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Medication Errors in Children – an Eight Year Review Using Press Reports

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A review of both local and national press in the UK in relation to medication errors occurring in children has been undertaken. Over an eight year period (1993 to 2000) there were 81 medication error incidents involving at least 1144 children. There were at least 29 deaths, nine of which involved neonates. The most frequent type of medication error involved an incorrect dose. The number of medication errors occurring in children, in particular the newborn infant, is of concern. There is a need for a national surveillance scheme for medication errors in paediatric patients.

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Introduction

The use of medicines in children is different to adults. Many medicines used for paediatric patients are either off-label or unlicensed[1–3]. There is greater variation in the individual dose requirement in paediatric patients when weight can vary from <1 kg to >70 kg. The formulation of many medicines is appropriate for adults but not for paediatric patients, therefore making age-specific proper dosing of many medications difficult. Given these circumstances (i.e. lack of prescribing information, individualised dosing and inappropriate formulations), a medication error has more opportunity of occurring in infants and children.

There has been considerable research on the extent and nature of medication errors in paediatric patients[4–10]. There have, however, been relatively few studies within the UK[11,12]. At present there is no national database in the UK to record medication errors that occur in children or adults. One of the authors (DC) has collected articles concerning medication errors published in the lay press. We have undertaken an examination of these articles to see if there are any important lessons to be learnt from the public

reporting of paediatric medication errors and related adverse experiences.

Methods

Romeike is a company that scans local and national newspapers for certain types of articles (Romeike Ltd, Hale House, 290-6 Green Lanes, London N13 5TP). Since 1993, they have been sending one of the authors (DC) articles concerning medication errors. Between 1993 and 31 December 2000, we have studied those in which the age of the patient in whom the medication error occurred was 18 years or less,.

The articles were divided into two groups in relation to the number of children affected. Cases involving a single child were separated from those where more than one child was involved. The articles were assessed "as-is", meaning that no attempts were made to independently verify their content and/or accuracy of reporting. For both groups, the year the first article was printed, the total number of articles, the number of articles in the national press, the outcome and the setting were all recorded.

Results

Over the eight years there were a total of 81 medication error incidents involving at least 1144 children reported in the press. There were at least 29 deaths. A total of 371 articles were published concerning these medication errors. Eight of these incidents involved more than one child and in the remaining 73 cases a single child was affected by the medication error. Over the eight year period there has been an apparent increase in the number of medication errors reported in the press (Table 1).

Table 1. The year in which the first article regarding each incident was published

Year	Number of reports
1993	1
1994	9
1995	5
1996	6
1997	15
1998	3
1999	19
2000	23
Total	**81**

Medication errors involving more than one child

Over 1000 children were affected in the eight incidents with up to eight fatalities. Details of the medication error incidents that involved more than one child are given in Table 2. Six of the eight incidents involved the wrong dose of the drug.

One medication error involved 857 children who received the wrong dose of BCG in a vaccination for tuberculosis as the incorrect strength was used. The babies received a dose five times greater than recommended. There was no significant toxicity reported although the incidence of skin reactions was greater than anticipated.

During an international multi-centre clinical trial, an inappropriate formulation of magnesium sulphate was distributed by the coordinating centre, resulting in over-dosage in 28 babies who received twice the recommended dose. Eleven babies died in the magnesium sulphate group compared to six in the control group. It is unclear how many deaths were due to medication error. The trial was discontinued once the medication error was realised and has not been published in the medical literature.

Another error involved a doctor prescribing excessive doses of methylphenidate to more than 150 children. Several of these incidents involved one individual making the same mistake repeatedly whereas others were one mistake that affected more than one child.

Medication errors where a single child was affected

There were 73 cases involving a single child subjected to at least one medication error. In 26 of these 73 cases, the child died, although it was not always clear if it had been as a direct result of the medication error. Eleven children had significant brain damage following the medication error.

If the child died, the case was more likely to be reported on at least one occasion in the national press. Fourteen of the 26 cases in which the result was fatal were reported at least once in the national press whereas only three of the 47 in which the result was non-fatal were reported in the national press.

There was a peak in reports for children less than one year old, with one third of press reports being in this age group. Nine of the 26 fatalities reported

Table 2. Medication error incidents that involved more than one child

Number of children	Number of fatalities	Brief description	Type of medication error
857	0	Wrong strength BCG given to babies for vaccination. Only noticed when the younger babies had more reactions than normal.	Incorrect dose
13	0	Labels wrong on a batch of vincristine that was sent to a children's hospital. This resulted in a double dose being given to 13 children. Age range 2–13 years.	Incorrect dose
12	0	A doctor prescribed and administered excessive doses of drugs to babies including diazepam, chlorpromazine and metoclopramide for biopsies.	Incorrect dose
4	3 *	TPN given to leukaemic children contained enterobacter cloacae due to poor aseptic manufacturing in the hospital. Led to huge changes in aseptic practice.	Poor aseptic technique
28 in control 28 in $MgSO_4$	? *	Multi-centre trial into magnesium sulphate for birth asphyxia. Given wrong formulation that meant a double dose was given. There were five more deaths in the treatment group than the control group	Incorrect dose
5	0	Decimal point error when making up pre-med so contained 10 times the amount of methadone.	Incorrect dose
150	0	A doctor prescribed large doses of methylphenidate inappropriately due to misdiagnosis of ADHD	Incorrect dose
2	0	2 children given the wrong drugs on 3 separate occasions in a children's home. Led to hospitalisation of one child.	Incorrect drug

*Also in Table 4

occurred in neonates. More than half of the total medication errors involved children under the age of 4 years. All types of health professionals were associated with the medication errors – doctors, pharmacists, nurses and dentists.

The most frequent type of medication error reported in the press involved an incorrect dose (32 incidents) and this was also the type of error most likely to be associated with a fatality (13 deaths). The types of medication errors that occurred are illustrated in Table 3. There were six cases where more than one medication error occurred in a single child which resulted in 80 medication errors for 73 children.

There were nine medication errors, which involved a decimal point error in the dose of the drug. Four of these errors involved morphine and the other drugs involved were diamorphine, digoxin, tacrolimus, methadone and adrenaline. There were five fatalities involving these decimal point errors, one each with morphine, diamorphine, digoxin, tacrolimus and adrenaline. The error involving adrenaline occurred in a child who was not experiencing a severe anaphylactic reaction.

The cases where a child died, including medication error incidents that involved more than one child (Table 2), are described in greater detail in Table

Table 3. Type of medication errors that occurred in a single child

Type of medication error	Number of errors	Fatal
Incorrect dose	32	13
Incorrect drug	16	5
Incorrect strength	3	1
Omitted in error	4	1
Incorrect patient	4	–
Duplicate dose	3	–
Expired drugs	3	–
Incorrect route	3	3
Incorrect container	2	1
Incorrect label	2	–
Incorrect rate	2	2
Miscellaneous	6	3
TOTAL	**80***	

*Six children experienced more than one error each

4. Five deaths occurred in association with administration of a general anaesthetic, four of which had been administered in a community dental practice. Three deaths were associated with opiates, two of which were decimal point errors. Three deaths were related to incorrect administration of IV fluids. Two of the deaths followed intrathecal administration of IV drugs (vincristine and benzylpenicillin). The other deaths were associated with a wide range of medicines. An orally administered drug was associated with a fatal medication error in only 3 cases.

Discussion

The lack of data in the National Health Service (NHS) has led us to use the lay press as a proxy database. There are major limitations in the use of the lay press as a reference source for medication errors. The vast majority of medication errors that occur in children will be of no interest to the media and, as a consequence, will remain unreported. None of the 600 medication errors described in the two studies that were carried out

Table 4. All fatal medication errors reported in the press over an eight year period

Medication error	Drug(s) involved	Brief description of events
Incorrect dose (Decimal point)	Morphine IV	15mg instead of 0.15mg morphine given to a one day old premature neonate.
"	Digoxin IV	320mg instead of 32mg given to a one day old baby.
"	Tacrolimus	5 year old girl, visiting relatives. Received 10 times the dose by staff at a hospital she did not usually attend.
"	Diamorphine	Neonate received 10 times the dose.
Incorrect dose (decimal point) and Route	Adrenaline	Allergic reaction (rash, wheezy) in a 13 year old. Given 10 times the dose of adrenaline, also IV not IM.
Incorrect dose	IV Fluids	17 year old given 10.5L fluid over three hours, which led to fluid overload. Patient's condition had been misdiagnosed.
"	Anaesthetic, atropine and adrenaline	5 year old had a heart attack whilst under general anaesthetic in a dental surgery. Adult doses of resuscitation drugs were given.
"	Diamorphine	GP gave six times dose of diamorphine to a 9 year old during circumcision.
"	Steroid	9 year old given high doses of oral steroid for a minor eye infection. Died from chickenpox.
"	Growth hormone test	4 year old was given an overdose by a locum.
"	Phenytoin IV	A 3 day old triplet was given an overdose.
Incorrect dose and route	Benzylpenicillin	300 times overdose of benzylpenicillin injected into spine of 17 month old infant.

Table 4. continued		
Medication error	**Drug(s) involved**	**Brief description of events**
Incorrect dose and administration system	Sodium nitroprusside	3 month old baby with a heart defect was given 4 times the correct dose after cardiac surgery. The drug was also given in the wrong administration system, which could have exposed the baby to cyanide.
Incorrect drug	Anaesthetic	10 year old under general anaesthetic in dental surgery given incorrect anaesthetic.
"	Nitrous oxide/ oxygen	The two cylinders had been wrongly connected in a 14 year old having a general anaesthetic in the dentist's surgery.
"	Dialysis fluid	Incorrect dialysis fluid used for preterm neonate.
"	Heparin	Preterm baby. Heparin was used to flush an umbilical catheter instead of saline.
"	Anaesthetic	7 year old given wrong anaesthetic as drugs were side by side.
Incorrect route (intrathecal)	Vincristine	12 year old boy received intrathecal vincristine instead of IV
Incorrect Strength	Chloroform Water Concentrated	Chloroform water concentrated was used instead of double strength chloroform water, for peppermint water for a 4 day old
"	Mg SO_4 *	Double strength used, i.e. double dose given. There were **five more deaths** in the treatment group
Incorrect Rate	IV Dextrose	3 day old preterm baby was given IV dextrose but the infusion rate was not controlled.
Incorrect Rate	Dobutamine	Infusion given too rapidly to one month old baby
Incorrect Container	Antidepressants	11 month old baby took her fathers antidepressants, which were not in childproof container.
Omitted in error	Potassium chloride	Preterm baby. Pharmacy failed to put potassium in the dialysis fluid due to communication problems.
Incorrect insertion	IV Line	Incorrect insertion of line for IV anaesthetics led to fluid around the 14 year olds heart led to a heart attack.
Bacterial contamination	TPN*	TPN given to four leukaemic children which was contaminated with Enterobacter cloacae. **Three children died** as a result.
Anaesthesia	Anaesthetic	5 year old old given general anaesthetic for a tooth extraction in a dental surgery.

*Also in Table 2

in the UK during the time period of this study have been reported in the media[11,12]. The medication errors reported in the press were those in which the child had suffered a significant adverse effect. Also, a given event was more likely to appear in the lay press in cases where an individual health professional had been blamed for the error or there had been a court hearing involving the health professional. Therefore, one cannot use our findings to determine the frequency or type of medication errors that occur in children. Rather, they can be viewed as illustrative of potentially significant and tragic paediatric adverse events associated with the use of proprietary medications in infants and children when less than complete information is present to guide paediatric prescribing and/or age-appropriate drug formulations are absent. It is also important to recognise that the number of medication errors reported in the press are very small in relation to the number of children receiving medicines in the UK.

Previous studies of medication errors in children[4–11] have evaluated over 3500 medication errors with periods of observation ranging from 6 weeks[9] to 5 years[7]. These studies have been invaluable in detecting medication errors. They have shown that the most frequent types of medication errors involve the time of administration, the dose of the drug, the wrong drug and the rate of administration of intravenous drugs. There have, however, been no fatalities reported in any of these reviews. We, therefore, feel that important lessons can be learnt from medication errors that have been reported in the press, which are more likely to be severe and where fatalities have occurred.

The most frequent type of medication error reported in the press involved an incorrect dose of the drug. This was for both medication error incidents that involved more than one child and those involving a single child. This is consistent with prospective studies that have shown that medication errors occur in approximately 5% of drug prescriptions, 28% of which involved an incorrect dose.[9]

The administration of the wrong drug was the second most common type of medication error reported in the press and was associated with five fatalities. The administration of the wrong drug was infrequent in the study by Kaushal *et al.* (1.3%).[9] Other studies, however, have shown that this type of medication error is common. A study in an American Children's Emergency Department found that 30% of medication errors involved the wrong drug[7].. This was usually associated with similar packaging or similar drug names. A retrospective study in the UK showed that 12% of medication errors involved the wrong drug being given[12].

There appears to be an increasing number of cases describing a medication error reported annually in the press. Reports also appear to reflect that there are many errors occurring in infants less than a year old and in preterm infants in particular. The errors may be occurring because of more complicated dose calculations and inappropriate formulations and presentation of medicines in this group. An example of this is shown in Table 4 where 15 mg of morphine was given instead of 0.15 mg to a premature neonate. It is possible to draw up 15 mg of morphine from two ampoules of the most dilute formulation commercially available, whereas a 100 fold overdose in an adult would be more likely to be detected as a large number of ampoules would be required.

It is well recognised that the toxicity of certain medicines is far greater than others. The medicines that are most likely to result in significant toxicity if there is a dosage error have been previously highlighted[13]. It is important that systems are introduced to try to focus on these medicines, in particular, as this would result in a significant reduction in morbidity and mortality. Medication errors involving oral medicines are less likely to result in a fatality than those involving parenteral administration.

There were four deaths associated with general anaesthesia in dental surgeries. The use of general anaesthesia in dental surgeries has been of concern by anaesthestists[14]. A recent guidance by the Department of Health concludes that general anaesthesia for dental treatment should only be administered in hospital from January 2002 [15]. The number of deaths reported in the press over the study period is less than the five deaths mentioned in the statement by the Department of Health[15]. This is surprising as one would anticipate that the death of a child following dental treatment would receive extensive publicity in the press and that all such cases would be fully reported. The decision to administer general anaesthesia for dental treatment only in hospitals will hopefully prevent further fatalities in this area.

The reasons behind an apparent increase in the number of medication error reports in the lay press are not entirely clear. We do not know whether this is because the country is becoming more litigious or there are genuinely more medication errors occurring, as medicine management becomes more complex. Nonetheless, the increasing number of reports demonstrates increased vigilance by society at large, thereby creating an awareness of a major health-related problem and potentially, a demand for change.

The recent developments in the NHS in becoming an organisation with a memory (i.e. learning from mistakes) are welcome as is the establishment of the National Patient Safety Agency[16, 17]. The target to reduce by 40% serious medication errors involving prescribed medicines in both children and adults by 2005 is admirable. However, it is impossible to achieve such a target if one does not know the number of medication errors occurring at present and also, all of the conditions and/or circumstances that exist and have the potential to contribute to the occurrence of a given medication error.

Medication errors that occur in children are often different from those occurring in adults. It is important, therefore, that the results for paediatric patients are analysed separately. Such an analysis

should be critical with attention paid to both patient factors (e.g., age, developmental stage, socio-economic considerations, disease state) and pharmacologic/pharmaceutical factors (e.g., proper drug selection, appropriate dose selection, issues of age-appropriate formulation, etc.). Without such a database containing this information, lessons cannot be learned at an institutional level that are required to prevent and/or minimize the occurrence of future serious medication error events.

Medication errors will continue to occur. It is important to recognize that most errors occur because of a system failure rather than the fault of an individual. Health professionals and the Department of Health have a responsibility to introduce systems minimising such errors and in particular, preventing medication errors involving high-risk medicines and high-risk patients. Both the training and the competency assessment of medical, nursing and pharmacy staff in relation to the calculation of doses, the preparation and administration of medicines for paediatric patients of all ages is an area where education and risk assessment has been sadly neglected. Given that all types of health professionals were involved in the genesis of paediatric medication errors, training is essential for all groups.

The requirement for a second independent check in relation to the preparation and administration of medicines (which includes a re-calculation of the drug dose) for paediatric patients should be mandatory. No clinical area is immune from medication errors and, in retrospect, it is likely that several deaths could have been prevented by a second independent check. The provision of appropriate medicines for paediatric patients (i.e. medicine products that are ready for use and do not enable 10-fold errors or 100-fold errors) is another area in which urgent discussions need to take place between the Department of Health, regulatory authorities, health professionals and the pharmaceutical industry. The aim must be to drastically reduce medication errors in all patients and, in particular, in infants, children and adolescents.

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