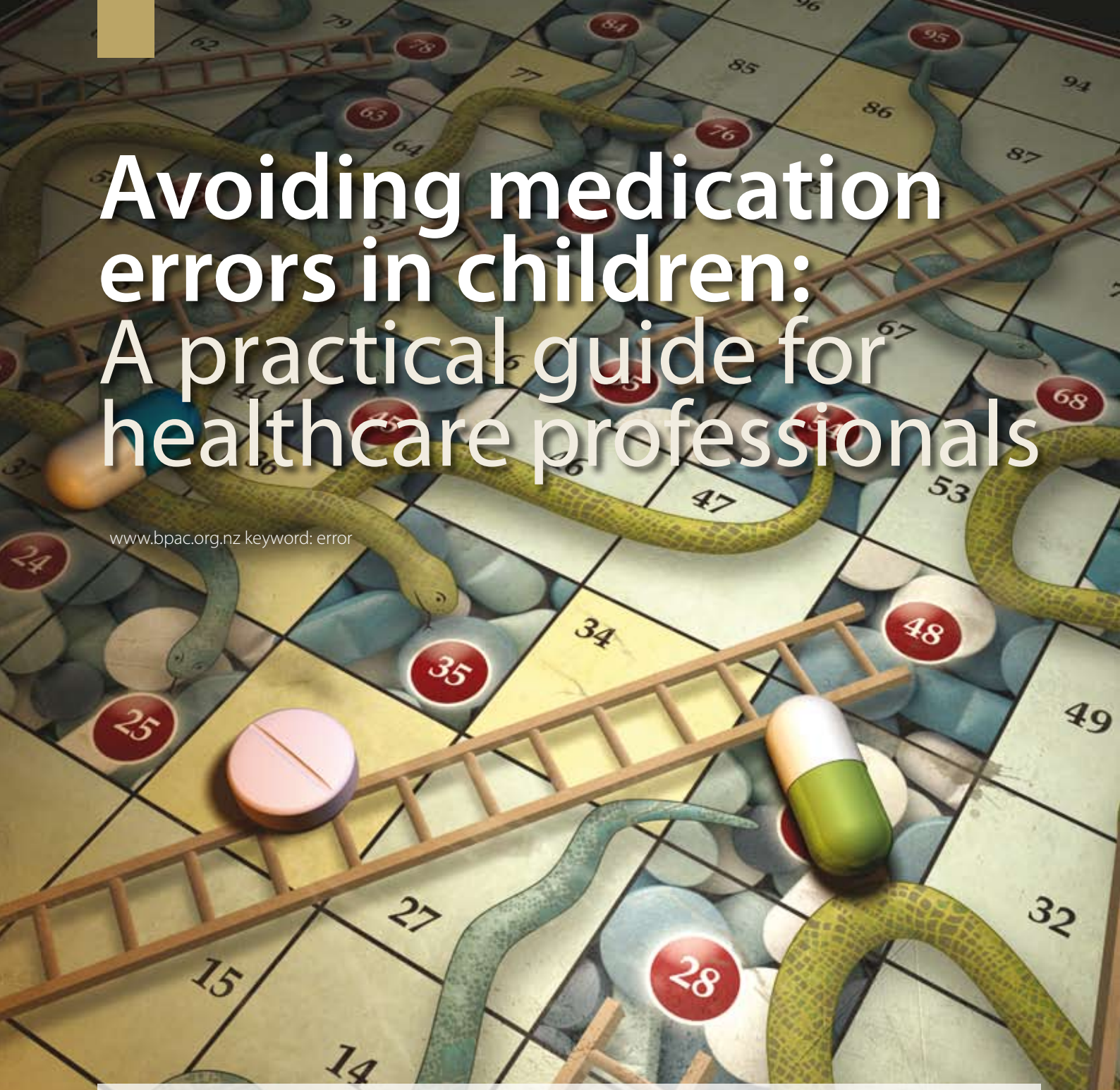
Avoiding medication errors in children: A practical guide for healthcare professionals

www.bpac.org.nz keyword: error



Key concepts:

Strategies for reducing medication errors in children include:

- Reducing dose calculation errors
- Focusing on safe use of medicines that are commonly associated with error including: analgesics, antibiotics, antiepileptic agents, asthma and allergy agents, vaccines and insulin products
- Improving access to specialised prescribing information e.g. BNF for Children
- Improving communication with parents
- Promoting error reporting systems to allow open discussion, for the benefit of healthcare professionals and patients

Minimising medication errors in children

Medication errors may never be completely eliminated, but strategies can be put in place to reduce the likelihood of error occurring. Practitioners are encouraged to identify and respond to signs that an error in prescribing or calculation may have occurred, so that harm can be prevented or reduced. It is also important to recognise circumstances in which errors are more likely to occur, e.g. care of unfamiliar patients, dealing with unusual or unfamiliar medicines, having an unusually heavy workload.[1]

Tips for healthcare professionals to minimise medication errors in children:

1. Take an accurate patient history - confirm that the child's weight is correct and current (record the weight in kilograms), check for drug allergies and adverse drug reactions, and enquire about any changes at each encounter.
2. Ensure full details appear on the prescription, including where appropriate:
    - Weight in kg (include the date the weight was measured)
    - Basis of dose i.e. mg/kg dose (ensure that weight-based dose does not exceed the recommended adult dose)
    - Indication for medicine e.g. on prescriptions for paracetamol state "only for use in pain or fever"
    - Specific instructions (avoid vague instructions such as "take as directed" or "when required")

    Avoid the use of abbreviations and symbols e.g. HCT is used for both hydrocortisone and hydrochlorothiazide, O.D can be mistaken for Q.I.D or BD ( For more information see Safe and Quality Use of Medicines Medication Alert 4, 2007 available from: **www.safeuseofmedicines.co.nz**)
3. For high-alert medicines (Page 12), comprehensive prescription details (as above) are even more important. Any complex calculations should be included as this facilitates independent double checking by other health professionals.
4. In pharmacies and practice medicine supplies, store paediatric products separately from adult preparations. Store look-alike and sound-alike medicines separate from one another.
5. Ensure that parents/carers understand medicine administration information, especially when multiple medicines are prescribed. Encourage use of oral syringes to improve the accuracy of dose measurement and administration of oral liquids. Inform parents of what to expect in terms of a response to the medicine and possible adverse effects. It can be helpful to ask the parent or carer to repeat back their understanding of the medicine and how it is to be administered.
6. Act on any feelings of uncertainty or questions raised by other health care professionals or parents/carers. Verify any unusual volumes or doses when questioned about a medicine or dose.
7. Make a final check of the prescription once it has been printed off. Do not just "click and sign", always look at the form and double check that the correct medicine has been prescribed to the correct patient at the correct dose.
8. Report medication errors so that other healthcare professionals can also learn from them.

Medication errors occur across the entire health sector

Medication errors can occur across the entire health sector, including at the interface between healthcare settings (e.g. hospital admission and discharge). They involve all routes of administration and all provider groups, and can occur in patients of all ages.[2]

A medication error has been defined 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. Such events may be related to professional practice, health care products, procedures and systems including: prescribing, order communication, product labelling, packaging and nomenclature, compounding, dispensing, distribution, administration, education, monitoring and use."[3]

Much of what is known about medication errors in children is based on research undertaken in the hospital setting. There is very little research from primary care. Medication errors can occur with any medicine, but most commonly occur with frequently prescribed medicines such as paracetamol.[4] Medicine classes most commonly associated with error in primary care include analgesics, antibiotics, antiepileptic agents, asthma and allergy agents, vaccines and insulin products.[5,6]

A primary care based study found that approximately 15% of children were dispensed a medicine with a potential dosing error (8% were potential overdoses and 7% were potential underdoses).[5] Medicine administration errors by parents are also common.[7]

A New Zealand study in a paediatric inpatient setting found that medication errors occurred at a rate of 12 per 100 items prescribed. While most of these errors resulted in no harm, two per 100 items had the potential for harm, and one in 100 resulted in actual patient harm. Dosing errors were most commonly implicated in the harmful or potentially harmful errors, particularly during the prescribing stage and with use of antibacterial agents and analgesics.[8]

Medication error rates in children are similar to the overall error rates in adults, but children are more at risk of harm from these errors.[9]

Some important factors contributing to medication errors in children include:

- Individualised dosing - the doses of most medicines used in children are calculated individually, based on the child's age, weight and their clinical condition, leading to increased opportunities for error.
- Small dose volumes – children often require a small dose of a medicine, therefore precise dose measurement is important, particularly for high alert medicines.
- Monitoring difficulties – children are often unable to communicate about adverse effects they may experience, making the monitoring of the safety of a medicine difficult.[5]

Common causes of dosing errors in children

Dosing errors are the most common type of medication error in children in both primary and secondary care[10] and therefore are the best target for prevention strategies.

Inaccurate patient information

It is important to ask about, accurately record and frequently update all patient information. This includes history of allergies and adverse drug reactions and a medicines list including over-the-counter (OTC) products.

Ask parents open-ended questions such as "what medicines do you give your child?", rather than closed questions such as "do you give your child paracetamol?" For example, some parents may not realise that Pamol is the same medicine as paracetamol, and that Fenpaed is the same medicine as ibuprofen.

Medicine doses in children and infants are often based on dose per kilogram of body weight. Incorrectly measured or recorded weight or failure to update records following periods of rapid growth, are common causes of dosing errors.

Equipment should be maintained and frequently checked for accuracy. Take an up-to-date and accurate body weight measurement whenever possible e.g. at times of vaccination. It is good practice to record the child's weight on any prescription as this allows the pharmacist to check the dose as an extra safety precaution.

The calculated dose should not normally exceed the maximum recommended dose for an adult. **As a general guide, dosing on a mg/kg basis should stop once the weight for a child reaches 40 kg.** At that point the regular adult dose can be prescribed. In the hospital setting clinicians may base dose calculations on body surface area e.g. for chemotherapy agents, however this is not usually required in general practice.

Lack of paediatric drug Information

There is a lack of prescribing information for children in general. Product information commonly offers no paediatric guidance, due to lack of clinical trial evidence on safe levels of use. As a result, many medicines are used "off-label" in children, e.g. fluoxetine, omeprazole, beta-blockers.[11,12] This is more common in a hospital setting.

Prescribing information can be unclear or unspecific and contribute to confusion. For example, some prescribing guides state that a child aged between one and five years (10 – 18 kg) may be prescribed 120 – 250 mg of paracetamol, four times per day. Depending on how this is interpreted, the child may be prescribed a daily dose of between 27 and 100 mg/kg.[12]

A paracetamol dose calculator for children is available on the bpac website: **www.bpac.org.nz** Keyword: **calculator**.

World Health Organisation formulary for children

The World Health Organisation (WHO) has recently released a model formulary for prescribing medicines to children aged up to 12 years. The guidance covers 240 "essential medicines" and provides information on standard doses, adverse effects and contraindications.

The formulary is designed for use in resource limited settings and is based on international evidence and prescribing. It is not specific to New Zealand based practice, but can provide general guidance.

Visit the WHO website for further information and to access the formulary: **www.who.int/mediacentre/news/releases/2010/medicines_children_20100618/en/**

The use of out of date references may also contribute to dosing errors. In the absence of a New Zealand specific guide, the British National Formulary for Children (BNFC) is recommended. This is available electronically via subscription or can be purchased in hardcopy at medical bookshops and online.

Manufacturers datasheets for individual medicines are available online from the Medsafe website: **www.medsafe.govt.nz/profs/datasheet/dsform.asp**

Calculation errors

Miscalculations can occur during prescribing, dispensing and administration.

Some common errors include:[13]

- Misplacement of the decimal point
- Lack of a leading zero e.g. writing .5 mg instead of 0.5 mg – which can easily be misread as five milligrams rather than half a milligram
- Use of trailing zeroes e.g. writing 5.0 mg instead of 5 mg – which can easily be misread as fifty milligrams rather than five milligrams
- Incorrect expression of the dosage regimen
- Incorrect units e.g. milligrams instead of micrograms or millilitres

Errors are more likely to occur with more difficult calculations. For example, a study demonstrated that a significantly greater number of incorrect dose calculations occurred for a 23 kg child compared to a 10 kg child, reflecting the more complex calculation required.[4]

"As required" prescribing

"As required" (prn) prescribing is prone to error.[4] Errors are commonly associated with prn administration based on a minimum dosage interval, without guidance about the maximum dosage frequency (as often occurs with paracetamol prescribing). This may result in the total daily dose being exceeded. It has been suggested that one in five children receiving a ''prn'' medicine are potentially receiving an incorrect dose.[5]

If a medicine is prescribed prn, make sure that clear instructions are given about both the minimum time frame between doses and the maximum amount of doses to be given per day. An example of clear instructions for paracetamol 120 mg/5 mL would be:

"5 mL to be given, every four hours, as required for pain or fever, maximum of four doses per day."

High-alert medicines

High-alert medicines are associated with a greater risk of causing significant harm if used in error. Although mistakes are not necessarily more common with these medicines, the consequences of an error are more serious to the child. Therefore it is particularly important that calculations are correct and that an accurate dose measurement is obtained. For oral liquids, recommend that parents/carers use an oral syringe or measuring device, not a teaspoon.

Be wary when prescribing promethazine

Promethazine (Promethazine Winthrop Elixir, Phenergan) is often used in children, but is also often associated with adverse events. Although it is a sedating antihistamine, it can cause paradoxical CNS stimulation reactions in some children, resulting in hyperactivity. Promethazine should not be given to children aged under two years, as its use has been linked to sudden infant death syndrome. It should also be used with caution in children with epilepsy as it may precipitate seizures.[14]

High-alert medicines and high-alert situations

Examples of paediatric high-alert medicines used in primary care include antiepileptics (e.g. phenytoin), insulin and digoxin. These medicines are generally initiated in secondary care but GPs may be involved in follow-up care and repeat prescribing.

Some medicines, e.g. frusemide and ranitidine are not high-alert medicines, but represent a high-alert situation – they are prescribed rarely, therefore their use is unfamiliar which increases the potential for errors to occur.

Another potentially high-alert situation is the use of medicines in emergencies e.g. adrenaline and steroids. It is good practice to have a range of paediatric doses calculated and easily accessible e.g. attached to the box containing adrenaline ampoules.

Labelling, packaging and formulation of products

Dispensing label errors are common and were found to be involved in one in 20 paediatric medication errors reported in the UK.[6]

Product packaging can also contribute to errors. Look-alike and sound-alike medicines are easy to confuse e.g. penicillin and penicillamine. Adult and paediatric preparations can also be mistaken.

Most medicines are packaged and designed for use in adults. Only a few medicines are commercially available in suitable dosage forms or the correct strength for children. As a result, complex calculations and dilutions may be required to get the appropriate formulation and dose for children.[4, 13]

There is no consistency in the way the strength of a mixture is expressed, i.e. mg/mL, mg/5 mL or mg/10 mL. For example, paracetamol oral liquid is available in strengths

Medication error involving multiple factors

A diagnosis of bacterial conjunctivitis was made in a child and the GP decided to prescribe fusidic acid eye drops. The GP explained to the mother that she would receive a small tube of medicine and that she should place a small drop into the child's eyes, twice daily, until the infection cleared.

When completing the electronic prescription, in error the GP selected fusidic acid ointment, rather than eye drops, and wrote on the script for it to be used twice daily.

The pharmacist dispensed fusidic acid ointment (which is indicated for treatment of skin infections). The mother tried using the ointment in her child's eyes but gave up after a few days as it was nearly impossible to apply.

Three errors were made by the doctor:

- Incorrect formulation prescribed
- Prescription did not contain specific instructions, e.g. "apply to the eyes twice daily", that may have helped alert the pharmacist to a potential prescribing error
- The prescription was not checked before it was signed

The mother realised that the packaging and administration was not as had been described to her but she did not feel confident enough to talk to the doctor or pharmacist about her concerns.

Parents/carers should be encouraged to express any questions or concerns they may have, including after they leave the surgery.

of 50 mg/mL (Pamol Infant Drops available OTC), 120 mg/5 mL or 250 mg/5 mL. It is therefore, important that careful explanation is given to parents when different formulations of the same medicine are prescribed.

Uncertainty and misunderstanding by parents

It is essential that parents/carers receive adequate information about their child's medicine and understand how it should be administered.

Parents should know the name, strength and dose of the medicine, understand the label instructions and know the correct dosing interval. They must be able to accurately administer the dose using an oral syringe or other suitable measuring device (available from a pharmacy), rather than a household teaspoon that is less accurate and could lead to large dose variations.

A study found that even when literacy is not considered an issue, dispensing label instructions are misunderstood by more than one third of patients.[15] Rates of misunderstanding are even higher among patients with marginal and low literacy (including those with English as a second language) or when multiple medicines are required. Although this study tested patient understanding, this also applies to parents who must understand the labels in order to administer the medicine to their child.

Reinforcement and further explanation of the doctor's instructions by the pharmacist and other members of the healthcare team improves understanding.

The New Zealand Pharmacovigilance Centre

The New Zealand Pharmacovigilance Centre (NZPhvC) has recently been awarded a Ministry of Health grant to pilot a national medication error reporting and prevention system.

The NZPhvC has always received small numbers of medication error reports however, it is hoped that development of this system will serve to provide comprehensive surveillance for medication errors originating in primary care. Alongside traditional adverse drug reaction surveillance, this will allow the best learning opportunities to improve patient safety. The system will operate on principles of anonymity under the umbrella of the NZPhvC.

Healthcare professionals are therefore encouraged to report any medication-related events (i.e. medication errors and adverse drug reactions) to the Centre for Adverse Reactions Monitoring (CARM). Reports can be made online and reporting forms downloaded by visiting: **http://carm.otago.ac.nz/reporting.asp**

Reporting medication errors

Without reporting, opportunities for learning are diminished. Organisations that do not encourage reporting of incidents, where few medication errors are reported, may be at greater risk of causing medicine related harm to patients as there is less opportunity to learn and improve systems.[7]

Patient Safety Incident Reporting

Primary care health professionals can now report incidents to the bpac[nz] Patient Safety Incident Reporting System. This is an anonymous service aimed at improving patient safety by identifying the factors that commonly contribute to incidents and sharing solutions to prevent these incidents from occurring again. Reports can be submitted online or by completing a paper-based form.

Visit **www.bpac.org.nz/safety** to submit a report or read and comment on reports from colleagues.

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Medication errors with vaccines

Vaccines are frequently associated with medication incident reports. Vaccines may be mistakenly administered when they are contraindicated, when they have previously been administered and where parental consent has been refused. Poor systems for documentation of vaccination records are often implicated.[6]

Error example: A child was due to receive a pre-school immunisation booster, which included MMR vaccine. The child's mother had previously stated that she did not wish her child to receive the MMR vaccine. The child was brought to the appointment by her grandmother, with the child's record book and in error the child was given the MMR vaccine with the DPT/Polio vaccine.[6]

Another common vaccine error is an "extra dose" error where two siblings attend for vaccination and one child receives two doses and the other child none.

Common errors when prescribing simple analgesics to children

The most likely error that occurs when analgesics are prescribed is overdose.[5] This is of particular concern as most of these medicines have a high likelihood of serious adverse events. One of the reasons that analgesics are associated with dosing error is that they are often prescribed "prn" which increases the potential for overdose.

Paracetamol

Paracetamol is the preferred first-line analgesic for children for fever and mild to moderate pain. It has few adverse effects when dosed correctly, however serious, and sometimes even fatal, liver toxicity can occur with acute and chronic overdose.

The weight-based dose for paracetamol in children is generally 10–15 mg/kg, every four to six hours (maximum of four doses in 24 hours).[11, 12]

The BNF for children states:[11]

Paracetamol 120 mg/5 mL

- Infants 1–3 months: 30–60 mg, eight hourly (maximum 60 mg/kg/day in divided doses)
- Infants 3–12 months: 60–120 mg every 4–6 hours (maximum 4 doses/24 hours)
- Children 1–5 years: 120–250 mg every 4–6 hours (maximum 4 doses/24 hours)

Paracetamol 250 mg/5 mL

- Children 6–12 years: 250–500 mg every 4–6 hours (maximum 4 doses/24 hours)

Lack of awareness of the strengths of different paediatric formulations e.g. 120 mg/5 mL or 250 mg/5 mL, and use of more than one preparation containing paracetamol, may lead to dosage errors and toxicity.

Error example: A mother is used to giving her five-year-old child 10 mL of paracetamol 120 mg/5 mL. When her child is then prescribed a higher strength formulation (i.e. 250 mg/5 mL), the change in dosing instructions was not carefully explained to her, she does not read the label and gives the usual 10 mL.

Error example: A child presents to the practice with symptoms of a respiratory infection. The GP diagnoses viral upper respiratory infection and explains that antibiotics are not necessary and that cough and cold preparations are not recommended. The GP writes a prescription for paracetamol 120 mg/5 mL, 5 mL, four times per day.

The mother returns with the child the next day, concerned because he is lethargic and sweaty. She reveals that she gave the child the paracetamol as instructed, but also had some "Pamol" at home and gave that too. In addition, as she was advised against giving "cough mixture" she made the child a warm "Lemsip" drink. The mother was not aware that all of these products contained paracetamol.

Over the past 24 hours the child had four 5 mL doses of paracetamol 120 mg/5 mL, four 5 mL doses of Pamol (paracetamol 250 mg/5 mL) and one sachet of Lemsip (paracetamol 500 mg). In total this is 1980 mg of paracetamol, giving a dose of 198 mg/kg in the 10 kg child.

The child was referred to secondary care with suspected paracetamol toxicity. Although the mother herself made many errors, this example highlights the importance of carefully explaining medicines to parents, including generic and trade names they might know them by. Also instruct parents how to read labels of over-the-counter medicine preparations and know what medicines they contain.

Ibuprofen

Ibuprofen is an alternative to paracetamol for the management of pain (e.g. musculoskeletal pain) and fever. It is associated with an increased risk of gastrointestinal bleeding. There have also been reports of renal toxicity and aspirin-like sensitivity reactions.[14] Ibuprofen should not be used if the child is dehydrated or has acute renal failure.

All NSAIDs have the potential to worsen asthma, either acutely or as a gradual worsening of symptoms.[11] Therefore children with asthma should preferably use paracetamol.

Dose recommendations:

Always use the lowest effective dose, for the shortest possible duration, and preferably administer after food. For infants and children the usual oral dose is 20 mg/kg/day, in divided doses (if over 7 kg and a severe condition, this can be up to 30 mg/kg/day). In children weighing less than 30 kg, the total daily dose should not exceed 500 mg.[11]

The BNF for children states:[11]

Ibuprofen 100 mg/5 mL:

- Infants 1–6 months: 5 mg/kg, three to four times daily
- Infants 6–12 months 50 mg, three times daily
- Children 1–2 years 50 mg, three to four times daily
- Children 2–7 years 100 mg, three to four times daily
- Children 7–18 years 200 mg, three to four times daily

Error example: A 10-year old child is prescribed 200 mg ibuprofen (100 mg/5 mL), with the instruction "use as required". The doctor is running late and does not weigh the child. The child is of lean build and weighs 27 kg. The child's parents give her five doses of medicine during the day (every four hours), equalling a total dose of 1000 mg.

Errors made:

- The doctor did not weigh the child for a more accurate dose
- The doctor did not provide clear dose instructions, with dosing intervals and maximum daily dose
- The pharmacist did not double-check the dose and explain the dosing instructions to the parents
- The maximum recommended daily dose of 500 mg in a child weighing less than 30 kg was exceeded.

Aspirin

Aspirin should not be used in children aged less than 12 years, although some countries, including the UK, do not recommend use under age 16 years. Although it is a well-documented analgesic, anti-inflammatory and antipyretic, aspirin is associated with Reye's syndrome in children.[14]

Given that other effective analgesics are available, it is usually not necessary to prescribe aspirin to a child of any age for pain relief in general practice.

See Correspondence "Aspirin in children", BPJ 17 (Oct, 2008) and BPJ 27 Quiz Feedback "What is Reye's syndrome" for further information.

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Ethics in General Practice

GENX 824

Semester Two, 2010 – 15 points

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