Poisoning in children

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Summary

Poisoning accounts for about 7% of all accidents in children under 5 years and is implicated in about 2% of all childhood deaths in the developed world, and over 5% in the developing world (National Poisons Information Service). In considering this topic, however, it is important to differentiate accidental overdose (common in the younger age groups) and deliberate overdose (more common in young adults). Although initial assessment and treatment of these groups may not differ significantly, the social issues and ongoing follow-up of these children will be totally different and the treating physician must remain aware of this difference. The initial identification and treatment of these children remains the mainstay of management, and many ingested substances do not have a specific antidote. Supportive treatment must be planned and the potential for delayed or long-term effects noted. The specific presentation and treatment of some of the commonly ingested substances will be addressed in this article, and guidance given on when to contact expert help.

Introduction

More than 100,000 individuals are admitted to hospital in England and Wales annually due to poisoning, accounting for 10% of all acute admissions. However, the true incidence of acute poisoning may be 2–3 times greater. In England and Wales, analgesics account for 20% of all cases of poisoning in children aged 14 years or less, with a further 40% ingesting other pharmaceutical preparations. The remaining 40% are poisoned by a variety of household products such as bleaches, detergents and turpentine substitutes.

Toxic compounds may be ingested or inhaled either accidentally or deliberately. Accidental poisoning can occur at any age, but is much more common in children. Peak incidence is around the age of 2 years and boys are at more risk than girls. Most incidents (80–85%) occur in the child’s home and in many cases the substances involved have not been stored in their usual place or have been put into a different container.

Household products are more commonly ingested than drugs by children and seasonal variability has been described. Pesticides and weed killers are more commonly ingested in the spring, berry poisoning occurs in the autumn, and cough and
cold remedies are more commonly ingested in the winter.

Deliberate poisoning is more common in adults, but is increasing in the teenage population; the incidence of analgesic ingestion has particularly increased. Depression and deliberate self-harm are often found concurrently with analgesic overdose, and the particular needs of this population differs from adults.

Poisoning accounts for a very small proportion of deaths in children under 10 years of age. This declining proportion of deaths in children may be attributable to the widespread introduction of childresistant closures on containers. However, other factors, including greater emphasis on safety in the home, improved access to information on poisons and improved treatment may also contribute to reducing mortality. In England and Wales, carbon monoxide remains the most common cause of childhood death due to poisoning. Tricyclic antidepressant ingestion remains a significant contributor to mortality, although it is relatively infrequently ingested.

**Initial approach, investigation and treatment**

The diagnosis of acute poisoning may be apparent from the clinical history. However, it should also be considered in patients who present with altered consciousness, those unable to give a history and those who present with an episode of deliberate self-harm. Wherever possible the constituents of the substance ingested and its dosage per kilogram of body weight should be identified as accurately as possible.

In cases where poisoning is suspected, but cannot be confirmed by clinical history, a detailed physical examination, including a full neurological assessment, is an essential part of substance identification. Initially, assessment and treatment of the airway, breathing and circulation is mandatory. Treatment should first focus on supportive measures, including use of high-flow oxygen and intravenous fluids. Depression of the nervous system can occur and fitting should be treated with intravenous benzodiazepines.

There is no place for the use of emetics in the modern treatment of poisoning. The use of activated charcoal for reducing drug absorption should be considered if a patient presents within 1 h of taking the substance. A single dose of 1 g/kg body weight for children can be given by mouth or via naso-gastric tube up to 1 h after ingestion of a potentially toxic amount of a well charcoal-adsorbed poison, and perhaps beyond an hour in cases involving sustained or modified-release drug preparation. A list of poisons for which activated charcoal has been proven to be ineffective is found in Table 1. The use of repeated doses of activated charcoal to remove toxins undergoing enterohepatic circulation is one of the simplest active elimination techniques. Table 1 lists the substances for which this technique may be useful.

Gastric lavage is not recommended by The American Academy of Clinical Toxicology or the European Association of Poisons Centres and Clinical Toxicologists unless a patient has ingested a potentially life-threatening amount of a poison and the procedure can be undertaken within 1 h of

<table>
<thead>
<tr>
<th>Poisons for which activated charcoal has been proven to be ineffective</th>
<th>Substances where repeat doses of activated charcoal may prove useful in enhancing clearance</th>
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</thead>
<tbody>
<tr>
<td>Cyanide</td>
<td>Carbamazepine</td>
</tr>
<tr>
<td>DDT</td>
<td>Theophylline</td>
</tr>
<tr>
<td>Essential oils</td>
<td>Digoxin</td>
</tr>
<tr>
<td>Organic solvents</td>
<td>Barbiturates</td>
</tr>
<tr>
<td>Iron</td>
<td>Salicylates</td>
</tr>
<tr>
<td>Lead</td>
<td>Phenytoin</td>
</tr>
<tr>
<td>Mercury</td>
<td>Phenylbutazone</td>
</tr>
<tr>
<td>Lithium</td>
<td>Dapsone</td>
</tr>
<tr>
<td>Bleach</td>
<td>Amanita phalloides</td>
</tr>
<tr>
<td>Alkalis</td>
<td>Quinine</td>
</tr>
<tr>
<td>Alcohols (i.e., methanol, ethanol, ethylene glycol)</td>
<td>Slow-release preparations</td>
</tr>
<tr>
<td></td>
<td>Sotalol</td>
</tr>
<tr>
<td></td>
<td>Piroxicam</td>
</tr>
</tbody>
</table>
Laboratory investigations

A careful history may obviate the need for blood tests. Standard haematological investigations are rarely diagnostically helpful, although the prothrombin time may be prolonged after ingestion of anticoagulants or in case of hepatic damage (e.g. in paracetamol poisoning). Blood glucose estimation should be performed in all cases, as hypoglycaemia is typically caused by an overdose of insulin or oral hypoglycaemic agents and complicates ethanol intoxication, particularly in children. Blood gas analysis should be undertaken in any patient with respiratory insufficiency, hyperventilation or when metabolic acid–base disturbance is suspected. Hypokalaemia has been described as a complication of acute poisoning and electrolyte estimation may be useful.

Routine measurement of plasma paracetamol should be performed in older children presenting with any deliberate ingestion. In one study, authors found one in 500 adult overdose patients not suspected of having taken paracetamol had levels above the treatment threshold. The routine measurement of salicylate is controversial, and although done in practice, is only necessary when symptoms become obvious. It is unlikely that a clinically significant concentration will be present in a patient without the typical signs of salicylism.

Radiology can be used to confirm ingestion of metallic objects or ingestion of elemental mercury or iron salts. An electrocardiogram (ECG) is of limited diagnostic value, although tachycardia with prolongation of the PR and/or QRS intervals in an unconscious patient should prompt consideration of tricyclic antidepressant overdose.

Specific antidotes

Antidotes should only be considered after the initial supportive treatment has been started. An example of an antidote is naloxone, a competitive antagonist at the opioid receptor. It is effective in reversing the symptoms of opioid overdose with all compounds except buprenorphine (which is a partial agonist and therefore not completely antagonised). Those who have taken very large overdoses, particularly of a long-acting agent such as dihydrocodeine and methadone, may need further doses of naloxone to competitively antagonise the opioid agonist, and continuous intravenous infusion of naloxone, together with intensive monitoring may be necessary in some cases. The use of flumazenil is not recommended in the suspected overdose of benzodiazepines because of the risk of fitting with co-ingestion of tricyclic antidepressants.

Specific poisons

Paracetamol

Children are more resistant to paracetamol-induced liver damage than adults. The volume and paracetamol concentration of the formulation should be established from the packaging and the volume remaining should be measured. The maximum possible ingestion should be assumed. If the dose of paracetamol consumed is known with absolute certainty to be below 150 mg/kg no further action is required. However, it is recommended that paracetamol levels should be investigated at least 4 h after the time of ingestion in any patient who has deliberately taken an overdose in order to commit deliberate self-harm. Samples taken before this may be unreliable.

Paracetamol levels should be compared with the standard adult normogram to determine the need for treatment with N-acetylcysteine (NAC). This may overestimate treatment required in children but there is at present no normogram available for the paediatric population. Children at high risk (i.e., those on cytochrome p450 enzyme-inducing drugs or those who are malnourished) should be treated as per the 'high-risk line'. Patients who have taken a staggered overdose should be started on NAC without awaiting the result of paracetamol levels and then bloods taken for INR, LFTs, U/Es after the NAC regimen has been completed. Those presenting more than 8 h post-ingestion should also be started on treatment immediately.

NAC is given via intravenous infusion, and should be administered when indicated using the normogram or in the situations already discussed. Adverse reactions such as nausea, vomiting, flushing and urticarial rash can occur, usually within the first 30 min of administration. This usually resolves once the infusion is stopped and an antihistamine is given. Once the reaction has settled NAC infusion can be recommenced at an infusion rate of 50 mg/kg over 4 h. Further reactions are almost unknown.
Blood should be taken for estimation of electrolytes, creatinine, INR/prothrombin time and liver function tests after the NAC regime has finished. A baseline INR is sometimes useful before treatment. Abnormal results should prompt further advice from a specialist liver centre and a further 16-h infusion of NAC should be commenced.

**Aspirin**

The incidence of salicylate toxicity has declined considerably since the withdrawal of paediatric aspirin preparations from the market in 1986. In children over the age of 4 years a mixed respiratory alkalosis and metabolic acidosis is the rule with normal or high arterial pH (normal or reduced hydrogen ion concentration). In children aged 4 years or less a dominant metabolic acidosis with low arterial pH (raised hydrogen ion concentration) is common.

Plasma salicylate concentrations should be measured for patients who are thought to have ingested more than 120 mg/kg of aspirin. The sample should be taken at least 2 h (symptomatic patients) or 4 h (asymptomatic patients) after ingestion, as it may take several hours for peak plasma concentrations to occur. There is no need to measure salicylate concentrations in conscious overdose patients who deny taking salicylate-containing preparations and who have no features suggesting salicylate toxicity. Table 2 details further management after an overdose of aspirin.

**Opiates**

Opioid toxicity produces the classic triad of reduced consciousness, pinpoint pupils, and a reduction of respiratory rate. These should be enough to lead to a rapid working diagnosis of opioid toxicity. Naloxone can be used as a diagnostic and therapeutic tool. A partial response is an indication for a further dose, although the patient may be sedated by another central nervous system agent, such as alcohol or a benzodiazepine. Clearly with opioid toxicity the first priority is to ensure that respiration and circulation are adequate, and if the patient appears to be close to respiratory arrest attention to the airway and provision of respiratory and cardiovascular support is more urgent than giving naloxone.

**Compound analgesics**

Compound analgesics are mixtures of paracetamol or aspirin with a variety of opioids or other ingredients. When assessing overdose of compounds each active constituent must be considered separately.

**Tricyclic antidepressants**

Tricyclic overdoses produce anticholinergic symptoms, including drowsiness, ataxia and agitation. Convulsions, central nervous system depression and hypotension can also occur. Increased tone and hyper-reflexia may be present with extensor plantar reflexes. In deep coma all reflexes may be abolished. Cardiac arrhythmias secondary to the prolonged QT interval are the most common cause of death.

Activated charcoal should be administered within 1 h if more than 4 mg/kg tricyclic has been ingested by a child, provided the airway can be protected. A second dose of charcoal should be considered after 2 h in patients with central features of toxicity. Investigations should include a 12-lead ECG to detect signs of cardiac toxicity. The patient should be observed for 6 h if asymptomatic and those who remain symptom free and have normal ECGs by 6 h are unlikely to develop late complications.

<table>
<thead>
<tr>
<th>Plasma salicylate</th>
<th>Fluids</th>
<th>Sodium bicarbonate</th>
<th>Consider repeated doses of activated charcoal</th>
<th>Urgent referral for haemodialysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;350 mg/l (2.5 mmol/l)</td>
<td>Encourage oral fluids</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>&gt;350 mg/l</td>
<td>Intravenous fluids</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;700 mg/l (5.1 mmol/l)</td>
<td>Intravenous fluids</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Iron

Early features of iron poisoning include vomiting, diarrhoea and abdominal pain. The vomitus and stools are often grey or black. Direct mucosal irritation by adherent tablets can cause gastrointestinal haemorrhage. These effects usually settle within 6 h.11

A careful history must be taken to find out the iron preparation consumed and the maximum quantity taken as different iron salts contain differing quantities of elemental iron.11 A child who is asymptomatic and has ingested less than 20 mg/kg body weight of elemental iron is said to have mild toxicity and does not require further investigation. Those who have ingested more than 20 mg/kg body weight of elemental iron are likely to develop features and so will warrant admission.

A serum iron estimation taken at about 4 h after ingestion is the best laboratory measure of severity. Plain abdominal X-ray has been recommended as a screening test within 2 h of a suspected ingestion. If less than 2 h has elapsed since the suspected ingestion, iron tablets are sometimes visible in the stomach or small bowel. Later abdominal X-rays are of no value, as tablets may have disintegrated thus giving a negative result and the absence of iron tablets on abdominal X-ray does not preclude the presence of a significant ingestion.11 In patients with tablets confined to the stomach, repeated gastric lavage or endoscopic removal can be considered. Patients with a serum iron level greater than 90 μmol/l should receive treatment with intravenous desferrioxamine, which chelates free iron, and expert advice should be sought.

Turpentine substitute

Turpentine oil has been largely replaced with white spirit and turpentine substitute, which are of relatively low toxicity when ingested. Their main toxicity relates to the risk of aspiration resulting in a chemical pneumonitis. For this reason gastric decontamination is contraindicated. All patients should be assessed for signs of respiratory distress, which should include measurement of oxygen saturation. The majority of patients are asymptomatic and do not necessarily require observation. Advice must be given to return if children develop cough or fast, noisy breathing. Children can develop symptoms up to 24 h post-ingestion.12

Hospital admission is mandatory for the ingestion of turpentine as it can cause irritation and burning throughout the gastrointestinal tract, metabolic acidosis, hepatic failure, renal damage and altered level of consciousness.12

Essential oils

Essential oils are used in perfumery and aromatherapy and are potentially very toxic. Initial effects include mucosal irritation, vomiting, epigastric pain and diarrhoea. Convulsions, central nervous system depression, and hepatic and renal failure may follow. Asymptomatic children require 6 h observation. Fluids should be encouraged. Symptomatic children require hospital admission with supportive treatment and blood glucose monitoring. Signs of respiratory distress may indicate oil aspiration.12

Plants and berries

Ingestion of or exposure to potentially poisonous plants is a relatively common presenting complaint in hospital paediatric departments, especially amongst toddlers.13 History taking needs to include the part of the plant that has been ingested, i.e., the berries or leaves, as toxicity may differ. Activated charcoal is recommended for initial management of ingestion of plants such as laburnum and deadly nightshade. It is recommended that the National Poisons Information Service be contacted for advice regarding initial and continued care.

Alcohol

The incidence of intoxicated children presenting to the Emergency Department is increasing nationally. Children who have ingested the equivalent of 0.4 ml/kg pure ethanol should be observed for at least 4 h and hypoglycaemia must be investigated and corrected if present. The fatal dose of alcohol in children is approximately 3 g/kg body weight (4 ml/kg absolute ethanol). Crawford et al.14 demonstrated the effectiveness of referring adult drinkers to alcohol health workers. Underlying social issues of an intoxicated child should be addressed once the child is sober and consideration of referral to alcohol services may be required.

National poisons information service

This must be the first port of call in dealing with any patient that presents after the ingestion of a ‘poison’. Poisons information specialists and nurses
answer telephone calls and consultant physicians are available to provide clinical advice, and their expertise is useful if a patient has presented with a toxidrome, i.e., a combination of symptoms secondary to ingestion of an unknown substance. 'Toxbase' (www.spib.axl.co.uk) is a database usually available to the treating physician in the local Emergency Department. Another website and programme that can be purchased is 'TicTac' (www.tictac.org) which contains a database of tablets allowing identification of unknown medications.

Conclusions

Poisoning can occur either accidentally or deliberately. Along with ascertaining a detailed history, the 'ABC' approach to the initial management of the patient must be adopted, along with the consideration of the use of charcoal and a specific antidote, if one exists.

Substances that are commonly ingested by children include household products and drugs, the ingestion of which may be deliberate or accidental. Treating physicians must consider ingestion of paracetamol in deliberate overdoses of any tablets and be knowledgeable about the use of the nomogram with NAC. Aspirin toxicity is still seen either alone or due to the ingestion of compound analgesics. Tricyclic antidepressant ingestion remains a significant cause of mortality in this group. Iron can be extremely toxic and the use of desferrioxamine may be required if a large amount has been taken. Turpentine substitutes and essential oils have been included as these are commonly ingested accidentally. Ingestion of alcohol and street drugs, such as ecstasy and cocaine, is on the increase by the teenage population and the management of these should be known, as well as the importance of dealing with any social issues. If in doubt the Poisons Information Service is a resource for all treating physicians in the management of poisoning.

References