ISMP Canada Safety Bulletin

Design of eMAR Systems with End-Users in Mind: Learning from a Fatal Incident in Long-Term Care

- *Work with both human factors specialists and end-users to ensure that the configuration of electronic medication administration record (eMAR) displays and printouts supports safe medication practices.*

- *When designing the eMAR display and printout, ensure that essential information, such as the drug name, strength, and required dose, are clear and readily apparent, while minimizing distracting information.*

- *Select an eMAR system that meets best practices and that is easy for users to navigate; one that is designed to meet the workflow and medication management needs of the work environment.*

Most long-term care (LTC) facilities have moved from a paper-based medication administration record system to an electronic medication administration record (eMAR) system. By automating scheduling and documentation, eMAR systems are intended to reduce medication errors through efficient workflow management and elimination of some of the error-prone paper-based processes.[1] However, failure to incorporate human factors principles into the design of such systems, as well as a lack of standardization, can lead to new errors.[2,3] As part of

an ongoing collaboration with a provincial death investigation service, ISMP Canada received a report that highlights opportunities to improve the design and presentation of key information in eMAR systems to prevent similar errors.

INCIDENT EXAMPLE

A resident in a LTC facility had a prescription for phenobarbital 20 mg, to be administered subcutaneously twice daily. The nurse was supplied with a 1 mL ampoule containing phenobarbital 120 mg/mL for injection. The resident was given 1 mL (containing 120 mg phenobarbital), instead of the required volume of 0.167 mL (for the prescribed dose of 20 mg). This 6-fold dosing error was deemed to have contributed to the resident's subsequent death.

BACKGROUND

Phenobarbital, a barbiturate for oral or parenteral administration, is prescribed as a sedative, hypnotic, or anticonvulsant.[4] The injectable form is available in Canada in 2 strengths and is supplied in 1 mL ampoules containing either 30 mg/mL or 120 mg/mL of phenobarbital.[5] Phenobarbital is a potentially inappropriate medication for individuals aged 65 or older because of, among other issues, an increased risk of toxic effects at comparatively low doses.[6]

The care needed to support LTC residents is becoming increasingly complex because residents now live longer with multiple, chronic medical conditions. About one-third of nursing time in LTC facilities is spent in activities related to medication administration, because of the number of medications prescribed, the complexity of residents' medication regimens, and the dependency on nursing staff due to residents' physical, functional or cognitive limitations.[7,8] Although studies have demonstrated improvements in safety associated with the use of eMARs in hospitals, similar studies have not been conducted in LTC facilities.[8] The expected benefits of eMAR systems include less emphasis on paperwork, opportunities to improve documentation (e.g., using bar codes), ability to generate reports and instructions for patient care, and accessibility of a patient's eMAR from multiple devices.[1] A potential future benefit is the capability to integrate the eMAR with electronic medical records and/or practice management software.

Medication practices in LTC facilities can vary. Medication orders may be entered by nursing staff directly into the eMAR or by pharmacy staff through an integrated system that populates the eMAR; verification of the orders can then be completed by pharmacists and/or nurses. Medication administration processes also differ between homes. In facilities with eMARs, nurses may use the eMAR display and/or a printout to identify medications to be given and then document their administration.
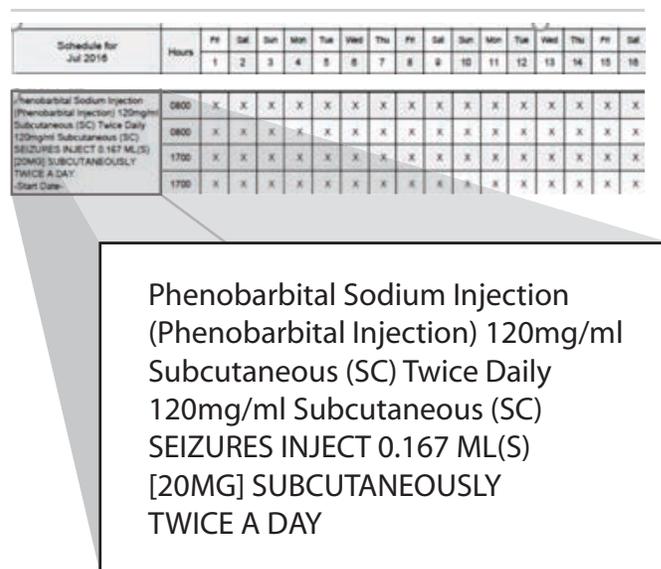
DISCUSSION

This bulletin focuses specifically on the eMAR design at the LTC facility where the reported incident took place, as the design was deemed to have been a significant contributing factor to the error. However, multiple other factors associated with this incident (e.g., choice of drug prescribed, strength of product selected/available, content/layout of dispensing label, requirement for dose calculation, independent check processes) also provide opportunities for learning.

Health information technology systems should have features that promote patient safety, such as easy navigation, simple and intuitive data displays, and

straightforward retrieval of data.[2,9] The eMAR display and printouts are especially important because these are the key information sources used to obtain the medication information needed to make patient care decisions.[9,10]

The critical elements of an eMAR display or printout that are required to safely administer a medication (e.g., drug name, unit strength, dose, route, and frequency of administration) must be clear and easily understood. In this incident, the presentation of the medication and its dose in both the eMAR display (screenshot not available, but likely similar to the printout) and the eMAR printout (see Figure 1) was determined to have led to misinterpretation of the information, resulting in administration of the incorrect dose.

Figure 1. Image of the phenobarbital entry on an electronic medication administration (eMAR) printout. The inset shows an enlarged image of the phenobarbital order display.

Phenobarbital Sodium Injection (Phenobarbital Injection) 120mg/ml Subcutaneous (SC) Twice Daily 120mg/ml Subcutaneous (SC) SEIZURES INJECT 0.167 ML(S) [20MG] SUBCUTANEOUSLY TWICE A DAY

Among the areas of concern identified, the following were specific to the display of medication information:

- *Placement of information:* The ordered dose (0.167 mL or 20 mg) is displayed in the middle of the reading pane, surrounded by other details, and is easily overlooked. Users may have difficulty locating the correct dose information because of

the cluttered display appearance and suboptimal placement of the critical elements, which increases the likelihood of an error.

- **Repetition of information:** Both the medication name (phenobarbital) and product concentration (120 mg/mL) were listed twice in the display and were positioned ahead of the prescribed dose. The route of administration appears 3 times, and the terms "injection" and "twice daily" each appear twice. This repetitive information is distracting and diverts attention from the critical elements. For medications such as phenobarbital, which are commonly identified only by generic name (i.e., without a brand name), the name should not be repeated on the display. Repetition of the product concentration before displaying the required dose likely contributed to a form of confirmation bias (i.e., perception that 120 mg was the required dose).

- **Use of capital (uppercase) letters:** The presentation of some words and terms in all capital letters in the eMAR display does not offer any benefit in terms of readability or understandability of the medication order. Prefacing the medication administration instructions with the capitalized word "seizures" is also confusing, as this format may reduce clarity about the intent of the order.

- **Multiple rows for administration times:** The display shows 4 rows of administration times for a medication that is intended to be given twice daily. More specifically, each of the 2 daily administration times is duplicated in the eMAR. Orders for other medications intended for twice-daily dosing have only 2 rows, 1 for each administration time. Although a concern regarding the display, this finding was unlikely to have contributed to the error.

The medication system software developer has made several changes to their system since the time of the incident and provided Figures 2 and 3 to share the improvements in the medication display.

RECOMMENDATIONS

Long-Term Care Homes

- Select an eMAR system that is easy for users to navigate and that is designed to meet the workflow

Figures 2 and 3.

| PHENobarbital Sodium Solution 120 MG/ML | Y | N |
| Inject 20 mg subcutaneously two times a day for | | |

1700 Seizures amount to be administered 0.167 ml   C

Dispensed Supply:
Needs to be ordered

A representation of an electronic medication administration record (eMAR) screenshot (top) and an eMAR printout (bottom) of a similar phenobarbital order using updated software.

Schedule for Sep 2018	Hours	Sat 1	Sun 2	Mon 3	Tue 4	Wed 5	Thu 6	Fri 7
PHENobarbital Sodium Solution 120 MG/ML Inject 20 mg subcutaneously two times a day for Seizures amount to be administered 0.167 ml -Start Date- 09/21/2018 1700	0600	X	X	X	X	X	X	X
	1700	X	X	X	X	X	X	X

and medication management needs of LTC home and pharmacy staff, and prescribers.[1] Ensure that end-users participate in the selection and configuration process.

- Ascertain and understand which components of the eMAR system can be configured to provide optimal workflow. Reach out to your pharmacy and software vendor to review any concerns and to ensure configuration follows best practices.

- Implement an eMAR with user-friendly safety design features, including the following:
  - a format that clearly distinguishes between the concentration or strength of the supplied medication and the patient-specific dose;
  - display of information in an order that matches facility workflow processes;
  - no unnecessary duplication of information in the reading pane;
  - appropriate use of upper- and lower-case letters to provide optimal readability of text.

- Test the eMAR system in a single care area before full-scale, facility-wide implementation, to evaluate the system's format and functionality.

Work with the software vendors to address any usability issues identified during the trial period. Further changes in eMAR format should be similarly assessed, on a step-wise basis, to ensure that the desired outcome has been achieved (e.g., improved "understandability" for end-users).

Medication System Software Vendors and Pharmacies Supporting Long-Term Care Homes

- Work with both human factors specialists and end-users to ensure that the configuration of eMAR displays and printouts supports safe medication practices.
- Collaborate with facilities to identify and support their specific needs and nursing processes.
- When designing/configuring the eMAR display and eMAR printouts, ensure that essential information, such as the drug name, strength, and required dose, are clear and readily apparent, while minimizing distracting information.
- Incorporate recommendations from existing published guidelines for display of electronic information.[10]
- Collaborate with LTC home staff to standardize order entry processes so that the display of medication information is consistent irrespective of who enters the order.

CONCLUSION

The need to incorporate technology into medication administration processes in LTC and other facilities is undeniable. However, the benefits anticipated from using an eMAR system can be offset by poor design and usability features, which can introduce a risk of new errors. This bulletin shares learning opportunities to improve the way in which medication orders are presented within the eMAR system, both on the display and in the printouts, to prevent errors similar to that in the incident described. Feedback from end-users and human factor specialists about the way information is displayed on the screen and in printouts should be incorporated into the design of an eMAR system, to minimize the risk of patient harm resulting from misinterpretation of that information.

ACKNOWLEDGEMENTS

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