

Errors of intravenous fluid infusion rates in medical inpatients

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ABSTRACT – Prescriptions for intravenous (iv) fluids in hospitals may not be closely adhered to. This study prospectively examined whether prescribed iv fluids are administered at the correct rate. During a four-week period, the iv infusion rates in patients requiring continuous iv fluids and cared for by a single medical team in a district hospital were studied. The periods over which iv crystalloid fluid bags were administered were compared with the time prescribed. Of a total 207 bags, 53 (26%) were correctly administered at the prescribed rate (percentage error 10% to -10%), 138 bags (67%) were infused too slowly and 16 bags (8%) were infused too fast. Overall, the median (interquartile range) absolute percentage error (positive or negative) for all infused bags was 23% (9.7-50). Thirty-nine per cent of bags were infused accurately when a metered pump was used, compared to 21% of bags infused accurately when a metered pump was not used ($p < 0.01$). Marked inaccuracies in iv fluid infusion rates are common, and do not seem to be perceived by staff as important. Metered pumps improve accuracy. Increased awareness of such errors, and the routine use of metered pumps should help improve the accuracy of iv fluid infusion rates.

KEY WORDS: error, fluid, intravenous, medication error, parenteral

Introduction

Prescribed intravenous (iv) fluids constitute an important treatment in hospital inpatients. Intravenous fluids are used in the resuscitation of sick patients and are also used to maintain levels of hydration, particularly in patients who are unable to drink adequate quantities of fluid. As inpatient healthcare becomes more complicated, in terms of investigation and treatment, and as inpatient care becomes busier with rapid throughput of patients, there are numerous opportunities for error in administration of prescribed treatments. Errors in administering prescribed drugs are well documented.¹⁻⁵ There was an impression that prescriptions for iv fluids were not being closely adhered to in our hospital. Therefore a prospective

study was undertaken as to whether prescribed iv fluids were administered correctly.

Methods

Over a four-week period, inpatients requiring continuous iv fluids, who were admitted under a single medical firm to general medical wards at our hospital were studied. To be entered into the study, the patients had to require continuous iv fluids. One investigator was responsible for ensuring that the studied patients always had a suitably sited patent iv cannula and ensured that the prescribed fluids chart was always correctly documented in advance and without any intended gaps in fluids administration. These safeguards, checked prospectively, ensured that absence or blockage of an iv cannula, or absence of a prescription did not lead to a failure in prescribed fluids being given.

At our institute, the nursing staff are responsible for setting up and maintaining iv infusions. On some wards, metered pumps are used to determine the rate of fluid administration, while on others the drip speed is gravity-reliant and is estimated by the nursing staff. The start time for each iv fluid bag is documented on the prescribed fluids chart. Daily review of the prescribed fluids chart enabled simple calculations to be made so that the time during which a bag of iv fluid was administered could be compared with the time prescribed.

Statistical analysis

For each one litre bag of fluid prescribed, a percentage error in the infusion rate was calculated. The percentage error was the difference from 100% of the actual time (minutes) during which the bag of fluid was given divided by the time during which it should have been given, expressed as a percentage:

$$\% \text{ error} = \left(1 - \frac{\text{actual administration time}}{\text{prescribed administration duration}} \right) \times 100$$

Where bags of fluid were administered too slowly, the percentage error is negative. Errors of between 0 and 10% or between 0 and -10% were considered accurate. Percentage errors greater than 10% represent too rapid fluid administration while percentage

errors below -10% represent too slow administration of fluid. When calculating absolute errors, negative errors were converted to absolute (positive) errors. The errors were not normally distributed and are expressed as median (interquartile (IQ) range).

The Mann-Whitney U test was used to compare errors in fluid delivery using, and not using, metered pumps. Comparisons of infusion rates in patients on the medical admissions unit (MAU) were compared with those on other general medical wards, since the MAU in our hospital is a more acute area with increased nursing numbers. Finally, the errors in infusions prescribed to be given in four hours or less were compared with those prescribed to be given over more than four hours.

Results

The administration rates of 214 one-litre bags of iv fluid infused into 25 patients (12 male, median age 70 years old) were recorded. The median (IQ range) number of bags per patient was six (4-12). The recording of start times was incomplete for

seven bags. Data for 207 bags of fluid were analysed: 149 bags (70%) were 0.9% saline, the remaining 30% being 5% dextrose or dextrose/saline.

Of the 207 bags, 53 (25.6%) were administered at the correctly prescribed rate: the percentage error was between -10% and 10%. One hundred and thirty-eight bags (66.7%) were administered too slowly with a percentage error below -10%. Sixteen (7.7%) bags were administered too fast, with a percentage error greater than 10%. Fig 1 gives a breakdown of the percentage errors. The greatest percentage error (-633%) was of a bag prescribed to be infused over two hours but given over more than 14. Overall, the median (IQ range) absolute error (positive or negative) for the entire group was 23% (9.7-50).

Metered compared to non-metered fluid administration

Of the bags of fluid, 44% were given by metered pump, and 56% without a metered pump. Fluids administered by a metered pump were more likely to be infused accurately: 39% of bags

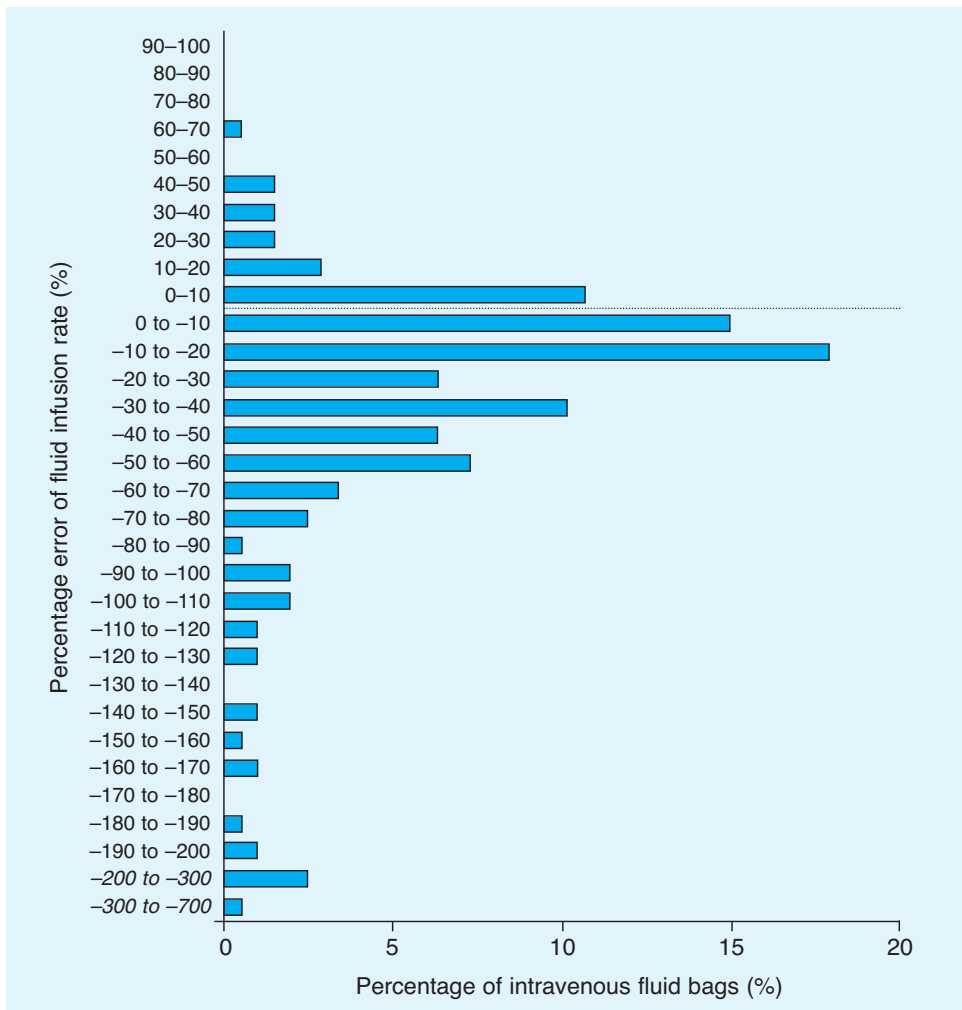


Fig 1. Percentage errors in fluid infusion rates for all fluid bags. Positive errors represent too rapid infusion, negative errors represent too slow infusion. Note change of scale for histogram bar increments of slowest infusion rates shown in italics.

were infused accurately using a metered pump, compared to 21% of bags infused accurately without ($\chi^2 = 7.7$, 1 df, $p < 0.01$, accurate v inaccurate bags). Table 1 shows the further breakdown of inaccurate bags into slow and fast bags.

The median absolute (positive or negative) percentage error of 14.6% (5.6–30.6) when a metered pump was used, was less than the percentage error of 33.3% (12.5–66) when a metered pump was not used ($p < 0.001$) (Fig 2).

Medical admissions unit compared to general medical wards

Intravenous fluids were administered more accurately in the MAU. The median (IQ range) percentage error of 19.3% (9.3–47.3) in the MAU was less than the percentage error of

31.3% (12.3–73.4) on the general medical wards ($p < 0.05$). A significantly greater proportion of metered pumps, however, was used on the MAU (53%) compared to the other wards (27%), $p < 0.0001$. This greater use of metered pumps is therefore likely to account for the better accuracy recorded on the MAU.

Prescribed fast v prescribed slow bags

There was no significant difference between the percentage errors of iv bags that were prescribed to be infused in four hours or less and the percentage errors of iv bags prescribed to be infused over more than four hours.

Discussion

This study has demonstrated that only one quarter of iv bags of fluid administered to patients on the acute medical wards are delivered at the prescribed rate. Two thirds are administered too slowly. The degree of error was surprising. Significantly, the use of a metered pump improved the accuracy of iv fluid administration duration.

There has been increasing acknowledgement of the errors associated with drug treatment in hospitals.^{6–8} Some of these problems are directly related to drug administration.^{1–5} Although errors of iv drug administration have been examined,^{9–11} studies of iv fluid administration rate are few. Incorrect iv infusion rates have been reported to be a common occurrence.^{12,13} On surgical wards in an Australian teaching hospital, incorrect infusion rate was the most common error associated with iv infusions. The likelihood of error was greater if fluids were prescribed at a slow rate and a metered pump was not used.¹³ This current study also confirms that metered pumps improve accuracy.

We are not aware that any harm came to any of the patients who received iv fluids at the incorrect rate in this study. In the paediatric hospital population such errors of fluid administration are more dangerous.^{14,15} Incorrect rates of iv fluid administration, however, can be disastrous in adults too. The clinical state of hypovolaemic-dehydrated patients receiving iv fluids too slowly is likely to worsen and there is a danger of fluid overload in patients with heart failure receiving fluids too quickly.

We suspect medical and nursing staff working on adult wards have an indifferent attitude to errors in iv fluid administration. During the same period that these infusions were studied, the hospital’s clinical incident reporting department received no reports of adverse incidents relating to incorrect infusion rate of iv fluids. If such errors of administration are not considered worthy of reporting, perhaps because they are so rife, then it is not surprising that they do not register as drug errors, or worthy of trying to correct.

There is a clear need for better education of staff about the potential dangers of incorrect iv fluid administration rates, so that efforts can be made to improve accuracy.

It is likely that the infusion rate errors identified on these wards are replicated in others. Measures that might help to improve infusion rate accuracy include changing iv fluid prescription charts so that there is advance recording of the

Table 1. Percentage of bags infused accurately, too slowly or too fast when a metered pump was and was not used.

	Metered pump (%)	No pump (%)
Accurate	39	21
Too slow	57	69
Too fast	4	10

$\chi^2 = 8.0$, 2 df, $p < 0.025$.

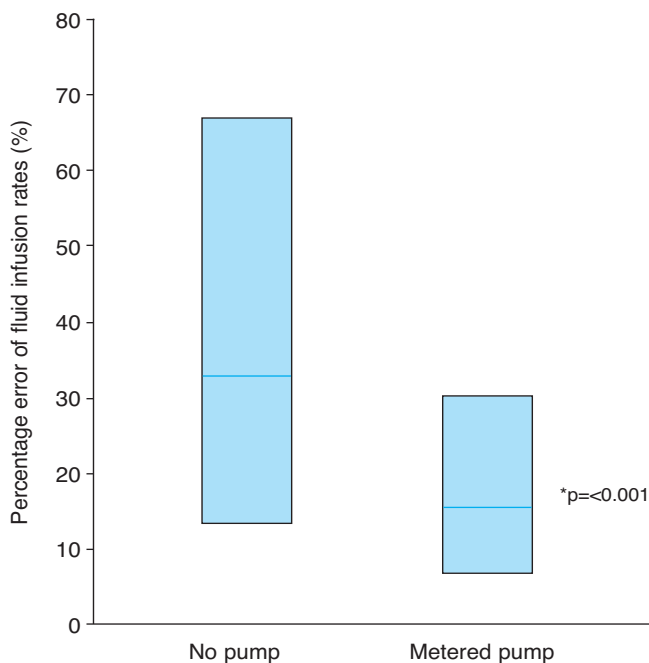


Fig 2. Box plots of percentage errors in infusion rates when not using and when using a metered pump. Horizontal lines within boxes represent median values, box limits represent interquartile range.

predicted start and finish time of each fluid bag. Likening infusion rate errors to formal drug errors, and involving pharmacists in the prescription of iv fluids, similar to their involvement in the prescription of iv drugs, would raise awareness of potential hazards arising from inaccurate administration. Specific ward targets to keep infusion rate errors to, say within 10%, and the triggering of an incident report if an infusion rate error exceeded, say 50%, might also improve accuracy.

The study has demonstrated that metered pumps help to improve accuracy. Without a metered device a patient's movement may interfere with the flow rate from a gravitational device adjusted by a roller-clamp, even if the rate was set accurately at the onset of infusion. With a metered device, the flow rate remains constant and is not altered by patient movement.^{16,17} Although the consequences of inaccurate iv infusion rates may be more serious in patients at risk of dehydration or fluid overload, the data from this study indicate that metered pumps should ideally be used in all situations in order to improve accuracy.

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