

## REVIEW

## Acute poisoning: understanding 90% of cases in a nutshell

S L Greene, P I Dargan, A L Jones

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The acutely poisoned patient remains a common problem facing doctors working in acute medicine in the United Kingdom and worldwide. This review examines the initial management of the acutely poisoned patient. Aspects of general management are reviewed including immediate interventions, investigations, gastrointestinal decontamination techniques, use of antidotes, methods to increase poison elimination, and psychological assessment. More common and serious poisonings caused by paracetamol, salicylates, opioids, tricyclic antidepressants, selective serotonin reuptake inhibitors, benzodiazepines, non-steroidal anti-inflammatory drugs, and cocaine are discussed in detail. Specific aspects of common paediatric poisonings are reviewed.

Paracetamol remains the most common drug taken in overdose in the UK (50% of intentional self poisoning presentations).<sup>1–9</sup> Non-steroidal anti-inflammatory drugs (NSAIDs), benzodiazepines/zopiclone, aspirin, compound analgesics, drugs of misuse including opioids, tricyclic antidepressants (TCAs), and selective serotonin reuptake inhibitors (SSRIs) comprise most of the remaining 50% (box 1). Reductions in the price of drugs of misuse have led to increased cocaine, MDMA (ecstasy), and  $\gamma$ -hydroxybutyrate (GHB) toxicity related ED attendances.<sup>10</sup> Clinicians should also be aware that severe toxicity can result from exposure to non-licensed pharmacological or common environmental agents including plants, herbal and traditional remedies, industrial chemicals, heavy metals, and animal bites or stings.

**A**lthough the overall severity of poisoning in the UK has decreased over the past 10 years the number of poisoned patients presenting to emergency departments (EDs) is increasing, accounting for 5%–10% of an ED's workload.<sup>1–3</sup> Rates of self poisoning in the UK are among the highest in Europe.<sup>4</sup> Provision of meticulous supportive care, identification of patients requiring treatment with an antidote, and the appropriate use of methods limiting poison absorption or increasing elimination, remain the cornerstones of management. This article will focus on the initial general management of the poisoned patient and examine more specific issues in the management of the most common and serious poisonings.

### EPIDEMIOLOGY

Accidental poisoning accounts for about 80 000 annual ED attendances in England and is most common in children under 5 years of age,<sup>5</sup> although most do not develop significant clinical features.<sup>6</sup> There are about 1000 deaths each year in the UK from accidental poisoning, predominantly in adults with 50% of cases attributable to opioid poisoning.<sup>7</sup> ED attendances in the UK after intentional self poisoning (347 per 100 000) are increasing and result in more than 2000 deaths each year, however only 29% of all intentional self poisoning deaths occur in hospital.<sup>5</sup> Poisoned patients account for 10% of admissions to general medical wards.<sup>8</sup> Iatrogenic poisoning caused by prescribing/administration errors or unrecognised adverse drug interactions has recently been identified as a significant problem, and these account for about 1% of calls to the National Poisons Information Service (NPIS), London.

### GENERAL MANAGEMENT

Serious clinical effects occur in less than 5% of acutely poisoned patients.<sup>3–6</sup> Overall in-hospital mortality rates are less than 0.5%.<sup>5</sup> Most poisoned patients can be treated with supportive care during an appropriate period of observation. The challenge for the attending clinician is to identify as early as possible patients who are at risk of developing serious clinical toxicity, and who may benefit from decontamination or a specific intervention.

Recent high profile terrorist activities have highlighted the need for ED decontamination facilities and the availability of appropriate antidotal therapy.<sup>11–12</sup> Poisoned patients who may contaminate others must be identified early and decontaminated appropriately before treatment. ED staff must be trained to use protective clothing, breathing apparatus, and decontamination facilities.

Internet based information services such as Toxbase (<http://www.spib.axl.co.uk>) and Isabel (<http://www.isabel.org.uk>) aid triage staff in identifying patients who may benefit from immediate intervention (for example, the administration of activated charcoal). Product information leaflets and older textbooks are often out of date and are not a reliable source of information in managing poisoned patients. The NPIS is a telephone based (0870 600 6266)

**Abbreviations:** ED, emergency department; NPIS, National Poisons Information Service; TCA, tricyclic antidepressant; NSAID, non-steroidal anti-inflammatory drug; IV, intravenous; IM, intramuscular; CNS, central nervous system; AC, activated charcoal; GI, gastrointestinal; MDAC, multidose activated charcoal; ALF, acute liver failure; NAC, N-acetylcysteine; LFT, liver function test; MI, myocardial infarction; SSRI, selective serotonin reuptake inhibitor; ACS, acute coronary syndrome

See end of article for authors' affiliations

Correspondence to:  
Dr S Greene, Medical  
Toxicology Unit, Avonley  
Road, New Cross, London  
SE14 5ER, UK; Shaun.  
Greene@gstf.nhs.uk

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resource available to all healthcare professionals. The NPIS provides 24 hour on call cover by clinical toxicologists.

### IMMEDIATE CARE

Treatment of cardiac arrest in the poisoned patient should generally follow ACLS guidelines, however there are circumstances in which different approaches are required (for example, early use of hypertonic sodium bicarbonate in cardiac arrest associated with TCA poisoning).<sup>13</sup>

The initial priority in treating seriously ill poisoned patients is standard resuscitation—that is, airway, breathing, and circulation. Inadequate ventilation caused by airway compromise or reduced respiratory effort may require an oropharyngeal or nasopharyngeal airway and bag-mask ventilation with the provision of supplemental oxygen until a definitive airway can be obtained, either through toxin reversal (for example, naloxone for opioids), or rapid sequence induction, intubation, and mechanical ventilation.<sup>14</sup>

Hypotension should be treated initially using intravenous (IV) fluids (an initial bolus of 10–20 ml/kg of crystalloid titrated to clinical effect). Hypotension produced by poisons such as opioids,  $\beta$  blockers, or digoxin can in addition be treated using the specific antidote (that is, naloxone, glucagon, and digoxin specific antibodies respectively). Hypotension resistant to treatment with IV fluids or appropriate antidotes is managed by measuring central venous pressure to ensure adequate circulatory filling and then cautious administration of an appropriate inotropic agent. Norepinephrine (noradrenaline) should be considered in poisonings producing peripheral vasodilatation whereas adrenaline is likely to be more effective where there is direct toxin related myocardial depression.<sup>15</sup> The use of inotropic agents may worsen cardiovascular toxicity and should generally be discussed with a clinical toxicologist.

Arrhythmias associated with poisoning should generally not be treated with antiarrhythmic drugs as a first line approach. Most antiarrhythmic agents have the potential to be pro-arrhythmic and negatively inotropic and so indiscriminate use of these agents in poisoned patients is inadvisable. Factors precipitating or contributing to the arrhythmia such as acidosis, hypokalaemia, hypomagnesaemia, and hypoxia should be corrected.<sup>15</sup> It is preferable to use specific measures rather than administering antiarrhythmic agents, for example, hypertonic sodium bicarbonate for TCA related arrhythmias, digoxin specific antibodies for digoxin related arrhythmias, and overdrive pacing for ventricular tachyarrhythmias.<sup>13–15</sup> Correction of precipitating factors and the appropriate use of antidotal agents negates the need for

antiarrhythmic agents in most cases. Electrical cardioversion may produce asystole in the presence of a poisoned myocardium and should only be used after correction of acidosis, metabolic abnormalities, and hypoxia, and the appropriate use of antidotal agents (particularly sodium bicarbonate in TCA poisoning). Electrical cardioversion is appropriate treatment in conjunction with the above measures in cases of pulseless VT and cardiac arrest according to ACLS guidelines.<sup>13</sup>

Sustained seizures should be treated using benzodiazepines (lorazepam 4 mg IV or IM, or diazepam 5–10 mg IV/PR initially).<sup>16</sup> It is important that a bedside blood sugar concentration (BM) is checked early in any patient with seizures to exclude hypoglycaemia as a cause. The sodium channel blocking properties of phenytoin can theoretically exacerbate the cardiotoxicity of some drugs such as cocaine and TCAs, and thus should be avoided in treating seizures secondary to these drugs.<sup>17</sup> Resistant seizures should be treated with general anaesthetic sedation (IV barbiturates) and supportive care (intubation and mechanical ventilation, with EEG monitoring).<sup>15</sup>

Agitated patients requiring sedation should be treated with IV benzodiazepines, 5–10 mg of diazepam or 2–4 mg of lorazepam IV are appropriate initial doses. Lorazepam may be administered intramuscularly (IM) but is more difficult to titrate via this route. Large doses are often required but should be administered in increments (5 mg of diazepam or 2 mg of lorazepam every three to five minutes until appropriate sedation is achieved) to avoid excessive central nervous system (CNS) and respiratory depression.<sup>15</sup> Phenothiazines or butyrophenones can increase toxicity of cardiotoxic drugs and reduce the seizure threshold and so are best avoided in the treating the agitated poisoned patient.<sup>18–21</sup>

Significant hypoglycaemia should be treated initially with a bolus of 50 ml 50% IV dextrose.<sup>22</sup> Insulin related hypoglycaemia may be prolonged and require a 10%–20% dextrose infusion carefully titrated against the blood glucose concentration, with close monitoring for possible electrolyte disturbances, particularly hypokalaemia.<sup>22</sup> Sulphonylurea and meglitinide induced hypoglycaemia should initially be treated with a boluses of dextrose (50 ml of 50% IV dextrose) followed by the administration of oral carbohydrates after initial euglycaemia is achieved. Continued hypoglycaemia should be treated using octreotide (50  $\mu$ g SC 8–12 hourly), which decreases IV dextrose requirements and therefore minimises the risk of glucose stimulated insulin release.<sup>23</sup>

Naloxone can be safely used as a diagnostic tool in unconscious patients.<sup>24</sup> The appropriate use of naloxone is discussed later in this article. Patients with a history of alcohol misuse at risk of Wernicke's encephalopathy should receive 100 mg of IV thiamine, followed by an oral preparation.<sup>25</sup>

Patients with core temperatures of greater than 39.0°C should be treated aggressively with cool IV fluids and active cooling measures because prolonged hyperthermia can result in significant complications such as rhabdomyolysis, acute renal failure, and disseminated IV coagulation.<sup>26–29</sup> Intravenous benzodiazepines are appropriate treatment in hyperthermic patients with evidence of excessive sympathetic stimulation such as that associated with cocaine and amphetamines.<sup>21–30</sup> Patients with resistant hyperthermia should be discussed with a clinical toxicologist. They may benefit from peripherally acting muscle relaxants (dantrolene), centrally acting serotonin antagonists (cyproheptadine), or general anaesthetic sedation.<sup>31–32</sup>

### INVESTIGATIONS

All acutely poisoned patients should have their heart rate, blood pressure, respiratory rate, and temperature recorded.

#### Box 1 Most common drug ingestion inquiries to London Poisons Information Service (2002)

- Paracetamol
- Ibuprofen
- Aspirin
- Diazepam
- Drugs of misuse
- Zopiclone
- Fluoxetine
- Paroxetine
- Coproxamol
- Temazepam
- Codeine
- Amitriptyline

An ECG may detect occult cardiac conduction abnormalities of diagnostic and prognostic importance. Estimation of patient weight by medical and nursing staff is often inaccurate and leads to treatment errors both in the estimation of the toxic dose of drugs ingested by patients and the dose of drugs administered in treatment.<sup>33</sup> Patients should undergo formal weight measurement as part of routine clinical care.<sup>33</sup>

All unconscious patients and those with features of severe toxicity (seizures, hypotension, cardiac arrhythmias, or respiratory depression) should have measurement of electrolytes, renal function, paracetamol concentration, and determination of acid-base status via a venous bicarbonate concentration or arterial blood gas analysis.<sup>15</sup>

Paracetamol concentration should be measured in all patients who present after overdose, particularly those who are unconscious or who are unable to give a reliable history.<sup>34-35</sup> Paracetamol poisoning is potentially lethal but can be detected and treated during the initial asymptomatic phase. It is important to remember that paracetamol may not be detected if the patient's presentation is delayed greater than 18 hours after overdose. In these cases clinicians should look for clinical and biochemical evidence of paracetamol toxicity. Patients without clinical features suggestive of salicylate poisoning (that is, tinnitus, sweating, changed conscious level, tachypnoea, metabolic acidosis) do not require routine measurement of salicylate concentrations.<sup>36</sup>

Bedside urine drug test kits are generally not helpful in managing acutely poisoned patients. They are non-specific and do not provide reliable information regarding time of drug exposure.<sup>37</sup> For example, a patient testing positive for metabolites of cocaine may have been exposed to the drug five days previously and have no significant acute toxicity.<sup>38</sup>

Measurement of plasma drug concentrations is not routinely helpful in treating poisoned patients and should not be part of clinical care.<sup>39</sup> Exceptions include paracetamol, salicylates, iron, lithium (especially in the presence of impaired renal function), theophylline, ethylene glycol, ethanol (when used as an antidote for ethylene glycol or methanol poisoning), and methanol and to a lesser extent digoxin, phenobarbitone, sodium valproate, and carbamazepine.<sup>40</sup> Most plasma drug concentrations do not correlate with observed clinical toxicity. Results of toxicology drug screens are rarely available rapidly enough and do not have a significant impact on patient management.<sup>41</sup> Most poisoning should be treated on the basis of observed clinical toxicity rather than drug concentration.

Toxicology screens may be appropriate in the medicolegal management of poisoned patients or if there is a suspicion of child abuse. Requests for urgent urine or blood toxicology screens should be discussed with a clinical toxicologist to make them as complete and relevant as required.

Patients who present alleging they have been the victim of a sexual assault after having their drink "spiked" should have biological samples taken in the ED for toxicological analysis only if the contaminated drink was ingested very recently. Common drugs used in date rape (GHB, midazolam) can only be detected in a urine or blood sample obtained within the first few hours of exposure.<sup>42</sup>

## GUT DECONTAMINATION

The role of gut decontamination procedures is outlined in a series of consensus statements published by the American Academy of Clinical Toxicologists (ACCT) and European Association of Poison Centres and Clinical Toxicologists (EAPCCT).<sup>43-47</sup>

Activated charcoal (AC) is a safe and probably effective agent used to decrease the amount of drug absorbed from the gastrointestinal (GI) tract into the bloodstream. Data

supporting the use of AC are extrapolated from volunteer studies and there is a paucity of well controlled data from clinical studies.<sup>43</sup> However, the position statement recommends that AC should be considered as a 50 g (1 g/kg in children) oral dose for patients who have ingested a potentially toxic overdose within the previous hour. Only 10%–15% of patients are seen within an hour of ingestion and further delays can occur in triage or waiting to see a doctor, therefore it is important that those who present early after a potentially serious overdose are rapidly identified so that AC can be administered.<sup>48-50</sup> There is little evidence for the effectiveness of AC in reducing GI absorption of toxins if given beyond an hour after ingestion, however it should be considered in large overdoses of toxic drugs where delayed GI absorption is possible (for example, TCAs, sustained release preparations).<sup>43-51</sup>

Activated charcoal is less effective at adsorbing metals (lithium, iron), alcohols (methanol, ethylene glycol), or petroleum distillates (white spirit).<sup>52</sup> AC causes vomiting in about 5% of patients.<sup>43-52</sup> AC can be given to unconscious patients after intubation through a large bore nasogastric tube.<sup>43</sup>

Gastric lavage has no role in routine GI decontamination of acutely poisoned patients. There is no evidence that gastric lavage improves patient outcome.<sup>46</sup> Gastric lavage may even push tablets further into the GI tract,<sup>53</sup> although a reanalysis of these data has brought this into question.<sup>54</sup> Vagal stimulation and hypoxia during gastric lavage potentially increases risk of cardiac arrhythmias.<sup>55</sup> Gastric lavage should only be considered in a patient presenting within one hour of ingestion of a potentially life threatening overdose.<sup>46</sup> Difficulties of monitoring acutely ill patients during the procedure and the need to maintain airway protection should not be forgotten.

Administration of syrup of ipecac to induce vomiting after acute overdose is not part of accepted clinical care.<sup>44</sup>

Whole bowel irrigation is a newer method of gut decontamination that entails administering polyethylene glycol (2 l/h adults, 500 ml/h pre-school children) orally until the resulting rectal effluent is clear.<sup>47-56</sup> Case reports and volunteer studies suggest that whole bowel irrigation reduces drug absorption by forcing tablets through the GI tract.<sup>47</sup> Whole bowel irrigation is used to treat large ingestions of drugs not absorbed by AC (for example, lithium, iron), large ingestions of enteric coated or sustained release tablets (for example, calcium channel blockers), and patients who have ingested packages of illicit drugs to avoid detection at international border crossings (body packers).<sup>47</sup> Polyethylene glycol is not absorbed and does not produce fluid or electrolyte imbalance. Contraindications to its use include obstructed bowel, ileus, or GI haemorrhage.<sup>47</sup>

## ANTIDOTES

Antidotes are only available for a limited number of drugs and poisons. The most widely used antidotes are *N*-acetylcysteine for paracetamol poisoning and naloxone for opioid poisoning. Table 1 lists some of the other antidotes used in clinical practice.<sup>15-16</sup>

## INCREASING ELIMINATION

Techniques used to increase the elimination of poisons continue to evolve. Patients who may benefit from one of these techniques should be discussed with a poisons unit or clinical toxicologist. Multidose activated charcoal (MDAC) increases the elimination of drugs that undergo enterohepatic or enteroenteric circulation. Evidence to support the effectiveness of MDAC in improving patient outcome is limited to volunteer studies, animal studies, and uncontrolled case reports.<sup>45</sup> MDAC should be used after potentially toxic

**Table 1** Antidotes used in the management of poisoned patients

Toxin	Antidote
β blockers	Glucagon
Oral anticoagulants	Vitamin K1 (phytomenadione)
Digoxin	Digoxin specific antibodies (Digibind)
Ethylene glycol/methanol	Ethanol/4-Methylpyrazole
Cyanide	Thiosulphate/dicobalt ededate/hydroxycobalamin
Organophosphates	Atropine/oximes
Iron	Desferrioxamine
Heavy metals	EDTA, DMSA, DMPS
Paracetamol	N-acetylcysteine
Opioids	Naloxone
Sulfonyleureas	Ocreotide
Tricyclic antidepressants	Sodium bicarbonate

ingestions of theophylline and carbamazepine, and is indicated after life threatening overdoses of dapsone, phenobarbitone, and quinine. MDAC is given as a 50 g (1 g/kg in children) dose and repeated four hourly.<sup>45</sup> When MDAC is used, a cathartic agent such as sorbitol should be given as a single dose with the first dose of AC to decrease the risk of obstruction.<sup>45</sup>

Urinary alkalinisation through administration of IV sodium bicarbonate (one litre of a 1.26% solution over three hours) effectively increases renal elimination of salicylates and chlorpropamide.<sup>57</sup> It is used for patients who are significantly poisoned with salicylates (plasma concentration 450–700 mg/l) who do not yet meet the criteria for haemodialysis.<sup>58</sup> IV potassium supplementation (20–40 mmol in each litre of 1.26% sodium bicarbonate) is necessary to ensure production of an alkaline urine and to combat subsequent renal potassium loss.<sup>15</sup>

Extracorporeal techniques are indicated in only a very limited subset of poisonings and only in patients with serious toxicity.<sup>59</sup> There is also the potential for significant complications (for example, hypotension, sepsis, air embolism) and they may entail transferring an unstable patient to another hospital.<sup>59</sup> Therefore the use of extracorporeal techniques should always be discussed with a clinical toxicologist.

Haemodialysis may be considered in life threatening toxicity caused by lithium,<sup>60</sup> salicylates,<sup>61</sup> theophylline,<sup>62</sup> methanol, and ethylene glycol.<sup>63–64</sup> Charcoal haemoperfusion may be considered in the treatment of severe toxicity caused by theophylline, carbamazepine, and phenobarbitone,<sup>65–66</sup> particularly in cases where MDAC administration is limited by ileus.<sup>45</sup>

## PAEDIATRIC POISONING

Most paediatric poisoning is accidental in nature and occurs between the ages of 1–5 years. Less than 1% of paediatric poisoning is clinically serious and death is rare.<sup>6</sup> However, some drugs including methadone, TCAs, iron, theophylline, antihistamines, methylsalicylate, phenothiazines, quinine/chloroquine, calcium channel blockers, essential oils, and MDMA can cause severe toxicity after very small ingestions.<sup>67–69</sup> Although treatment of paracetamol poisoning in the paediatric patient currently follows adult guidelines there is some evidence to suggest that paracetamol is less hepatotoxic in children,<sup>70–73</sup> the toxic dose being 200 mg/kg (150 mg/kg in adults), however if there is any doubt regarding the dose of paracetamol ingested a plasma paracetamol concentration should be obtained.

Button batteries are commonly ingested by children.<sup>74</sup> Systemic toxicity is rare; however localised mucosal ulceration with subsequent gastrointestinal haemorrhage or per-

foration may occur if the battery remains in the oesophagus or stomach.<sup>74–76</sup> Batteries that have passed beyond the pylorus are unlikely to cause toxicity unless gastrointestinal transit is delayed resulting in battery corrosion and leakage of contents.<sup>74</sup> Batteries identified on plain film within the oesophagus should be removed endoscopically.<sup>77</sup> A patient with a battery within the stomach should be admitted for observation and repeat plain films at 24–48 hours. Batteries remaining in the stomach after 48 hours should be removed endoscopically.<sup>78</sup> Children in whom the battery has moved beyond the pylorus can be discharged home with repeat abdominal plain films every 48 hours to ensure the battery remains intact and is passed.<sup>79</sup>

Nearly one third of children under the age of 6 years who present after accidental poisoning will subsequently experience a second episode.<sup>80</sup> Providing poison prevention education to parents at the time of the first presentation is an important method of reducing the number of paediatric poisonings. Evidence suggests that currently ED staff only provide advice to parents regarding the prevention of further poisoning in a minority of cases.<sup>81</sup>

## PARACETAMOL

Paracetamol is the most common drug ingested in overdose in the United Kingdom (50% of acute poisoning related hospital presentations) and causes about 150–200 deaths a year through acute liver failure (ALF); however ALF only occurs in about 0.6% of patients presenting with paracetamol overdose.<sup>1–9</sup> We have recently produced an evidence based flowchart to guide the management of patients presenting with paracetamol poisoning.<sup>83</sup>

Intravenous N-acetylcysteine (NAC) is the antidote of choice for significant paracetamol poisoning.<sup>84</sup> It acts as a glutathione donor and is almost 100% effective in preventing hepatotoxicity and nephrotoxicity if administered within eight hours of a non-staggered toxic paracetamol overdose.<sup>85</sup> The mechanism of action and efficacy of NAC in late paracetamol poisoning is more controversial.<sup>85–86</sup>

## Risk factors

The hepatotoxic dose of paracetamol is generally accepted as 150 mg/kg.<sup>87–89</sup> There are a number of factors that may potentially increase the risk of hepatotoxicity in patients presenting with paracetamol poisoning (table 2). The following “high risk” factors have become established despite the fact that they are based on little substantive evidence; however currently we support their use: (a) conditions that decrease hepatic glutathione stores or<sup>90–91</sup> (b) regular use of drugs that induce certain cytochrome p450 microenzymes.<sup>92–94</sup> A toxic dose of paracetamol in high risk patients is generally considered to be 75 mg/kg.<sup>88</sup> Whether or not long term alcohol excess is a risk factor for paracetamol poisoning is controversial, but the balance of evidence is probably against this being the case.<sup>95–98</sup>

AC reduces paracetamol absorbed from the GI tract if given within one hour of non-staggered overdose.<sup>43–99</sup> Ondansetron

**Table 2** Risk factors in paracetamol overdose

Decreased hepatic glutathione stores	Induction of cytochrome p450 microenzymes
Anorexia nervosa	Phenytoin
Bulimia	Carbamazepine
HIV	Rifampicin
Cystic fibrosis	Phenobarbitone
Malnourishment	? Long term ethanol ingestion (see text)

effectively reduces paracetamol induced vomiting if first line antiemetics fail.<sup>100</sup>

The management of paracetamol poisoning is best categorised depending on whether the patient presents after a single/non-staggered (total ingestion taken over a few minutes) or staggered overdose (ingestion of a number of doses over a prolonged period of time) and whether the patient presents early or late after ingestion.<sup>83</sup>

**Early single/non-staggered paracetamol poisoning (less than 15 hours after ingestion)**

Patients are usually asymptomatic or have nausea and vomiting only. Management is guided by a plasma paracetamol concentration (taken at presentation or four hours after ingestion whichever is later) plotted on the Prescott nomogram (fig 1).<sup>83, 88</sup> Paracetamol concentrations on or above the curve indicate significant risk of hepatotoxicity and warrant treatment with NAC. High risk patients are treated using the lower time concentration curve in figure 1.

NAC provides almost 100% protection if given within eight hours of ingestion and so patients presenting within eight hours of a non-staggered ingestion of any amount of paracetamol do not require immediate treatment with NAC.<sup>83, 101, 102</sup> The decision to administer NAC in this instance can be made on the basis of the paracetamol concentration provided this is obtained within eight hours of ingestion.<sup>83</sup> NAC should be started immediately in patients presenting after eight hours of a potentially toxic paracetamol ingestion (>150 mg/kg or >75 mg/kg if in a high risk group) and in any case where paracetamol concentration will not be available within eight hours of ingestion.<sup>83</sup> NAC can be withdrawn if the subsequent paracetamol concentration is well below the relevant treatment line on the Prescott nomogram. Paracetamol concentrations obtained within four hours of overdose cannot be interpreted using the nomogram and are not helpful in patient management. It is important to remember that the successful use of the Prescott nomogram to treat paracetamol poisoning is entirely dependent on an accurate knowledge of time zero, the time of ingestion. Clinicians must use the maximum probable period since time of ingestion to avoid treatment failure through inappropriate non-use of NAC.

**Late single/non-staggered paracetamol poisoning (more than 15 hours after ingestion)**

These patients have a greater risk of developing hepatotoxicity because of the reduced efficacy of NAC.<sup>102</sup> Any patient who presents after ingestion of a potentially hepatotoxic dose

of paracetamol should be given NAC and blood should be taken for a plasma paracetamol concentration, INR, liver function tests (LFTs), creatinine, and plasma venous bicarbonate.<sup>83</sup> The decision to stop NAC will then be based on these results taken in the context of clinical features such as right upper quadrant tenderness.<sup>83</sup>

Paracetamol concentrations obtained beyond 15 hours of non-staggered overdose must be interpreted with caution; the limit of detection of some laboratory assays may not be sufficient to distinguish between toxic and non-toxic paracetamol concentrations, and in addition a small error in the stated time of ingestion can have a significant impact on the interpretation of the plasma paracetamol concentration.<sup>103</sup> In practice, clinical findings and laboratory markers indicating possible paracetamol toxicity are more useful in guiding management between 15 and 24 hours of paracetamol overdose. A paracetamol concentration either above or just below the line at any time beyond 15 hours of non-staggered ingestion is an indication for treatment with NAC.<sup>83, 88</sup>

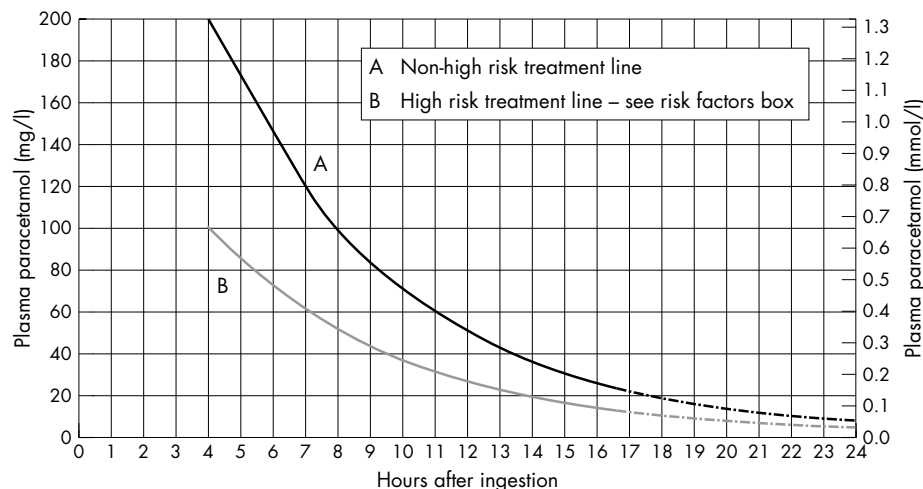
The plasma paracetamol concentration cannot be used to assess the risk of toxicity in patients presenting at more than 24 hours after ingestion.<sup>87</sup> In this group the decision to treat is based on the presence of clinical features such as vomiting and right upper quadrant tenderness, the dose ingested (more than 150 mg/kg per 24 hours; 75 mg/kg per 24 hours in high risk groups), and the results of the INR, LFTs, creatinine, and plasma venous bicarbonate at presentation.<sup>83, 86</sup> If any of these are abnormal the patient should be treated with a full course of NAC.<sup>83, 86</sup>

**Staggered paracetamol poisoning**

The plasma paracetamol concentration cannot be used to assess the risk of toxicity in these patients and so the decision to administer NAC is based on amount ingested within a 24 hour period.<sup>87</sup> Patients who have ingested greater than 150 mg/kg of paracetamol in any 24 hour period (75 mg/kg if in a high risk group) are given the full course of NAC.<sup>83</sup>

Effective treatment of non-staggered paracetamol overdose is dependent on knowledge of time of ingestion while effective treatment of staggered overdose is dependent on knowledge of total amount ingested. In cases where there is doubt regarding one of these factors and toxicity is possible, it is safer to err on the side of caution and administer NAC.

NAC is associated with a 5%–15% incidence of anaphylactoid reactions.<sup>104, 105, 108</sup> These are dose dependent and commonly occur during the initial 15 minute infusion.<sup>105, 106</sup> Most reactions are short lived and are effectively managed by stopping the infusion for 30 minutes.<sup>106</sup> Some patients may



**Figure 1** Prescott nomogram for treatment of paracetamol poisoning.

require an antihistamine. Reactions are more likely to occur in patients who have ingested smaller quantities of paracetamol and in asthmatic patients; however this is not a contraindication to the use of NAC in those where it is clinically indicated.<sup>107–109</sup> Methionine is an oral antidote that can be used in patients with true anaphylaxis to NAC and in those where IV access cannot be obtained, however methionine has a number of disadvantages as an antidote and therefore its use should be discussed with a poisons centre.<sup>15 110</sup> Methionine is only effective in treating paracetamol toxicity if it is administered within 10 hours of paracetamol ingestion.<sup>110</sup>

Venous bicarbonate, LFTs, INR, and creatinine should be determined at the end of the course of NAC. If these are abnormal NAC is continued at 150 mg/kg/24 hours until the INR begins to improve.<sup>83 111</sup> NAC directly decreases clotting factors and increases the measured INR slightly.<sup>112</sup> An INR of up to 1.3 after a full course of NAC in conjunction with normal LFTs and creatinine in an asymptomatic well patient does not indicate hepatotoxicity and requires no further treatment. Any patient with one of the findings outlined in box 2 should be discussed with a specialist liver centre.<sup>113</sup>

Patients who have ingested any amount of paracetamol and exhibit no symptoms or signs other than vomiting, can safely be managed on a medical ward or ED observation ward. Patients with evidence of ALF should receive meticulous supportive care in an ICU environment and be discussed early with a specialist liver unit to ensure that transfer takes place before criteria for liver transplantation are met.<sup>114</sup>

## NSAIDS

NSAIDs are ingested commonly in overdose, however severe toxicity is rare.<sup>115</sup> Ibuprofen overdose was the second most common inquiry received by the NPIS (London) in 2002.

Ibuprofen ingestion of >100 mg/kg is associated with GI symptoms including abdominal pain, vomiting, and diarrhoea.<sup>116</sup> Seizures occur in up to 10%–20% of patients and are more common after mefenamic acid overdose.<sup>117 118</sup> Very large ingestions may cause drowsiness, coma, acidosis, apnoea, bradycardia, and renal failure.<sup>119–121</sup> Patients who do not develop symptoms within four hours of ingestion are unlikely to experience delayed toxicity.<sup>115</sup>

Patients presenting within an hour of ingestion of 100 mg/kg of ibuprofen or 10 tablets of any other NSAID should be given AC.<sup>43</sup> Seizures are often self limiting, but if persistent should be treated with benzodiazepines.<sup>15</sup> Symptoms of gastrointestinal irritation are generally of short duration and therefore may be most effectively treated with antacids, a mucosal protective agent, or an oral proton pump inhibitor (PPI); there is currently little evidence showing which agent is most effective.

### Box 2 Criteria for contacting a specialist liver centre after paracetamol overdose

- PT in seconds greater than the number of hours since ingestion
- INR >2 at 24 hours, >4 at 48 hours, greater than 6 at 72 hours
- Renal impairment (creatinine >200 µmol/l)
- Hypoglycaemia
- Metabolic acidosis (pH <7.35)
- Hypotension despite fluid resuscitation
- Encephalopathy

## SALICYLATES

Although salicylate poisoning is less common than it was 20 years ago, it remains the third most common inquiry received by both the London and Scottish NPIS.<sup>10</sup> We have recently produced an evidence based flowchart to guide the management of salicylate poisoning.<sup>122</sup> Table 3 summarises toxicokinetics, clinical features, and recommended management of salicylate poisoning.

Mild toxicity follows ingestion of more than 150 mg/kg of salicylate<sup>123 124</sup> and is characterised by nausea, vomiting, tinnitus, and deafness.<sup>124 125</sup> Salicylates produce respiratory alkalosis secondary to direct stimulation of the respiratory centre.<sup>126</sup> Uncoupling of oxidative phosphorylation produces metabolic acidosis, which increases the transit of salicylates into the CNS and decreases renal salicylate elimination.<sup>127</sup> Children tend to present with a metabolic acidosis, whereas adults who present early after overdose commonly have a respiratory alkalosis that progresses to a mixed acid-base disturbance.<sup>128</sup> Compensatory loss of electrolytes via the renal tract further complicates metabolic disturbances.

Moderate salicylate poisoning (ingestion of more than 250 mg/kg) produces peripheral vasodilatation, sweating, and agitation.<sup>123 124</sup> Decreased platelet function can lead to petechiae and subconjunctival haemorrhage. Hypoglycaemia is more common in children.<sup>129</sup> Severe salicylate poisoning follows ingestion of greater than 500 mg/kg<sup>123 124</sup> and is characterised by metabolic acidosis, seizures, renal failure, agitation, coma, and eventually cardiovascular collapse.<sup>129</sup> Pulmonary and cerebral oedema are rare.

Patients who have ingested more than 125 mg/kg of salicylate should be given AC.<sup>122 130</sup> Gastric lavage should be considered if patients present within one hour of ingestion of more than 500 mg/kg.<sup>122</sup> The use of MDAC is controversial in salicylate poisoning, but we currently recommend its use to prevent delayed absorption, until the plasma salicylate concentration has peaked.<sup>45 122 131 132</sup>

Plasma salicylate concentration, FBC, and urea and electrolytes should be measured at least four hours after ingestion.<sup>122</sup> However, the salicylate concentration at presentation can be an unreliable guide to the severity of poisoning, particularly after ingestion of enteric coated tablets, and levels may not peak until 12–18 hours after ingestion. We would therefore advise that the plasma salicylate concentration is repeated every three to four hours until the plasma concentration has peaked.<sup>122</sup>

Plasma salicylate concentrations correlate roughly with toxicity, however they need to be interpreted in the context of the clinical features and whether or not the patient has a metabolic acidosis.<sup>133</sup> A metabolic acidosis is a particularly important negative predictor because it results in a decrease in renal elimination of salicylates, and an increase in the unionised salicylate concentration leading to increased transit into the CNS, higher CNS salicylate concentrations, and therefore greater CNS toxicity.<sup>122</sup>

Mild salicylate poisoning (salicylate concentration 300–600 mg/l in adults and 200–450 mg/l in children/elderly people<sup>133 134</sup>) can be treated by rehydration using oral or IV fluids, and MDAC until the plasma salicylate concentration has peaked.<sup>122</sup>

Urinary alkalisation is a simple and effective method of increasing renal excretion of salicylates<sup>57 58 135</sup> and should be used for patients with features of moderate salicylate poisoning (salicylate concentration 600–800 mg/l in adults and 450–700 mg/l in children/elderly people<sup>133 134</sup>). Adults are given one litre of 1.26% sodium bicarbonate over three hours.<sup>122</sup> Potassium (20–40 mmol) is added to this solution to promote production of an alkaline urine and to combat potassium loss once an alkaline diuresis is achieved. Urine pH should be checked every 30 minutes with indicator paper to

**Table 3** Toxicokinetics, clinical features, and recommended management of salicylate poisoning

Severity	Dose ingested	Salicylate concentration	Clinical features	Recommended management
Mild	>150 mg/kg	Adults 300–600 mg/l	Lethargy	MDAC until salicylate concentration peaks Oral or IV fluids
		Children/elderly people 200–450 mg/l	Nausea Vomiting Tinnitus Dizziness	
Moderate	>250 mg/kg	Adults 600–800 mg/l	Tachypnoea Hyperpyrexia Sweating Dehydration Ataxia	MDAC IV fluids Urinary alkalinisation
		Children/elderly people 450–700 mg/l		
Severe	>500 mg/kg	Adults >800 mg/l Children/elderly people >700 mg/l	Hypotension Metabolic acidosis Renal failure Coma Convulsions	MDAC IV fluids Haemodialysis

ensure a pH of 7.5–8.5 is achieved; if there is difficulty in achieving adequate urinary alkalisation (in the context of a normal serum potassium), a bolus of 8.4% sodium bicarbonate may be required as patients can have a significant base deficit.<sup>122</sup>

Patients with a significant metabolic acidosis (pH < 7.3) should be treated with 50 ml 8.4% sodium bicarbonate.<sup>15</sup> Patients who have seizures, coma, acute renal failure, pulmonary oedema, or metabolic acidosis resistant to correction should receive haemodialysis; haemodialysis should also be considered in patients with a plasma salicylate concentration greater than 800 mg/l in adults or 700 mg/l in children or elderly patients.<sup>129 136 137</sup> Haemoperfusion is effective in decreasing salicylate concentrations, but does not correct acid-base disturbances and so haemodialysis is the extracorporeal method of choice in severe salicylate poisoning.<sup>122</sup>

## OPIOIDS

Deliberate or recreational overdose of opioids including morphine, heroin, codeine, and methadone is a common ED presentation. Acute opioid poisoning causes about 300 deaths per year in the UK, most of these occur before hospital admission.<sup>7</sup>

Provision of an adequate airway and ventilation, and the appropriate use of naloxone remain the most important aspects in treatment of acute opioid toxicity.<sup>24</sup> Patients with significant opioid toxicity have pin-point pupils, depressed respiration, and a decreased level of consciousness.<sup>15</sup> Mixed pharmacological effects arising from preparations containing an opioid and a stimulant drug (cocaine and heroin combined as a “speedball”) may cloud this typical clinical picture.

Naloxone is an opioid antagonist. In life threatening acute opioid toxicity naloxone can be administered IM, IV, intranasally, or via an endotracheal tube. Ideally naloxone should be administered IV as this permits accurate titration of a dose to restore adequate respiratory function while avoiding complete arousal (which may produce an acute withdrawal state or an aggressive, uncooperative patient).<sup>138</sup> Administration of naloxone via other routes can lead to unpredictable absorption and does not permit accurate dose titration. IM administration of naloxone does

not guarantee opioid antagonism will continue for long enough to prevent further life threatening opioid toxicity after an aroused patient has left the ED, particularly in patients who have ingested long acting opioids such as methadone.<sup>139</sup>

The bolus dose of naloxone required in patients presenting with opioid poisoning can be difficult to predict and it is best to give small (100 µg) boluses titrated against the level of consciousness (Glasgow coma score 13–14/15), respiratory rate/depth (RR > 10–12), and oxygen saturations. We recommend that naloxone is titrated by mixing a known amount (typically 1200–2000 µg) in normal saline (10 ml) and administering this slowly IV until the desired clinical state is achieved.<sup>15</sup> Naloxone can be safely used as a diagnostic tool in unconscious patients where opioid toxicity may be contributing to CNS depression. A total of 10 mg of naloxone (given in increments) may be required to overcome opioid toxicity after a large overdose.<sup>138</sup>

Naloxone has a short half life (30–100 minutes) whereas some opioids (particularly oral agents such as methadone) have half lives of up to 24 hours. Therefore repeated doses of naloxone or an infusion are sometimes required. The dose of a naloxone infusion can be calculated by giving two thirds of the dose required to initially resuscitate the patient per hour.<sup>140</sup> Patients who have ingested long acting opioids (such as methadone) or sustained release preparations (for example, MST continuous) may require naloxone infusions for up to 72 hours. Naloxone infusion rates required to overcome opioid toxicity may increase as blood opioid concentration rises after adsorption of sustained release preparations. Patients should be observed for at least four hours before discharge after stopping a naloxone infusion.<sup>15</sup>

Coproxamol is more likely to lead to death after overdose than other compound analgesics containing opioids.<sup>141</sup> The opioid component, dextropropoxyphene has membrane stabilising effects and can produce QRS prolongation and negative cardiac inotropy.<sup>142</sup> Cardiovascular compromise associated with QRS prolongation after coproxamol overdose may respond to IV sodium bicarbonate.<sup>143</sup>

All patients with opioid poisoning, particularly those who have ingested a compound opioid analgesic containing paracetamol, should have plasma paracetamol concentration measured.<sup>34</sup>

## BENZODIAZEPINES

Benzodiazepine toxicity commonly produces drowsiness, and mid-sized or dilated pupils. Dysarthria, ataxia, nystagmus, agitation, and confusion can occur, however after lone benzodiazepine ingestion symptoms and signs are usually mild, well tolerated, and resolve within 24 hours.<sup>144</sup> Large overdoses of benzodiazepines can produce mild hypotension and respiratory depression. Patients rarely develop a Glasgow coma score of less than 10 after lone benzodiazepine overdose.<sup>144</sup>

Benzodiazepine overdose is less well tolerated in patients who have ingested a significant quantity of another CNS depressant (including ethanol), those with chronic obstructive airway disease, and elderly patients.<sup>145 146</sup>

Activated charcoal may be considered in patients presenting within an hour of a very large benzodiazepine overdose.<sup>15</sup> Lone benzodiazepine overdose is generally very well tolerated and the mainstay of treatment is supportive care.<sup>15</sup>

Flumazenil is a benzodiazepine antagonist acting on the GABA receptor. We do not advocate the use of flumazenil as either a diagnostic or therapeutic tool in the treatment of acute poisoning. Administration of flumazenil after a mixed overdose may unmask adverse effects of coingestants, particularly cardiotoxic agents such as TCAs leading to seizures or malignant arrhythmias.<sup>147–150</sup> Patients who have a history of seizures may develop uncontrolled seizures after receiving flumazenil.<sup>151</sup> Administration of flumazenil to patients with a history of long term benzodiazepine use can precipitate an acute withdrawal state.<sup>151 152</sup> It is much safer to provide supportive care until benzodiazepine toxicity has resolved. In rare circumstances where airway and ventilatory support are not available, lone benzodiazepine overdose is suspected, and the ingestion of any other drugs has been excluded, flumazenil may be used cautiously in small increments.

## TRICYCLIC ANTIDEPRESSANTS

TCA overdose is the most common cause of acute poison related ICU admission in the UK.<sup>1 5</sup> Ingestion of greater than 10 mg/kg of a TCA is likely to produce significant toxicity while 20–30 mg/kg is considered a potentially lethal dose.<sup>153</sup>

TCAs have a large number of pharmacological properties and therefore produce a wide range of clinical effects in overdose. Patients who have ingested a significant quantity of a TCA will generally exhibit clinical effects within one hour of ingestion.<sup>154</sup> Severe clinical effects typically resolve over a 24–48 hour period.<sup>155</sup> Patients who do not develop signs of toxicity for six hours after overdose can be safely discharged.<sup>15</sup>

The anticholinergic properties of TCAs produce sinus tachycardia, warm dry skin, brisk reflexes, sedation, seizures, and urinary retention.<sup>156</sup> Pupils are commonly poorly reactive and dilated, but can vary in size. This cluster of signs helps to identify the causative agent in an unconscious patient who has ingested a TCA, but anticholinergic effects alone rarely cause death. Coma and ECG conduction abnormalities are more predictive of severe toxicity than anticholinergic signs alone. The high mortality rate (34.9 deaths per million prescriptions<sup>157</sup>) associated with TCAs is primarily caused by sodium channel block, which occurs in overdose and leads to cardiac conduction abnormalities.<sup>158</sup> The  $\alpha$  receptor block contributes to sedation and worsens systemic cardiovascular function by causing vasodilatation.<sup>156</sup>

Severe clinical effects after overdose include coma, seizures, malignant arrhythmias, and hypotension attributable to myocardial depression and peripheral vasodilatation.<sup>159 160</sup> ECG abnormalities include QRS, QT, and PR prolongation, and right axis deviation.<sup>161</sup> QRS duration is a prognostic factor and should be measured in all patients who

have ingested a TCA in overdose.<sup>161 162</sup> QRS prolongation greater than 100 ms is associated with an increased risk of seizures while QRS prolongation greater than 160 ms increases the likelihood of malignant arrhythmias.<sup>162–164</sup>

Patients who have signs of severe toxicity should be sedated and receive meticulous supportive care in an ICU environment.<sup>15 165</sup>

Sodium bicarbonate is the first line agent used to treat TCA related cardiovascular toxicity.<sup>13 161</sup> Systemic alkalinisation and hypertonic sodium loading both contribute to sodium bicarbonate's mechanism of action in treating TCA related toxicity.<sup>158 166–168</sup>

All patients with TCA poisoning who have cardiac arrhythmias, QRS prolongation of greater than 120 ms, or hypotension should receive sodium bicarbonate even in the absence of acidosis.<sup>155 156</sup> The initial dose of sodium bicarbonate is 1–2 ml/kg of an 8.4% IV solution given as a bolus and administered through a large peripheral vein if necessary, until central venous access is obtained.<sup>13 167</sup> Sodium bicarbonate boluses should be repeated until a pH of 7.50–7.55 is obtained.<sup>13</sup> Patients with features of severe TCA toxicity (systolic BP < 90 mm Hg, QRS duration of > 160 ms, pH < 7.1, arrhythmias, recurrent seizures) may initially require large doses of sodium bicarbonate (1–3 ml/kg 8.4% IV solution every three to five minutes titrated to clinical response to obtain a pH of 7.5–7.55). These patients should receive further bolus doses of IV 8.4% sodium bicarbonate or an IV infusion of 1.26% sodium bicarbonate to maintain a pH of 7.5–7.55. Administration of sodium bicarbonate can cause hypokalaemia and so it is important that the serum potassium is monitored and potassium supplementation given as necessary.<sup>13</sup>

Patients who remain hypotensive despite a pH in the range of 7.50–7.55 and adequate central venous filling should be discussed with a clinical toxicologist. They may require additional hypertonic saline and the cautious use of inotropes such as adrenaline and norepinephrine (noradrenaline) to maintain adequate systemic perfusion.<sup>156 165</sup> Adrenaline and norepinephrine have the potential to cause further cardiac toxicity and should only be used after administration of sodium bicarbonate.

All antiarrhythmics should be avoided where possible in patients with TCA poisoning, particularly class Ia antiarrhythmics (quinidine, procainamide, and disopyramide), which are contraindicated in the treatment of TCA induced cardiac arrhythmias.<sup>156</sup> Atrioventricular block resistant to treatment with sodium bicarbonate may require temporary cardiac pacing. Prolonged (one hour) resuscitation after TCA induced cardiac arrest has been associated with full neurological recovery<sup>169 170</sup>; hypertonic sodium bicarbonate should be used early in the resuscitation of these patients.<sup>13</sup> Ventricular tachyarrhythmias resistant to treatment with sodium bicarbonate (with pH 7.50–7.55) are best treated with either DC cardioversion or overdrive pacing.<sup>15</sup>

Seizures are generally short lived and are treated using benzodiazepines.<sup>171</sup> Patients who have seizures should receive sodium bicarbonate (1–2 ml/kg bolus of 8.4% IV solution, repeated every 15–30 minutes to maintain pH 7.5–7.55) to limit further acidosis (which increases the risk of arrhythmias) and the transit of TCA into the CNS.<sup>166</sup> Resistant seizures should be treated aggressively with general anaesthetic sedation and supportive care.<sup>15</sup>

## SELECTIVE SEROTONIN REUPTAKE INHIBITORS

SSRIs taken in overdose commonly produce drowsiness and sinus tachycardia, however ingestions of less than 500 mg rarely cause clinically significant toxicity.<sup>172</sup> Nausea, vomiting, diarrhoea, and dizziness can occur. Serious clinical



effects (hypotension, coma, seizures) may occur with ingestions of greater than 1500 mg.<sup>173–175</sup>

Citalopram causes QRS and QT prolongation.<sup>176</sup> Venlafaxine, a selective norepinephrine (noradrenaline) reuptake inhibitor is associated with seizures<sup>177, 178</sup> and causes QRS prolongation.<sup>179–181</sup>

AC is indicated within one hour of ingestion of more than 10 tablets of an SSRI. Patients should be observed for six hours and symptomatic patients should be cardiac monitored. Venlafaxine is available in a modified release preparation and so prolonged clinical toxicity may be observed after overdose.<sup>16</sup> Convulsions can be treated with benzodiazepines.<sup>15</sup>

The combination of SSRIs with other agents such as, dextromorphan, MDMA, lithium, TCAs, and monoamine oxidase inhibitors that also increase CNS serotonin concentrations may lead to the development of the serotonin syndrome.<sup>182</sup> The serotonin syndrome can also occur after lone SSRI overdose, or overdose of SSRIs and non-serotonergic agents.<sup>183</sup> This is characterised by changed mental status (agitation, confusion, coma), autonomic instability (diaphoresis, hyperpyrexia, tachycardia, hypertension), and neuromuscular dysfunction (myoclonus, hyper-reflexia, muscle rigidity, tremor)<sup>184</sup> and can potentially occur with therapeutic doses of serotonergic agents.<sup>185, 186</sup> Effective management includes good supportive care and the withdrawal of all serotonergic agents.<sup>15, 187</sup> Benzodiazepines should be used to treat agitated patients and should also be used in combination with cooling measures to treat hyperthermic patients.<sup>15</sup> Patients with severe features of toxicity or those not responding to supportive care should be discussed with a clinical toxicologist. They may benefit from administration of serotonin antagonists such as cyproheptadine.<sup>188</sup>

### COCAINE RELATED ACUTE CORONARY SYNDROME

Cocaine related chest pain might be musculoskeletal, respiratory, or cardiac in origin. Cocaine related myocardial infarction (MI) occurs in 6% of patients with cocaine related chest pain.<sup>189</sup> It is unrelated to the dose ingested and route of administration.<sup>190</sup> It has been reported to occur in first time as well as habitual users.<sup>190</sup> The risk of acute coronary syndrome (ACS) is increased by a factor of 24 in the first hour after cocaine use but may be delayed for four to six hours.<sup>191</sup>

Cocaine related ACS is caused by a number of mechanisms. The sympathomimetic action of cocaine produces an increase in myocardial oxygen demand by increasing heart rate and myocardial contractility. In the face of increased myocardial oxygen demand, supply is limited by direct cocaine induced coronary artery vasospasm,<sup>192</sup> an effect more pronounced in diseased vessels<sup>193</sup> and smokers.<sup>194</sup> Cocaine increases platelet activation and aggregation,<sup>195–197</sup> and can produce vascular endothelial damage and accelerated atherosclerosis in long term users.<sup>198–200</sup>

Diagnosis of cocaine related MI is difficult as 84% of patients with cocaine related chest pain have abnormal ECGs even in the absence of MI.<sup>189, 201</sup> Half of all cocaine users have increased creatinine kinase concentrations in the absence of MI.<sup>201, 202</sup> Troponin concentrations are more sensitive and specific in diagnosing MI.<sup>190</sup>

The management of cocaine related ACS differs from that of classic “medical ACS” because of cocaine induced coronary artery spasm that is present in addition to possible coronary artery thrombosis (secondary to coagulation abnormalities and advanced atherosclerotic disease).<sup>189</sup>  $\beta$  Blockers are contraindicated in the treatment of cocaine related ACS.<sup>203</sup>  $\beta$  Receptor block produces unopposed  $\alpha$  receptor stimulation and worsening of coronary artery spasm and systemic hypertension. Thrombolysis should not be used routinely as this will not overcome coronary artery spasm and can

increase the risk of intracranial haemorrhage associated with hypertension secondary to cocaine use.<sup>190</sup>

First line agents used in the treatment of cocaine related ACS are oxygen, benzodiazepines (which reduce central stimulation, tachycardia, and hypertension), IV or buccal nitrates (to overcome coronary artery vasospasm), and aspirin (to reduce platelet aggregation).<sup>204, 205</sup> Second line agents include calcium channel blockers (verapamil) and  $\alpha$  blockers such as phentolamine.<sup>204, 205</sup> Patients with continuing chest pain and/or ECG changes despite these measures should undergo coronary angiography.<sup>190</sup>

If coronary artery angiography shows vascular spasm, GTN can be injected directly into the vascular lumen. Thrombolytic reperfusion therapy can lead to a clinically significant haemorrhage and should only be given if angiography shows a thrombosis or medical treatment fails and angiography is not available.<sup>190</sup>

### PSYCHOLOGICAL ASSESSMENT

All patients who present after deliberate self poisoning should be assessed to determine the risk of further self harm. Box 3 lists the risk factors indicating serious self harm intent and high likelihood of further significant self harm.<sup>1</sup> Patients who are at risk of further self harm should receive appropriate assessment by the psychiatry team during medical treatment of the poisoning.

Patients who are not at risk of further self harm can complete medical treatment before undergoing a psychological assessment before discharge. The use of antidepressants with low toxicity in overdose (SSRIs) should be considered in depressed patients who require pharmacological treatment.<sup>15, 181</sup>

### CONCLUSIONS

Most acutely poisoned patients can be managed with supportive care during a period of observation in an ED observation ward or general medical ward, or for those with severe poisoning, a critical care ward (HDU or ICU). Information sources are available to identify patients who will benefit from an early or specific intervention. The potential benefit of using gastrointestinal decontamination techniques and methods to increase toxin elimination should be assessed for each individual patient.

The commonest form of self poisoning in the UK is paracetamol poisoning. Presentation within eight hours of ingestion can be successfully treated with the antidote *N*-acetylcysteine, but delay in antidote administration beyond eight hours is associated with reduced efficacy and increased risk of hepatotoxicity. In cases where the time of ingestion or amount of paracetamol ingested is unclear it is safest to treat

#### Box 3 Factors indicating serious self harm intent and high likelihood of further significant self harm

- Sex (male)
- Age (elderly)
- Recently bereaved
- Unemployed
- Suicide note
- Evidence of planning of overdose
- Presence of terminal illness
- History of depression
- Found in isolated place by another person after taking overdose

the patient with NAC. Patients with signs of ALF should receive further NAC and be discussed with a specialist liver unit.

The reduction in the price of drugs of misuse has led to an increase in opioid, cocaine, and benzodiazepine poisoning. Naloxone is a safe antidote that can be used as a diagnostic and therapeutic agent in treating opioid poisoning. Naloxone is best administered IV and titrated to restore adequate respiratory function. Flumazenil should not routinely be used to treat benzodiazepine poisoning because of the risk of significant adverse events; most patients are successfully treated with good supportive care. Thrombolysis is not routinely indicated in the treatment of patients with cocaine related myocardial infarction. Initial treatment is aimed at decreasing coronary artery spasm (with benzodiazepines and nitrates) and platelet aggregation (with aspirin).

TCA's are more toxic in overdose relative to SSRIs. Sodium bicarbonate is the antidote of choice in TCA poisoning and should be used early in patients who have QRS prolongation, cardiac arrhythmias, hypotension, or seizures. QRS prolongation is a prognostic indicator for the occurrence of seizures and malignant arrhythmias.

All poisoned patients who have taken an intentional overdose should undergo a psychological assessment as a routine part of their treatment.

#### Authors' affiliations

S I Greene, P I Dargan, A L Jones, National Poisons Information Service (London), Guy's and St Thomas's NHS Trust, UK

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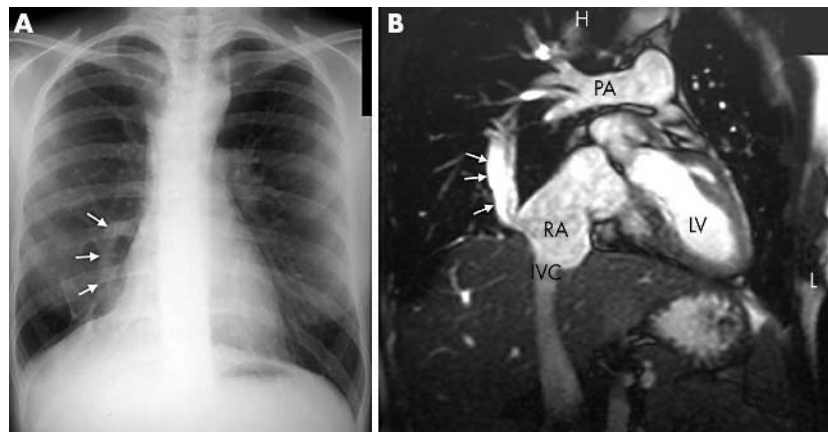
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### Scimitar syndrome (congenital pulmonary venolobar syndrome)

**A** 19 year old woman was referred for left sided chest pain. There were no other symptoms but a day earlier she had been lifting heavy boxes. Her examination was entirely normal except for left sided localised chest wall tenderness. A clinical diagnosis of musculoskeletal chest pain was made. Her ECG and the rest of the baseline laboratory tests were normal. Her chest radiograph (fig 1 (A)) shows a small right hemithorax and an anomalous pulmonary vein on the right side (arrows). The magnetic resonance imaging scan (fig 1 (B)) shows that the anomalous vein (arrows) is draining into the right atrium (RA). The hypoplastic right lung and anomalous pulmonary vein confirmed that she had congenital pulmonary venolobar syndrome also known as scimitar syndrome. The name scimitar comes from the anomalous pulmonary vein that courses along the right cardiac margin as a curvilinear shadow and is said to resemble a "scimitar," or Turkish sword. The anomalous venous return is usually to the inferior vena cava but it can also be to the portal vein, a hepatic vein, or the right atrium. Presentation and clinical course depends on the size of the shunt and varies from heart failure in infancy to asymptomatic adulthood. About 25% of the patients have associated congenital heart disease, most commonly septal defects. Our patient did not have any such defect. She remained well and active and did not need any further intervention.



**Figure 1** (A) Chest radiograph. (B) Magnetic resonance imaging scan. RA, right atrium; LV, left ventricle; PA, pulmonary artery; IVC, inferior vena cava.

**A Khan, N J Ring, P D Hughes**

Department of Respiratory and General Medicine, Derriford Hospital, Plymouth, UK

Correspondence to: Dr A Khan, Department of Respiratory and General Medicine, Derriford Hospital, Plymouth PL6 8DH, UK; Ayaz.khan@phnt.swest.nhs.uk