INTEGRATED ELECTRONIC PRESCRIBING AND ROBOTIC PHARMACY DISPENSING
Are there Any Benefits?

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Keywords: Electronic prescribing, Automated dispensing Robot, Benefits.

Abstract: Sunderland Royal Hospital (1,000 beds) has used an integrated electronic prescribing (EP) system for 8 years, and recently (2009) linked 2 robotic dispensing machines to the pharmacy module. The impact on dispensing error rates (quality) and efficiency (costs) were assessed. The implementation delivered staff efficiencies above expectation, whilst not adversely affecting the dispensing error rates. It was significant that although the combination of EP plus robot did eliminate dispensing errors, some errors continue to occur for items not stocked in the robot (e.g. part-packs). In achieving this, the professional pharmacy model changes.

1 BACKGROUND

In 2005, the Department of Health issued a report authored by the Chief Pharmacist 'Building a safer NHS for patients. –Improving medication safety' (Smith J. M. 2005). This was a detailed paper on medication errors, the causes, and potential remedies, and stemmed from the paper 'An Organisation with a memory' (Donaldson L. 2001). 'Building a safer NHS for patients' made many suggestions to design out errors through use of a systems approach to medication systems. Electronic prescribing and robotic dispensing were put forward as potential tools to help reduce dispensing errors. However, the advantages of electronic prescribing and robots are not systematically documented in the literature, and it remains unclear as to what features provide the greatest safety. There is a variety of design in electronic prescribing (EP) and robotic dispensing systems, and it is important when surveying the literature to consider the context of the medication system in a hospital.

The Chief Pharmacist (Smith J. M. 2005) quoted a study from the dispensing error analysis scheme [DEAS] published by Cardiff and Vale NHS trust in his paper. This paper analysed errors from 66 contributing hospitals from 1991 to 2001, and looked at 7000 errors. As such, it represents one of the biggest surveys of its kind in the UK. The following categories of errors was recorded by frequency as shown in table 1.

Table 1: Frequency and type of dispensing errors.

Type of error	Proportion %
wrong drug supplied	23%
wrong strength of correct drug supplied	23%
wrong quantity	10%
wrong warnings or directions	10%
wrong drug name on the label	9%
wrong strength on label	8%
wrong form	7%
wrong patient name on label	7%

Beard (Beard R. J. 2009) described the benefits of EP, and what features would contribute to the benefits of EP. His study demonstrated that the greater the integration of EP with other hospital systems, the greater the benefit. Similarly, over the last 10 years, robots have seen increasing use in hospitals, and whilst some of the benefits seem obvious, the precise features of a robot which yields the greatest benefit are yet to be identified. City Hospitals Sunderland has the following profile;

Beard R..
INTEGRATED ELECTRONIC PRESCRIBING AND ROBOTIC PHARMACY DISPENSING - Are there Any Benefits?.
DOI: 10.5220/0003191603760381
In *Proceedings of the International Conference on Health Informatics* (HEALTHINF-2011), pages 376-381
ISBN: 978-989-8425-34-8

Table 2: Types of errors prevented by EP and robots.

Type of error	Proportion %	EP prevents	Robot prevents	EP + Robot prevents
wrong drug supplied	23%		Y	Y
wrong strength of correct drug supplied	23%		Y	Y
wrong quantity	10%		Y	Y
wrong warnings or directions	10%	Y		Y
wrong drug name on the label	9%	Y		Y
wrong strength on label	8%	Y		Y
wrong form	7%		Y	Y
wrong patient name on label	7%	Y		Y

- It serves a general population of 350,000
- It serves a sub-regional population of 750,000
- It has 1,000 acute beds
- It employs 5,000 staff
- It has an income of £300 million

The pharmacy has been operating and integrated EP system for over 8 years, and recently implemented a robotic dispensing machine. In doing so, medication safety was a feature of the business case. Using EP and robotic dispensing as per implemented at Sunderland, we can regard medication errors prevention in the same way as the DEAS study documented in Table 2.

It follows that provided EP and robotic dispensing are integrated in a specific way, many dispensing errors can be 'designed out 'by skilful application of technology.

However, at Sunderland we have realised to achieve such a system, the professional model for pharmacy changes. It is the purpose of this report to identify and document those changes, and to suggest the pros and cons of such a model.

Traditional Pharmacy Dispensing Models

In the typical dispensing model, and the process is as follows in the numbered sequence.

1 Decision to discharge patient

2 Doctor writes prescription

3 Prescription delivered to pharmacy

4 Professional check of prescription

5 Prescription dispensed

6 Prescrition checked

7 Prescription placed ready for delivery to ward

This process can take up to 4-8 hours (Beard J.{ not this author} and Wood D. 2010) for non-urgent items for a variety of reasons. The key point to remember is that in the pharmacy, *the prescription and dispensed item can always be seen togethe*r until bagged for ward delivery. Below is the process model at Sunderland is shown in figure 1.

The key points to remember are:

- Because EP is integrated, when the doctor prescribes the medicine on the computer, he is also in fact writing the label to attach to the medicine. This means the label is ***always*** what the doctor requested
- Because the label is always accurate to the prescription there is no transcription error
- Drugs can only be stored in the robot by bar code identification. There is a direct electronic link between the medicine, bar code, and item selected on the electronic prescription, **and** the label that the robot applies. ***These are the crucial links in deriving safety benefits from technology***
- To ***design in*** these links is to ***design out*** potential errors.
- Once designed, the system works from anywhere in the hospital**.** ***This allows 60% of dispensing activity to be triggered outside the pharmacy at Sunderland***
- Automatic labelling is a ***critical component*** of this system
- Once medication has been checked by a pharmacist (usually at ward level at Sunderland) the dispensing ***becomes nearly instantaneous***. The remaining bit of the process is to get the medication from pharmacy to the ward.

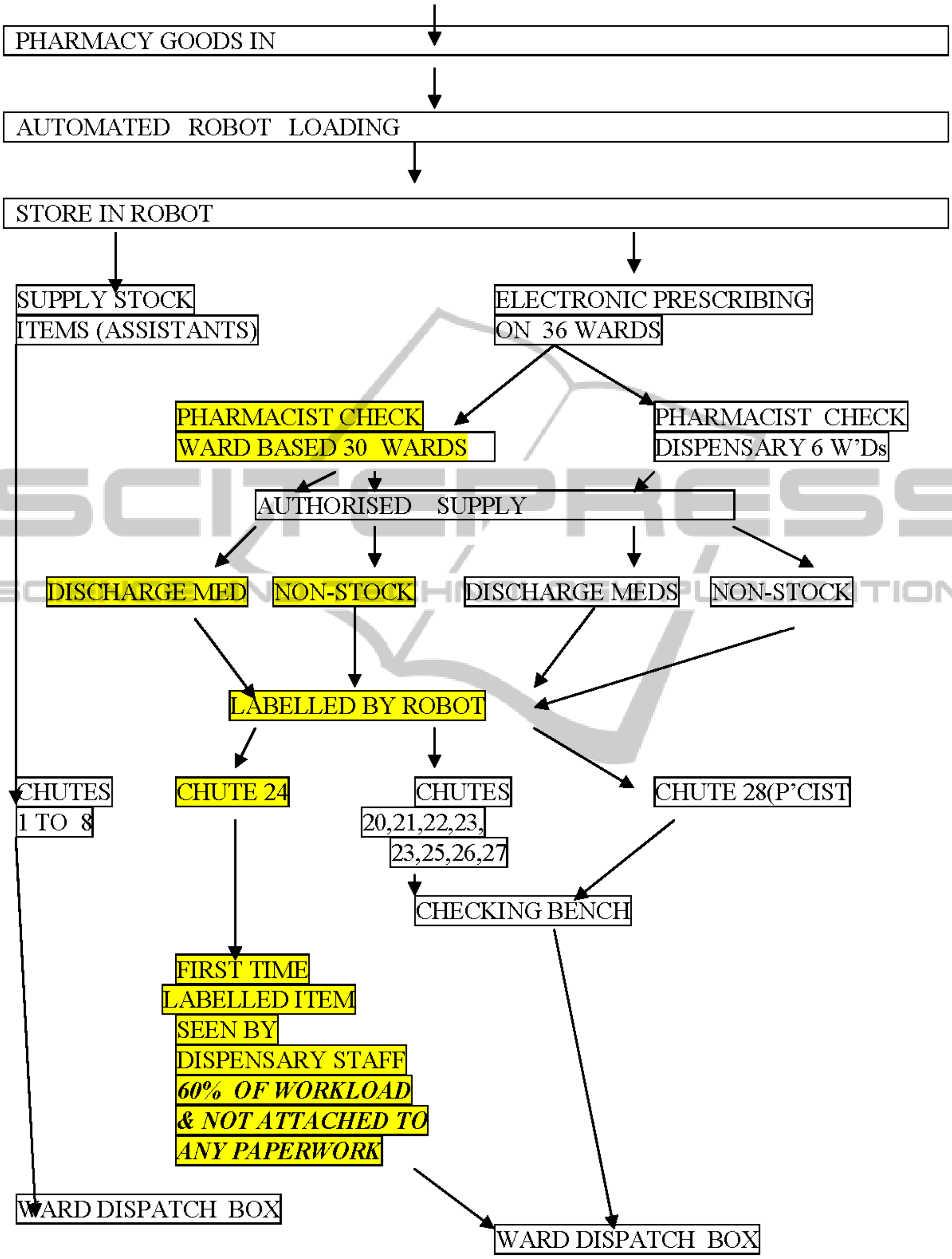

Figure 1: Diagram of dispensing processes at Sunderland.

- In achieving 'instantaneous dispensing' the role of the pharmacist changes. ***No longer are pharmacists directly in control over the whole dispensing process***. It is akin to craftsmen producing goods being replaced by production lines where quality control is through process control, and each individual is responsible for a part of the overall process, not all of it.

2 MEASURING THE BENEFITS

Setting. Sunderland Royal Hospital is a 1,000 bed hospital in Northern England. The hospital operates 2 dispensaries, including a smaller discrete out-patients pharmacy dispensing around 5000 items per month. Control charts have been widely used by industry for many years to manage process variation, but the literature for healthcare in Europe suggests this method of process control is less widely used. This paper uses of control charts to look at the impact on out-patient dispensing errors when robotic dispensing and skill mix reductions are introduced.

Method. Dispensing errors per month was plotted on a control chart for 12 months prior and subsequently to the installation of the first dispensing robot (March 09). On installation, staff was reduced by 1.4wte (in line with business case). Skill mix was also adjusted (not in business case) to meet overall operation needs of the department. All NHS Hospitals in the UK pay staff on a banding system that equates all jobs on their value. The higher the job band, the more highly skilled the post. The job band and whole time equivalents for staff were determined, and used as a measure of the 'quantity of skill' to run the Outpatient pharmacy. The monetary value of the 'skill quantity' changes is calculated from the mid-point salary scale.

Results. The change in skill mix was 50% ; (Table. 3). On installing the robot, band 5 technical staff could be replaced with lower banded dispensing staff, without adversely affecting the quality of the dispensing process. This was 16% more efficient than the business case required.

Discussion. Changes in skill mix equates to an additional saving on top of staff reduction more than the business case. Early data from the control chart suggests de-skilling the dispensary workforce using robots has a no worse impact on dispensing errors. However, towards the end of 2009, there was an increase in dispensing errors. This is where control charts are useful to monitor the processes, when dealing with small numbers. There is no EP function at present in the Out-patient pharmacy, and analysis of the 'blip' was undertaken by looking at the errors and other factors. An audit of the prescriptions received was undertaken, revealing that 25% of the written prescriptions required further clarification by the pharmacist.

It should be noted that the out-patient dispensary does not yet have EP, but uses traditional pharmacy prescriptions. The impact on errors, efficiency and skill mix apply without any of the EP benefits. A previous paper (5) listed the different types of dispensing methods at CHS, and the error rates associated with them. The same approach has been taken for looking at errors for in-patient dispensing. The results to date are shown in figure 2.

Figure 2 shows a spike in errors just after installation. Error analysis showed them to be non-robot errors,i.e. they were picking errors from those shelves of the pharmacy where items cannot go into robots (part packs, round tubs of medicines, or items too small (e.g. eye drop bottles) to be labelled by robot.

Significantly, we have found zero errors for the robot plus EP system combined, based on around 800,00 items per annum. Potentially a huge benefit in safety. However, dispensing is not risk-free, since not all items are supplied and labelled from the robot. Clearly though, the opportunity for errors is significantly reduced.

Turn Around Time for Prescriptions. Speed of turnaround time taken from clinical check *is nearly instantaneous*, very different from many hospitals. At busy periods dispensing times can rise to up to 20 to 30 minutes, but this situation tend not to last beyond about half an hour. Normally dispensing times can often be up to 4 hours for non-urgent dispensing. (Beard J. and Wood D 2010). These authors quotes how be using lean processes they reduced the dispensing time of the prescription from 4 hours to around 2 hours. (These times include the time it takes a signed prescription to get from ward to pharmacy.). This is not untypical of non-EP – robotic system. The concept of instantaneous dispensing is not currently part of hospital pharmacy culture, nor is dispensing triggered from over 36 different points in the hospital.

Dispensing Rate. Whittlesea (7) quotes a Welsh benchmark of 10 items per person per hour. Sunderland dispenses a maximum of 360 items per hour, equating to 36 dispensing staff. The in-patient pharmacy operates with around 10 dispensary staff. Sunderland's robot chute 24 issues 60 % of the dispensing activity, which is from the ward based pharmacy staff. Ours is not a directly comparable situation. However if one takes the figure of 360 items an hour the pharmacy can dispense, it has therefore a capacity of 57,000 items per month. To

Table 3

Job band	wte	job band x wte	salary paid £'s	mid point salary £'s	**new wte**	**new skill amount**	**salary total £'s**
band 6	1	6	28000	28000	1	6	28000
band 6	1	6	28000	28000	1	6	28000
band 5	2.4	12	56040	23350	0	0	0
band 4	1	4	19500	19500	1	1	19500
band 3	1	3	17000	17000	1	1	17000
band 2	1	1	14360	14360	2	2	28720
totals	6.4	**32**	162900		5	**16**	121220
						cost reduction	**41680**
			wte= whole time equivalent		skill reduction = 50%		
			BC = business case		BC =£35k reduction		
					Additional benefit over BC = 16%		

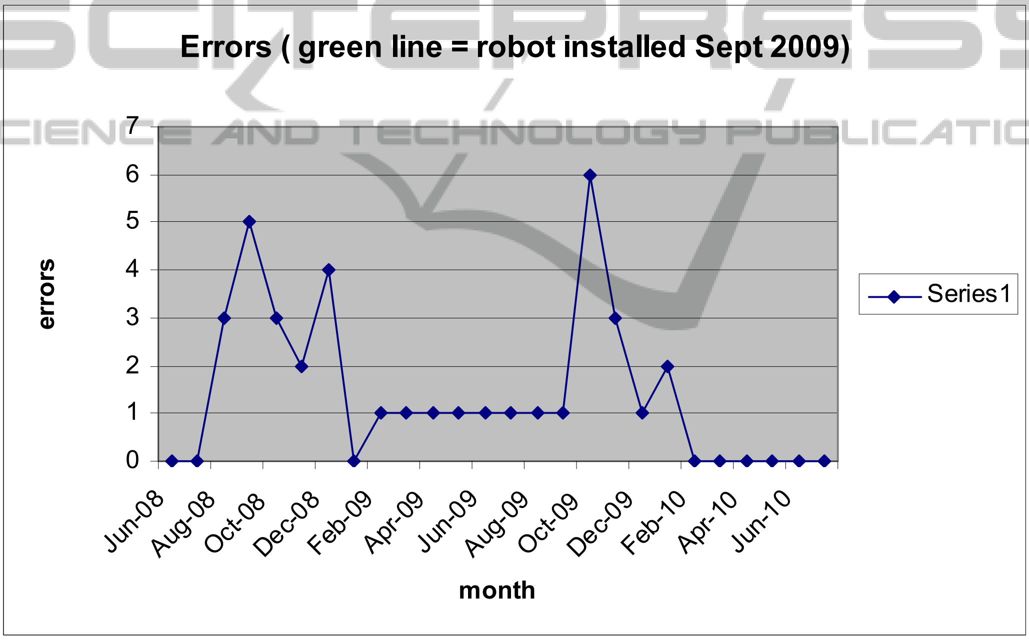

Figure 2: Dispensing errors in in-patient pharmacy per month. Green line marks use of robot with EP.

put this in community pharmacy terms, a community pharmacy needs around 7,000 items a month to be solvent, and a very busy pharmacy might do around 20,000 items per month. The capacity of the in-patient pharmacy is about 3 times that rate.

3 CONCLUSIONS

There are clear benefits in using electronic prescribing and robotic dispensing, and these will be realised so long as the following conditions are met:

- The EP system used is integrated with all the other hospital software systems
- The robotic dispenser is integrated to the EP system
- There are automated labellers for those items robotically dispensed.

When the above conditions are applied several advantages become apparent:

- For items in the robot, there is no scope to make a dispensing error, improving patient safety.

- The process is much more efficient, and the skill mix of staff can be adjusted within the dispensary
- The speed of the prescription process increases dramatically.

The consequences of the above are that the purchasing of medicines needs to be given consideration so that items with appropriate bar codes are purchased. There is also a change in the professional model, as the dispensary pharmacist is no longer in complete control of the dispensing going on in the dispensary. The implications of this are not within the scope of this paper.

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