

Unmet Needs for Transdermal Patch Management in Electronic Medication Administration Records: An Analysis of Data from 66 Aged Care Facilities

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Abstract

Background Transdermal medication patches have caused serious adverse events in residential aged care facilities (RACFs). Preliminary research suggests that facilities are using a workaround consisting of manually entered reminders in their electronic medication administration records (eMARs) to prompt staff to check and remove patches, because the eMAR does not support these tasks. However, the prevalence and factors associated with use of this workaround among facilities is unknown.

Objectives The objectives of this study were to (1) examine the frequency and consistency with which manual reminders to check and remove transdermal patches were used in facility eMARs, and (2) identify resident and facility factors associated with reminder use, to inform eMAR redesign.

Methods This was a retrospective cross-sectional analysis of eMAR data from 66 Australian RACFs including 4,787 permanent residents, aged ≥ 65 years in January 2017. Prevalence of the use of reminders to check and remove patches, and consistency in their application within facilities were examined. Generalized estimating equations were used to determine factors associated with use of manual reminders.

Results One in five ($n = 937$) residents used a patch, and 83.6% of patches contained opioids, a high-risk medicine. 56.9% of facilities implemented manually entered check patch reminders in the eMAR, and 72.3% implemented remove reminders. The reminders were applied inconsistently, with only half of these facilities having reminders for all residents with patches. Residents in facilities in regional areas were more likely to have a check reminder compared with those in major cities (adjusted odds ratio = 4.72 [95% confidence interval: 1.69–13.20]).

Keywords

- ▶ medication therapy management
- ▶ homes for the aged
- ▶ nursing homes
- ▶ electronic health records
- ▶ transdermal patch
- ▶ narcotics
- ▶ system design
- ▶ data

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Conclusion Transdermal patches containing high-risk medicines are frequently used in RACFs, but their safe administration is not supported by a widely implemented eMAR. The frequent, but inconsistent use of a workaround to manually enter reminders indicates an unmet need for new eMAR functionality to improve safety.

Background and Significance

Medication safety in residential aged care facilities (RACFs) is a concern globally due to the fragmented nature of care that residents receive, lack of clinical staff, and vulnerability of residents to adverse events.^{1–5} Residents are at greater risk of harm from medication mismanagement and errors due to multiple comorbidities, polypharmacy, and age-related physiological changes which impact their pharmacokinetic and pharmacodynamic characteristics.⁶ It has been estimated that between 16 and 27% of residents will experience a medication error, and residents experience higher rates of fatal medication errors (9–15% of errors) than the general population.¹

Transdermal patches are able to maintain a steady therapeutic medication concentration over long periods of time and eliminate frequent oral dosing. However, patches have been involved in fatal and serious medication error incidents.^{7–9} Patches are a particular concern given they frequently contain opioid analgesics, a high-risk medicine.¹⁰ A recent systematic review identified that each step in the transdermal patch administration process, including patch application, monitoring, removal, and disposal, is prone to error.⁷ Thus, transdermal patches require careful handling and administration to be used safely and effectively, but they require a different workflow from other medicines that do not require further management after administration. Prior to applying a new patch, the old patch needs to be removed. Patches that have been used for the indicated time still contain the active ingredient, and failure to remove the patch can result in an overdose and death.^{7,11} Some patches need to be removed up to 12 hours before the new patch is applied. Many patches are left in place for several days at a time, and so they need to be monitored regularly to ensure they have not been unintentionally displaced. Adhesion problems with transdermal patches are common and can lead to the medication not being delivered at the required dose.⁷ Displaced patches can also create a hazard by adhering to surfaces and other individuals.⁷

Electronic medication administration records (eMARs) are increasingly being implemented in RACFs and should facilitate medication safety. However, a formative evaluation of an eMAR in one RACF,¹² identified that the eMAR was not adequately supporting the tasks related to the safe administration of transdermal patches, as there was no electronic alert functionality to indicate when a patch should be checked or removed.¹² In response, the facility, in collaboration with the pharmacy, implemented a workaround reminder system, whereby text was manually entered in the medication name fields of the system to remind staff to carry out the extra tasks associated with transdermal patches. This

included checking the patch between applications and removing the old patch prior to applying a new one.¹² Previously, on paper medication charts, staff administering medications were able to more easily view all of a resident's medications, including transdermal patches that required monitoring or removal. Thus, facility staff working with paper medication charts were prompted to carry out these checks on patches. However, the eMAR only displayed the medications due for administration at each round, thus eliminating the prompt for staff to check or remove patches that did not require administration.

The workaround reminder system relied on pharmacy staff remembering to add reminders in the eMAR. If the reminders are applied inconsistently and occasionally not added, facility care workers who expect to see reminders may not check or remove patches. This is a safety concern, particularly in the context of the widespread issue of the lack of care staff, including registered nurses, in Australian RACFs. Furthermore, facilities located away from major cities may have reduced access to tertiary care in case of incidents resulting from medication errors.

Objectives

Given the risks associated with transdermal patch errors and the challenges they pose to medication workflow post-eMAR implementation, this study set out to examine the application of reminders in the eMAR among RACFs to inform eMAR redesign. Thus, our objectives were to examine how frequently and consistently the eMAR workaround was used in RACFs, and to identify resident and facility factors associated with the use of reminders. We hypothesized that RACFs with lower staff ratios or in remote areas may have a greater focus on safety procedures such as reminder use.

Methods

This study was conducted using routinely collected electronic health record data from 66 RACFs in New South Wales and the Australian Capital Territory, Australia, which were home to 4,784 permanent residents in January 2017. This study forms part of a larger program of research examining medication use among aged care facility residents.^{13–17} We report our study according to the Reporting of studies Conducted using Observational Routinely Collected Data (RECORD) checklist of items (an extension of the Strengthening the Reporting of Observational Studies in Epidemiology [STROBE] statement) for observational studies using routinely collected health data (**→ Supplementary Appendix A**).¹⁸

Medication Process

Residents in RACFs in Australia are treated and prescribed medications by general practitioners and nurse practitioners based in the community who visit the facilities. Residents' medications are supplied to the facility by pharmacies that are also off-site. Typically, there is one pharmacy supplying each RACF. Roll out of the iCareHealth¹⁹ eMAR module (without bar coded medication administration) in the study facilities began in 2014 and was completed across all facilities in the provider's network by the second quarter of 2015. The iCareHealth system is the market leader in the provision of electronic records in RACFs and is used in 80% of facilities with electronic systems to manage medications in Australia.²⁰ Pharmacies enter all medications supplied to a resident into the eMAR and the staff in the facilities use the eMAR to administer the medications to residents.¹² Care workers administer most medications, but registered nurses are required to administer controlled medications such as opioid analgesics.

Transdermal Patch Workflow and the eMAR

At the time of data extraction, transdermal patches were entered into the eMAR by the pharmacy in the same way as other medications. This involved entering the medication name, instructions, and administration day and time. There was no capacity to enter the additional check and remove tasks associated with patches within the same medication entry. In the facilities, during a medication round, the eMAR only displayed medications due for administration at a particular medication round. Thus, if a new patch application was not required, the patch entry was not displayed on the eMAR during the medication round. Facilities requested that pharmacies enter "check patch" and "remove patch" task reminders in the eMAR, so that they would appear during a medication round. To achieve this, the pharmacist needed to make a separate "medication" entry into the eMAR and manually enter the text for the reminder. Tasks to remove patches had to be manually entered as text into the medication fields, or into the instructions of the patch entry if administration and removal were at the same time.

Electronic Health Record Data

We used three sets of data from the electronic records to examine how frequently and consistently these manually entered reminders were used and the resident and facility characteristics association with reminder use: resident demographics, medication profiles, and facility characteristics. Data were extracted for all residents on a single day in January 2017. The resident demographics included date of birth, gender, date of entry into facility, care needs of residents (high, i.e., requiring assistance with most daily living activities, or low care), and residents' diagnoses (in a free-text field). Residents' diagnoses were used to identify residents with cognitive impairment and dementia.

The medication profiles contained all the medication data entered by pharmacies. The medication data consist of a medication name field and instructions field, both of which are free text. The medication names in the dataset were standardized using the World Health Organization's (WHO) Anatomical Therapeutic

Chemical Classification System (ATC) coding.²¹ Residents who were using a transdermal patch at the time of data extraction were identified through a combination of text searches and ATC codes, based on the transdermal patch preparations available locally. Those residents on patches containing opioid analgesics were flagged. We identified whether a manually entered electronic reminder to check and/or remove a patch was present for residents on transdermal patches using text searches in the medication name and instructions fields.

Facility data contained the number of staff, number of beds, and facility location. We used this data to derive the number of staff per bed, which was missing for two facilities. The facility location was used to assign a remoteness category to the facility using the Australian Bureau of Statistics remoteness categorization which is allocated on the basis of access to services.²² There are five possible remoteness categories (major cities, inner regional, outer regional, and remote and very remote), but facilities in our dataset fell into three of these (major cities and inner and outer regional areas). We grouped facilities into metropolitan or regional facilities, with regional encompassing both inner and outer regional locations, due to the small number of facilities in outer regional areas. Lastly, we created a variable using the residents' care needs to classify facilities into two categories: those with 50% or less of residents with high-care needs and those with over 50% of residents with high-care needs.

Statistical Analysis

Permanent residents aged 65 years and over were included in this analysis. Descriptive statistics were generated for transdermal patch use, demographic variables, and manual reminder use. Resident and facility level factors associated with the presence of a reminder to either remove or check a patch for a resident were examined using generalized estimating equations modeling to account for clustering of residents within facilities. Residents from two facilities with missing number of staff per bed data were excluded from the models. An exchangeable correlation matrix was used as we had a clustered cross-sectional dataset with residents clustered within facilities, and each facility typically had supplied medication by one pharmacy responsible for entering medication and reminders into the eMAR. Thus, we assumed the same correlation between residents within each facility. Robust estimation of standard errors was applied. We estimated unadjusted odds ratios (ORs) with 95% confidence intervals (CIs) using univariable models and adjusted odds ratios (AOR) with 95% CIs using multivariable models to account for all resident and facility factors (listed in ►Tables 1 and 2). Manually entered remove and check reminder use in the eMAR were also summarized at the facility level to examine the proportion of residents using a patch with each reminder. Data management and cleaning was done using SAS 9.4 and modeling was conducted in STATA 15.

Results

Transdermal Medication Patch Use

In January 2017, 19.6% of residents ($n = 937$), across the 66 facilities, were using a transdermal medication patch. One

Table 1 Resident and facility characteristics for all residents and residents using transdermal patches

Characteristic	All residents (<i>n</i> = 4784)	Residents on patches (<i>n</i> = 937)
Resident characteristics		
Females <i>n</i> (%)	3,318 (69.4)	714 (76.2)
Care needs <i>n</i> (%)		
High care	3,333 (69.7)	723 (77.2)
Low	1,451 (30.3)	214 (22.8)
Age (y) Mean (standard deviation)	85.3 (8.0)	86.2 (8.0)
Time in facility (y) Mean (standard deviation)	3.0 (3.2)	3.2 (2.9)
Dementia or cognitive impairment <i>n</i> (%)	2876 (60.1)	558 (59.6)
Type of medication in patch ^{a,b} <i>n</i> (%)		
Opioid	–	784 (83.7)
Other patch ^b	–	187 (20.0)
Patches left in place for >1 day <i>n</i> (%)	–	796 (85.0)
Facility characteristics		
Facility by percentage of high care residents <i>n</i> (%)		
≤ 50%	1,144 (23.9)	222 (23.7)
> 50%	3,640 (76.1)	715 (76.3)
Remoteness area <i>n</i> (%)		
Major cities	3,569 (74.6)	658 (70.2)
Regional ^c	1,215 (25.4)	279 (29.8)

^aResidents can be on more than one type of patch, thus the percentage on an opioid patch and other patch exceeds 100%.

^bIncludes: glyceryl trinitrate, rivastigmine, nicotine, oxybutynin, rotigotine, and oestradiol.

^cRegional areas include both inner and outer regional remoteness areas as defined by the Australian Bureau of Statistics.¹⁷

facility had no residents using a transdermal patch. Of the residents on a transdermal patch, the majority (83.7%) was using a patch containing an opioid, 85.0% (*n* = 796) were using patches left on for multiple days at a time, and a small proportion, 3.6% (*n* = 34), were using two or more types of transdermal patches. Resident characteristics are shown in **Table 1**. A higher proportion of residents using a patch were women (76.2 vs. 69.4% for all residents), had high-care needs (77.2 vs. 69.7% for all residents), and were in regional areas (29.8 vs. 25.4% for all residents).

Use of Manual Reminders in the eMAR to Check Patches

Across all facilities, manually entered reminders in the eMAR to check patches were used in 47.9% (*n* = 381) of residents with patches applied for periods of more than one day. **Fig. 1** (Panel A) shows the percentage of residents with a reminder to check their patch by facility. There were 37 (56.9%) facilities using reminders to check patches, and in these facilities, the percentage of residents using patches with a check reminder ranged from 3 to 100%. There were 17 (26.2%) facilities where all residents on a patch had a reminder for the patch to be checked. Of the facilities using reminders to check patches, 73% (*n* = 27) were also using manually entered reminders to remove patches.

Table 2 shows the regression results of characteristics associated with the use of manually entered reminders in the eMAR to check transdermal patches. The adjusted models showed that resident level characteristics (age, time in facility, gender, and level of care needs) were not associated with use of a manual check reminder. However, residents in facilities located in regional areas were over four and a half times as likely to have a check reminder as those in metropolitan areas (AOR = 4.79; 95% CI: 1.68–13.20). The facility size, number of staff per bed and whether the facility had a high proportion of residents with high-care needs were not associated with the presence of a check reminder.

Use of Manual Reminders in the eMAR to Remove Patches

Of all the residents on patches, 43.3% (*n* = 406) had a manually entered reminder in the eMAR to remove the existing patch prior to applying a new patch. **Fig. 1** (Panel B) shows the percentage of residents with a reminder to remove their patch by facility. Forty-seven (72.3%) facilities were using reminders to remove patches, and in these facilities, the percentage of residents using patches with a remove reminder ranged from 3 to 100%. There were 20 (30.7%) facilities where all residents on a patch had a reminder for the patch to be removed. Of the facilities using reminders to remove patches, 57.5% (*n* = 27) were also using reminders to check patches.

Table 3 shows the regression results of characteristics associated with the use of reminders to remove transdermal patches. No resident or facility characteristics were associated with the presence of a reminder to remove the existing patch prior to application of the new patch.

Discussion

Our results show that the use of a workaround in the eMAR to aid in the transdermal patch administration process is widespread across facilities, indicating an unmet need in eMAR design for this medication dose form. One in five aged care facility residents used a transdermal medication patch and 84% of these residents used patches containing opioid analgesics, a high risk medicine. Over 50% of facilities had at least one resident on a patch with a manually entered

Table 2 Regression estimates of resident and facility characteristics associated with the presence of an eMAR reminder to check^a a transdermal patch ($n = 766$)

	Number with reminder (%)	Unadjusted (univariable) models		Adjusted (multivariable) model	
		Odds ratio (95% CI)	<i>p</i> -Value	Odds ratio (95% CI)	<i>p</i> -Value
Resident characteristics					
Age	–	1.00 (1.00–1.01)	0.204	1.01 (1.00–1.02)	0.237
Time in facility	–	1.02 (0.99–1.05)	0.222	1.02 (0.98–1.06)	0.306
Gender					
Male	84 (50.6)	1		1	
Female	297 (49.5)	0.99 (0.83–1.20)	0.941	0.95 (0.76–1.19)	0.664
Care level					
Low	67 (41.1)	1		1	
High	314 (52.1)	1.25 (0.83–1.89)	0.291	1.27 (0.77–2.08)	0.359
Facility characteristics					
Number of beds	–	1.00 (0.99–1.01)	0.716	1.00 (0.99–1.01)	0.732
Number of staff per bed ^b	–	1.19 (0.44–3.18)	0.731	0.75 (0.28–2.00)	0.560
Facility by percentage of high care residents					
≤ 50%	43 (23.1)	1		1	
> 50%	338 (58.3)	1.69 (0.59–4.86)	0.332	1.75 (0.62–4.91)	0.290
Remoteness area					
Major cities	216 (39.6)	1		1	
Regional areas ^c	165 (75.0)	3.95 (1.55–10.04)	0.004	4.72 (1.69–13.20)	0.003

Abbreviations: CI, confidence interval; eMAR, electronic medication administration record.

^aSample limited to residents on a transdermal patch applied for multiple days.

^bData missing for two facilities.

^cIncludes inner regional and outer regional areas.

reminder to check the patch in the eMAR, and this figure was over 70% for reminders to remove patches. The implementation of manual reminders in the eMAR to remove patches was more widespread and consistently applied than those to check patches. This lack of support for tasks related to the safe administration of transdermal patches, frequently containing high-risk medicines, raises important quality and safety concerns for RACFs.

Information technology workarounds can be defined as a situation where technology is circumvented or used in unintended ways to complete tasks.^{23,24} Workarounds are the result of a misfit between the technology and work processes, which ideally should be addressed through modifications to the electronic system.^{23,24} The majority of the literature examining workarounds used with eMARs has focused on workarounds adopted by individuals during their work process.^{23,24} However, in our study, the workaround was implemented by the organization, that is, the facilities requested that pharmacies enter the reminders. The same issue was faced by a hospital after implementation of an electronic medication management system, in which a similar transdermal patch workaround was implemented.²⁵ Prescribers were required to enter tasks into the electronic medication management system to prompt nurses to check transdermal patches during medication administration

rounds, and remove old patches prior to applying new patches.²⁵ However, doctors failed to enter these tasks into the electronic system at a rate of 6 to 12 times per 100 admissions.²⁵ Thus, there is a need for the safe administration of transdermal patches to be supported in eMARs in RACFs, and more broadly in other health care settings.

eMAR workarounds have predominantly been viewed as having negative consequences for patient safety, as they are often used with the intention of completing tasks more efficiently.^{23,26} For example, research has shown that nurses circumvent bar code medication administration systems, a patient identification safety feature, by scanning the patient barcode on a patient list, rather than on the patient's wrist band during medication administration.^{23,27} However, the eMAR reminders for transdermal patch checks and removals were implemented by the RACFs in our study to improve resident safety. By alerting staff to check patches during medication rounds and remove existing patches prior to the application of a new patch, the workaround is prompting the completion of tasks that otherwise may be overlooked. This is important in the RACF setting where staff have high workloads and where staff shortages are an issue.²⁸

A key result from this study was that, in many facilities, the manually entered reminders in the eMAR were added inconsistently to the profiles of residents with patches. Only 46 and 43% of

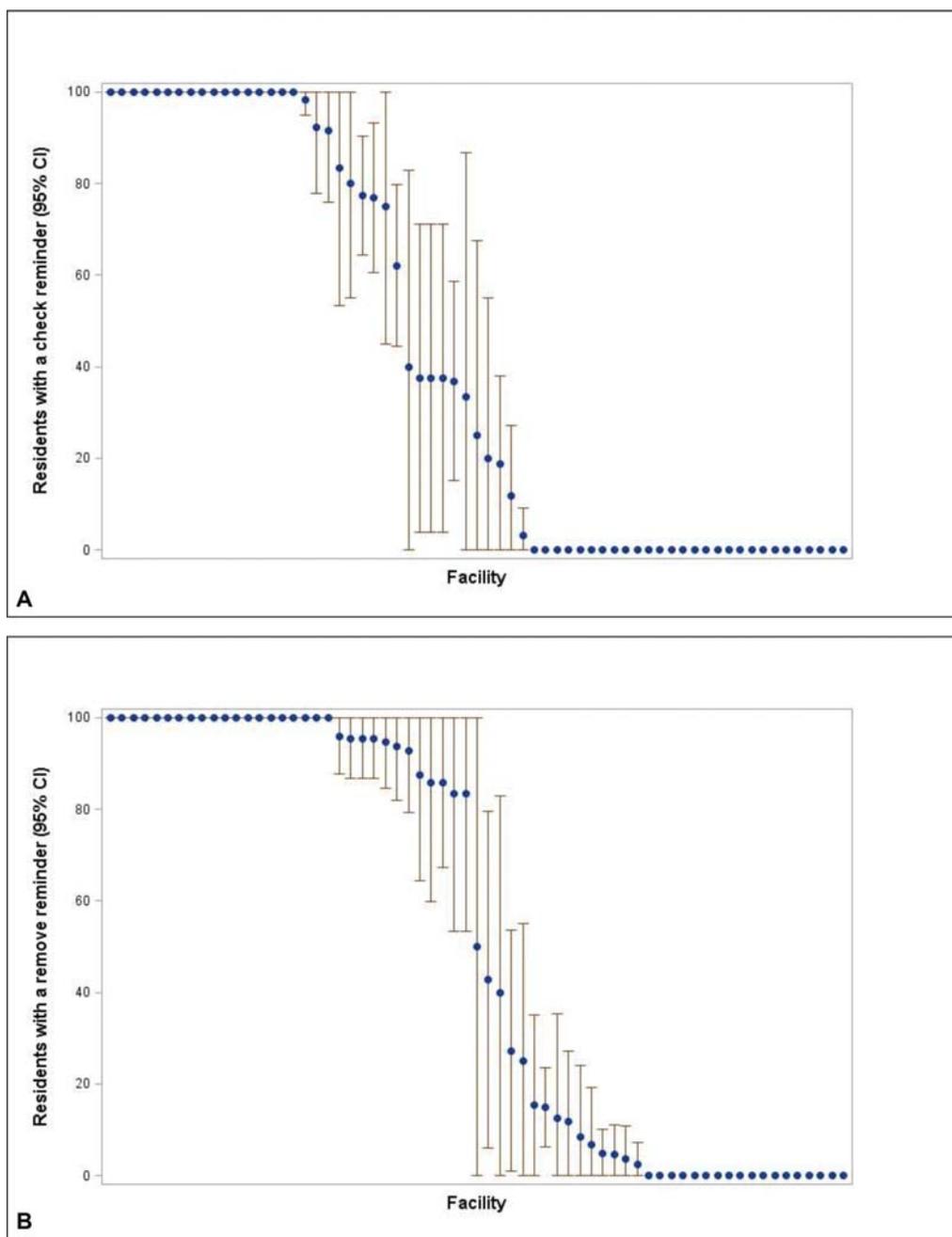


Fig. 1 Percentage of residents in each facility (with 95% confidence intervals [CIs]) using a transdermal patch with an eMAR reminder. (A) A reminder to check the patch; sample limited to residents on a transdermal patch applied for multiple days ($n = 796$). (B) A reminder to remove the patch; includes all residents using a patch ($n = 937$). eMAR, electronic medication administration record.

facilities using manually entered reminders had check and remove reminders present for all residents using a patch, respectively. This is a safety concern, irrespective of the type of medication contained in the patch.⁷ If staff members expect to see reminders to complete the patch tasks for residents, but these do not appear for all residents, there is a risk that these tasks will be omitted since users come to rely on the eMAR to alert them that tasks are due. Automation bias, “the tendency to use automated cues (such as CDS [clinical decision support] alerts) as a heuristic replacement for vigilant information seeking and processing,” has been identified as a significant risk when using health information technology.^{29,30} In this context, the reminders

are added to the eMAR during the dispensing process at the community pharmacy, which is not colocated within the RACF, and typically employs multiple staff members who are responsible for eMAR entries. These factors likely contribute to the inconsistent use of reminders and reinforce the need for a more sustainable eMAR solution to address this issue.

We found that facilities in regional areas were more likely to have a manually entered check reminder in the eMAR. This is a positive finding as facilities in regional areas have reduced access to health services, including tertiary care, which can have implications should there be an adverse event. Our results may indicate that facilities are putting

Table 3 Regression estimates of resident and facility characteristics associated with the presence of an eMAR reminder to remove a transdermal patch ($n = 900$)

	Number with reminder (%)	Unadjusted (univariable) models		Adjusted (multivariable) model	
		Odds ratio (95% CI)	p-Value	Odds ratio (95% CI)	p-Value
Resident characteristics					
Age	–	1.00 (1.00–1.01)	0.591	1.00 (1.00–1.01)	0.281
Time in facility	–	0.99 (0.70–1.74)	0.669	0.99 (0.97–1.01)	0.378
Gender					
Male	96 (45.3)	1		1	
Female	274 (39.8)	0.88 (0.72–1.07)	0.191	0.86 (0.71–1.12)	0.206
Care level					
Low	96 (48.0)	1		1	
High	274 (39.1)	0.92 (0.75–1.13)	0.414	0.89 (0.71–1.12)	0.322
Facility characteristics					
Number of beds	–	1.00 (0.99–1.00)	0.273	0.99 (0.99–1.00)	0.197
Number of staff per bed	–	0.76 (0.25–2.30)	0.626	0.74 (0.21–2.59)	0.636
Facility by percentage of high care residents					
≤ 50%	82 (36.9)	1		1	
> 50%	288 (42.5)	0.86 (0.33–2.3)	0.762	1.03 (0.36–2.92)	0.957
Remoteness area					
Major cities	294 (45.6)	1		1	
Regional areas ^a	76 (29.8)	0.48 (0.17–1.33)	0.158	0.45 (0.16–1.28)	0.133

Abbreviations: CI, confidence interval; eMAR, electronic medication administration record.

^aIncludes inner regional and outer regional areas.

processes in place to mitigate this heightened risk. The use of reminders to remove patches was more widespread among facilities than electronic reminders to check patches. This may be due to a higher perceived risk of unremoved patches by pharmacies.

We used routinely collected electronic data from a large sample of 66 RACFs to examine the use of transdermal patches and manual reminders in the eMAR to aid in the patch administration process. This data analytics approach allowed us to examine how widely a workaround identified in a previous study in one facility¹² was routinized across the provider network of over 60 aged care facilities. What remains unknown is whether the manually entered reminders in the eMAR were effective in improving the monitoring of transdermal patches and preventing adverse events. It is also likely that facilities which did not implement the use of the reminders in the eMAR had implemented alternative processes for transdermal patch administration. Moreover, transdermal patches require the application site to be rotated, so as to avoid skin irritation. This process was also not supported by the eMAR and facilities continue to use paper charts to assist with this process. Nonetheless, this study demonstrates how routinely collected data can be used to examine not only medication use but also system use to inform further system development.

Conclusion

Transdermal medication patch use is common among RACF residents. Currently, the eMAR systems available to RACFs do not address the work process needs of staff to ensure the safe administration of these patches. Changes to the eMAR to support these needs in a safe, sustainable, and consistent manner should be a high priority.

Clinical Relevance Statement

The design of electronic medication systems in residential aged care facilities needs to pay close attention to the workflow requirements, and electronic systems should be adapted in a timely manner to support these needs. Data from the electronic systems can be used to support the assessment of user needs and requirements for system features.

Multiple Choice Questions

- When managing transdermal medication patches, which of the following tasks was supported by the electronic medication administration record (eMAR) system design?
 - Checking the patch between administrations
 - Application of a new patch

- c. Removal of an existing patch
- d. Washing the patch

Correct Answer: The correct answer is option b. The eMAR only displayed the medication due for administration during a medication round. Thus, it alerted staff to the fact a new patch was to be applied but did not prompt staff to check an existing patch between administrations or to remove an existing patch (prior to application of a new one). The facilities, in collaboration with the pharmacy, implemented a workaround using manually entered reminders to prompt staff to check and remove patches. This was not a feature of the original eMAR design.

2. To overcome the eMAR limitations, the workaround for transdermal patch management was implemented by:
 - a. Individual nurses
 - b. Personal care attendants
 - c. Pharmacies
 - d. Facilities

Correct Answer: The correct answer is option d. The facilities requested that the pharmacy enter the reminders in the eMAR to prompt staff to check and remove patches.

Note

Preliminary results from this study were presented at the 20th Congress of the International Ergonomics Association, August 26 to 30, 2018, Florence, Italy.

Protection of Human and Animal Subjects

This research was approved by the University of New South Wales (HC113091) and the Macquarie University Human Research Ethics Committees (5201401005). Permission for accessing data was granted through a Collaborative Research Agreement between the University of New South Wales and the aged care provider.

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Conflict of Interest

None declared.

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