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Evaluation of automatic loading devices with a ROWA Speedcase system

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- OBJECTIVE — To establish whether the use of automatic loaders on a ROWA automated dispensing system affects the time taken to store and dispense items and to examine ways of maximising any time savings achieved.
- METHODS — The study comprised four phases. Phase 1 examined the effects of using the automated loaders on the time taken to store items. Phases 2 and 3 examined the effects of using the automated loaders on the time taken to dispense items. Phase 4 examined the efficiency of the automatic loaders when they were left running, unattended, overnight.
- RESULTS — Use of the automatic loaders was associated with a reduction in the time taken to store items, but an increase in the time taken to dispense items, when the loaders are in operation during normal working hours. When the automatic loaders were left to run overnight, most items were successfully put away, but each automatic loader stopped once during a five-night period.
- CONCLUSION — The results suggest that, in order to maximise the time savings that the implementation of automated loading can bring, it is necessary to maximise the efficiency of the automatic loaders so that they can be left running overnight.

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Following a competitive tendering process, the Freeman Hospital, part of Newcastle Hospitals NHS Trust, purchased a tandem ROWA automated dispensing system (ie, two robots), which was installed in March 2005. Each robot includes refrigerated shelves and a "Pro-Logic" automatic loader [See Figures 1 and 2, p376, and Figure 1 of reference 1].

One of the potential benefits of implementing automated loading is an overall reduction in the time taken by staff to perform dispensary activities. We therefore set about assessing whether this potential benefit was realised and whether any time savings could be maximised because the automatic loaders were efficient enough to be left running, unattended, overnight. This research was particularly important because, as far as we are aware, our automatic loaders (known colloquially as "Pro-Logs") were the first to be installed in a hospital worldwide and the first installation in any organisation in the UK.

A study in four phases was therefore devised to determine:

- The impact of automatic loading on the time taken to store dispensary stock (phase 1)
- The impact of concurrent automatic loading on the time taken to dispense prescription lines in controlled conditions (ie, where all the prescription items are contained in the robots) (phase 2)
- The impact of concurrent automatic loading on the time taken to dispense prescription lines in routine practice conditions (phase 3)
- The efficiency of the automatic loaders when left running, unattended, overnight (phase 4)

Methods

Timings were made with a Quantum split-second stopwatch. An agreed form for data collection was prepared and used for each phase. Staff collecting data were experienced dispensary staff, trained in the data collection requirements.

Data on, for example, the number of packs loaded into the robots, were retrieved from the computer files of the robots and automatic loaders as appropriate.

For phases 1 to 3, the automatic loaders were operated within working hours, so that any problems encountered could be assessed and rectified quickly.

Phase 1 The time taken to put away stock using three methods was compared. The methods were:

- Using the automatic loaders on the robots, by tipping the stock into the hoppers
- Manually loading the robots, using the barcode scanners on the robots, by passing individual packs across the scanner and then placing the item on the input conveyor belt for transfer into the robot
- Using a conventional dispensary storage system, by placing stock by hand into a large "rhombic" drawer system, a carousel for fast moving lines, and various shelves and under-bench drawers (supplied by Sintek) as appropriate

All stock that arrived in the dispensary was checked and any issues resolved before timing began so that only the "putting away" stage was timed. Items that required refrigerated storage were not included in this phase of the study. Stock for loading (either manually or automatically) into the robots was separated into two labelled boxes, so that approximately equal quantities of each product went into each machine. It should be noted that, for each method, the most efficient way of loading was carried out. For example, when using the barcode scanners, operators scanned the product's barcode and then positioned the pack on the conveyor belt feeding into the robot, repeating this quickly, until the conveyor belt was full. When loading was done in this way, the picking head did not attempt to put the stock away until that input session had ended. The machine was then allowed to put the packs away while the operator began loading the second robot. Timing began when the first pack was presented to the barcode reader and finished when the input belt was full. Timing restarted when loading began again. The time taken to load 500 packs, equally split between the two robots, was measured. At the time these measurements were made, the system had been operational for six weeks and staff were adept at this method of loading.

For the conventional storage system, stock location was determined using the receipt documentation that is included with

Figure 1. An automatic loader. Items for loading are tipped into a hopper, which then feeds individual packs onto a light table. An infra-red beam and a series of mirrors ensures a barcode can be detected no matter how the pack is presented.

each box of stock as it arrived in the dispensary. The number of items put away was determined from the receipt documentation.

The timed process for the automated loaders involved tipping the known quantity of packs from the labelled box into the appropriate hopper and then returning later to tip in another box load. The time taken to tip a box load into each hopper was recorded on three separate occasions. Hoppers were not loaded above two thirds of their height.

Phase 2 This phase was designed to determine the effect of running the automated loaders on the dispensing process. The stages timed were from the entry of patient details on to the dispensary computer through to the self-check (ie, excluding the clinical check and the final accuracy check). Data relating to outpatient prescriptions and discharge prescriptions were collected for a known number of lines and packs when the automatic loaders were operating and a known number of lines and packs when they were not. Only prescriptions where all the lines were contained in the robots were included in this phase. Prescriptions containing refrigerated items were included.

Figure 2. The picking head of the automatic loader.

Phase 3 The effects of a range of parameters on the operation of the robot during routine use were explored during phase 3. Parameters are set out in Table 3 (p377). Prescriptions where at least one line on a prescription was stored in the robot were included, as were those containing refrigerated items.

The process timed in phase 3 was the same as that timed in phase 2. Data relating to outpatient prescriptions and discharge prescriptions were collected for a known number of prescriptions and lines when the automatic loaders were operating, and a known number of prescriptions and lines when they were not. Phase 3 followed on from phase 2, over the summer of 2005.

Phase 4 After some of the problems with the automatic loaders identified during phases 1 to 3 were resolved, the loaders were left to load stock overnight. Each morning the number of packs that had been rejected was counted and identified. Rejected packs were put through the same automatic loaders again. If they were still rejected, an attempt was made to load them manually into the robot, as described in phase 1 above.

This phase was undertaken on consecutive weeks for each automatic loader, during autumn 2005 (five overnight sessions for each loader). The same person examined the rejected packs each morning. Those that were not in the database, because the barcode was not held on the software, were excluded from the analysis, and so the results presented relate only to packs available for loading.

Results

The time taken to put away packs using the three methods is set out in Table 1. A total of 49,404 packs were loaded into the robots over a 53-day period (excluding weekends and bank holidays) and so the mean number of packs loaded per working week was 4,661.

The time taken to dispense discharge and outpatient prescriptions with and without the automatic loaders running during

Table 1: Time taken to put away stock using three different methods

System used	Number of packs put away	Time taken to put packs away (mins)	Mean "put-away" time per pack (secs)
Placing on conventional shelving or in conventional cupboards/carousel*	9,661	1,150.00	7.14
Manual loading of robots	500	102.00	12.24
Automated loading of robots	974	1.65	0.10

*The figures shown are the total of four sessions of putting stock away. The mean time taken per pack for each session ranged from 7.12 to 7.15 seconds.

Table 2: Time taken to dispense discharge and outpatient prescriptions with and without automatic loaders operating

System used and prescription type	Number of lines	Number of packs	Total time (mins)	Mean time per line (mins)	Mean time per pack (mins)
No loading occurring					
Discharge	484	505	393.91	0.81	0.78
Outpatient	146	265	234.58	1.61	0.89
Combined	630	770	628.49	1.00	0.82
Automatic loaders running					
Discharge	400	504	389.43	0.97	0.77
Outpatient	126	187	220.17	1.74	1.18
Combined	526	691	609.6	1.16	0.88

Table 3: Time taken to dispense discharge and outpatient prescriptions with and without automatic loaders running in the context of routine dispensary practice

System used and prescription type	Number of prescriptions	Number of lines	Number of operators	Number of robot lines	Number of robot packs	Total time (mins)	Mean lines per prescription	Mean robot lines per prescription	Mean number of operators	Mean percentage of robot lines	Mean time per line (mins)
No loading of robots											
Discharge	234	968	696	774	970	1,385	4.14	3.31	2.97	79.96	1.43
Outpatient	296	405	720	374	551	812	1.37	1.26	2.43	92.35	2.00
Combined	530	1,373	1,416	1,148	1,521	2,197	2.59	2.17	2.67	83.61	1.60
Automatic loaders running											
Discharge	222	1,045	664	783	990	1561	4.71	3.53	2.99	74.93	1.49
Outpatient	144	220	320	195	341	471	1.53	1.35	2.22	88.64	2.14
Combined	366	1,265	984	978	1,331	2,032	3.45	2.67	2.68	77.31	1.60

controlled conditions (phase 2) and during routine practice (phase 3), respectively, are set out in Table 2 (p376) and Table 3. Data obtained from the robots' computers showed that, for the three months when phase 2 of the study was carried out, the robots dispensed 18,703 (July 2005), 18,973 (August 2005), and 18,788 (September 2005) packs.

During phase 4, a total of 4,133 packs were available for automatic loading. Of these, 3,996 were successfully loaded overnight at the first attempt, with an additional 116 loading successfully on the second attempt. All of the 21 packs that could not be loaded using the automatic loaders were successfully loaded manually using the barcode scanners. Each automatic loader stopped working once during the five-day period. On each occasion, the system "failed safely", meaning that no product was misidentified and stored incorrectly.

Discussion

Putting away stock was considerably quicker when using the automatic loaders than when using either of the other two methods. The increase of 5.1 seconds taken to load the robot manually (as compared with the conventional method of putting stock away) was most likely because operators had to scan each individual pack into the robot, while an outer wrapper was often put onto the shelf when the conventional method was used.

Based on the results, staff time taken to load 4,661 packs (the average number of packs loaded per week) was 9.2h per week when using conventional storage methods, 15.8h when using manual front loading and 0.13h when using the automatic loaders. This equates to a saving of between 0.24 and 0.42 whole time equivalents being made at the Freeman Hospital, by using the automatic loaders (depending on whether conventional storage or manual loading of the robots is taken as a baseline).

The contemporaneous use of automatic loaders was associated with an increase in the dispensing time of 0.16 mins per line or 0.06 mins per pack. Based on the number of packs dispensed, this equates to an additional 18.7h (July), 19.0h (August), or 18.8h (September) per month being required to dispense items when the automatic loaders were operated during working hours. This therefore cancels out approximately half of the time savings made in storing stock using the automatic loaders. It should be noted that this aspect of the study was designed to investigate the effects of the automatic loaders on the dispensing process, and the effect or significance of any concurrent manual loading was not determined.

A sustained increase in dispensing time when using the automatic loaders was unexpected. Although the operating system prioritised for dispensing, it was likely that there would still be times when both robot heads were in loading mode as an instruction to pick was processed, resulting in a delay in dispensing. It was thought that this delay would be less of an issue when the system was handling a number of prescriptions, each with a number of lines on them, than when a single prescription with a single line was being dispensed. However, this assumption did not appear to be borne out by the results. It was therefore particularly important to be able to load the robots overnight, so that time savings could be maximised.

When routine practice was examined in phase 3, the mean time taken to dispense a prescription line was still greater when the automatic loaders were in use than when they were not. The time difference was greater for outpatient prescriptions than discharge prescriptions. In addition, the results of both phase 2 and phase 3 indicate that the dispensing time taken per line for discharge prescriptions is less than for outpatients, regardless of whether the automatic loaders atr running or not. This is probably because discharge prescriptions contain more items and so the time taken to record patient details is spread across more lines.

It should be noted that no attempt was made during phase 3 to ensure that there was an even distribution of robot and non-robot lines either between situations (ie, loaders on or off) or between prescription types, because routine practice was being measured. However, this did mean that it was difficult to draw any conclusions about, for example, the effects of the number of operators.

During phase 4, the automatic loaders successfully loaded 96.7 per cent of the available packs on the first attempt. The main reasons that packs were rejected included:

- The barcode being poorly printed on the pack
- Packs having more than one barcode printed on them
- The head of the automatic loader being unable to "tip over" a pack to the required orientation
- The head of the automatic loader being unable to separate multiple packs presented on the light table

It should be noted that the barcode scanners at the front of the robots that are used to load the packs manually differ in design and specification to the barcode readers in the automatic loaders — the latter need to be able to read barcodes from different angles and positions.

The main problem associated with having the automatic loaders operating overnight is that if the system fails and the loading process stops, there is no one in the department to resolve the problem. Of the two stoppages that occurred during phase 4, one resulted from a failure within the robot and not within the automatic loader itself. The

other was caused by the signal from the suction head sensor not arriving when the automatic loader expected it, because a pack "strayed" onto the barcode scanner glass plate and the automatic loader tried to put another pack on top of it. It is of concern that both of the automatic loaders stopped on one of five loading sessions.

Issues resolved There were minor issues associated with the use of the automatic loaders that the supplier worked with us to resolve. One deserving of mention occurred because the configuration of robots we purchased included cold storage shelving, as well as automatic loaders. The system software prioritised for dispensing but after that did not prioritise between putting away the items placed in the hoppers of the automatic loaders or putting away the cold-chain items that are "barcoded in" and placed manually on the input conveyor belt. Initially we therefore needed to switch off the automatic loaders while cold-chain items were being loaded, so that these would be put into the cold storage shelves promptly. The supplier worked with us and the manufacturer, to change the software, so that the system now prioritises for dispensing, then for items to be loaded from the front input belt, and then from the automatic loaders. This potential problem only became apparent when the cold storage area came into use. Now that the automatic loaders are primarily used out of hours, it is less of an issue.

Potential developments The time taken to load using the automatic loaders could be further reduced if the length of the hoppers was extended — ie, more packs could be put in them at a time. We have decided not to explore this option further at the Freeman Hospital, because we will be looking to receive individual orders for the robots direct from suppliers in the future. Once new software is available (expected before the end of the financial year), the intention is for these individual orders to be loaded into the hoppers, which are unlikely to be completely filled, allowing the automatic loaders to check the orders, put the stock directly on to the robot shelves and update stock levels on the pharmacy computer system without manual input. This will obviously provide further savings in staff time. Issues relating to incorrect deliveries being received into stock require considerable thought.

Conclusion

Using automatic loaders reduces the time taken to put stock away. Using the loaders during the working day interfered with the dispensing process, but the impact of this is reduced when considered against prescriptions containing a mix of items stored both in and outside the robot. However, to realise the full staffing benefits, it is sensible to run these loaders at periods of low workload, for example, overnight. Our experience suggests that the failures are few and that when they occur, the system "fails safely".

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