ORIGINAL ARTICLE

Peripheral line dead space: an unrecognised phenomenon?

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Objective: To determine if peripheral intravenous cannula dead space is taken into account when setting up intravenous infusions (in particular nitrate infusions) in the emergency department.
Method: A postal survey of UK emergency departments.
Results: Of the 143 (58%) of UK departments who responded, only 15% reported priming the cannula before commencing the nitrate infusion.
Conclusions: Knowledge of peripheral intravenous cannula dead space in UK emergency departments is very poor and, as a result, there is probably significant widespread under treatment of patients in severe cardiogenic pulmonary oedema. Departments should amend their treatment guidelines to take account of peripheral cannula dead space

Intravenous infusions and bolus doses of drugs are commonly used in emergency medicine. Whereas bolus drugs are nearly always followed with a flush to eradicate residual drugs in the cannula, the personal experience of both the authors was that the lines used to give nitrate infusions are rarely (if ever) primed with the relevant medication in order to take account of their ''dead space''. A current (at time of writing) national trial (the 3CPO trial) makes no mention in its treatment guidelines of priming the peripheral cannula when setting up a nitrate infusion.[1] Indeed, its guidelines suggest commencing an infusion at 0.6 mg/h. If a large peripheral (Orange (14G)) cannula was being used this would mean a delay (presuming an infusion concentration of 1 mg/ml) of up to 30 min before any nitrate enters the circulation. If (perhaps more commonly) a green (18G) cannula was being used there would be still be a delay of approximately 20 min. We designed a questionnaire study to look at the current treatment of left ventricular failure/ cardiogenic pulmonary oedema. As part of that questionnaire we asked if intravenous nitrates were routinely used and if cannulas were routinely primed prior to commencing intravenous nitrate infusions.

METHODS

An anonymous, tick box questionnaire was sent to the clinical directors of all the emergency departments in the UK as listed in the British Association of Emergency Medicine (BAEM) website directory (www.emergencymed.org.uk/asp/links.asp) on 1 August 2006. Minor injury units were excluded.

A stamped addressed envelope was enclosed for the reply.

RESULTS

A total of 246 questionnaires were sent out and 143 (58%) replies were received.

Of the departments that replied, 67 (47%) of them stated that they had a proforma/guidelines for dealing with cardiogenic pulmonary oedema. On questioning regarding routine treatment used, 143 (100%) departments stated that they used oxygen, 132 (92%) furosemide, 126 (88%) opiates, 113 (79%) sublingual nitrates, and 127 (89%) intravenous nitrates of which glyceryl trinitrate (61%) was the most common (table 1).

It was also noted that in some departments it was not the emergency department staff that decided on treatment but rather the on-call medical team. Most departments used a variety of sizes of cannula for the administration of intravenous nitrate. The most common cannula size used was reported to be 18G (green) (72% of departments), while 28 (20%) of departments reported routinely using 14G (orange/brown) cannulas.

Only 21 (15%) of respondents reported routinely priming cannulas with intravenous nitrate before commencing an infusion.

DISCUSSION

A literature search revealed very little regarding cannula dead space with regards to intravenous infusions (there are some articles citing the importance of flushing cannulas after administrating bolus drugs to reduce retention of the drugs in the cannula dead space).[2] We believe it is a little appreciated phenomenon and rarely compensated for in emergency medicine. As a result, many patients may well be having the treatment of life-threatening conditions substantially delayed.

Table 1 Proportion of UK emergency departments using different treatments for acute cardiogenic pulmonary oedema/ left ventricular failure

Treatment	Percentage of UK emergency departments
Oxygen	100
Furosemide	92
Opiate	88
Sublingual nitrate	79
Intravenous nitrate	89

Table 2 Dead space/priming volume in different size cannulas (information provided by Becton Dickinson Ltd)

Cannula size	Colour	Mean (SD) priming volume (ml)
22G	Blue	0.16 (0.03)
20G	Pink	0.17 (0.03)
18G	Green	0.19 (0.03)
17G	White	0.22 (0.03)
16G	Grey	0.24 (0.03)
14G	Orange	0.28 (0.03)

Table 3 Dead space/priming volume in single lumen central lines (information provided by Becton Dickinson Ltd) (all measurements for catheters with no external arms)

Cannula size	Length (cm)	Priming volume (ml)
18G	20	0.24
16G	15	0.25
16G	20	0.3
14G	15	0.61
14G	20	0.65

Many drugs used in the critical care setting and resuscitation rooms appear to have initially low infusion rates. Internationally recognised guidelines for the setting up of such infusions do not appear to exist (although it is our understanding that this is currently being looked at by the intensive care society) and there is wide variability in the concentrations and infusion rates used.[3] Of the local and textbook guidelines available to us it would appear that line dead space is potentially a problem in the administration of inotropes, sedatives, muscle relaxants and heparin, although none of the guidelines we looked at had initial rates as low as those commonly used for nitrates (most initial low infusion rates were between 2–5 ml/h).

Bolus doses of emergency intravenous medication (to prime the cannula) are not without serious potential side effects. In particular, large bolus doses of intravenous nitrate risk profound hypotension (as is frequently seen with sub-lingual nitrate administration).

We contacted Becton Dickinson (who provide the majority of intravenous and central line catheters in the UK (brand name Venflon + Careflow)) and they kindly provided us with a table of priming volumes for their BD Venflon range (table 2) and their central venous catheter range (tables 3 and 4). We would suggest using boluses of an appropriate amount of infusion liquid via the syringe driver before commencing the infusion proper.

An alternative is to give a ''flush'' of the same concentration of infusion via the side port of the cannula using a 1 ml syringe. Close monitoring of the patient's blood pressure is essential. The same principles should be applied to other infusions, particularly central lines where the dead space may be as much as 0.5 ml. We did not survey our critical care colleagues/intensivists but our personal experience suggests that, although they seem more aware of the phenomenon than emergency medicine specialists, many of them are still unaware of its existence.

Table 4 Dead space/priming volume in triple lumen central lines (information provided by Becton Dickinson Ltd)

Cannula size	Length (cm)	Priming volume (ml): distal port	Priming volume (ml): proximal port	Priming volume (ml): medial port
16G	20	0.4	0.36	0.3
14G	20	0.48	0.35	0.35

We acknowledge the relatively poor (<60%) response rate from our questionnaire. However, despite this, we believe we have demonstrated widespread ignorance of the ''infusion dead space phenomenon'' in UK emergency departments and we suggest that trusts and individual departments amend their infusion policies to take account of this. At the moment this is largely a theoretical problem which has not yet been proven to affect patient care directly. We therefore write this article in order to increase awareness of this potential problem and to stimulate further research in to it.

CONCLUSION

Priming of peripheral intravenous cannulas with nitrate before commencing a nitrate infusion is rarely performed in UK emergency departments. As detailed above, this can potentially lead to a delay of 20–30 mins before any nitrate enters the circulation.

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