TOXICOLOGY: AN AUSTRALIAN PERSPECTIVE

A risk assessment based approach to the management of acute poisoning

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Toxicology series

This month we publish a paper from Perth, Western Australia. It is the first of six commissioned articles to be published bi-monthly. The toxicology service of Western Australia is managed and led by emergency physicians. The series will outline how their service works and will also report individual cases, as case based learning modules, to demonstrate their approach to the poisoned patient. We hope that readers of this journal will find the articles stimulating and educational.

Early assessment and management of poisoning constitutes a core emergency medicine competency. Medical and psychiatric emergencies coexist; the acute poisoning is a dynamic medical illness that represents an acute exacerbation of a chronic underlying psychosocial disorder. The emergency physician must use an approach that ensures early decisions address potentially time critical interventions, while allowing management to be tailored to the individual patient's needs in that particular medical setting. This article outlines a rationale approach to the management of the poisoned patient that emphasises the importance of early risk assessment. Ideally, this approach should be used in the setting of a health system designed to optimise the medical and psychosocial care of the poisoned patient.

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Acute poisoning is a dynamic medical illness usually representing an acute and potentially life threatening exacerbation of a chronic underlying psychosocial disorder.[1] The assessment and management of acute poisoning constitutes a core emergency medicine competency. Acute poisoning is a common presentation and requires early management decisions to ensure an optimal outcome while at the same time avoiding unnecessary investigation, intervention, or observation.

Patients with acute poisoning are a heterogeneous group. Management of an individual patient requires more than an understanding of the agent ingested. To formulate a rational management plan the clinician must also consider the dose ingested, time since ingestion, clinical features, patient factors, geographical location, and available medical facilities. A highly organised approach is essential if the emergency physician is to ensure effective delivery of time-critical interventions while at the same time devising a management plan tailored to the individual patient's needs in that particular medical setting (box 1). The assessment and management of the underlying psychosocial disorder should commence early in the presentation.

An organised approach to individual patient assessment and management ideally takes place within a health system that supports the provision of expert care to all acutely poisoned patients. Not all patients can be treated within a regional toxicology treatment centre (box 2)[2] but such a centre, if it exists, can act as a focus to support high quality care across the region.

This is the first in a series of articles examining the principles of management for acute poisoning. The objective of this article is to define a robust general approach to the acutely poisoned patient that can be adopted for every patient. It emphasises the fundamental importance of an early risk assessment in determining a rational approach to subsequent management. The role of health systems in the delivery of expert toxicological care is also discussed. In subsequent articles these principles will be illustrated using individual cases managed by the Western Australian Toxicology Service.

APPROACH TO THE INDIVIDUAL PATIENT

Resuscitation

Assessment and management of immediate threats to the airway, breathing, and circulation in the acutely poisoned patient usually follow conventional lines.[3] Basic resuscitative measures, familiar to all emergency physicians, will ensure the survival of the vast majority of patients. In some specific situations, standard resuscitation algorithms may not apply. Examples of interventions specific to toxicology include sodium bicarbonate and hyperventilation to prevent or terminate ventricular tachycardia secondary to cyclic antidepressants and benzodiazepines to treat tachycardia secondary to sympathomimetic agents.[3]

Seizures,[4] hypoglycaemia,[5 6] and hyperthermia[7] must be detected and treated promptly to ensure good neurological outcome. Toxic seizures are usually controlled with intravenous benzodiazepines. Barbiturates are second line treatment. Pyridoxine is an additional option for seizures associated with poisoning from isoniazid.[8]

Box 1: General approach to acute poisoning

- Resuscitation
  - Airway
  - Breathing
  - Circulation
  - Seizure control
  - Correct hypoglycaemia
  - Correct hyperthermia
  - Resuscitation antidotes
- Risk assessment
- Supportive care and monitoring
- Investigations
  - Screening (ECG, paracetamol)
  - Specific
- Decontamination
- Enhanced elimination
- Antidotes
- Disposition

Phenytoin is contraindicated in the treatment of toxic seizures.[9]

Occasionally, administration of an antidote may constitute an essential component of initial resuscitation. In addition to intravenous sodium bicarbonate, examples include naloxone in severe opioid intoxication and digoxin specific antibodies for patients with suspected digoxin intoxication and cardiovascular compromise.[3]

Risk assessment

Following resuscitation, risk assessment is the next essential step in the management of the poisoned patient (box 3). Risk assessment is a distinct cognitive process through which the clinician attempts to predict the likely clinical course and potential complications for the individual patient at that particular presentation. Risk assessment should be quantitative and take into account agent, dose, time of ingestion, current clinical status and individual patient factors (for example, weight and comorbidities).[1]

Risk assessment is vital as it allows the clinician to make specific decisions about all subsequent management steps (appropriate supportive care and monitoring; screening and specialised testing; decontamination; enhanced elimination; antidotes and disposition) that are appropriate to the individual patient at that particular time. Early recognition of trivial poisonings allows patient and family to be reassured and unnecessary investigations, interventions, and observation abandoned.[10] Psychosocial assessment can occur earlier and it is likely that length of stay in hospital will be shortened.[10 11] Alternatively, risk assessment allows early identification of potentially serious poisonings and implementation of a directed and proactive management plan.[10] Balanced decisions about gastrointestinal decontamination can be made and appropriate investigations selected.[12] If a specialised procedure or antidote might be required in the next few hours, early communication and disposition planning may begin.

Provided they have a normal mental status, patients with deliberate self-poisoning are generally both willing and able to give a good history from which an accurate risk assessment can be constructed.[13] A physician ignores the patient's history at their peril. Where an alteration in mental status precludes obtaining a direct history, back-up strategies are used to obtain the necessary information. These include asking ambulance officers or family to search for agents, counting missing tablets, checking medical records for previous prescriptions, and questioning relatives about agents potentially available to the patient. Under these circumstances, the risk assessment is less accurate and may, at least initially, be based on a ''worst case scenario''. In unknown ingestions, the patient's clinical status should be correlated with knowledge of the agents commonly prescribed in that geographical area.[14]

Box 2: Characteristics of a regional toxicology treatment centre[2]

- Philosophical commitment to the treatment of poisoned patients
- Liaison with poison information centres
- Multidisciplinary team with integrated psychiatric services
- Adequate staffing
- Timely availability of appropriate beds
- Equipment and laboratory support
- Adequate stocking of antidotes
- Research and education
- Review and audit

Box 3: Risk assessment

- Distinct cognitive step
- Quantitative
- Takes into account:
  - Agent(s)
  - Dose(s)
  - Time since ingestion
  - Current clinical status
  - Patient factors

The agent, dose, and time since ingestion should correlate with the patient's current clinical status. If they do not, the risk assessment is revised. Acute poisoning is a dynamic process and important decisions can often be made at particular time points. For example, following cyclic antidepressant deliberate self-poisoning, life-threatening events occur within six (and usually within the first two) hours of ingestion.[15] Patients at low risk can be identified on clinical grounds at six hours after ingestion.[16] In contrast, following deliberate self-poisoning with sustained-release calcium channel blockers, patients may not exhibit clinical features of poisoning during the first few hours but the risk assessment anticipates delayed severe cardiovascular effects.[17]

Investigations

Investigations in acute poisoning are employed either as screening tests or for specific purposes. Screening refers to the performance of a medical evaluation and/or diagnostic test in asymptomatic persons in the hope that early diagnosis may lead to improved outcome.[18] In the acutely poisoned patient, screening tests aim to identify occult toxic ingestions for which early specific treatment is indicated. The recommended screening tests for acute poisoning are the 12-lead electrocardiogram (ECG) and the serum paracetamol level.[1 19]

The ECG is a readily available non-invasive tool that assists in the identification of occult but potentially lethal cardiac conduction abnormalities, such as in cyclic antidepressant cardiotoxicity. Life threatening paracetamol poisoning is occult in the early stages but progression to fulminant hepatic failure and death can be prevented by timely administration of *N*-acetylcysteine.[20] Although a thorough cost benefit analysis has never been performed, it is postulated that the cost of thousands of serum paracetamol measurements is offset by the detection of one potentially preventable paracetamol related death or liver transplant. For this reason, it is advisable to screen for paracetamol in all cases of known or suspected acute deliberate self-poisoning. Screening is particularly important where altered mental status precludes obtaining an ingestion history directly from the patient.

Many poisoned patients will require no further investigation beyond the screening ECG and paracetamol level.[1] Other investigations are ordered selectively where the results assist management. Potential indications for specific tests in the acute poisoning patient are shown in box 4. For the majority of agents, the risk assessment and subsequent clinical progress dictate management decisions. Drug concentrations will not further assist decision making. For a small number of agents, drug concentrations are useful in refining the risk assessment and allowing important interventions to be instituted in a timely manner. Such drugs include paracetamol, digoxin, salicylate, valproic acid, iron, methotrexate, and theophylline.

Gastrointestinal decontamination

Gastrointestinal decontamination procedures aim to reduce absorption of an ingested agent. In the past, physicians have tended to overestimate the potential benefits of gastrointestinal decontamination while simultaneously underestimating the potential hazards of such procedures. No benefit has been demonstrated when applied routinely to groups of heterogeneous deliberate self-poisoned patients.[21–25] However, the efficacy of gastrointestinal decontamination in selected rare poisonings has not been evaluated and so the decision remains one of clinical judgment involving a risk benefit analysis.[12] It is indicated where the expected benefits of the procedure are judged to outweigh the associated risks and the resources required to perform the procedure. Potential benefits are reduced mortality, reduced permanent sequelae, reduced length of stay, and reduced need for interventions that are expected by preventing absorption of the agent likely to still be present in the gastrointestinal tract. The potential risks are those associated with aspiration of charcoal or lavage fluid, distraction of staff from attending to supportive care, and diversion of departmental resources to performance of the procedure.

Box 4: Indications for specific testing in the acutely poisoned patient

- Refine risk assessment or prognosis
- Exclude or confirm an important differential diagnosis
- Exclude or confirm an important specific poisoning
- Exclude or confirm a complication that requires specific management
- Establish an indication for antidote administration
- Establish an indication for institution of enhanced elimination
- Monitor response to therapy or define an endpoint for a therapeutic intervention

Employing this rationale, gastrointestinal decontamination is reserved for severe or life threatening poisoning where supportive care or antidotal treatment alone may not be adequate to ensure a satisfactory outcome. There should be reasonable grounds to believe that a considerable amount of agent remains in the gastrointestinal tract and is amenable to removal by the selected procedure. The performance of the procedure should not entail a risk of pulmonary aspiration. Decontamination should never be performed to the detriment of basic resuscitation or supportive care. Nor should it be performed until the airway is secured in any patient where the risk assessment indicates a high likelihood of subsequent decline in conscious state or grand mal seizures. In contrast with meticulous resuscitation and supportive care, gastrointestinal decontamination seldom saves a life.

Enhanced elimination

Interventions aimed at enhancing elimination of an agent from the body include multiple-dose activated charcoal, haemodialysis, charcoal haemoperfusion, and manipulation of urinary pH. These interventions are employed if it is thought they will reduce mortality, reduce length of stay or complication rate, or reduce the need for other more invasive interventions. In practice, they are rarely indicated because the risk assessment for most acute poisoning is relatively benign or anticipates a good outcome with a short period of supportive care.

For those agents likely to cause more severe poisoning, relatively few drugs possess the pharmacokinetic properties (small volume of distribution, small molecule size, slow endogenous elimination) that render them amenable to enhanced elimination. Risk assessment allows early identification of the need for enhanced elimination before established poisoning develops. Early implementation of these techniques can prevent or minimise toxicity. It also allows time for the communication, planning, and transport that may be required to access more sophisticated methods of enhanced elimination. Use of enhanced elimination techniques requires predefined clinical or laboratory endpoints for therapy.

Antidotes

Antidotes are drugs that correct the effects of poisoning. They only exist for a few specific poisonings and many are used rarely. Like all therapeutic agents, they have contraindications, indications, correct methods of administration, monitoring requirements, appropriate therapeutic endpoints, and adverse effect profiles.

As with any other drug, the indications to administer an antidote are derived from an analysis of potential benefits and risks to that individual patient. The potential therapeutic benefit to the patient is balanced against the potential adverse effects for the patient, cost, staff, and other resource requirements and availability. Rational antidote use also requires planning in terms of stocking, storage, monitoring, training, and protocol development. Many antidotes are rarely used, and are expensive and have limited shelf life. Stocking should therefore be considered on a regional basis in tandem with regional policies concerning the treatment of poisoned patients. It is often cheaper and safer to transport an antidote to a patient rather than visa versa.

Disposition

Again, an initial risk assessment allows early planning for appropriate disposition. Arrangements should be made for a patient to be admitted to an environment capable of providing an appropriate level of monitoring and supportive care (and occasionally specific antidotal or enhanced elimination therapies) until the effects of poisoning resolve. These conditions can usually be met at the initial institution but if not, transfer to an institution with these capabilities must be made. Importantly, with acute poisoning, transfer

may take place during the most severe phase of the illness, or even during the period where the patient's clinical status is likely to deteriorate. For these reasons, the patient must be stabilised as far as possible prior to transport, and transfer should not involve an interval of a lower level of supportive care and monitoring. Management should be discussed with the accepting institution, to allow mobilisation of resources and preparation for urgent interventions.

Final disposition of the deliberate self-poisoned patient is made in the context of the underlying psychosocial disorder. All patients with deliberate self-poisoning should undergo psychosocial assessment prior to discharge.[26 27] This assessment and disposition planning begins before the clinical resolution of the effects of acute poisoning.

REGIONAL TOXICOLOGY TREATMENT CENTRES AND NETWORKS

Established regional clinical networks for toxicology treatment should ideally support the above approach to acute poisoning management. Systems must support rapid access to toxicological information and expertise to assist with the early risk assessment of difficult cases.[10] Access to such advice via telephone frequently allows clinicians to comfortably manage patients without transfer to larger institutions. Where transfer is required, it permits early planning and preparation, delivery of antidotes, liaison with critical care transport teams, and continuity of care.

Where large numbers of deliberate self-poisoning cases are managed, a toxicology treatment unit provides coordinated comprehensive services to address the medical and psychosocial aspects of care in a cost effective manner.[28] Such a unit is then able to act as a regional centre for telephone consultation and accept transfer of difficult cases. The expertise developed centrally is also available to support toxicology education, protocol development, antidote stocking and clinical network development in the larger region (box 2).

The Western Australian Toxicology Service (WATS) comprises two inpatient treatment units at separate adult teaching hospitals in metropolitan Perth. Emergency physicians with two years subspecialty training in clinical toxicology staff both units. There are two fellows in training and a registrar post accredited for advanced training with the Australasian College for Emergency Medicine.

Care is provided in the emergency department (ED), intensive care unit (ICU), and an emergency observation unit. The observation units comprise 10–16 beds in secured areas and accept transfers from both the ED and ICU. Daily multidisciplinary rounds are conducted with the toxicology, psychiatry and social work teams (youth deliberate self-harm social worker, alcohol and drug liaison service, and aboriginal liaison service) across all three areas. Medical and psychosocial care occurs in parallel, rather than in separate phases in series.

Advantages of the above system include the use of existing bed resources, streamlining of bed management, decreased length of stay in hospital, availability of specialist toxicology consultation, utilisation of staff and training that are already in place, and concentration of expertise in one clinical area. Patients are only admitted to parts of the hospital that have 24-hour coverage by senior clinicians (ICU and emergency observation unit), rather than remote medical wards supervised by junior medical staff. Weekly case conferences and quality improvement meetings are held.

WATS clinicians provide toxicological expertise by telephone across Western Australia, South Australia, and the Northern Territory through the Western Australian Poisons Information Centre. Within Western Australia, strong links with regional general practitioners and the Royal Flying Doctor Service have been facilitated by provision of content to their respective continuing education activities. This assists early consultation before and during transport of difficult cases to Perth, and obviates the need to transport many patients long distances to the central teaching hospitals.

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REFERENCES

1 **Murray L**. General principles in the management of drug overdose. In: Cameron P, Jelinek G, Kelly A-M, *et al. Adult Emergency Medicine*, 2nd edn. Edinburgh: Churchill Livingston, 2004.
2 **Anonymous**. Facility assessment guidelines for regional toxicology treatment centers. American Academy of Clinical Toxicology. *J Toxicol Clin Toxicol* 1993;**31**:211–17.
3 **International Liaison Committee on Resuscitation**. 2005 American Heart Association Guidelines for Cardiopulmonary and Emergency Cardiovascular Care—Part 10. 2 Toxicology in ECC, *Circulation* 2005;**112**(24 suppl I):126–32.
4 **Kunisaki TA**, Augenstein WL. Drug- and toxin-induced seizures. *Emerg Med Clin North Am* 1994;**12**:1027–56.
5 **Fischer KF**, Lees JA, Newman JH. Hypoglycemia in hospitalized patients. Causes and outcomes. *N Engl J Med* 1986;**315**:1245–50.
6 **Hoffman RS**, Goldfrank LR. The poisoned patient with altered consciousness: controversies in the use of the ''coma cocktail''. *JAMA* 1995;**274**:562–9.
7 **Callaway CW**, Clark RF. Hyperthermia in psychostimulant overdose. *Ann Emerg Med* 1994;**24**:68–76.
8 **Wallace KL**. Antibiotic-induced convulsions. *Crit Care Clin North Am* 1997;**13**:741–62.
9 **Wallace KL**. Toxin-induced seizures. In: Brent J, Wallace KL, Burkhart KK, *et al. Critical care toxicology: diagnosis and management of the critically poisoned patient*. Philadelphia: Elsevier Mosby, 2005:225–39.
10 **Whyte IM**, Dawson AH, Buckley NA, *et al*. Health care. A model for the management of self-poisoning. *Med J Aust* 1997;**142**:142–6.
11 **Lee V**, Kerr JF, Braitberg G, *et al*. Impact of a toxicology service on a metropolitan teaching hospital. *Emerg Med (Fremantle)* 2001;**13**:37–42.
12 **Bailey B**. Gastrointestinal decontamination triangle. *Clin Toxicol (Philadelphia)* 2005;**43**:59–60.
13 **Tournier M**, Molimard M, Abouelfath A, *et al*. Accuracy of self-report and toxicological assays to detect substance misuse disorders in parasuicide patients. *Acta Psychiatr Scand* 2003;**108**:410–18.
14 **Buckley NA**, Whyte IM, Dawson AH. Diagnostic data in clinical toxicology—should we use a Bayesian approach? *J Toxicol Clin Toxicol* 2002;**40**:213–22.
15 **Boehnert MT**, Lovejoy FH Jr. Value of the QRS duration versus the serum drug level in predicting seizures and ventricular arrhythmias after an acute overdose of tricyclic antidepressants. *N Engl J Med* 1985;**313**:474–9.
16 **Foulke GE**. Identifying toxicity risk early after antidepressant overdose. *Am J Emerg Med* 1995;**13**:123–6.
17 **Howarth DM**, Dawson AH, Smith AJ, *et al*. Calcium channel blocking drug overdose: an Australian series. *Hum Exp Toxicol* 1994;**13**:161–6.
18 **Martin GJ**. Basic principles of screening. In: Kasper DL, Braunwald E, Fauci AS, *et al. Harrison's Principles of Internal Medicine*, 16th edn. New York: McGraw-Hill, 2005.
19 **Prescott L**. *Paracetamol (acetaminophen): A bibliographic review*. London: Taylor and Francis, 1996.
20 **Smilkstein MJ**, Knapp GL, Kulig KW, *et al*. Efficacy of oral N-acetylcysteine in the treatment of acetaminophen overdose. Analysis of the national multicenter study (1976 to 1985). *N Engl J Med* 1988;**319**:1557–62.
21 **Albertson TE**, Derlet RW, Foulke GE, *et al*. Superiority of activated charcoal alone compared with ipecac and activated charcoal in the treatment of acute toxic ingestions. *Ann Emerg Med* 1989;**18**:56–9.
22 **Kornberg AE**, Dolgin J. Pediatric ingestions: charcoal alone versus ipecac and charcoal. *Ann Emerg Med* 1991;**20**:648–51.
23 **Kulig K**, Bar-Or D, Cantrill SV, *et al*. Management of acutely poisoned patients without gastric emptying. *Ann Emerg Med* 1985;**14**:562–7.
24 **Merigian KS**, Woodard M, Hedges JR, *et al*. Prospective evaluation of gastric emptying in the self-poisoned patient. *Am J Emerg Med* 1990;**8**:479–83.
25 **Pond SM**, Lewis-Driver DJ, Williams GM, *et al*. Gastric emptying in acute overdose: a prospective randomised controlled trial. *Med J Aust* 1995;**163**:345–9.
26 **Owens D**, Dennis M, Jones S, *et al*. Self-poisoning patients discharged from accident and emergency: risk factors and outcome. *J R Coll Phys Lond* 1991;**25**:218–22.
27 **Kapur N**, House A, Creed F, *et al*. General hospital services for deliberate self-poisoning: an expensive road to nowhere? *Postgrad Med J* 1999;**75**:599–602.
28 **Daly FFS**, Murray L, Little M, *et al*. Specialized centers for the treatment of poisoned patients. In: Dart RC, ed. *Medical Toxicology*, 3rd edn. Philadelphia: Lippincott Williams and Wilkins, 2004:6–9.

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