Providing a Secure Solution For The Integration Of Electronic Prescription Transfer Within The United Kingdom National Health Service

D.P.Mundy

Abstract

This paper provides an overview of how a proven secure solution for the ElectronicTransfer of Prescriptions (ETP), that it is felt could be integrated successfully into the UK National Health Service (NHS), was developed. The described Electronic Prescriptions Processing project commenced in September 2000 and since that time has gone through a lifecycle of requirements elicitation, design and development. The project is now in the final evaluative stages of its lifecycle before its conclusion in August 2003. After its conclusion the project will have made a significant contribution to both the field of ETP and towards the deployment of an ETP system in the UK NHS.

1 Introduction

The United Kingdom Government as part of its national plan of reform [UKGOV] for the NHS is required to integrate a system for ETP by 2004. It is felt that ETP *"has huge potential to bring real benefits to patients, and will make a real contribution to the modernisation of primary care in the NHS."* [HUNT]. The benefits and modernisation will be realised through reduced administration, a reduction in the mechanisms available for fraudulent practice, increased use of technology throughout NHS work practices and perhaps eventually to the death of the hand written paper prescription. However, the switch to ETP will not be without its perils. In an environment where computer security incidents are exponentially increasing the UK Government must adopt a system in which considerable thought has been given to security issues present within the field of ETP [3].

In 2000 Salford University in collaboration with Huddersfield University and Hope Hospital, Salford were awarded a 3 year grant by the Engineering and Physical Sciences Research Council (EPSRC) to investigate the conversion of the paper based practice of prescribing to an ETP system.

The overall aim of the research detailed within the following paper has been: -

to provide a proven secure solution for ETP covering all concepts of computer security that it is felt could be integrated successfully into the UK NHS [MUNDY02].

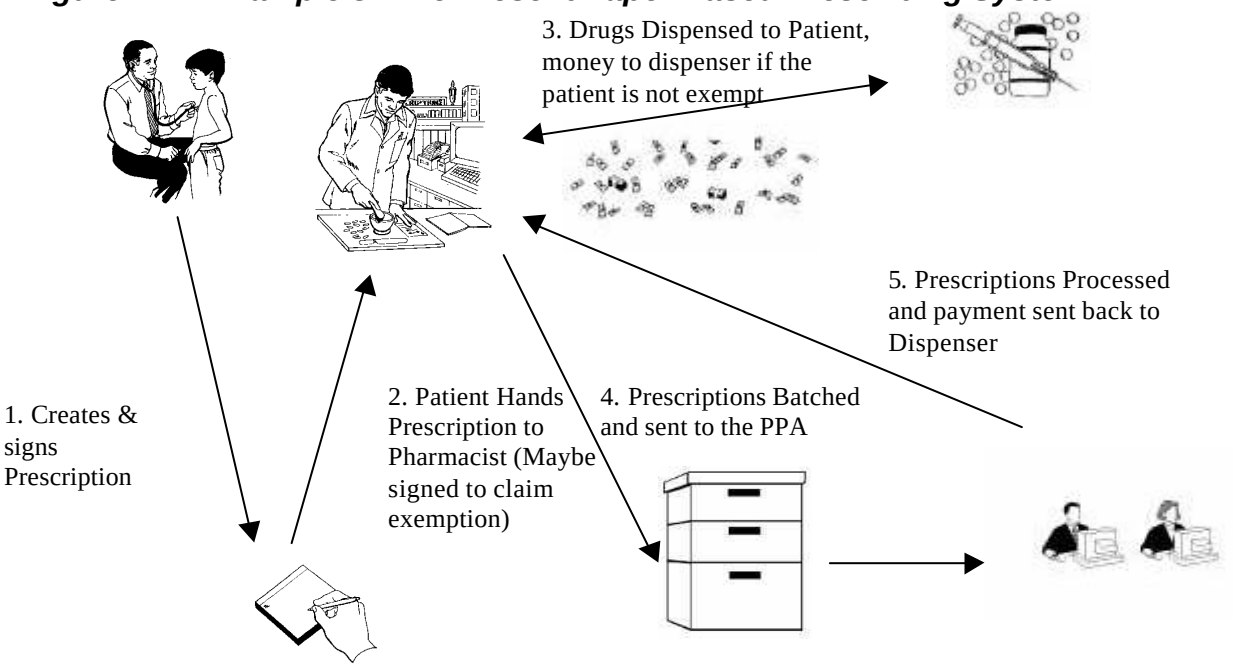
The paper will commence with a simple overview of paper based prescribing in the UK NHS. This will be followed by a brief introduction to the system designed, constructed and evaluated. The methods used throughout are then described. Finally the conclusion section of this paper will sum up the reasons for choices made.

2 Paper Based Prescribing

The basics of the paper based prescribing system in the UK are depicted in Figure 1 and described below:

The patient visits their prescribing healthcare provider (General Practitioner (GP), Dentist, Nurse) for consultation. Once the consultation is complete the prescribing healthcare provider constructs a medicinal prescription of drugs for the patient on a paper prescription form. The health care provider signs this form by hand. The patient can then take and present this form at any pharmacy in the country. Patients are required to sign the back of the prescription to state whether or not they are exempt from payment. The pharmacist dispenses the prescribed drugs listed on the prescription to the patient and keeps the prescription. Every prescription dispensed by a pharmacy over a 1 month period is batched together and sent to the Prescription Pricing Authority (PPA). The PPA makes payment in lieu for Pharmacy services.

Figure 1 An Example Of The Present Paper Based Prescribing System



3 Brief Overview of Developed Electronic Transfer of Prescriptions System

The model [MUNDY02] developed by Salford University is shown in Figure 2. It is again useful to go through a typical patient/prescriber scenario to describe how the system works in practice.

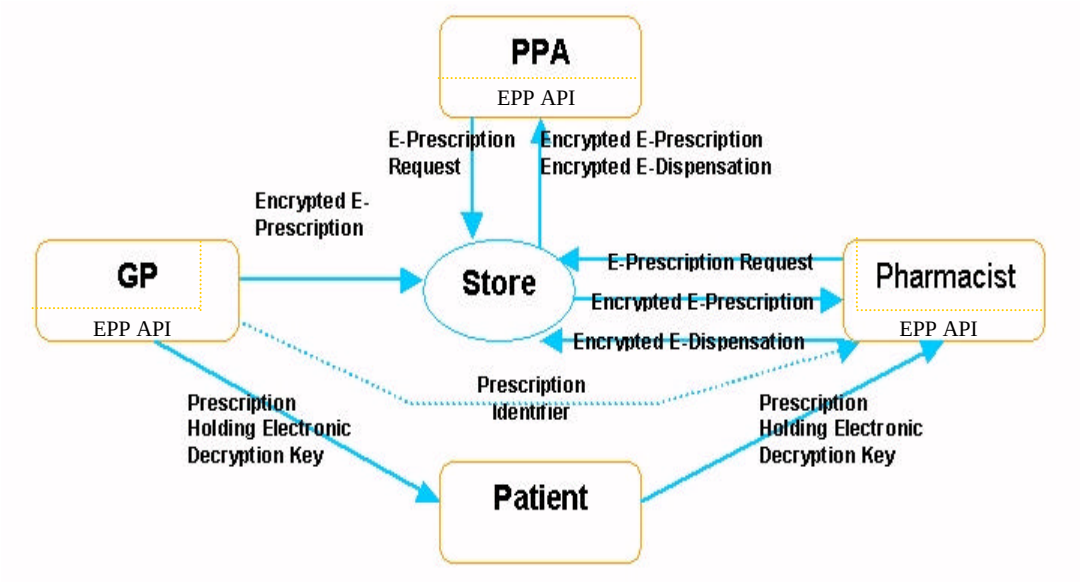
The patient visits their prescribing healthcare practitioner for diagnosis. The practitioner using a modified version of their present prescribing software application would generate an electronic prescription (if required) for the patient. The practitioner would then sign this prescription electronically to create a digital signature. At this point the electronic prescription would be encrypted (mathematically scrambled) to a one time encryption key [BALL] and sent to an electronic prescription holding store (can be one per GP practice, one per region, one for the country). The patient would receive a paper prescription as in the present system but with two barcodes on the bottom. The first barcode would identify the exact address of the prescription within a prescription store. The second would be a representation of the encryption key allowing the pharmacist to decrypt the prescription.

The patient could then take this prescription to any pharmacy in the country for dispensing. On arrival at the pharmacy the patient would hand their prescription note to the pharmacist. The pharmacist would then scan both barcodes into a modified version of his present dispensing application. Then the application would request the electronic prescription from the holding store, decrypt (mathematically unscramble) the prescription, verify (check) the electronic signature of the signing practitioner and display the prescribed drugs on screen. The pharmacist would then make any amendments they wished to the electronic version, dispense the drugs to the patient and generate an electronic dispensation note. They would electronically sign the dispensation note and send it back to the holding store.

At regular intervals the PPA will scan the holding stores and retrieve all dispensed prescriptions and all time expired prescriptions. Payment exemption and practitioner authorisation to prescribe/dispense is carried out automatically by the system [CHADWICK03]. Patients are granted digital certificates by the PPA to say they are exempt from payment and the dispensing system checks to see if one of these exists for the patient. Practitioners are granted the rights to prescribe/dispense by a regulatory body for example the General Medical Council (GMC) and the prescribing/dispensing application checks to ensure they can carry out the action (prescribe) they are wishing to do. To integrate this system design

into present practice an Application Programming Interface (API) has been generated [MUNDY03b]. Existing systems would require modification to call the API methods.

Figure 2: University of Salford ETP Model



4 Research Methods Used

4.1 Requirements Phase

The research aims identified for the requirements phase were to: -

- Fully describe current system
- Determine the ideal ETP system from a multiple user perspective
- Identify resource constraints
- Identify implementation risks
- Inspire user confidence and ownership
- Limit interference with practice operations

It was felt that the analysis of present practice should be conducted through both qualitative and quantitative measures. The requirements phase for this project consisted of two stages.

The initial stage

In the initial stage of the project a literature study was carried out to determine previous work in the area [NHSME, SHARPLES, STRANGE, MEDCOM, etc.], reviews of user opinions [KEMBER97, KEMBER99a, KEMBER99b] and identified barriers to ETP in the NHS [BRENNAN]. Following this a small-scale analysis of the requirements of the different stakeholders involved in ETP was carried out. To do this the ETP project team at Salford University visited the PPA at their head office in Newcastle, local area pharmacies, the local area hospital Salford Hope Hospital and the registered GP's of team members. At each of these places procedures were observed and questions were asked about the present system. Quantitative measurements were also taken with each stakeholder where the time taken to process prescriptions was noted down. Questions were asked to each stakeholder to ascertain subjective quantitative amounts for data that could not be observed e.g. how many prescriptions dispensed in a month. Observation also enabled the author to produce a list of procedures carried out by each of the different stakeholders. These were used to form a procedural analysis of the present prescribing system. These initial processes resulted in an appreciation of :

- the way the present system operated
- the ergonomics of their environment
- users opinions about what ETP would mean for them

- quantitative measurements for performance comparison between the paper based system and any ETP system
- the identification of risk factors in the design and implementation of an ETP system.

The second stage

As part of this project the University of Huddersfield received funding commencing in January 2001 through to July 2002 to conduct ETP user analysis work. Huddersfield University conducted a stakeholder analysis during 2001/2002. 1,700 possible stakeholders in ETP including 417 GP's, 162 pharmacists, 319 dentists, 796 reception staff and 120 patients were canvassed by postal survey. The aim was to gain qualitative analysis through stakeholder opinions towards present practice and ETP, and also to gain quantitative results such as number of prescriptions dispensed in an average pharmacy. The results from this work [BELL02a][BELL02b] directly fed into the design and implementation phase of the ETP system described in this paper.

4.2 Design and Implementation Phase

The research aims identified for the design and implementation phases were to: -
- design a secure ETP system that would satisfy user requirements
- mitigate particular risk factors identified at the analysis stage
- prove design theory and research decisions

To generate a secure solution for ETP initially the selected method was to examine the results from the requirements analysis phase studying the procedural steps of the paper based system coupled with user perspectives and identified risks. Then to design a secure, user-friendly system which mitigated the identified risks without introducing multiple new risk factors. All of the project team had prior knowledge of providing secure solutions in an healthcare environment [CHADWICK01]. This coupled with a literature survey of available technologies and existing secure health care information systems provided the knowledge required to design a secure ETP solution.

As an example of a risk factor and steps taken towards risk mitigation we can look at system performance. Performance of any ETP system was found to be a key success factor to implementing any ETP system in the NHS. One of the factors, which would affect system performance, was data representation. Research was carried out into which data representation syntax to use for communication assessing the viability of using eXtensible Markup Language (XML) [W3C] and Abstract Syntax Notation One (ASN.1) [ITU-T]. It was found [MUNDY03c, MUNDY03d] that XML would provide major performance problems in any ETP system if it became the syntax of choice for communication.

The findings made at the requirements analysis and design stage lead to the conclusion that an Application Programming Interface (API) would need to be generated in order for the secure ETP solution to be accepted for adoption by the UK NHS. The API was designed using Object Oriented design principals and built using the Java programming language [SUN]. In order to provide a demonstration system of our ETP model two dummy applications were generated. These dummy applications have a front end which mirrors (using screenshots) particular applications [VISION,NEXPHASE] in operational use by GP's and pharmacists. This meant that the users could gain an appreciation of the functionality of the model without comparing interface issues directly with the application they use at present.

4.3 Evaluation Phase

The research aims identified for the evaluation phase were: -
- To gain feedback on the system design and implementation
- To ensure the system met the qualitative requirements of the users
- To see if the users felt once they have seen the system that their are benefits to be had from using ETP and this model in particular
- To ensure from a quantifiable perspective the system met performance requirements

In September 2000 it was announced that three ETP pilots would be set-up within the UK NHS. The resources required were far in excess of this project remit in which it was suggested the created ETP system would be trialed with a small number of users. Therefore no application was made to be one of the pilot systems. From a research perspective the results would be valid whether a pilot system or not. At the evaluation phase it was decided again that it was needed to provide both qualitative and quantitative assessment of the developed system and compare the system directly to the pilot systems. Identifying where the system outperforms the pilot systems and perhaps particular parts of the pilot systems that outperform our system.

Qualitative Evaluation

In order to gain a qualitative evaluation of the ETP system design it was decided to run evaluation sessions. In these evaluation sessions a presentation would be given on ETP, the NHS pilots and the Salford University ETP model. A focus group session would take place after the presentation. Two of these evaluation sessions would include GP's and two sessions would include pharmacists from the Salford and Huddersfield local areas. One of these has been completed (11th March) whilst the other 3 are scheduled over the next two months. The focus group sessions it is hoped will provide definitive comments from GP's and Pharmacists as to whether this system would be acceptable to their operation and indeed if in fact they see significant benefits within the presented system. It is hoped by also providing them with details of the other pilot systems they will be able to reach a reasonable opinion as to whether or not a particular system is favourable.

Quantitative Evaluation

The quantitative results for the system will be generated through a laboratory performance test bed. A series of performance tests have been designed and are at present in progress. Initial performance testing has been carried out on which commercial or non-commercial product to use as the prescription store for the ETP design [THORNTON]. These quantitative results will be compared directly with the requirements analysis results and user requirements. For example in a paper based system it usually takes a pharmacist less than a minute to dispense a prescription. If it is found that the performance results obtained from the developed ETP system are taking extortionate amounts of time then in the pharmacists case the system would be unacceptable.

If the PPA identified that the system developed as part of this project represented the preferable solution to ETP in the UK NHS then stage 2 of the project would be a live system trial.

5 Conclusion

The project detailed in this paper is now in its final year and reaching its conclusion. A proven secure solution for ETP covering all concepts of computer security that it is felt could be integrated successfully into the UK NHS has been developed. At present there are only parts of the evaluation process left to complete.

In the requirements analysis phase it was decided to use both qualitative and quantitative methods to formulate an overview of how the present system worked, what the user requirements were and the risks involved within the system. It was felt that this approach would inspire user confidence and provide the users with a sense of ownership. Also unlike other approaches such as more formal methods like Structured Systems Analysis and Design Methodology (SSADM) [GOODLAND] it would involve less interference with practice operations and expedite development of such an ETP system.

At the design and implementation stages, the requirements elicited, coupled with a procedural analysis of the present system enabled a secure design for ETP to be developed. By matching user needs and ensuring a low amount of noticeable change for the principle users of the system it was believed such a developed system would be more easily accepted and have a better chance of success. An API was produced using Object Oriented principles to ensure that the system could be easily integrated into current practice through its modular status and to make the system maintainable.

At the evaluation stage it was decided to obtain evaluative qualitative and quantitative results from focus group sessions and a performance test bed. The focus group sessions would allow the users to

express their opinions about the designed model for ETP and the performance test bed would allow for analysis of whether or not the system in practice would perform well enough to satisfy user requirements.

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Contact Details

Darren P Mundy
Email: d.mundy@salford.ac.uk
Postal: IS Institute, University of Salford, The Crescent, Salford M5 4WT