

Identifying medication documentation errors using handwritten versus pre-printed ICU flowcharts

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KEY WORDS

Intensive Care Unit, medication errors, prescribing and administration documentation errors, ICU flowcharts, adverse drug events.

ABSTRACT

Objective

To compare and review medication documentation errors using handwritten versus pre-printed ICU flowcharts.

Design

Randomised retrospective audit comparing handwritten ICU flowcharts from 2004 and pre-printed ICU flowcharts from 2009.

Setting

Ten bedded, Level 2 Intensive Care Unit in Australia.

Subjects

Total of 60 ICU flowcharts: 30 handwritten flowcharts from 2004 and 30 pre-printed flowcharts from 2009.

Main outcome measures

To determine whether using pre-printed ICU flowcharts eliminated or significantly reduced the number of medication documentation errors compared to handwritten medication orders using ICU flowcharts.

Results

Although the sample size of this audit was small, this audit showed that there was no overall difference when using handwritten and pre-printed ICU medication flowcharts. Four error categories were initially measured against, but a fifth category was identified during the audit. The third category 'prescribing documentation errors' was identified as the largest category for errors, with a 44% error rate using handwritten ICU flowcharts and a 78% error rate using pre-printed ICU flowcharts.

Conclusion

This audit demonstrated although there was no overall difference using handwritten or pre-printed ICU medication flowcharts, using pre-printed ICU medication flowcharts reduces the risk of an adverse drug event that may result in patient harm by classifying error categories. This audit has also highlighted the need for further research into medication documentation errors using paper-based or electronic medication charting in the ICU, the role of pharmaceutical review during the prescribing process and to explore the role of nurse practitioners in the ICU.

INTRODUCTION

Medication errors are one of the most commonly preventable incidents in Australian hospitals (Hughes 2008; Roughead and Semple 2008). Medication errors are defined as “any errors in the prescribing, dispensing or administering of a drug, whether an adverse consequence occurred or not” (Bohomol et al 2009, p. 1260). As well as the significant impact medication errors cause patients in terms of morbidity, mortality and increased length of hospital stay, it is estimated nationally, medication errors occur in 5 to 20% of all drug administrations and approximately 1.5 million patients experience an adverse drug event (ADE) costing the healthcare system annually an extra \$380 million (Roughead and Bedford 2010; Bohomol et al 2009; Leach 2006).

Medication errors within Intensive Care Units (ICUs) have been attributed to multiple reasons including; staffing levels, fatigue, skill mix, workloads, multiple medication orders, lack of familiarity with medications, complex and critically ill patients requiring high technology care and a lack of knowledge relating to hospital medication policies (Jones and Treiber 2010; Roughead and Bedford 2010; Henneman 2009; McDowell et al 2009; Valentin et al 2009; Roughead and Semple 2008; McHugh 2005; Shulman et al 2005; Watterneck et al 2004; Donchin et al 2003). The incidence of medication errors and medication documentation errors in ICUs have been widely discussed within the literature (Kane-Gill et al 2010; Ali et al 2009; Bohomol et al 2009; Henneman 2009; McDowell et al 2009; Valentin et al 2009; Roughead and Semple 2008; Kane-Gill and Weber 2006; Shulman et al 2005; Ridely et al 2004; Watterneck et al 2004;). A landmark study by Bates et al in 1999 showed that prescribing errors have accounted for 56% of all medication errors. There is clear evidence to support the finding that medication documentation errors most commonly occur in the prescribing phase and that these prescribing errors are preventable, alongside drug administration errors (Ali et al 2009; Coobes et al 2009; Kopp et al 2006; Hogden et al 2005; Shulman et al 2005; Ridley et al 2004; Watterneck et al 2004). Literature has long supported the concept of ‘pharmacist participation’ in the prescribing stage of medication orders, aiming to reduce the number of prescribing errors (Leach 2006; Leape et al 1999).

There is a legal requirement for nurses are to be aware and demonstrate an understanding of the legal issues surrounding the correct documentation of medication orders to ensure and maintain patient safety (Jones and Treiber 2010; ANMC 2008; Deans 2005; Manias and Street 2001). Despite the relatively newly introduced sixth right ‘Right documentation’, there is limited research exploring medication documentation errors by nurses. However, one multi-national research study did highlight that there was a 45% error rate relating to ‘time of administration’ when documenting medication administration amongst nurses (Valentin et al 2009).

Many ICUs use 24-hour specialised observation charts known as ‘flowcharts’ that records patients haemodynamic details that are then used to formulate treatment decisions (Kim et al 2008; Manias and Street 2001). As the Australian National Inpatient Medication Chart is intended for general medicines use and intravenous (IV) infusions require a specialised ordering chart many ICU flowcharts contain a specialised medication chart for continuous and intermittent IV infusions (DoHA 2000).

While many studies have shown that medication errors have decreased using pre-printed IV orders compared to handwritten IV orders, the aim of this audit was to determine that the rate of medication documentation errors had reduced or had been eliminated altogether using pre-printed ICU flowcharts (Donihi et al 2006; Hodgen et al 2005; Shulman et al 2005; Watterneck et al 2004). It was hypothesised that the number of medication documentation errors using a pre-printed ICU flowchart would be significantly reduced but that medication documentation errors were still occurring using the new ICU flowchart.

METHOD

Design

This was a randomised retrospective audit conducted using a quantitative data collection tool, Microsoft Excel. The inclusion criteria comprised of day one adult-ventilated patients requiring varying types of IV therapy such as; sedatives, analgesia, catecholamine infusions, total parenteral nutrition, IV fluid and blood product therapy. 'Day one' patients were selected to reflect the higher acuity of the patients and to reflect the various reasons as previously described that may lead to medication documentation errors.

Sample

The sample size of this audit consisted of 60 flowcharts: 30 handwritten flowcharts from 2004 (n=852) and 30 pre-printed flowcharts from 2009 (n=727). The 60 flowcharts were selected from the 2004 and 2009 ICU patient admission roll-book. As a further consideration, handwritten flowcharts only from 2004 and pre-printed flowcharts from 2009 were selected to avoid any changes in documentation standards that may have occurred during pre-printed flowchart trials held between 2005 and 2008.

Data Instrument

As there are no mandated policies or guidelines for specialised medication charts, four categories were used as an audit instrument developed from the guidelines of the Australian National Medicines Policy (DoHA 2000) and the Australian Commission on Safety and Quality in Healthcare (2009). These guidelines stipulate the safe inpatient prescribing standards shown in Table 1.

Table 1: Required inpatient documentation standards for authorised prescribers.

Guideline	Components
3.1 Patient identifying information	Patient name, hospital identification number and date of birth and gender
3.5 Adverse drug reaction alerts	Unknown allergies, known allergies or adverse drug reactions, name of drug/substance, reaction details and date of reaction occurred
4.5 Medication order	Date of order, generic name of drug, dose, route, frequency, time to be administered and prescriber signature and name

The audit instrument also encompassed the legal requirements for nurses set by the Australian Nursing and Midwifery Council (2008), the Australian National Medicines Policy (DoHA 2000) and the Australian Commission of Safety and Quality in Healthcare (2009) in relation to administering and managing medications summarised in Table 2.

Table 2: Required medication administration standards for nurses.

Guideline	Components
Know relevant medication legislations	Poisons Act 1964 and Poisons Regulation 1965 in relation to the management of scheduled medications
Adequate knowledge of medications	Knowledge of medication, therapeutic purpose and dose, frequency, route of administration, specific precautions, contraindications, side effects, adverse effects and correct storage of medications
Adhere to organisational policies and procedures	Verbal orders, delegation of medication administration to medication endorsed nurses, student nurses and student midwives and management of nurse-initiated medications
Check medication order	Check correct prescription order with prescriber and/or pharmacist before medication administration
Allergy identification	Determine any unknown or known allergies or adverse drug reactions
Adhere to the '6 rights' of medication administration	Right drug, right individual, right dose, right time, right route and right documentation
Report and manage medication incidents	Report any medication incidents according to organisational policy

Data evaluation

Both flowcharts contained a specialised IV ordering section and the four categories were grouped according to the guidelines and components required for legal medication documentation standards for prescribers and nurses. Table 3 outlines the four relevant categories identified and the components of each category analysed.

Table 3: Categories & components identified to meet legal documentation standards.

Category	Components
A. Patient identifying details	Patient's full name, date of birth and hospital registration number
B. Identified drug allergies or adverse drug reactions	Documented known or unknown drug allergies or adverse drug reactions
C. Prescribed medication infusions	Date of order, patient's weight, drug, drug solution, dose and rate and signature of prescriber
D. Administered medication infusions	Time of administration and a signature from two nurses

Ethical Considerations

This audit is classified as 'negligible risk research' meaning there was no foreseeable risk or harm to patients by undertaking the audit (NHMRC 2007). Written consent was obtained from the local Government Department to access patient medical records. By a way of disclosure the author of this audit had previously worked within this ICU and had been the main facilitator in planning, designing, trialling and implementing the pre-printed ICU flowchart into clinical practice.

FINDINGS

The number of IV infusions handwritten in 2004 was 464. Of these 464 infusions there were a total of 495 documented medication errors identified. In 2009 the total number of pre-printed drug infusions was 185. The decreased number of infusions can be attributed to each drug infusion lasting for a 24 hour period instead of requiring a new drug order for each individual infusion¹. A total of 189 documentation errors were identified for 2009.

Error Categories

Category A comprised of an overall 46% (14/30) error rate in 2004 versus 0% (0/30) in 2009. There was a 100% (30/30) error rate in Category B during 2004 compared to a 1.3% (4/30) error rate in 2009. Figure 1 shows that the majority of documentation errors occurred in Category C. 44% (215/484) of errors relating to prescribing documentation standards occurred in 2004 versus an increase in prescribing errors in of 70% (130/185) during 2009. In Category D, 17% (87/484) of documentation errors occurred in 2004 compared to 20% (37/185) in 2009. A fifth category, Category E, was formed when it was recognised that nurses had scribed IV infusions. 30% (149/484) of documentation errors related to nurses scribing IV infusions occurred in 2004 versus 0.1% (2/185) in 2009.

Error components

Category A showed there were no errors relating to documenting patients' names and hospital registration numbers in 2004 and 2009 as shown in Figure 2. During 2004 fourteen documentation errors occurred versus zero errors in 2009 when documenting patients' date of birth.

During 2004 there was no documentation cited of known or unknown drug allergies or adverse drug reactions on all 30 flowcharts. In 2009 this standard improved by 86% (26/30) where patients' drug allergy or adverse drug reaction was identified in all but four charts².

¹ Patient admission numbers and patient acuity were taken into consideration when evaluating the decline in prescribed infusions. Although there was an overall decline in patient numbers, patient acuity had increased in 2009 from 2004. The mean APACHE II score in 2004 was 15.2 (n=832) and 16.3 in 2009 (n=727).

² Drug allergy or adverse drug reaction status was determined in all patients using previous National Inpatient Medication Charts and medical progress notes.

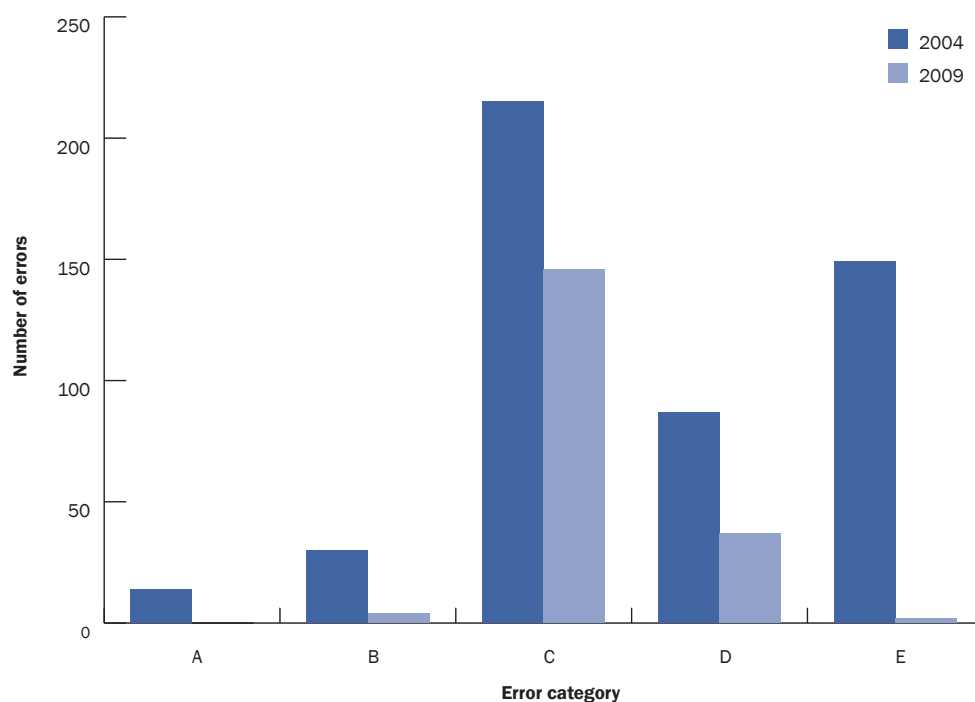
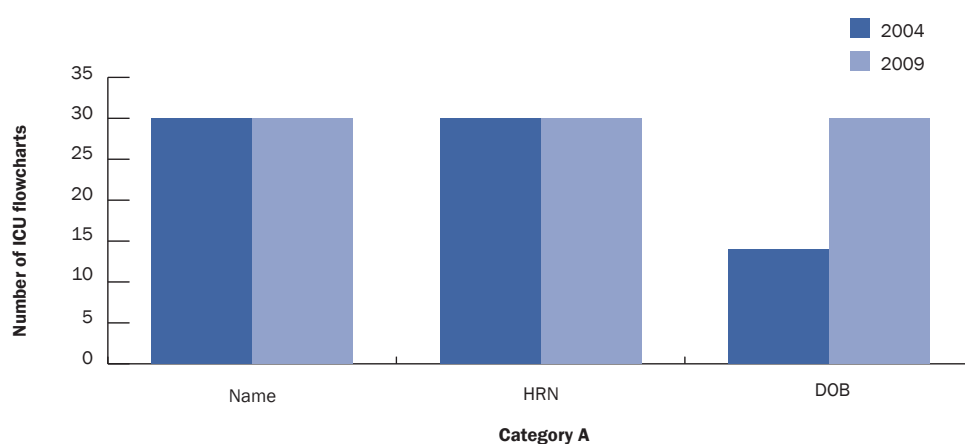
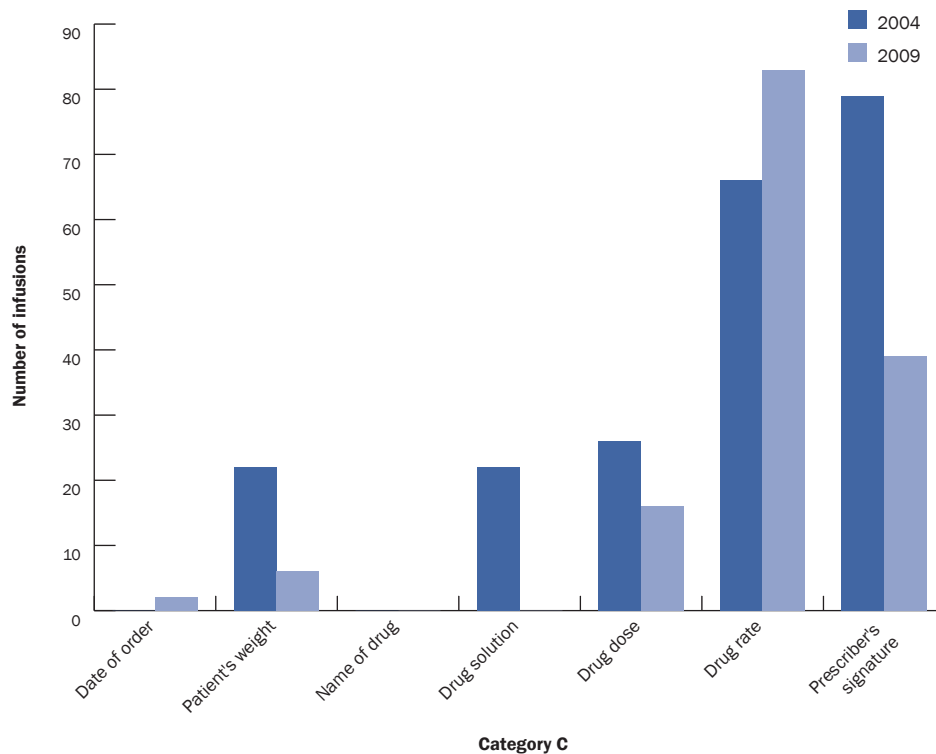
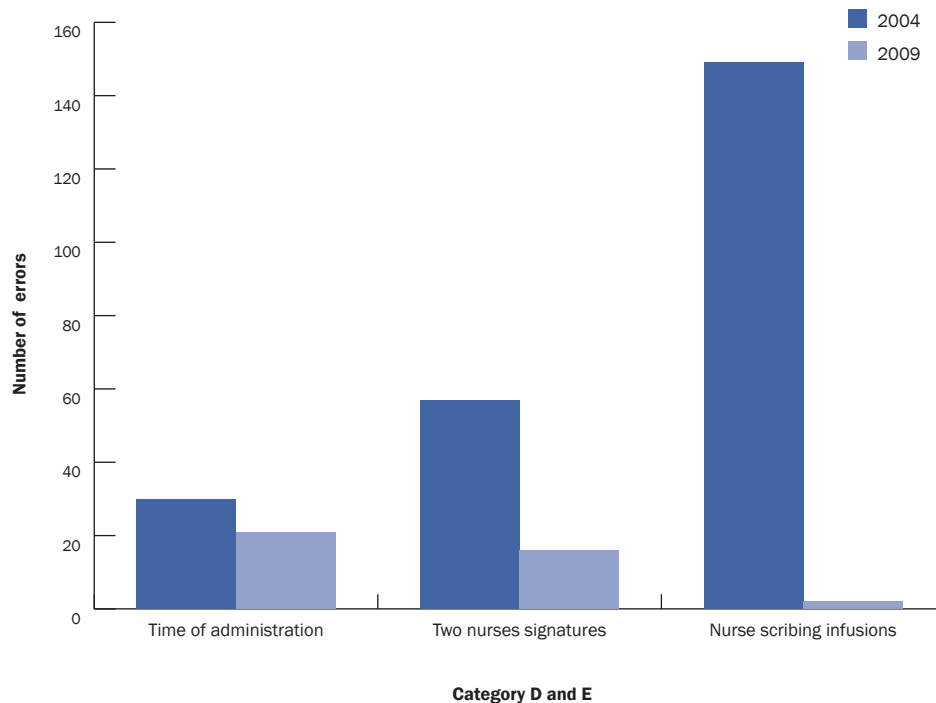
Figure 1: Number of documented errors**Figure 2: Patient's identifying details**

Figure 3 outlines the seven components of prescribing standards of Category C. This figure shows that in 2004 there were 0% (0/30) errors documenting the prescribing days' date versus 0.6% (2/30) in 2009. 73% (22/30) of flowcharts did not have patient's weight documented in 2004 compared to 0.2% (6/30) in 2009. 0% errors occurred in both 2004 (0/464) and 2009 (0/185) when documenting the medication to be infused. In 2004 there was a 0.4% (22/484) solution error rate versus zero errors in 2009. 0.5% (26/484) occurred in 2004 when documenting drug dose versus 0.8% (16/185) errors in 2009. During 2004 there was a 14% (66/484) error rate regarding drug rate versus 44% (83/185) in 2009. 16% (79/484) of all IV infusions were not signed for by an authorised prescriber in 2004 compared to 21% (39/185) in 2009.

In 2004 there was a 0.6% (30/464) error rate when documenting time of IV infusion administration (Category D) and this standard fell to a 1% (21/185) error rate in 2009. Conversely, in 2004 1.2% (57/464) of IV infusions infused did not have two nurses signatures documented as opposed to 0.8% (16/185) in 2009. Thirty two percent (149/464) of actual documented errors in 2004 were as a result of nurses' scribing IV infusions (Category E). This percentage fell to 0.1% (2/185) in 2009 as shown in Figure 4.

Figure 3: Prescribed drug infusions 2004 (n=464) and 2009 (n=185)**Figure 4: Documentation errors by nurses**

DISCUSSION

This audit compares medication documentation standards using handwritten versus pre-printed flowcharts. As technology advances ICUs are moving away from paper-based systems to electronic documentation systems including electronic medication prescribing (Gozdan 2009; George et al 2009; Roughead and Semple 2008; Whyte 2005). Many ICUs however, continue to use paper-based flowcharts and specialised medication charts for intermittent or continuous IV infusions.

During this audit no error free flowcharts were identified meaning every flowchart contained at least one documentation error. The rate of documentation errors for both 2004 and 2009 were significantly high with an error rate of 102%. In 2004 there were 495 documentation errors out of the 484 IV infusions and in 2009 there were 189 errors out of the 185 IV infusions.

Medication documentation errors can potentially lead to an ADE and jeopardise patient safety through iatrogenic injury. While the gold standard of zero medication documentation errors is strived for eradicating medication errors from practice may be difficult to achieve and unrealistic given that error is a fact of human condition (Leape 2009; McDowell et al 2009). Medication errors have been broken down into four classes as seen in Table 4 and while human error exists, the ideal aim and standard is the fourth class of 'minor clinical significance' during the medication process (Kopp et al 2006).

Table 4: Class and definitions of medication errors ^{9,10}

Class	Definition
I. Fatal	Resulting in patient death
II. Life-threatening	Resulting in serious adverse effects requiring prolonged length of hospitalisation
III. Significant	Resulting in patient monitoring but not requiring corrective treatment
IV. Minor	Has no clinical implications to the patient

Category A

Documenting patient identifying details resulted in an improved standard when recording patients' *date of birth* by 53% (16/30). Documentation of patients' *date of birth* is of significant importance as it is key identifier of the patient under the 'six rights' of medication administration for nurses (Crisp and Taylor 2010). Likewise the National Medicines Policy (DoHA 2000) also stipulates the documentation of patients' *date of birth* to differentiate a patient with the same full name to avoid prescribing, dispensing and administering medications errors. Failure to document patients' date of birth may result in a medication class error of either I, II, III, IV.

Category B

Documenting patients' *allergies* or *adverse drug reactions* status is important to avoid Class I or II adverse events from occurring. The improved standard of 86% (26/30) when documenting patients' *drug allergy* or *adverse drug reaction* status can be attributed to the introduction of an allergy box on the pre-printed flowchart in accordance with the Australian Commission on Safety and Quality in Healthcare (2009) guidelines.

Category C

The largest error of documentation errors occurred in prescribing standards and this study found that prescribing errors had actually increased using the pre-printed medication flowchart by 34%. The significance of the prescribing documentation errors requires closer scrutiny.

Date

Category A showed that documentation standards of the *date the drug order* was prescribed had declined in 2009 (2/30) compared to 2004 (0/464). According to the Australian Commission on Safety and Quality in Healthcare (2009) guidelines describe that date the order is written is required. As both the 2004 and 2009 flowcharts are patient specific and used to document a variety of subjective and objective data the risk of an ADE occurring is categorised within Class IV.

Weight

Adult patients' *weights* are documented for a variety of clinical reasons including drug and dose calculations when administering various IV infusions. In 2009 there was a 72.8% rise when documenting patients' *weight* and can be attributed to the 'weight box' being larger and placed next to where the patient's name is recorded. Failure to document patients' *weight* may lead to a Class IV or III ADE.

Medication

Correct prescribing standards were present both in 2004 and 2009 when documenting the *medication* to be infused. This ideal standard ensures that patients are not at risk for an ADE to incur.

Drug Solution

Incorrect documentation of drug solutions in 2004 was 0.4% (22/484) compared to 0% (0/185) error rate in 2009. This appears at face value to be attributed to pre-printed drug solution orders. It is concluded that this increase in documentation standard meets the ideal aim of placing patients at 'no risk' of an error.

Drug Dose

Initially it would appear that *drug dosage* prescribing standards were worse in 2009 by 0.3% using the pre-printed medication charts. However, risk to patient safety was actually minimised as instead of making handwritten *drug dosing errors*, incorrect *drug dose* errors were due to doctors not circling what drug strength was required. This error can be categorised into Class IV errors as all drug infusions are made according to the ICU's drugs protocols.

Drug Rate

Documentation standards of drug infusion rates also declined in 2009 by 30%. Failure to *document drug infusion* rates can have significant implications to patients in ICU leading to Class II or III ADEs. Patients receiving sedation and analgesia to assist with intubation and ventilation may be at risk of over-sedation without proper assessment and titration of drug infusions. This can cause significant delays in patients being extubated resulting in prolonged stays in ICU and hospital that may place patients at risk of acquiring ventilator-associated nosocomial infections (Quenot et al 2007).

Prescriber signature

Both nursing and medical legislation standards require a signature from an authorised prescriber when ordering drug infusions. Failure to prescribe or administer a medication without a *prescriber signature* is a breach of legislation standards and has the potential to cause an ADE from classes I to IV (Coombes et al 2009). In 2009 documentation of *prescriber signatures* fell by 5%. One possible explanation for decline in documentation standards may be caused by drug infusions being pre-printed on the flowcharts and prescribers not being prompted to sign infusions as with handwriting IV infusions.

Category D

Documentation standards for category D were divided between the two components *time of administration* and *signature of two nurses*. *Time of administration* documentation standards fell in 2009 by 10.4%. However, documentation standards in for two nurses' signing IV infusions increased by 10.2% in 2009. *Time of administration* documentation errors may only result in a Class IV adverse event, while failure to sign for IV infusions may result in a Class I ADE.

Category E

Of significance is the additional risk factor discovered during the study of Category E. Category E was not identified at the planning stages of the study when assessing against the legal documentation standards for authorised prescribers and nurses. However, during the data collection and analysis of the 2004 flowcharts it was identified that 30% (149/484) of the IV infusions had been scribed by nurses. Of these 149 infusions, 70 infusions had then been clearly identified as being signed for by an authorised prescriber other than the person scribing the drug infusion. The phenomenon of nurses scribing infusions without 'written' or 'verbal orders' to maintain a patient's haemodynamic and/or ventilation status and doctors signing infusions 'off' at a later date is well-recognised within ICU despite no literature to support this concept.

In 2009 evidence of nurses scribing drug infusions fell by 44%. This has placed patients at far greater lesser risk of a Class I, II, III or IV ADE from occurring. Through the introduction of nurse practitioners in ICU there may be a greater need for more nurse practitioners to avoid such documentation errors that may lead to patient injury (Hoffman et al 2004).

Limitations

This study was undertaken as a quality improvement activity and one of the main limitations of the study was the population sample size of 60 flowcharts. Counter-claiming this limitation is the number of IV infusions prescribed in 2004 (n=484) and in 2009 (n=185). In light of the number of IV orders for 2004 and 2009, increasing the sample size of the study may not have necessarily yielded different overall percentage results as all charts were from the first day of admission into ICU when on average the largest volume of IV infusions are prescribed.

CONCLUSION

Medication errors in ICU have been an area of concern resulting in extensive research in order to reduce ADEs from occurring. Research so far has identified that medication errors are largely preventable and over half the medication errors that occur happen during the prescribing stage as this study also found. Medication errors in ICU are attributed to multi-factorial reasons including high patient acuity, busy workloads, stress, fatigue and lack of knowledge and training. Medication documentation errors in ICU can lead to ADEs that can have a significant impact on the patient and to healthcare expenditure as a result of iatrogenic injury.

The purpose of this study was to examine medication documentation rates using handwritten and pre-printed medication charts using the Australian National Medicines Policy (DoHA 2000) as measuring standards. Based on these standards this audit found that there are high medication documentation error rates using handwritten and pre-printed specialised medication flowcharts. The significance of this study to clinical practice was to classify the errors in terms of 'risk to the patient' as a result of medication documentation errors.

This audit has found that using pre-printed ICU medication flowcharts reduces the risk of patients experiencing a Class 1 or 11 ADEs and patients are more likely to move across the continuum to a Class IV ADE. Despite the small population size of this audit, this audit has highlighted the need for pharmaceutical review during the prescribing phase and to explore implementation of electronic medication charting nationally. Finally, further qualitative research investigating the phenomenon found in Category D may support the role and growth of nurse practitioners in Intensive Care.

REFERENCES

- Ali, J., Barrow, L. and Vuylsteke, A. 2009. The impact of computerised physician order entry on prescribing practices in a cardiothoracic intensive care unit. *Anaesthesia*, 65(2):119-123.
- Australian Commission on Safety and Quality in Healthcare. 2009. *National Inpatient Medication Chart Guidelines*. Safety and Quality Council. [http://www.health.gov.au/internet/safety/publishing.nsf/content/80A0EF37F281A8D7CA25718F000CCC2F/\\$File/chguide.pdf](http://www.health.gov.au/internet/safety/publishing.nsf/content/80A0EF37F281A8D7CA25718F000CCC2F/$File/chguide.pdf) (accessed 18.05.2010).
- Australian Nursing & Midwifery Council. 2008. *Code of professional conduct for nurses in Australia*. [http://www.anmc.org.au/userfiles/file/new%20Code%20of%20Professional%20Conduct%20for%20Nurses%20August%202008\(1\).pdf](http://www.anmc.org.au/userfiles/file/new%20Code%20of%20Professional%20Conduct%20for%20Nurses%20August%202008(1).pdf) (accessed 17.05.2010).
- Bates, D.W., Cullen, D.J., Laird, N., Peterson, L.A., Small, S.D., Servi, D, Laffel, G, Sweitzer, B.J., Shea, B.F., Hallisey, R., Vilet, M.V., Nemesskai, R. and Leape. L.L. 1999. Incidence of adverse drug events and potential adverse drug events implications for prevention. *Journal of American Medical Association*, 274(1):29-34.
- Bohomol, E., Ramos, L.H. and D'Innocenzo, M. 2009. Medication errors in an intensive care unit. *Journal of Advanced Nursing*, 65(6):1259-1267.
- Coombes, I.D., Stowasser, D.A., Reid, C. and Mitchell, C.A. 2009. Impact of a standard medication chart on prescribing errors: A before and after audit. *Quality Safety Healthcare*, 18(6):478-485.
- Crisp, J. and Taylor, C. 2009. *Potter & Perry's fundamentals of nursing*. (3rd edn). Elsevier: Australia.

- Deans, C. 2005. Medication errors and professional practice of registered nurses. *Collegian*, 12(1):29-33.
- Department of Health and Ageing (DoHA). 2005. *National Medicines Policy*. Australian Government. <http://www.health.gov.au/internet/main/publishing.nsf/3e9bdcd6b9de8edaca25692100069835/c5d9c0c157ab188ca256f2a0015be67?OpenDocument> (accessed 13.05.2010).
- Donchin, Y., Gopher, D., Olin, M., Badihi, Y., Biesky, M., Sprung, C.L., Pizov, R. and Cotev, S. 2003. A look into the nature and causes of human errors in the Intensive Care Unit. *Quality and Safety in Health Care*, 12(2):143-145.
- Donihi, A.C., DiNardo, H.M., DeVita, H.M. and Korythowski, M.T. 2006. Use of standardised protocol to decrease medication errors and adverse drug events related to sliding scale insulin. *Quality Safety in Health Care*, 15(2):89-91.
- George, J., John, P., Binila, C., Kishore, P., Aparajita, R. K. Subbalakshmi, K., George, S., Agarwal, S., Anuncia, E. and Sunderraj, A. 2009. A computer-assisted recording, diagnosis and management of the medically ill system for use in the intensive care unit: A preliminary report. *Indian Journal of Critical Care Medicine*, 13(3):136-142.
- Gozdan, M.J. 2009. Using technology to reduce medication errors. *Nursing*, 39(6):57-58.
- Henneman, E.A. 2009. Unreported errors in the Intensive Care Unit. *Critical Care Nurse*, 27(5):27-34.
- Hodgen, L.A., Low, J.K., Knoerlein, K.D. and Edwards, W.H. 2005. Preprinted prescription forms decrease incomplete handwritten medication prescriptions in a neonatal Intensive Care Unit. *Journal of Patient Safety*, 1(2):100-104.
- Hoffman, L.A., Happ, M.B., Scharfenberg, C., Divirgilio-Thomas, D. and Tasota, F.J. 2004. Perceptions of physicians, nurses, and respiratory therapists about the role of acute care nurse practitioners. *American Journal of Critical Care*, 13(6):480-488.
- Hughes, C.F. 2008. Medication errors in hospital. *Medical Journal of Australia*, 188(5):267-268.
- Jones, J.H. and Treiber, L. 2010. When the 5 rights go wrong: Medication errors from the nursing perspective. *Journal of Nursing Care Quality*, 25(3):240-247.
- Kane-Gill, S. and Weber, R.J. 2006. Principles and practices of medication safety in the ICU. *Critical Care Clinics*, 22:273-290.
- Kane-Gill, S.L., Jacobi, J. and Rothschild, J.M. 2010. Adverse drug events in intensive care units: Risk factors, impact, and the role of team care. *Critical Care Medicine*, 38(6):s83-s89.
- Kim, H. Harris, M.R. Savova, G.K. and Chute, C.G. 2008. The first step toward data reuse; disambiguating concept representation of the locally developed ICU nursing flowsheets. *Comput Inform Nurs*, 36(5):282-289.
- Kopp, B.J., Erstad, B.C., Allen, M.C., Theodorou, A.A. and Priestly, G. 2006. Medication errors and adverse drug events in an Intensive Care Unit: Direct observational approach for detection. *Critical Care Medicine*, 34(2):415-425.
- Leach, H. 2006. National Inpatient Medication Chart Implementation. *Journal of Pharmacy Practice and Research*, 36(1):1-2.
- Leape, L.L., Cullen, D.J., Clapp, M.D., Burdick, E., Demonaco, H.J., Erickson, J.I. and Bates, D.W. 1999. Pharmacist participation on physician rounds and adverse drug events in the Intensive Care Unit. *Journal of American Medical Association*, 281(3):267-270.
- Leape, L.L. 2009. Errors in medicine. *Clin Chim Acta*, 404:2-5.
- McDowell, S.E., Ferner, H.S. and Ferner, R.E. 2009. The pathophysiology of medication errors: How and where they arise. *British Journal of Clinical Pharmacology*, 67(6):605-613.
- Manias, E. and Street, A. 2001. Nurses and doctors communication through medication order charts in critical care. *Australian Critical Care*, 14(1):17-23.
- McHugh, G.J. 2005. Prescription errors in Intensive Care. *Anaesthesia*, 60(7):716-717.
- National Health and Medical Research Centre (NHMRC). 2007. *National Statement in Ethical Conduct in Human Research*. Australian Government. http://www.nhmrc.gov.au/_file_nhmrc/file/publications/synopses/e72-jul09.pdf (accessed 18.05.2010).
- Quenot, J-P., Ladoire, S., Devoucoux, F., Doise, J-D., Cailliod, R., Cunin, N., Aube, H., Blettery, B. and Charles, P.E. 2007. Effect of a nurse-implemented sedation protocol on the incidence of ventilator-associated pneumonia. *Critical Care Medicine*, 35(9):2031-2036.
- Roughead, L. and Semple, S. 2008. *Literature review: Medication safety in acute care in Australia*. University of South Australia. 1-46.
- Roughead, L. and Bedford, G. 2010. *Medication safety: Will adverse drug events be reduced?* Australian Commission in Safety and Quality in Healthcare. [http://www.safetyandquality.gov.au/internet/safety/publishing.nsf/Content/DODABD9912D44A14CA257516000FDABB/\\$File/NatRep-Windows.PDF](http://www.safetyandquality.gov.au/internet/safety/publishing.nsf/Content/DODABD9912D44A14CA257516000FDABB/$File/NatRep-Windows.PDF) (accessed 08.05.2010).
- Ridley, S.A., Booth, S.A. and Thompson, C.M. 2004. Prescription errors in UK Critical Care Units. *Anaesthesia*, 59:1193-1200.
- Shulman, R., Singer, M., Goldstone, J. and Bellingan, G. 2005. Medication errors: A prospective cohort study of hand-written and computerised physician order entry in the Intensive Care Unit. *Critical Care*, 9(5):16-21.
- Valentin, C., Capuzzo, M., Guidet, B., Morena, R., Metnitz, B., Bauer, P. and Metnitz, P. 2009. Errors in administration of parenteral drugs in intensive care units: Multinational prospective study. *British Journal of Medicine*, 338(b184):1-8.
- Wetterneck, T., Paris, B., Blosky, M.A., Cartmill, R., Walker, J. and Carayon, P. 2004. *Error recovery in the ICU medication use process*. University of Wisconsin School of Medicine & Public Health, http://www.heps2008.org/abstract/data/PDF/Wetterneck_276.pdf (accessed 17.05.2010).
- Whyte, M. 2005. Computerised versus handwritten records. *Paediatric Nursing*, 17(7):15-19.