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## CLINICAL REVIEW

### **Technical and Environmental Impact on Medication Error in Paramedic Practice: A review of causes, consequences and strategies for prevention**

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#### **Abstract**

Medication error has been highlighted as a significant issue within the health care industry and paramedic practice is not immune to this concerning problem. The patient, their family, the paramedic and the health care system are all affected by the outcomes of medication error.

As the scope of paramedic practice increases so too does the possibility of medication error, and for this reason a proactive approach must be developed. Central to this approach should be a reporting system for medication errors that is without fear of reprisal, within which environmental and system errors are highlighted and dealt with. Additionally, paramedics must continually develop and be aware of their own self-guided commitment to high standards in clinical practice.

**Keywords:** *drug administration; drug delivery; drug dosage calculations; contraindications; emergency medical services; medication errors; paramedic; prehospital.*

#### **Introduction**

Medication error is defined by the National Coordinating Council for Medication Error Reporting and Prevention as “any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional, patient, or consumer.”<sup>1</sup>

The Australian Commission on Safety and Quality in Health Care recognises that over 1.5 million Australians suffer an adverse drug event each year. One hundred and forty thousand (140,000) of these events result in hospitalisation.<sup>2</sup> Further to this, Roughead and Semple indicate that results of incident reporting from hospitals in Australia show that “incidents associated with medication remain the second most common type of incident after falls”.<sup>3</sup>

While there have been many studies of medical and medication error, it appears that much of the research ignores the prehospital environment.<sup>4</sup> By its very nature, the prehospital environment is uncontrolled. Paramedics are required to deliver the highest level of clinical care in adverse environments, dealing with significant distractions while having to be vigilant

about their own safety. Vilke et al's examination of continuing quality improvement reviews showed that medication errors by paramedics do occur. Their survey of paramedic self-reported medication errors demonstrated that 9% of respondents admitted to having made errors in the previous 12 months.<sup>5</sup>

As the scope of paramedic practice is continually evolving, and the introduction of new drugs to the prehospital environment increases, the risk of medication error may also have the potential to increase. A proactive approach therefore needs to be adopted with regard to medication error in paramedic practice. This approach must involve regular review of the causes and consequences linked to medication error, as well as proposing strategies for prevention.

### **Prevention of medication error**

According to McGovern<sup>6</sup> the ten 'golden rules' for the safe administration of medication are:

- Administer the right drug
- Administer the drug to the right patient
- Administer the right dose
- Administer the drug by the right route
- Administer the drug at the right time
- Teach the patient about the drugs they are receiving
- Take a complete patient drug history
- Find out if the patient has any allergies
- Be aware of potential drug/drug interactions
- Document each drug administered

### **Administer the right drug**

Practicing paramedics carry a large number of drugs for administration and in this setting many of these drugs have a similar appearance, particularly when in glass or plastic ampoule form. Ampoules are often indistinguishable, apart from the label or printing, which can be difficult to distinguish in low light conditions. Additionally, the kit may include the same drug in two different forms or concentrations - for example atropine as a 600mcg or a 1.2mg presentation. Many modern paramedic kits have a design layout with only the ampoule tips exposed to view. In this situation, there is potential for the incorrect vial to be taken out for administration, particularly if the paramedic is not familiar with the kit layout. Craig et al<sup>7</sup> discussed these system factors in a field study of equipment and medication safety where three selected drug storage areas within an EMS system were examined. EMS staff was interviewed and potential sources of medication error within these areas were identified. It was concluded that 19.1% of self reported errors made over a four year period within this system were attributed to these system factors.

Tang et al<sup>8</sup> demonstrated that administration of the wrong drug was one of the two most common medication errors reported by nurses. Administration of an incorrect drug can occur through syringe swap, drawing up from an incorrect ampoule, or labelling errors. In a review by Abeysekera et al of 896 reports of drug related errors in anaesthetic practice, 50% of the total errors were related to these factors.<sup>9</sup> Drugs are also often drawn up and 'stored' temporarily prior to administration, increasing the likelihood of medication error related to syringe swap, particularly when poor labelling is taken into consideration.<sup>10</sup>

### **Administer the drug to the right patient**

The presence of distractions and interruption to concentration have been identified as significant predisposing factors to medication error.<sup>11</sup> In the prehospital environment, a multi-casualty incident places attending paramedics in this situation, where the possibility of drug administration to the wrong patient exists. The chaotic environment can lead to concentration lapses caused by inability to ignore the physical and environmental distractions that are present.

### **Administer the right dose**

A study by Hubble<sup>12</sup> in 2000, revealed that in a group of practicing paramedics, an average score of only 51% was obtained for a drug calculation examination. This is a concerning statistic given the requirement for paramedics to perform drug calculations in stressful emergency settings, or while performing other tasks such as driving to an incident. Hubble et al suggest 'skill decay' as the cause of this poor performance, with infrequent requirements to perform dose calculations and a lack of refresher training offered by employers.<sup>12</sup> Their paper also highlights that paramedics in the group were reluctant to request assistance from their partners, or to ask them to cross-check calculations. Some paramedics in the group also admitted to simply estimating dosages. The study suggests that dosage errors are possibly among the most prominent medication errors in paramedic practice, which concurs with the study by Vilke et al<sup>5</sup> showing that 63% of self reported paramedic medication errors are dose related.

Compounding these concerns are the actual stressors placed on paramedics by the very nature of their work. Le Blanc et al<sup>13</sup> showed that the stress faced by paramedics whilst managing a complex clinical scenario affected their performance in calculating drug dosages.

As suppliers and presentations of medications change, the likelihood of medication error increases. Without due care and attention, a new dose in a given volume can be erroneously administered on the premise that it is the old dose. The at-risk behaviour of "grab and go" noted in health care professionals in an emergency situation, without fully reading medication labels increases the possibility of this form of dosage error occurring.<sup>14</sup>

### **Administer the drug by the right route**

Paramedics administer medications via various routes such as: oral, sublingual, nebulised, intramuscular, intravenous, intranasal, interosseus and via an endotracheal tube. The same drug may often be indicated for use via as many as four different administration routes. The choice of route is made depending on patient presentation and drugs required. Tang et al<sup>8</sup> rank the administration of medications via the wrong route at 8.3%, suggesting that it is less common than other medication errors. Lesar<sup>15</sup> indicated that drugs which were able to be administered via multiple routes were most likely to be involved in route related errors. Three quarters (75.9%) of the 'wrong route' errors identified in the study were related to drugs that were able to be administered via a number of routes.

### **Administer the drug at the right time**

Depending on geographic and temporal factors (traffic, time of day, day of the week etc), paramedics may be responsible for the care of patients who require, over lengthy periods of time, repeat doses of medications throughout the patient care continuum. Therapeutic levels of drugs rely on consistent administration times.<sup>6</sup> In paramedic practice a number of drugs are administered to allow for other specific treatments to be performed, such as sedation for procedures. The time frame for a drug to have effect must also be taken into account in deciding the time(s) for administration and subsequent doses of the same drug, or doses of alternative drugs.

### **Inform the patient about the drugs they are receiving**

Valid and informed consent must be sought from all patients prior to drug administration and medical treatment. When doing so, factors such as religious and cultural beliefs must be acknowledged, in addition to potential complications or side effects of drugs which must also be considered to necessitate informed choice. Medication errors that can be avoided through informed consent relate more to moral and 'natural justice' values than to drug choice, dosage or administration route. However, in prehospital practice, securing informed consent in emergency situations is often confounded by the conscious state of the patient and resuscitation requirements. As such, paramedic practice and treatment decisions are often governed more so by the principles of implied consent.

### **Take a complete patient drug history**

To help prevent the risk of adverse drug interactions and ensure patient safety, being informed of the medications a patient takes is vital. The risk of this type of medication error is most prominent in the elderly and in the chronically ill, due to the large number of medications prescribed for various co-morbidities. Knowing the medication history of the patient assists in determining a provisional diagnosis which the paramedic can then begin to treat with appropriate drugs. However, full medication lists are often impossible to obtain in the emergency prehospital environment, either as a consequence of the conscious state of the patient, or absence of informed secondary reporting from partners and/or carers.

### **Find out if the patient has any allergies**

Lack of knowledge of a patient's allergies and/or co-morbidities is a commonly recognised and important risk behaviour associated with medication error.<sup>14</sup> Patients may not have the ability in an emergency to communicate allergies, which can have devastating consequences if the patient has a severe allergy to the administered medication. It is also an unfortunate fact that not all patients with significant allergies have immediate access to, or are in possession of a medical alert notification.

### **Be aware of potential drug/drug interactions**

When two or more drugs are administered, the potential for drug interactions is increased. Extensive knowledge of medications that a paramedic is authorised to administer is vital in reducing this aspect of medication error. In a literature review of factors contributing to medication errors, O'Shea<sup>11</sup> refers to a study by Leape et al in 1995, which reports lack of drug knowledge to be the most common system failure, accounting for 29% of the 334 medication errors made by nurses, doctors and pharmacists.<sup>16</sup> It is known that practitioners who continually update their drug knowledge make fewer medication errors.<sup>11</sup>

### **Document each drug administered**

To assist continuity of care between different disciplines of health care, accurate documentation of the drugs administered to a patient is essential. In addition to continuity of patient care, liability relies heavily on documentation. To ensure that this transpires, drug documentation must involve an accurate recording of information, such as name of drug, dose, route, time, response, and most importantly, accurate details of any allergies to, or refusal of medications by the patient.

### **Additional factors**

The work environment in which paramedics are sometimes required to operate, is often unpredictable and outside of a controlled setting. The following examples, which are unique to the paramedic work environment, can also increase the possibility of paramedic medication error.

- Danger and possible violence or abuse of the paramedic.
- Darkness or limited light.
- Prevailing weather conditions (heat, rain, strong winds).
- Distractions through aspects such as bystanders, noise, traffic etc.
- Cramped and/or a moving work environment.
- Remote settings with poor communication coverage (particularly in a single officer response with the associated lack of supervision and benefit of consultation).
- Inability to gain information such as medical history, medications and allergies of a patient.
- Inadequate access to general drug information to assist in decision making.
- Lack of uniformity of equipment and kits being used by different staff.
- Constant or excessive workload making timely restocking of kits difficult to achieve.

### **Consequences of medication errors**

Medication error has significant consequences at a personal and corporate level. The Australian Institute of Health and Welfare reports costs relating to the inappropriate use of medicines are approximately \$380 million annually. It should be noted that this figure is reported for the public hospital system alone and is likely to be significantly higher across the whole health care system.<sup>17</sup> Factors which contribute to the financial burden as a result of medication error include additional resources consumed, increased hospital stay and bed occupancy.

On a personal level, patients suffer longer hospital stays, loss of income, significant social and family disruption, additional financial costs, disability or even death. The financial and emotional burden also frequently extends to the patient's family.

The direct impact on the health care professional should not be overlooked. Schelbred describes that after incidents of medication error, nurses reported feelings of guilt, fear, loss of clinical and self confidence, difficulties regaining confidence, and fear of the consequences of disciplinary action and litigation.<sup>18</sup> If court action is initiated, the financial burden to the employer or the individual can be significant.

Medication error may also result in costs to the employer arising from re-education and training of the paramedic, support for the paramedic if stress or sick leave ensues, and re-deployment to off-road duties if the paramedic does not regain his/her clinical confidence.

Consequences of medication error by paramedics are potentially compounded by the relative difficulty of identifying prehospital medication errors compared to those occurring in hospital. It is suggested that a medication error not identified by the paramedic is likely to go unnoticed.<sup>12</sup> This is analogised by Hobgood et al<sup>4</sup> in an example where a higher than recommended dose of nitroglycerin in the prehospital setting results in hypotension being interpreted as cardiac failure on hospital arrival, rather than drug overdose.<sup>4</sup> There is also the danger of 'blame shift' to hospital staff should an adverse outcome occur when paramedic medication error is not identified.

Adverse outcomes from medication error may attract scrutiny from the media, which in turn can result in public loss of confidence in the abilities of paramedics. In a society that has low tolerance levels to medical errors and justifiably high expectations of safe medical care, the consequences of adverse outcomes can be costly at both corporate and personal levels.

## **Strategies for Prevention**

The multifaceted causes of medication error are reflected in the range of strategies necessary to maximise prevention. As no single strategy can be expected to limit medication errors in the prehospital setting, a systematic approach is required. To meet this in part, contemporary paramedic practice is developing an evidence-based approach to practice to ensure that prevention and control of medication error is governed by evidence. This was recognised by Jenson et al when they proposed evidence-based strategies for preventing drug administration errors in anaesthesia.<sup>19</sup> Although based on anaesthetic practice, five specific ‘strong recommendations’ can be adapted for the purposes of paramedic practice as follows:

1. The label on any drug ampoule or syringe should be carefully read before a drug is drawn up or injected.<sup>19</sup>

In a multitasked environment such as the prehospital setting it is vital that ‘pressure to proceed’ in an emergency does not compromise checking routines.<sup>9</sup> Paramedics must take the time to ‘stop and read’, thereby ceasing risk behaviours such as ‘grab and go’.<sup>14</sup>

2. Legibility and content labelling on ampoules and syringes should be standardised to optimise font, size, colour and information on the label.<sup>19</sup>

Christie et al discuss the debate regarding drug labels. There are advocates who propose that drug labelling should be printed in black and white to ensure that all labels are easily read, whilst others encourage colour coding of labels into drug classes.<sup>20</sup> Either way, consensus over the consistency of labelling by drug manufacturers would help to overcome current inconsistencies. It is also proposed that paramedics work in conjunction with manufacturers to obtain product labelling that specifically meets the challenging environment of prehospital care.<sup>7</sup> The following suggestions may assist this in the interim:

- Printing in a font that is clearly readable and shows the drug name, concentration/presentation and expiry date.
- Printing that is protected and does not wear off in the elasticised ampoule placements in kits.
- A background that highlights printing for legibility in poor light.
- A small abbreviation of the drug printed on the ampoule tip to assist with the identification of ampoules that are partially concealed under elastic placements in the kit. (The label must still be read in addition to this.)

The use of pre-filled packaged syringes may circumvent ampoule labelling problems in addition to dilution and calculation errors in the setting of multiple drugs and doses.<sup>9,12</sup>

3. Syringes should be labelled.<sup>19</sup>

It has been recognised that the pharmaceutical industry can provide design solutions to assist in the reduction of medication error. In addition to pre-filled syringes, manufacturers can provide ampoules and vials with flag labels that can be easily transferred to the syringe or infusion bag.<sup>10</sup> A further proposal that may be useful in addition to flag labels, is the manufacture of syringe packaging with an inclusive removable label. Figures 1 and 2 below, illustrate how the label can be used to write up the specific drug and concentration prior to being transferred onto the syringe. Labelling is therefore always available when a syringe is used and the drug is drawn up.

**Figure 1:** Removable label



**Figure 2:** Label attached to syringe



4. Formal organisation of drug drawers and workspace should be used with attention to: tidiness, position of ampoules and syringes, and separation of similar or dangerous drugs.<sup>19</sup>

Within a single ambulance service or EMS provider, all paramedics of equal clinical qualification are authorised to administer the same drugs under the same clinical guidelines or protocols. It stands to reason that these paramedics should therefore be issued with kits that conform to a uniform design layout. Furthermore, it is postulated that familiarity with a uniform drug location and kit layout across the services as a whole would result in a reduction in medication errors, particularly administration of the wrong drug. The literature supports this in the definition of 'errors of transference', meaning, errors that occur when people are confronted with new, unfamiliar or non-standard equipment.<sup>21</sup>

5. Labels should be cross-checked with a second person before a drug is drawn up or administered.<sup>19</sup>

Further preventative measures from a service perspective may include a reduction in single officer treatment. This is supported by results from a nursing model that proved fewer errors occurred with a system of two-nurse medication administration.<sup>11</sup> The 'cross-checking' measure is also viewed by Jenson et al as the most effective single measure to reduce medication error.<sup>19</sup>

To complement these five key strategies, the following measures may also assist in the reduction of medication error in paramedic practice:

- The issuing of calculators, drug dosage tables and infusion charts, in addition to ambulances equipped with medication infusion pumps.<sup>12</sup>
- Double verification of drug doses and infusions by the paramedic team as a protocol.<sup>12</sup>
- The implementation of in-service training to ensure continual competency in drug calculation skills<sup>12</sup> and service provider support for continuing education and knowledge of drugs.
- The implementation of an adequate non-punitive reporting system where paramedics are encouraged to report errors without fear of reprisal.<sup>5</sup> A person-centred approach to medication error is counter-productive. Blaming the individual is likely to overlook environmental factors as well as system errors.<sup>22</sup>

- The encouragement of a culture of caring and peer support among paramedics. Self esteem and respect lead to confidence, and confidence can minimise errors. Paramedics need to be confident that reporting of errors will not lead to group ridicule.
- Possible universal use of medication safety items similar to the device shown in Figure 3.

**Figure 3:** The check clip attaches the ampoule to the corresponding syringe, thus reducing medication error. (Image reproduced with permission from QlickSmart®).<sup>23</sup>



The system shown in Figure 3 clearly has advantages over simply taping an ampoule to the syringe. However, while appearing technically sound for the hospital environment, even tools such as this may have limitations in all paramedic settings.

### **Conclusion**

Medication errors in paramedic practice will occur. The development and implementation of a reporting system that involves full participation by paramedics is central to the reduction of prehospital medication error. For this to occur, the paramedic must be free of the fear of reprisal, knowing that the reporting process is designed to highlight the ‘bigger picture’, facilitate reflective learning, and institute change to avoid recurrence. Through the implementation of a central mandatory reporting system, data specific to the prehospital sector could be obtained and routinely audited. The data should provide the evidence to highlight the technical and environmental impacts of paramedic medication error and pave the way for development of an evidence base to construct specific prevention and remediation strategies.

Evidence specific to the prehospital setting is currently limited. Technically sound methods for minimising error in controlled medical environments may not necessarily prove to be as effective in the emergency prehospital setting, and as such, will require further testing.

As a supplement to the proposed systemic responses relating to the technical and environmental factors associated with medication error, paramedics must develop their own self-guided allegiance to high quality clinical practice. The core of any professional performance must involve a commitment to reflective self-examination and mentoring, and keeping the doctrine of ‘*above all, do no harm!*’ as a central platform for practice.

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