



Inadvertent overdosing of neonates as a result of the dead space of the syringe hub and needle

V Bhambhani, R S Beri and J M Puliye

Arch. Dis. Child. Fetal Neonatal Ed. 2005;90;444-445
doi:10.1136/adc.2004.070045

Updated information and services can be found at:
<http://fn.bmjournals.com/cgi/content/full/90/5/F444-a>

These include:

Rapid responses

3 rapid responses have been posted to this article, which you can access for free at:
<http://fn.bmjournals.com/cgi/content/full/90/5/F444-a#responses>

You can respond to this article at:
<http://fn.bmjournals.com/cgi/eletter-submit/90/5/F444-a>

Email alerting service

Receive free email alerts when new articles cite this article - sign up in the box at the top right corner of the article

Topic collections

Articles on similar topics can be found in the following collections

[Adverse drug reactions](#) (541 articles)
[Perinatal](#) (1276 articles)

Notes

To order reprints of this article go to:
<http://www.bmjournals.com/cgi/reprintform>

To subscribe to *Archives of Disease in Childhood - Fetal and Neonatal Edition* go to:
<http://www.bmjournals.com/subscriptions/>

PostScript

LETTERS

Changes in body temperature after birth in preterm infants stabilised in polythene bags

Low admission temperature is an independent risk factor for morbidity and mortality in preterm infants.¹ Thermal stability is enhanced by use of polythene bags during stabilisation,² but it has been suggested that this may induce potentially harmful hyperthermia.³ We have measured the changes in body temperature during the first 15 minutes after birth in infants stabilised in polythene bags.

For an eight month period, infants born at <29 weeks gestation in the Simpson Centre for Reproductive Health, Edinburgh were studied prospectively. They were laid on a temperature probe within a polythene bag immediately after birth and stabilised under a radiant heater set to maximum. Interscapular temperature was recorded every minute for the first 15 minutes of life.

Transcutaneous temperature taken at a thermally insulated site (in this instance the baby's back, insulated by a non-conducting mattress) represents core body temperature once the insulated skin warms to body temperature.^{4,5} Our observations suggested that this equilibration took around seven minutes (fig 1). We took the temperature at seven minutes as representative of the baseline and attributed all changes in temperature that occurred after seven minutes to the postnatal thermal care. Fetal temperature is higher than maternal temperature.⁶ We defined the upper limit of normal temperature at birth as 37.5°C. Hypothermia was defined as <36°C.

Twenty seven infants (14 boys and 13 girls) were studied. Mean (range) birth weight and gestation were 916 g (490-1470) and 26+4 weeks (24-28+5). Mean (range) temperature at 15 minutes was 37.3°C (36.3-38.1). No infant became hypothermic. Sixteen infants had temperatures that never exceeded 37.5°C. Three infants with normal baseline temperature were warmed to temperatures above 37.5°C during stabilisation. The increases in temperature were 0.2°C,

0.6°C, and 0.6°C with the maximum temperature reached being 38.1°C. Eight (30%) infants had baseline temperatures above 37.5°C: of these, five gradually cooled towards 37°C during stabilisation and the remaining three warmed by 0.2°C, 0.3°C, and 0.4°C with a maximum temperature of 38°C. Figure 2 categorises temperature progression of the infants during the 15 minute study period.

These data confirm that early neonatal hypothermia can be eliminated by the use of polythene bags during initial stabilisation of small preterm infants. A significant proportion (30%) of infants are probably hyperthermic at birth. Iatrogenic temperature increases occurred in a minority of the infants in this study and were small. The significance of transient small temperature increases is uncertain.

C L Smith, D Quine, F McCrosson, L Armstrong, A Lyon, B Stenson

Neonatal Unit, Simpson Centre for Reproductive Health, Royal Infirmary of Edinburgh, Little France Crescent, Edinburgh EH16 4SA, UK

Correspondence to: Dr Smith; claire.l.smith@luht.scot.nhs.uk

doi: 10.1136/adc.2004.061937

Competing interests: none declared

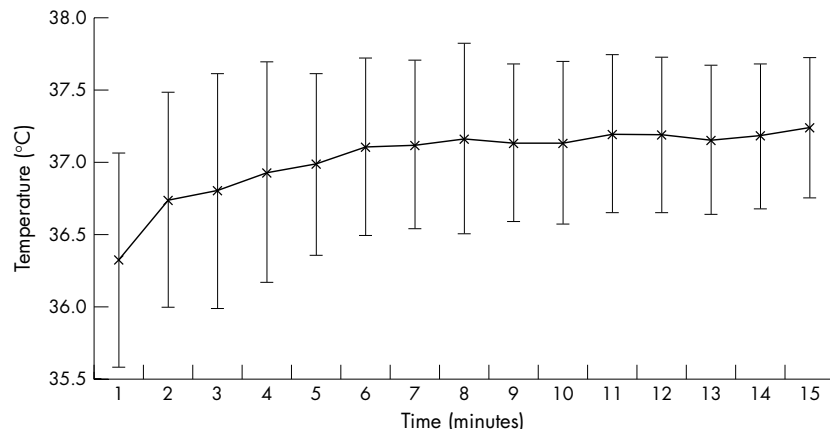


Figure 1 Interscapular temperature during stabilisation. Values are mean (SD).

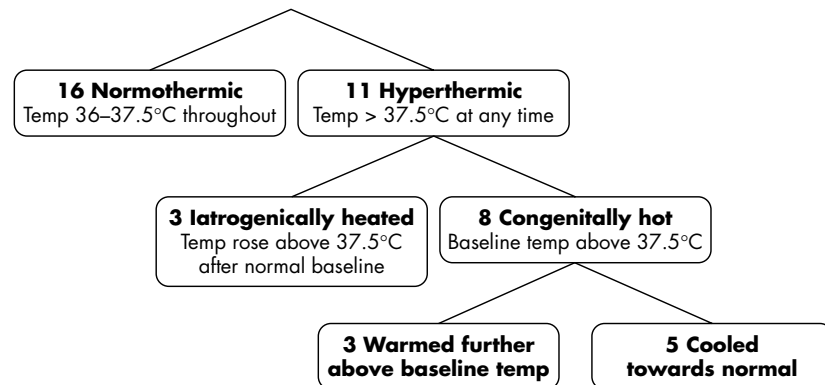


Figure 2 Flow chart categorising temperature progression from baseline to 15 minutes of age.

References

- 1 Costeloe K, Hennessy E, Gibson AT, et al. The EPICure study: outcomes to discharge from hospital for infants born at the threshold of viability. *Pediatrics* 2000;**106**:659-71.
- 2 Vohra S, Frent G, Campbell V, et al. Effect of polyethylene occlusive skin wrapping on heat loss in very low birth weight infants at delivery: a randomised trial. *J Pediatr* 1999;**134**:547-51.
- 3 Newton T, Watkinson M. Preventing hypothermia at birth in preterm babies: at a cost of overheating some? *Arch Dis Child Fetal Neonatal Ed* 2003;**88**:F256.
- 4 Dollberg S, Xi Y, Donnelly MM. A noninvasive transcutaneous alternative to rectal thermometry for continuous measurement of core temperature in the piglet. *Pediatr Res* 1993;**34**:512-17.
- 5 Dollberg S, Rimon A, Atherton HD, et al. Continuous measurement of core body temperature in preterm infants. *Am J Perinatol* 2000;**17**:257-64.
- 6 Walker DW, Wood C. Temperature relationship of the mother and fetus during labor. *Am J Obstet Gynecol* 1970;**107**:83-7.

Inadvertent overdosing of neonates as a result of the dead space of the syringe hub and needle

Chappell and Newman¹ have asked for urgent initiatives to ensure the manufacture of neonatal targeted products to reduce the risks associated with intravenous drug administration. We endorse their view and report a little recognised problem with the use of adult formulations in neonatal nurseries.

This investigation was conducted after we noticed symptoms of digoxin overdose (bradyarrhythmia) in a neonate. Retrospective

Table 1 Inadvertent overdose for different drugs

Drug (concentration of drug in vial/ampoule)	Dose (mg/kg)	Amount of drug for a neonate weighing 2 kg (mg)	Drug volume taken in a 1 ml syringe (ml)	Volume of drug in dead space (ml)	Amount of drug in dead space (mg)	Total amount of drug neonate is getting (mg)	Inadvertent overdose factor
Digoxin (1 ml=0.25 mg)	0.025	0.005	0.02	0.07	0.0175	0.005+0.0175=0.0225	4.5
Digoxin (1 ml=0.1 mg)	0.025	0.005	0.05	0.07	0.007	0.005+0.007=0.012	2.4
Adrenaline (1 ml=1 mg; 1:1000)	0.03	0.06	0.06	0.07	0.07	0.06+0.07=0.13	2.16
Furosemide (1 ml=10 mg)	1	2	0.2	0.07	0.7	2+0.7=2.7	1.35
Dexamethasone (1 ml=4 mg)	0.1	0.2	0.05	0.07	0.28	0.2+0.28=0.48	2.4
Midazolam (1 ml=5 mg)	0.1	0.2	0.04	0.07	0.35	0.2+0.35=0.55	2.75

Assuming the drug for a 2 kg neonate is drawn up in a 1 ml syringe and diluted by drawing up the diluent into the same syringe. Doses of drugs taken from *Pediatric drugs and nursing implications*.² Digoxin is available in two formulations: 250 µg/ml 100 µg/ml.

review of the case suggested that the overdose received was due to the unaccounted for drug in the dead space of a 1 ml syringe.

The nursing drug dose manual *Pediatric drugs and nursing implications*² gives the maintenance dose of intravenous digoxin as 2.5 µg/kg/dose. The nursing instruction³ states that the dose must be diluted, with at least four times the volume, using normal saline or 5% dextrose, and the drug must be given over five minutes. In practice, for a 2 kg neonate who is to receive a 5 µg digoxin intravenous injection (250 µg/ml), the drug volume required is 0.02 ml. This is drawn up in a 1 ml syringe up to the 0.02 ml mark. The nursing practice in our nursery was to draw up normal saline to dilute this four times and give it intravenously, slowly over five minutes. Cognizance is not taken of the dead space in the needle hub and syringe.

We estimated this dead space by drawing up saline in the 1 ml syringe and flushing out the syringe (Syringe and Precision Glide Needle; 1 ml; 26 G; 0.5 inch; Becton-Dickinson, Singapore). The syringe piston was then withdrawn again, and the volume of saline in the dead space was drawn into the syringe barrel. This volume was noted. The dead space volume is 0.07 ml in this syringe. When the diluent is drawn up, the drug in the dead space is also drawn up resulting in toxicity. In the case of digoxin, the baby received 0.09 ml digoxin instead of 0.02 ml.

Ordinarily if the digoxin is drawn up to the 0.02 ml mark and injected directly, the drug in the dead space is retained in the syringe, and there is no overdose delivered. However, when the diluent is drawn up into the syringe for dilution, the drug in the dead space is also drawn up, and this results in the overdosing.

We looked at the magnitude of error induced by the dead space in some of the drugs routinely used in the nursery. Table 1 shows the standard volume of drug required for a 2 kg neonate and the magnitude of error introduced by the dead space of a 1 ml syringe. It is assumed that these drugs were first drawn in a 1 ml syringe and then diluted in the same syringe. The neonate will get 4.5 times the recommended dose if 250 µg/ml digoxin is used, and 2.4 times the recommended dose if 100 µg/ml digoxin is used. The inadvertent extra dosing factors using a

1 ml syringe for different drugs used in the neonatal unit have been calculated. The dose of adrenaline can be exceeded by a factor of 2.16, for furosemide by 1.35, for dexamethasone by 2.4, and for midazolam by a factor of 2.75.

To avoid this inadvertent overdosing of neonates, prediluted drug formulations are required. Until such drug formulations are more widely available, especially in developing countries, awareness of this error can help circumvent the problem.

A method that can be used to circumvent the problem is to draw up the required volume in a 1 ml syringe and transfer it to a larger volume syringe, leaving the dead space drug behind in the first syringe. This is a crude method and it is not a closed system (as it requires transfer of the drug from one syringe to another).

The insulin syringe (U-40 insulin; 29 G; 0.5 inch ultra-fine 1 ml needle; Becton-Dickinson Consumer Products, Franklin Lakes, New Jersey, USA) does not have a dead space and its needle is fixed to the syringe. Use of this syringe can also obviate the problem.

Another way would be to add the drug contained in this dead space (0.07 ml) to the calculation for dilution.

Although no reports of life threatening adverse effects have been reported in the literature, this inadvertent dosing error has the potential of being serious.

V Bhambhani, R S Beri, J M Puliyl

Department of Paediatrics, St Stephen's Hospital, New Delhi, India

Correspondence to: Dr Bhambhani; vikasbhambhani@hotmail.com

doi: 10.1136/adc.2004.070045

Competing interests: none declared

References

- 1 Chappell K, Newman C. *Arch Dis Child Fetal Neonatal Ed* 2004;**89**:F483-4.
- 2 Bindler RM, Howry LB. *Pediatric drugs and nursing implications*, 2nd ed. Connecticut: Appleton and Lange, a Simon and Schuster Company, 1997.
- 3 Bindler RM, Howry LB. In: *Pediatric drugs and nursing implications*, 2nd ed. Connecticut: Appleton and Lange, a Simon and Schuster Company, 1997:208-9.

BOOK REVIEWS

Managing newborn problems: a guide for doctors, nurses and midwives

Edited by World Health Organization. Published by World Health Organization, Geneva, 2004, £27.00, pp 274. ISBN 9241546220

It is a sobering thought that world wide there are more than four million neonatal deaths per year, the majority occurring in the first week of life with an equal number of stillbirths. Most of these deaths are preventable and the result of a combination of poor maternal health and nutrition and inadequate perinatal care. This manual is the result of a collaboration between the WHO, UNFPA, UNICEF, and the World Bank and represents a renewed effort to address this problem. It forms one of the WHO IMPAC (Integrated Management of Pregnancy and Childbirth) series. Its remit is to complement the Integrated Management of Childhood Illness (IMCI) guidelines and expand these into a comprehensive evidence based perinatal care manual with the emphasis on illnesses in the first week of life. It is targeted at health professionals (doctors, nurses, and midwives) in under-resourced settings where the vast majority of these deaths occur.

The guide has four distinct sections. The first, "Assessment, findings, and management", is in the IMCI emergency management style. It guides the recognition and diagnosis of sick neonates and the institution of appropriate management of a range of common clinical scenarios such as fast breathing, maternal fever, poor feeding. In section 2 ("Principles of newborn care") the basics of safe general care from temperature management to immunisation are reviewed. Section 3 describes frequently used procedures including resuscitation, and section 4, the appendices, deals with medical record keeping. Many management pathways will begin in section 1, the scenario/problem, and will be followed through by cross referencing the later sections. There are also additional training packages to accompany the IMPAC guides.

The manual is both detailed and thoughtful: detailed in its cover of most common neonatal illnesses in a clear, well thought through style, and thoughtful in the emphasis afforded to often neglected areas. Emotional support to the family, note taking, and coping with a death are good examples of the way in which the manual looks beyond the immediate clinical realm. It is also gratifying that (in the main) appropriate levels of care are addressed; for example, IPPV is not discussed in the management of respiratory distress but instead suitable, more appropriate, and (for most) equally effective alternatives of delivery such as nasal and ambient oxygen.

The book might sometimes miss the mark in trying to be "all things to all men". There will inevitably be differences in training and experience between the professionals for whom it is intended, and, for some, the amount of detail and need for cross referencing may be "too much information". This could confuse and risk that less experienced less educated caregivers revert to the "tried and tested" treatment format. Greater use of short, flow chart style algorithms within the guidelines (as opposed to in a separate manual) would aid interpretation. Some medical workers may find a more pictorial format easier. I assume the manual has been translated into a number of languages but could find no details about which (English being far from universal).

One other (small) criticism is the emphasis placed on facilities for investigation, particularly lab service. This is a "luxury" that is often unavailable, and I think the slant should as far as possible be on management based on clinical features, especially as it assumes by no means guaranteed accuracy and consistency in lab performance.

One final point is that, although the manual comprehensively covers care of the neonate, it does not mention either prevention or recurrence. It is debatable as to whose responsibility this is, but ensuring access to good antenatal care including maternal anti-tetanus vaccination, nutrition, and family planning before the next baby is surely at least partly the remit of the paediatric team.

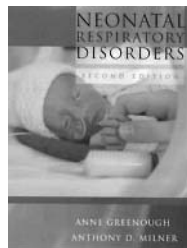
These points aside, this is a commendable and impressive guide, which comes as close as any I've seen to combining the factual information needed in a reference with practical management in the field. One can only hope that it impacts on neonatal morbidity and mortality in the way it deserves to, as these have been static for far too long in the settings for which the book is intended.

N Brown

MRC EEU, Southampton General Hospital,
Tremona Road, Southampton SO16 6YD, UK;
n_janbrown@yahoo.co.uk

Neonatal respiratory disorders, 2nd edn

Edited by A Greenough, A D Milner. Published by Arnold, 2003, £115.00 (hardback), pp 533. ISBN 0340808136



The title of this second edition should be borne in mind by prospective readers. Those looking for a manual of respiratory care in the wee small hours should look elsewhere. Instead, Greenough and Milner have set themselves the more ambitious task of

recording current expert opinion on the causes, management, and outcomes of respiratory disorders affecting the newborn. To achieve this, the editors have drawn on the expertise of those researchers around the world who are recognised leaders in this field and have allowed them a refreshing degree of freedom in expressing their opinions. Herein lies the strength of this text.

The 15 contributors from the first edition have expanded to more than 40. There is far greater international representation and presumably anticipation of an international readership (traditionalists among us will mourn the demise of caesarean and aetiology in favour of cesarean and etiology). Despite the increased number of authors, this second edition is only marginally longer than the first. No space has been allowed for excess verbiage; fact is backed by reference, leaving opinion to stand alone.

Although the chapters dealing with basic science have been retained, change in authorship means that many have been rewritten and all have been updated. New chapters include lung liquid, immunology, and microbiology. The clinical management chapters have been rewritten to reflect advances in the use of high frequency oscillation, ECMO, and nitric oxide and to emphasise the importance of feeding. Emphasis is given to long term outcomes in individual conditions, reflecting the increased data available. Additional chapters include respiratory presentation of cardiac disease, apnoea, and bradycardia of prematurity and respiratory problems of infants with neurological disease. Certainly, those who bought the first edition will find enough here to justify investing in the second edition.

The enthusiasm of contributors for their own areas of research has been allowed to shine through, yet a balance of views

has been maintained—Robertson and Johansson's new chapter on surfactant springs to mind. This leads, inevitably, to differences in style and some idiosyncrasies—how else to explain the fact that CNEP is given almost as many column inches as CPAP? Nonetheless, this book achieves the hallmark of successful medical texts, namely that each chapter can stand alone as a thesis with reasoned argument as to why a particular approach is advocated.

There are rewards too for those who seek answers to clinical questions. Greenough and Davenport's revised chapter on abnormalities of the diaphragm complements Nicolaides' chapter on antenatal imaging and therapy and provides a concise and up to date review of the causes, associations, management, and outcomes of congenital diaphragmatic hernia. The answers to almost all questions raised during antenatal consultation for this condition can be found here.

Who should buy it? The first edition had a readership wish list of students, physiotherapists, and obstetricians, as well as doctors and nurses working in neonatal intensive care. This edition is aimed at the neonatal clinician and in my view hits the target, thus earning its place in the unit library. In addition, those wishing to explore the literature underpinning current understanding of newborn respiratory disease would be well rewarded by spending some time with this text.

This then is an eclectic collection of opinions on neonatal respiratory disease built on a sound foundation of basic science. It is a stimulating, rewarding, and enjoyable read—words that don't often spring to this reader's mind when contemplating medical texts—and fills the gap between traditional textbook and latest research admirably.

K McCormick

Book reviews in ADC this month

The following book/DVD reviews are published in this month's *Archives of Disease in Childhood*:

- Spotting the sick child (DVD)
- Immunization in practice, a practical guide for health staff
- Key topics in neonatology, 2nd edition
- Prevention of allergy and allergic asthma: World Health Organization project report and guidelines

Pre-published book reviews

Book reviews that have been accepted for publication but have not yet been published in the print journal can be viewed online at <http://adc.bmjournals.com/misc/bookreviews.shtml>