

Electronic prescribing and medication management at a residential aged care facility

Uptake by general practitioners and qualitative evaluation of the benefits and barriers

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Keywords

Electronic prescribing, residential facilities, general practitioners, Australia

Summary

Background: A cloud-based mobile electronic prescribing and medication management system (ePMMS), in which prescribers' orders directly populate residential aged care facility (RACF) medication administration records (MARs) and are communicated electronically to the RACF's pharmacy, may create efficiencies and improve patient safety when compared to the paper-based and hybrid paper-electronic medication management systems used in most Australian RACFs. Little is known about general-practitioners' (GPs'), nurses' and pharmacists' acceptance of, or experiences with, ePMMS.

Objectives: To explore the uptake of an ePMMS by GPs, and the experiences and perceptions of GPs, nurses and pharmacists, at a 90-bed RACF that tested a beta-version ePMMS.

Methods: Retrospective audit to determine the proportion of medicines ordered by GPs via the ePMMS over a three-month period. Focus groups conducted three-to-four months after implementation: one with GPs (n=5), one with nurses (n=12); in-depth interview/survey of pharmacists (n=2). Qualitative data were analysed thematically.

Results: Three of seven GPs used the ePMMS to order medicines; 53/205(25.9%) medicines were ordered via the ePMMS by GPs.

Two broad themes were identified: benefits of the ePMMS, and barriers/limitations. Benefits related to patient safety and workforce efficiency, and included GPs' ability to access and modify residents' MARs remotely, no need for nurses to fax orders to the pharmacy, and no need for pharmacy transcription of GPs' handwritten orders to create electronic MARs. Barriers and limitations related to inefficiency, low GP uptake and training/support, and included slower prescribing compared to written orders, the need for GP-signed paper copies of the MAR, lack of integration with GP clinic software, and low GP motivation to use the system, especially GPs with few patients at the RACF.

Conclusions: GPs, nurses and pharmacists felt the ePMMS improved medication-safety and workforce-efficiency, however a number of barriers were identified that contributed to low GP-uptake and limited the benefits.

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1. Introduction

Most residential aged care facilities (RACFs) in Australia use either a paper-based medication management system (in which medicines are administered from a paper medication administration record [MAR], handwritten by a medical practitioner) or a hybrid paper-electronic system (in which medical practitioners' orders are entered into an electronic medication management system by the RACF's contracted pharmacy service to create a paper or electronic MAR) [1].

Handwritten charts contribute to medication errors through illegible handwriting, incomplete or ambiguous orders and transcription errors when MARs are re-written [2–4]. Hybrid paper-electronic systems improve medication chart legibility and eliminate the need for charts to be re-written, but they contribute to medication errors because of the need for transcription of medication orders to create and update the MAR, delays in availability of a current MAR, and existence of multiple medication lists [4–7].

Neither paper nor hybrid systems enable prescribers to amend medication charts remotely, resulting in use of phone and fax orders, and both systems require orders to be manually communicated (via fax or email) to the RACF's pharmacy service [6–8].

1.1 Electronic prescribing (e-prescribing)

The use of e-prescribing to directly populate the RACF's MAR has the potential to improve medication safety and efficiency, by eliminating the need for handwritten medication charts and data transcription by pharmacists or pharmacy technicians to create the MAR.

There has been limited implementation or evaluation of e-prescribing in RACFs, in Australia or internationally [4, 9, 10]. E-prescribing systems that have been described were systems in which prescribers' electronic orders were printed on a paper MAR [10–12]. For example, Burns *et al.* described the implementation of computer-generated paper MARs at four Australian RACFs [12]. The system improved legibility of MARs, but did not enable prescribers' orders to populate an electronic MAR or be automatically transmitted to a pharmacy. Rochon *et al.* described a computerized physician order entry system at a large long-term care facility in the USA. Prescribers' electronic orders were printed and then transcribed onto a paper MAR by nurses [10].

1.2 Study background and the electronic medication management system

A RACF in Melbourne, Australia that had been using a hybrid paper-electronic medication management system (in which the electronic MAR was managed by the RACF's off-site pharmacy, based on prescribers' handwritten orders) piloted a beta-version of a novel cloud-based integrated e-prescribing and medication management system (ePMMS). The ePMMS was developed by the aged care software vendor that provided the RACF's existing resident management and hybrid paper-electronic medication management systems, in consultation with the RACF and its general medical practitioners (GPs). User acceptance testing was conducted by the vendor as part of the development process.

The ePMMS enabled GPs to order medications electronically, at the RACF or remotely. The prescribing interface was designed to be used on small touch-screen mobile devices and desktop computers. Medication orders automatically populated the existing electronic MAR at the RACF, and were transmitted electronically (as an e-message) to the pharmacy (► Figure 1). The system was designed to eliminate handwritten medication orders, manual transmission of orders to the pharmacy, and data transcription by pharmacists to create MARs. All medications and routes of administration were included in the system, with the exception of continuous infusions. The system included an electronic messaging function, enabling GPs, nurses and pharmacists to send and receive messages, and it provided GPs with access to their patients' electronic RACF progress notes, enabling them to review and add notes remotely. It did not include decision support functionality, and it was not integrated with the GP clinic's electronic medical record and prescribing system.

Whilst the intention of the ePMMS was for all orders to be entered electronically by GPs, pharmacists were able to enter orders when the GP was unable, or unwilling, to do so; in these cases a paper medication chart or prescription could be faxed by RACF staff to the pharmacy for data entry (the same process that was used in the hybrid paper-electronic medication management system).

1.3 Objectives

The objectives of this study were to explore:

1. Uptake of the ePMMS by GPs at the study site; and
2. Experiences and perceptions of GPs, RACF staff and pharmacists with the ePMMS.

2. Methods

2.1 Setting and participants

The study was conducted at a single-site 90-bed not-for profit RACF. The RACF had commenced working with the software vendor to develop the ePMMS, described in section 1.2, before approaching the researchers to conduct the evaluation.

Seven GPs (from one clinic) trialed the ePMMS. They provided care for 55 (61.1%) RACF residents. Each GP was provided with a tablet computer for the duration of the trial, however they could also access the ePMMS from any desktop computer or mobile device with internet access. The RACF was serviced by an external community pharmacy, where two pharmacists managed the supply of medications to the RACF.

2.2 Training

General practitioners, RACF staff and pharmacy staff attended a training session on use of the ePMMS, conducted by an employee of the software vendor at the RACF, GP clinic and pharmacy. A nurse received additional training and was available at the RACF to support nurses and GPs during implementation. The ePMMS was piloted from November 2013 to March 2014.

2.3 GPs' uptake of the ePMMS for ordering medicines

To evaluate uptake of the ePMMS by GPs, the proportion of new medication orders that were entered into the system by GPs over three months (December 2013 to February 2014) was determined, using data extracted retrospectively from the ePMMS. For orders entered into the ePMMS by pharmacists, the origin of the order (GP, locum doctor, specialist, hospital) was ascertained by reviewing residents' RACF records. Use of the ePMMS by GPs to modify and discontinue existing medication orders was not assessed.

2.4 GPs', nurses' and pharmacists' perceptions and experiences with the ePMMS

To explore the experiences and perceptions of GPs' and RACF staff with the ePMMS, focus groups were conducted with a convenience sample of GPs (n=5) and RACF staff including registered and enrolled nurses (n=12) three to four months after implementation (February/March 2014). To explore pharmacists' experiences and perceptions, an in-depth interview was carried out with one pharmacist, and the second pharmacist provided written responses to interview questions (as she was unable to participate in an interview). All participants provided written consent. Focus groups were conducted by two experienced researchers (CYL/RAE); they were conducted at the GP clinic and the RACF and lasted for one hour each. The pharmacist interview was conducted by one researcher (CYL) at the pharmacy and lasted approximately one-and-a-half hours. Semi-structured guides, developed by the research team, were used to stimulate discussion. Topics covered in the

guides were based on the study objectives as well as anecdotal feedback received from RACF staff, GPs and pharmacists during the pilot of the ePMMS. They included questions/prompts related to participants' experiences with the ePMMS compared to the previous hybrid paper-electronic medication management system, impact of the ePMMS on the workforce and residents' care and reasons for low uptake by GPs (Supplementary file 1). Focus groups and interviews were audio-recorded and transcribed verbatim by a professional transcriber. Transcripts were checked for accuracy by two members of the research team prior to importing into QSR NVivo 10 to facilitate data coding and analysis.

Data were analysed thematically using the framework approach, an analytic method which is typically deductive and based on the research objectives and questions [13]. This analytical method was chosen as it is useful for applied qualitative research in which the objectives of the investigation are set in advance and linked with quantitative findings [13]. Transcripts were initially read by two members of the research team (CYL/RAE) to identify key issues and themes related to the study objectives. The data were then coded by one researcher (CYL) using open-coding techniques. Coding consisted of descriptive (participant group, setting/context) coding followed by thematic coding. Coding reports were reviewed by all members of the research team to ensure accuracy and agreement in data interpretation and coding.

3. Results

3.1. GPs' uptake of the ePMMS for ordering medicines

Over the evaluation period there were 205 new medication orders for residents under the care of participating GPs. Of these, 53 (25.6%) were entered by the residents' GP and 152 (74.1%) were entered by a pharmacist (► Table 1). Most of the GP-entered orders ($n = 44$, 83.0%) were from one GP, who cared for 38 residents. Four GPs did not enter any orders via the ePMMS.

Of the 152 orders entered by pharmacists, the origin of the order was able to be identified in 128 (84.2%) cases: 53 were new orders initiated by the resident's regular GP; 33 were new orders initiated by a locum doctor, other GP, palliative care service or specialist; and 42 were pre-admission medicines that needed to be ordered on the RACF electronic MAR when a person was admitted (or re-admitted) to the RACF from home or hospital.

3.2. GPs', nurses' and pharmacists' perceptions and experiences with the ePMMS

Analysis of focus group and interview data identified two broad themes: *benefits of the ePMMS*, and *barriers and limitations*.

3.2.1. Benefits

Benefits identified by GPs, nurses and pharmacists related to two sub-themes: patient safety and workforce efficiency.

3.2.1.1 Patient safety

GPs reported safety benefits when they used the ePMMS from their clinic.

"... from our desktops here [in the clinic] you can make changes to the medications, which then go straight to [the MAR]. [GP 1]

"Having access to the correct [medication] list is beneficial, because at times our [clinic] records do get out of sync [with the RACF]." [GP 6]

Nurses felt that when GPs used the ePMMS to order (and cease) medicines it avoided some of the errors and delays associated with the hybrid paper-electronic medication management system.

"...[with the hybrid paper-electronic system] it could be a few days [over a weekend] before they're [the pharmacy] actually even looking at messages where we have requested a medication change." [Enrolled nurse 4]
 "For something that was ceased, and the GP ceased it [via the ePMMS], you know that it's correct [on the MAR], ...so it reduces the chance of an error." [Registered nurse 1]
 "If we've got the palliative care medications or antibiotics or analgesics, you can start it immediately because it [the GP's order] comes straight through to your tablet [MAR] so you're not waiting 24 or 48 hours." [Registered nurse 2]

Pharmacists felt that not having to interpret handwritten GP orders improved safety.

"Reading a [handwritten] drug chart can be interesting at times ... This [ePMMS order] is clear cut." [Pharmacist 1]

3.2.1.2. Workforce efficiency

GPs reported that being able to modify the electronic MAR from their clinic saved time.

Previously they [RACF staff] used to fax the drug chart to us, we used to fill it out and fax it back to them, so if you have to make a quick change it's much easier [with the ePMMS]." [GP 1]

Being able to remotely modify the MAR sometimes enabled GP visits to the RACF to be avoided or rescheduled to a more convenient time.

"You can plan more when you go [to the RACF], so you mightn't have to go today, because you can make a change to analgesics or whatever [via the ePMMS], but then you might go tomorrow or the next day, which is more convenient." [GP 1]
 "If you're going to make significant changes you're usually going to have to see the person anyway, but if you're going to make trivial changes ... or if they've been to see a specialist and the specialist wants them to have a week of eye drops, that's easy to do [via the ePMMS]." [GP 2]
 "Saving a visit here and there, or being able to go the next day where it suits you a bit more, they're the benefits." [GP 6]

When GPs ordered medicines via the ePMMS, nurses and pharmacists reported that it saved them time.

"If a doctor prescribes it through the system [ePMMS], it automatically goes to the pharmacy... and there's no need for us to fax the medication chart to the pharmacy." [Enrolled nurse 3]
 "... the doctor's putting details directly into the [electronic] drug chart is actually saving us a lot of time." [Pharmacist 1]

3.2.2. Limitations and barriers

Limitations and barriers reported by GPs, nurses and pharmacists related to three sub-themes: inefficiency, uptake by GPs and training and support .

3.2.2.1 Inefficiency

GPs felt that when they were at the RACF the ePMMS slowed them down and did not offer a major advantage over paper-based prescribing.

"I think it was quicker when you were just scribbling" [GP 3]
 "I think it's slower prescribing is a disadvantage, and also having to wait for the [RACF] staff to then print out a medication chart after you've made a change, so you can sign that, that's a disadvantage." [GP 1]

3.2.2.2 Uptake by GPs

Nurses and pharmacists reported that resistance and poor uptake by some GPs prevented the full benefit of the system from being realised.

"I think it has the potential to be a great system, but it's all about the compliance of the doctors, if they use the system, it's fantastic, because it eliminates errors and you've got the order there [on the electronic MAR] and it works like it's supposed to. It's the fact that some doctors are reluctant to use it and therefore you're still having to go through the old way of faxing a chart and the pharmacy having to import it." [Enrolled nurse 3]
 "[when GPs don't use the ePMMS]...we spend more time entering data, double handling data [to manage the MAR]." [Pharmacist 2]

GPs and nurses felt that the ePMMS was most beneficial for GPs with larger numbers of residents at the RACF.

"Dr X [GP 1] uses the system, because he's got so many residents here." [Enrolled nurse 3]
 "It would be an advantage if you had a large number of people at the facility, but if you've only got 1, 3 or whatever there, the system doesn't really advantage you a lot." [GP 2]

The need for paper copies of the medication chart (for the GPs' signature) and paper prescriptions (for the pharmacy, to enable medicine costs to be subsidised under the Australian Government Pharmaceutical Benefit Scheme [PBS]) were seen as barriers to uptake of the ePMMS.

"I think the big advantage is going to be when they accept electronic signatures, and when that [electronic MAR] will be your prescription rather than having to write [paper] scripts for the pharmacy, ... that'll save a lot of time, because I probably spend two hours each week writing scripts." [GP 1]

The use of different electronic medication management systems at different RACFs was also viewed as a barrier, as GPs with residents at multiple RACFs would need to master multiple electronic systems. It was suggested that RACF medication management systems should ideally be integrated with general practice clinical software.

"I think [the success of ePMMS] really depends on whether all of the [GP] practices can communicate directly with the [RACF] computer system, because ... ultimately the main communication really is through the hub, you know the actual computer system within the surgery." [GP 3]

Despite being provided with a tablet computer, GPs reported infrequently using mobile devices to access the ePMMS. Only one GP reported accessing the ePMMS while away from the clinic and RACF.

"If we're there [at the RACF] it's easier to use their computer, if you're here [at the clinic] it's easier to use our computer." [GP 5]
 "The only use [of a mobile device] is if you are offsite and can't use a desktop computer, but that's fairly rare, especially in a practice like this, if they can't find you they can always get one of the other doctors." [GP 3]

One GP disliked using a tablet to access the ePMMS because of the small screen size.

"... it's a very small screen, I find it very difficult to see." [GP 5]

Some GPs, especially those infrequently using the system, reported difficulties using the ePMMS, which led to reduced motivation and willingness to use the system, contributing to low uptake.

"I haven't used it much to be honest, the times I have used it it's been frustrating." [GP 5]
 "You really need to use it all the time, because otherwise you just forget." [GP 3]

3.2.2.3 Training and support

The need for additional training and support was raised by GPs and nurses.

"Someone came here [to the clinic] did face to face session, basically it was trial and error by yourself after that. ...it might be worthwhile doing another session. [GP 1]

"[The RACF] allocated a person to be an educator or helper, ... if you're there she'll help you work through the system, but if she's not there's no one to help you." [GP 5]

"I think their [GPs'] training probably hasn't been sufficient, and therefore it hasn't flowed through." [Enrolled nurse 3]

"I've sat down with doctors when they come and I'll say okay what are you wanting to order,..... just going through the steps, having done that a few times they're a lot more confident in doing it." [Enrolled nurse 3]

"Probably [need] follow up sessions for staff or something, you know we only had that one initial session. I think we struggled with it for a while, as you would with any change and such a new system, as it ironed out the kinks I think it's got easier and easier." [Registered nurse 1]

4. Discussion

This study highlights potential safety and efficiency benefits associated with integrated e-prescribing and medication management in the RACF setting, and a number of barriers to implementation of e-prescribing.

In an earlier study we reported that a hybrid paper-electronic medication management system contributed to discrepancies between GPs' paper orders and the RACF's electronic MAR, and delays between ordering and administering medicines, which led to medication administration errors.[7] Other studies have similarly highlighted problems and inefficiencies with hybrid paper-electronic medication management systems.[4–6] In the current study RACF staff reported that by eliminating the need for transcription of GPs' medication orders by the pharmacy to create a MAR, the ePMMS was able to reduce discrepancies between GPs' orders and the MAR, and delays between prescribing and charting. RACF and pharmacy staff also reported that the ePMMS saved them time.

However, uptake of the ePMMS by GPs was low. A number of reasons for this were identified. The fact that it was a stand-alone system, not integrated into the GPs' practice software, was a factor. Some GPs, especially those with few residents at the RACF, were reluctant to use the system. The need for additional training and support was also raised by GPs and nurses. The absence of decision support within the ePMMS may have contributed to the view that it offered little advantage over paper prescribing. Time was an important factor, as GPs felt that it was faster to handwrite medication orders than to use the ePMMS when prescribing at the RACF.

On the other hand, GPs reported that when they were away from the RACF the ePMMS had advantages over paper-based and hybrid paper-electronic systems, including remote access to the patient's MAR, ability to order or modify medicines, and sometimes ability to avoid or delay a visit to the RACF.

Another factor that contributed to low usage of the ePMMS by prescribers was that not all medication orders were initiated by residents' GPs. This suggests that for an e-prescribing system to be successful in the RACF setting, it may need to be accessible to all prescribers involved in the resident's care, including locums, specialists, nurse practitioners and others [10].

Low uptake of the ePMMS by GPs resulted in dual medication management systems being used (hybrid paper-electronic system and ePMMS), which created inefficiencies for nurses and pharmacists and reduced the potential safety benefits. For the benefits to be fully realised, all GPs caring for residents at the RACF would need to use the ePMMS, and be willing to use it consistently (with paper and telephone orders only used when the system is down).

A barrier to GPs' uptake of the ePMMS and a source of inefficiency and risk that was cited by GPs, nurses and pharmacists, was the need to print a paper copy of the electronic medication chart (for the GPs' signature) and the need for additional paper prescriptions for PBS purposes (PBS prescriptions could not be generated by the ePMMS). The need for paper copies of the MAR sometimes resulted in discrepancies between the electronic MAR and paper copies (e.g. when the GP and RACF staff forgot to print a new paper chart after a medication order was added, ceased or modified online). Eliminating the need for this step (► Figure 1, Step 3) would further improve safety and efficiency, and may enhance the uptake of e-prescribing. GPs felt that the ePMMS would become most beneficial once a truly paperless, integrated e-prescribing system, which includes PBS claiming from the electronic medication chart, becomes available in Australia.

There may be concerns that the ability to prescribe remotely may lead to residents being seen less frequently by their GP. However, the nurses and GPs in this study did not share this concern. The GPs reported that they mainly used the remote functionality for minor medication changes, or to commence or adjust therapy, prior to visiting the RACF in the next 24–48 hours to conduct a clinical review, when it was not convenient to visit immediately. They reported continuing to visit the facility when a resident was unwell or needed significant medication changes.

With the system described in this study, although the pharmacy doesn't need to enter data to populate the RACF medication chart, they still need to enter data into medication dispensing and packing software for the purpose of medication supply and PBS claiming (as is the case with existing paper and electronic medication management systems). Transcription of prescription data is a well-known source of medication errors [2, 3, 14]. To maximise patient safety, and efficiency, the ideal medication management system would be fully integrated, so prescribers' orders populate both the RACF medication chart and pharmacy dispensing and packing software, thus eliminating the need for data transcription [15].

The Australian Government recently developed a National Residential Medication Chart (NRMC), which can serve as both a MAR and PBS prescription, thus avoiding the need for prescribers to write separate PBS prescriptions to enable access to most government-subsidised medicines [16]. The NRMC is a paper chart, but has been converted into a hybrid paper-electronic format by some software vendors. Whilst it is likely to have positive impacts on patient safety and health professionals' workloads, ultimately it would need to be built into a paperless, fully integrated ePMMS in order to optimise patient safety and workforce efficiency [17]. The Australian Government also recently implemented a 'personally controlled electronic health record' (PCEHR), designed to provide an electronic summary of a person's health and medication history that is accessible online to the person and their healthcare professionals. However the PCEHR does not have e-prescribing or eMAR functionality, and information in the PCEHR cannot auto-populate medication management systems [18].

Our study has some limitations. It involved a single RACF, a single pharmacy and seven GPs from one clinic, which limits generalisability. Due to time constraints for study completion imposed by the funding body, evaluation occurred soon after implementation of the ePMMS. It is possible that GPs' uptake and acceptance of the ePMMS may increase or decrease over time. Our evaluation of uptake was limited to new medication orders. GPs' use of the ePMMS to modify or discontinue existing orders was not assessed. Nevertheless, this is the first study to explore the uptake and views and experiences of users' of a mobile, cloud-based, integrated ePMMS at a RACF. It provides useful insights that could guide future development and research in this area.

Some of our findings are consistent with other e-prescribing studies. Several studies have reported that medical practitioners found hand-writing medication orders to be easier and faster, which was a barrier to uptake of e-prescribing [10–12]. It has also been previously reported that GPs value the ability to remotely access and edit the MAR for RACF residents [10, 12]. Although there is no evidence from the RACF setting, it has been reported that integrated ePMMS in the hospital setting may reduce transcription errors [9, 15]. The importance of adequate training and support for users has also been highlighted [10, 19, 20].

For the benefits of an integrated ePMMS to be fully realised, the barriers identified in this study will need to be overcome. Resistance to change is a well-recognised barrier to implementation of e-prescribing systems [20, 21]. Prescribers need to see a direct benefit to themselves and their patients, the system needs to be easy and efficient to use, and users need to be adequately trained and supported [21]. As noted earlier, legislation and accreditation standards that enable paperless prescribing and prescription claiming may help to increase GPs' willingness to use the ePMMS. Improved system integration between the RACF and GP clinics could also increase uptake of the system by GPs and reduce the need for duplicated data entry and storage. Access to the system by other approved prescribers, and/or integration with hospitals and specialist clinics, could also be beneficial because, as reported in this study, a significant proportion of medications were ordered by prescribers other than the GP. Since the ePMMS appeared to provide a greater benefit to GPs with multiple patients at the RACF, a model of care where GPs manage larger numbers of residents (rather than having only one or two, as is often the case in Australia) could also enhance system up-

take and utility. Financial incentives for prescribers have also been suggested as a mechanism to drive uptake of e-prescribing in the long-term care setting [19].

5. Conclusions

General practitioners, nurses and pharmacists reported patient safety and workforce efficiency benefits with a mobile ePMMS. However, low uptake by GPs resulted in dual medication management systems being used and prevented the full benefits from being realised. A number of barriers were identified that would need to be overcome to achieve successful and sustainable implementation of an ePMMS in the RACF setting.

Clinical Relevance Statement

Integrated e-prescribing and medication management systems have potential to reduce the risk of medication errors and improve efficiency in residential aged care. However there are a number of barriers to the successful implementation of e-prescribing in this setting that need to be overcome. The findings of this study will help to guide the development and implementation of e-prescribing and medication management systems in residential care.

Conflict of Interest Statement

The authors declare that they have no conflicts of interest related to the research.

Human Subjects Protections

The study was performed in compliance with the Australian National Health and Medical Research Council National Statement on Ethical Conduct in Human Research (2007), and was approved by the Monash University Human Research Ethics Committee (Project No. CF12/3435–2012001669).

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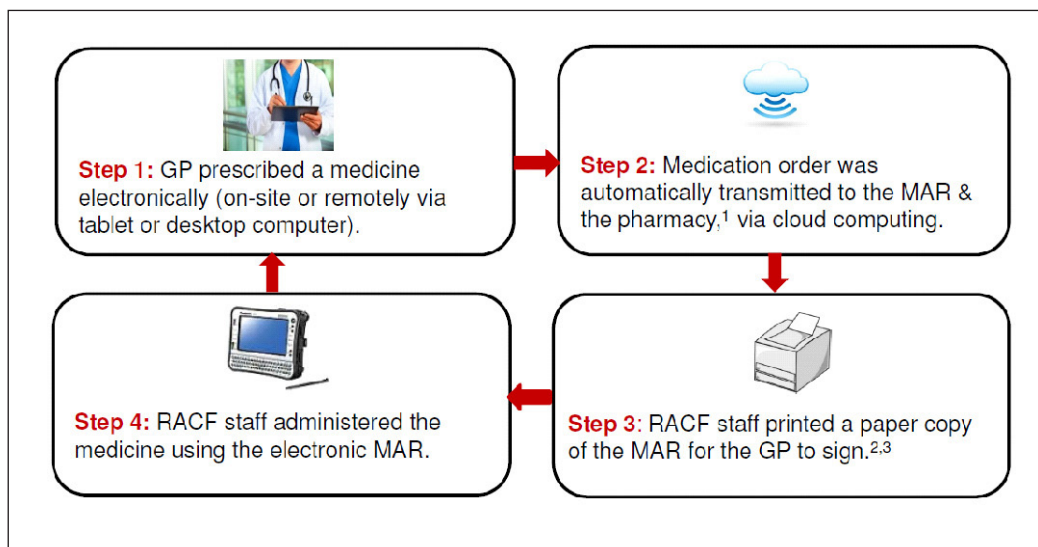


Fig. 1 Integrated electronic prescribing and medication management system

GP: general practitioner; MAR: medication administration record; RACF: residential aged care facility

Note:

1. The pharmacy dispensed the medicine and packed it into a dose administration aid if appropriate (these processes required manual entry of medication data into dispensing and packing software).
2. A paper copy of the medication chart, with the prescriber's handwritten signature, was required to comply with state legislation and accreditation standards.
3. The GP also prepared a separate Pharmaceutical Benefits Scheme (PBS) paper prescription (using their clinic's e-prescribing software which was not integrated with the ePMMS) to enable the resident to access the medicine at a government-subsidised price, if eligible.

These additional steps were common to all RACF medication management systems in Australia, whether paper-based or electronic, at the time of this study. Recent legislative changes have enabled some medicines to be supplied by a pharmacist without a separate PBS prescription if the RACF medication chart complies with certain specifications [16].

Table 1 General practitioners' (GPs) use of the electronic prescribing and medication management system (ePMMS) to order medicines

| GP | Number of residents | Number of medication orders | Number (%) medication orders entered into ePMMS by GP | Number (%) medication orders entered into ePMMS by pharmacist |
|--------------|---------------------|-----------------------------|---|---|
| 1 | 38 | 125 | 44 (35.2) | 81 (64.8) |
| 2 | 4 | 23 | 3 (13.0) | 20 (87.0) |
| 3 | 4 | 17 | 0 | 17 (100) |
| 4 | 3 | 30 | 0 | 30 (100) |
| 5 | 3 | 2 | 0 | 2 (100) |
| 6 | 2 | 8 | 6 (75.0) | 2 (25.0) |
| 7 | 1 | 0 | 0 | 0 |
| Total | 55 | 205 | 53 (25.9) | 152 (74.1) |

References

1. Australian Commission on Safety and Quality in Health Care. Analysis of Residential Aged Care Facility Medication Charts. Sydney; 2012. <http://www.safetyandquality.gov.au/wp-content/uploads/2012/02/NRMC-Project-RACF-Medication-Chart-Analysis-Report.pdf> (Accessed 19/11/15)
2. Velo GP, Minuz P. Medication errors: prescribing faults and prescription errors. *Br J Clin Pharmacol* 2009; 67(6): 624-628.
3. Keers RN, Williams SD, Cooke J, Ashcroft DM. Causes of medication administration errors in hospitals: a systematic review of quantitative and qualitative evidence. *Drug Safety* 2013; 36(11): 1045-1067.
4. Scott-Cawiezell J, Madsen RW, Pepper GA, Vogelsmeier A, Petroski G, Zellmer D. Medication safety teams' guided implementation of electronic medication administration records in five nursing homes. *Joint Commission Journal on Quality & Patient Safety* 2009; 35(1): 29-35.
5. Australian Commission on Safety and Quality in Health Care. Analysis of Residential Aged Care Facility Medication Chart Staff and Approved Providers Surveys Sydney; 2012. <http://www.safetyandquality.gov.au/wp-content/uploads/2012/06/NRMC-Analysis-of-RACF-Staff-and-Approved-Provider-Surveys-20122.pdf> (Accessed 19/11/15)
6. Tariq A, Lehnbohm E, Oliver K, Georgiou A, Rowe C, Osmond T, Westbrook J. Design challenges for electronic medication administration record systems in residential aged care facilities: a formative evaluation. *Appl Clin Inform* 2014; 5(4): 971-987.
7. Elliott RA, Lee CY, Hussainy SY. Evaluation of a hybrid paper-electronic medication management system at a residential aged care facility. *Aust Health Rev* Published online 21 September 2015 doi: 10.1071/AH14206.
8. Tariq A, Georgiou A, Westbrook J. Coping with information silos: an examination of the medication management process in residential aged care facilities (RACFs). *Studies in Health Technology & Informatics* 2014; 204: 156-162.
9. Oliver KV, Raban MZ, Baysari MT, Westbrook JI. Electronic medication administration records. Evidence Briefings on Interventions to Improve Medication Safety, Australian Commission on Safety and Quality in Health Care 2013; 1(5). <http://www.safetyandquality.gov.au/publications/evidence-briefings-on-interventions-to-improve-medication-safety-electronic-medication-administration-records/> (Accessed 19/11/15)
10. Rochon PA, Field TS, Bates DW, Lee M, Gavendo L, Erramuspe-Mainard J, Judge J, Gurwitz JH. Computerized physician order entry with clinical decision support in the long-term care setting: insights from the Baycrest Centre for Geriatric Care. *J Am Geriatr Soc* 2005; 53(10): 1780-1789.
11. Bollen C, Warren J, Whenan G. Introduction of electronic prescribing in an aged care facility. *Aust Fam Phys* 2005; 34(4): 283-287.
12. Burns P, Perkins DA, Larsen K, Dalley A. The introduction of electronic medication charts and prescribing in aged care facilities: An evaluation. *Australas J Ageing* 2007; 26(3): 131-134.
13. Pope C, Ziebland S, Mays N. Analysing qualitative data. *BMJ* 2000; 320(7227): 114-116.
14. Lisby M, Nielsen LP, Mainz J. Errors in the medication process: frequency, type, and potential clinical consequences. *Int J Qual Health Care* 2005; 17(1): 15-22.
15. Franklin BD, O'Grady K, Donyai P, Jacklin A, Barber N. The impact of a closed-loop electronic prescribing and administration system on prescribing errors, administration errors and staff time: a before-and-after study. *Qual Saf Health Care* 2007; 16(4): 279-284.
16. Australian Government Department of Health and Ageing. Fact sheet: Supply and PBS claiming from a medication chart in residential aged care facilities. 2012. <http://www.safetyandquality.gov.au/wp-content/uploads/2012/03/MedCharts-Fact-Sheet-for-Pharmacy-FINAL-June-2012.pdf> (Accessed 19/11/15)
17. Hoti K, Hughes J, Sunderland B. Medication supply to Residential Aged Care Facilities in Western Australia using a centralized medication chart to replace prescriptions. *BMC Geriatr* 2012; 12: 25.
18. Australian Government Department of Health. The Personally Controlled eHealth Record System. 2015. <http://health.gov.au/internet/main/publishing.nsf/Content/ehealth-record> (Accessed 19/11/15)
19. Subramanian S, Hoover S, Gilman B, Field TS, Mutter R, Gurwitz JH. Computerized physician order entry with clinical decision support in long-term care facilities: costs and benefits to stakeholders. *J Am Geriatr Soc* 2007; 55(9): 1451-1457.
20. Kruse CS, Goetz K. Summary and Frequency of Barriers to Adoption of CPOE in the U.S. *J Med Syst* 2015; 39: 15.
21. Charles K, Cannon M, Hall R, Coustasse A. Can Utilizing a Computerized Provider Order Entry (CPOE) System Prevent Hospital Medical Errors and Adverse Drug Events? *Perspectives in Health Information Management* 2014; 11: 1b.