

Evidence Briefings on Interventions to Improve Medication Safety

Electronic medication administration records



Policy question: Do electronic medication administration records (eMAR) reduce medication administration errors and improve efficiency?

Current evidence shows: There is some evidence that eMAR systems in hospitals are associated with reduced dose omissions and improved medication administration documentation. However, there is a lack of evidence that eMARs are effective in reducing medication errors in residential aged care facilities. Studies measuring efficiency of medication administration following eMAR implementation present mixed results. All of the eMAR systems reviewed were implemented in combination with other information technology such as electronic prescribing or bar coding systems, thus isolating the specific effects of the eMAR component is difficult.

Background

Electronic medication administration records (eMAR) are electronic records of medications and administrations made to patients. Perceived benefits from implementing these systems include the ability to track dose omissions, enforce recording by staff of reasons for any dose omissions, improved timing

of administrations, and reduced risk of accidental medication discontinuities. Following on from these perceived benefits are possible improvements in the efficiency of the medication administration process and better medication management for patients.

eMARs are populated with electronic medication orders generally entered by doctors (often in conjunction with an electronic prescribing system), but also in some instances by pharmacists, pharmacy technicians or nurses. eMARs are frequently integrated with bar code technology and/or electronic prescribing systems as these combinations improve workflow and increase the potential for significant safety gains. In general terms, to administer a medication using an eMAR, the nurse signs onto the system and selects the medications to be given. Nurses may select a reason for not administering the medication, such as patient refusal if necessary, or confirm administration of each dose. When all administrations are complete, the nurse logs-out of the system. Typically, an electronic signature is stamped against the medications administered and the time at which these administrations were made. Some systems trigger alerts (or orders will change colour)¹ when medications are due or overdue etc. Documentation of reasons for medication omission are often mandatory using these systems, ensuring the sixth “right” of medication safety, right documentation of medication administration, is supported.

Methods

We performed a review of the literature to identify evidence of the effects of eMAR use on patient safety and work efficiency. We searched PubMed, Embase and Web of Science using the search terms *electronic medication administration record*, *eMAR*, *electronic medication management*, *eMM* or *medication administration error*. Grey literature was searched via Google Scholar and references of included papers were hand-searched for articles not captured using the other methods. The search was limited to papers published between January 2003 and June 2013.

Duplicates, letters, conference abstracts, dissertations and review articles were excluded. Original research papers evaluating the effects of eMAR implementation, with or without electronic prescribing systems and pharmacy dispensing and related systems were included.

Some studies implemented eMAR with bar code medication administration (BCMA) technology.

These studies were excluded as BCMA is the subject of a previous briefing². After the initial review of search results, titles and abstracts, 76 potentially relevant

full-text articles were retrieved. Eleven articles were included in this review, 10 were studies in the hospital setting, and one from residential aged care facilities. Two were Australian studies^{3,4}, three were from the UK⁵⁻⁷, one from Taiwan⁸, one from Canada⁹ and the remaining four were from the US^{1-10,12}.

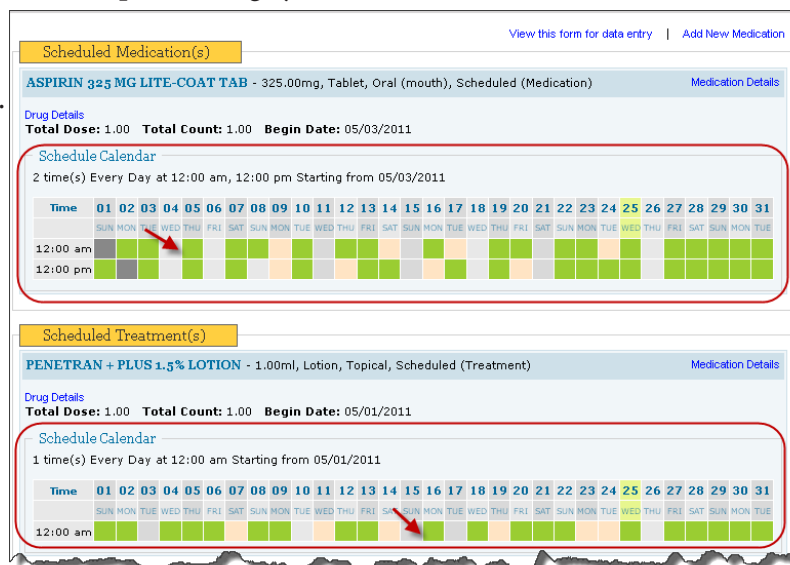
Results

Most of the included studies used before-and-after study designs to assess indicators of the effects of an eMAR. These indicators included medication administration and transcription error rates, quality of care, and timeliness and efficiency of administration. Studies used prospective or retrospective audit of medication administration records and reports, incorporating qualitative methods to provide contextual understanding and information in some instances. Definitions and descriptions of the eMAR and processes involved in medication administration before and after technology implementation were lacking in most studies.

Medication Administration Errors and Transcription Errors

Transcription of medication orders from the prescription onto an ordering sheet or eMAR by a third person, someone other than the prescribing doctor is common practice, particularly overseas. In the Australian context however, transcription may refer to the process of recharting a (paper-based) medication order onto a new medication chart for continuation of treatment. Two studies were found to have assessed transcription, one based in Australia³, the other based in Canada⁹. Medication administration error (MAE) rate, particularly dose omission was examined in four hospital based studies^{3-5,7}. All studies used either medication administration charts, incident reports or medication administration re-

ports produced by the eMAR as their primary data source and reported a reduction in MAE and/or transcription error rates after the technology was implemented, but only one⁷ reported a statistically significant decrease in MAEs. In all studies, the eMAR was integrated with another system, such as an electronic prescribing system.



Two of these studies assessed implementation of an eMAR in Australia^{3,4}, and both had simultaneously integrated electronic prescribing systems. The first study examined medication-related incident reports from two hospitals; one hospital with integrated eMAR and electronic prescribing and dispensing systems, the other hospital with a paper-based system. In the hospital with the paper-based system, there were five incident reports relating to transcription errors (one was wrong drug, one wrong dose, while three related to documentation problems more generally). No transcription errors were reported in the hospital with electronic systems³.

The second Australian study compared the rate of dose omissions pre- and post-implementation of an eMAR system⁴. The study used reports generated by the eMAR to estimate the dose omission rate post-implementation, although some high risk medications (such as intravenous potassium) were not included as they cannot be entered into the eMAR. This was compared to the rate of dose

omissions found by medication chart review pre-eMAR. Although implementation of the eMAR was not associated with an overall reduction in dose omission rate (approximately 7.5% in 2001 and 2011), it was associated with a reduction in the proportion of dose omissions with “no documented reason” (26% pre-eMAR versus 4.4% post-eMAR).

Two further studies examined the effect of eMAR on medication administration errors, both were conducted in the UK. A paediatric intensive care unit used three audits of medication administration charts (at pre-implementation, one week post-implementation and again six months after implementation) to identify dose omissions⁵, with “once only” medications and oxygen prescriptions excluded from the audit. A reduction in omitted medications was observed (8.1% pre versus 1.4%

6 months post eMAR), reasons for dose omissions documented as “other” or left blank were eliminated, while dose omissions documented as “unavailable”

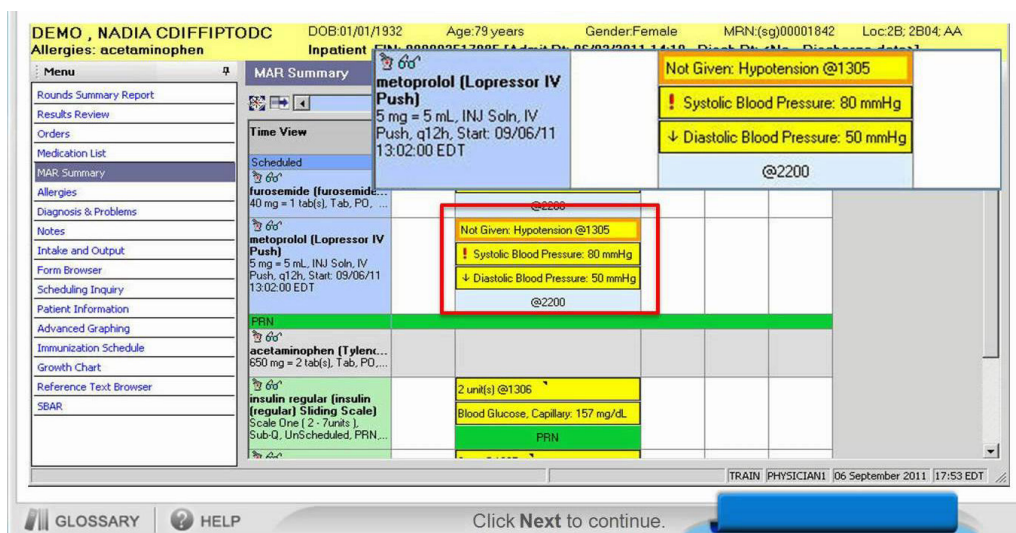
were reduced, although no attempt was made to test these differences statistically⁵. The second study used an interrupted time series analysis to evaluate how changes to an existing electronic prescribing and eMAR system impacted on dose omission rates⁷. Four interventions were implemented sequentially and evaluated across the hospital (except obstetrics, paediatrics and mental health). Over the entire 4.5 year study period, dose omission rates for medications reduced by 53%. The effect of each of the four interventions was also examined independently. Clinical dashboards which displayed individual ward performance on omitted doses for all managerial and clinical staff, and monthly executive team meetings with a focus on omitted doses, showed a statistically significant reduction in dose omissions post-implementation. Interestingly, the implementation of a visual indicator to show overdue doses was not associated with a change in dose omission rates.

Chart audits and medication incident reports were used to source data to calculate a transcription error

rate in a group of Canadian health facilities where a new eMAR system was being implemented⁹. To test the effect of the eMAR on transcription error, medication orders from one general medical unit were reviewed for two months before and two months after system implementation. Chart audits showed a decrease in the major transcription/ordering error rate from 10.2% to 6%, while minor errors were eliminated. The number of incident reports (relating to transcription error) submitted from across the group of hospitals also decreased after the eMAR was implemented across all hospitals, from 0.7 to 0.1 reported incidences per unit/month, an 80% reduction⁹.

While these studies present some encouraging results, the studies also include some methodological weaknesses. For example, incident reports submitted

on a voluntary basis do not provide comprehensive data on error rates and pre-post comparisons were often based on different data sources (e.g. review of paper based medication administration



charts vs electronic reports generated by an eMAR). The studies lacked controls, some collected data over a very short period or performed their research on single wards or units. Definitions of transcription error varied for each of the studies making comparison of results for this indicator difficult across studies. More large-scale studies applying robust methods are required to create a solid evidence base.

Quality of care

Only one study examined how the introduction of eMAR, and eMAR with electronic prescribing, was associated with changes in quality of care¹⁰. Data were drawn from three national databases on 2,603 acute-care hospitals in the U.S to conduct a cross-sectional analysis. Quality of care was assessed using 11 evidence-based quality indicators (e.g. patients with a diagnosis of heart attack prescribed aspirin at discharge). Hospitals that were using an eMAR (with or without electronic prescribing systems), had a higher odds of performing better on 10 of the 11

quality indicators, when compared with hospitals without technology. Hospitals with electronic prescribing systems alone showed only marginally improved performance in quality indicators compared with hospitals that had not adopted any technology¹⁰.

prescribing systems, making it difficult to isolate its effects. Studies conducted in the US may not be generalisable to the Australian setting as the medication administration processes differ across countries. In aged care facilities, no studies have assessed the impact of eMAR on MAEs. As with other information technology in the healthcare setting, consideration of the impact of eMAR on workflow and existing systems is important for successful implementation.



Timeliness, workflow and efficiency of medication administration

Two studies reported conflicting results in relation to changes in the efficiency of medication administration after implementation of

an eMAR¹⁶. In one UK hospital, the time taken to complete drug rounds was reported to increase from 69 seconds per item to 98 seconds per item ($p > 0.05$) after implementation of an integrated electronic prescribing and eMAR system⁶. In a nursing home setting, nurses were administering approximately 57 medications per hour to residents following eMAR introduction, compared to 40 medications per hour pre eMAR¹, although statistical significance was not assessed.

Perceptions of eMAR systems

Four studies used qualitative methods to assess usability and user perceptions of implemented eMAR systems^{6,8,11,12}. Concerns from users centred around integration of the eMAR with other systems and its impact on workflow and patient safety. Generally, in all four studies, nurses were positive about the eMAR after initial implementation^{6,8,11,12}. In two studies, users' perceptions improved over time^{11,12}. Aspects of medication administration documentation such as accuracy¹¹ and quality of information⁶ were believed to have improved following eMAR implementation, while effects on teamwork and communication between healthcare professionals varied between studies^{11,12}.

Conclusion

Few studies have assessed the impact of eMAR on MAEs and efficiency in hospitals, and fewer still in residential aged care facilities. eMAR and the processes followed for medication administration were poorly defined in many studies. There is some evidence that eMAR in hospitals may reduce dose omission errors and improve documentation related to medication administration. However, the current evidence base is weak. eMAR is frequently implemented alongside other technology, such as electronic

References

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Viewing MAR - Medication Administration Record

Beginning Date: 10/12/2011 to 11/04/2011

Patient Name: SAMPLE, JOE'SKITTLE*

HOLIDAY LIVING

Phone: 2

Patient DOB: 01/01/1931

CLONAZEPAM 2MG TAB*
Rx #: 100804
Controlled
RND/VHT/35
Daily
Start: 10/5/2011 Stop: 4/10/2012
Sig: TAKE 1 TABLET BY MOUTH ONCE A DAY FOR ANXIETY (EQ: KLONOPIN)
Consult: SE-EXCESSIVE DAYTIME DROWSINESS, WEAKNESS

Time	Color	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3
8 P	ORG																														

DIVALPROEX ER 500MG TAB*
Rx #: 342355
Controlled
RND/VHT/473
Daily
Start: 9/10/2011 Stop: 9/15/2012
Sig: TAKE 1 TABLET BY MOUTH TWICE A DAY FOR MOOD STABILIZATION (EQ: DEPAKOTE ER) *DO NOT CRUSH*
Consult: SE-EMOTIONAL LABILITY, IMPROVED DEPRESSION

Time	Color	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3
8 A	YEL																														
8 P	BLU																														

FLUTICASONONE 50MCG NS*
Rx #: 344982
Controlled
RND/VHT/473
Daily
Start: 6/12/2011 Stop: 6/27/2015
Sig: INHALE TWO PUFFS IN BOTH NOSTRILS EVERY OTHER DAY FOR ALLERGIES (EQ: FLONASE)
Consult: SE-TIZZINESS, HA, NASAL REGITATION/IRRITATION

Time	Color	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3
NOON	WHT																														

NASAL SPRAY
Alternating
Start: 6/12/2011 Stop: 6/27/2015
Sig: TAKE ONE (1) TABLET BY MOUTH THREE TIMES A DAY FOR SEIZURES (LEVETACETAM)
Consult: SE-WEAKNESS, DROWSINESS, COORD. LOSS

Time	Color	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3
8 A	YEL																														
8 P	ORG																														
8 P	BLU																														

Patient Name: SAMPLE, JOE'SKITTLE*
Address: 123 GREAT CARE AVE. HOMETOWN, KS 65555
Diet: REGULAR
Diagnosis: SEIZURE D/O, EPS, ARTHRITIS, SEASONAL ALLERGIES, MOOD D/O, CONSTIPATION, INSOMNIA, SCHIZOPHRENIA, ASTHMA

Zoom: 106%