**		X-ray contrast	8
				Ultrasound	9
Consultant	1	None	1	Other	10
Registrar	2	Respiratory Systems	2	**Total count**	
GP	3	Upper respiratory tract infection	3	**DRUG TREATMENT**	
Student Alone	4	Asthma	4		
PRESENTING SYMPTOMS		Nervous System	5	No drugs	1
		Otitis Media	6	Analgesic	2
No symptoms	1	Eye problems	7	Anti asthmatic	3
Cough / wheeze	2	Skin	8	Antibiotic	4
Pain in ear	3	Musculoskeletal (non injury)	9	Anti depressant	5
Pain in throat	4	Arthritis	10	Anti hypertensive	6
Pain in abdomen	5	Injury	11	Contraception	7
Pain in back	6	Mental System	12	Gastrointestinal	8
Pain in chest	7	Anxiety	13	Hypnotic/Tranquilliser	9
Pain in head	8	Depression	14	Insulin/Oral hypoglycaemic	10
Pain in neck/shoulders	9	Circulatory system	15	Other drug	11
Pain in upper/lower limb	10	Hypertension	16	**Total count**	
Pain in other part of body	11	Digestive System	17	**PROCEDURE**	
Disturbance bowel function	12	Urological	18		
Disturbance gastric function	13	Pregnancy	19	ACC form	1
Spots. Sores, Ulcers	14	Female genital/breast	20	Wound - suturing	2
Other rashes	15	Male genital	21	Wound - dressing	3
Menstrual Disturbance	16	Blood system	22	Wound - clean/debride	4
Changes in energy	17	Endocrine / Nutrition / Metabolic	23	Reduce fracture/dislocation	5
Emotional / psychological	18	Neoplasm	24	Apply plaster	6
Other	19	Infectious Disease	25	Apply splint	7
Total count		Ill defined condition	26	Apply bandage	8
PSYCHOSOCIAL PROBLEM		Non-illness	27	incise & drain	9
		Immunisation	28	Aspirate	10
None	1	Contraceptive advice	29	Remove foreign body	11
Economic	2	Cervical cytology	30	Remove nail from digit	12
Employment problem	3	Other	31	Eye - irrigation	13
Housing problem	4	**Total Count**		Eye - fluorescein	14
Legal problem	5	**FOLLOW UP**		Eye - apply pad	15
Marital problem	6			Perform CPR	16
Parent & Child problem	7	Return as needed	2	Intubation	17
Phase-of-life problem	8	Asked to return to Surgery	3	IV line insertion	18

Violence	9	Referred Specialist / OPD	4	Vaccination - routine child	19
Other psychosocial problem	10	Admitted	5	Vaccination - other	20
Total Count		Other Health Professional	6	Injection - excl vaccination	21
LOCATION		Other	7	Nebuliser	22
		REFERRAL		Venepuncture	23
GP Consultation	1			Lumbar puncture	24
Hospital Outpatient	2	medical	1	Punch biopsy	25
Hospital Inpatient	3	surgical	2	Excision of lesion	26
A & E	4	other medical	3	Endoscopy	27
After Hours Clinic	5	radiology	4	Record PEFR	28
ADVICE		pathology	5	Urinary catheter	29
		physiotherapy	6	IUCD insertion/removal	30
No advice or information	1	occupational therapy	7	Issue certificate	31
Specific advice/information	2	social work	8	Mental Status Evaluation	32
Unclear advice/information	3	dietician	9	Base recordings temp.,BP etc	33
Other	4				