Review Article

Decontamination Methods in Poisoning Revisited

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ABSTRACT

India ranks high in the incidence of poisoning as compared to all other countries in the world. The effective management of a case of poisoning begins with appropriate decontamination procedures undertaken on time. Specific treatment measures may be futile without removal of the poison that has already entered the system. Decontamination of skin and eyes are as important as removal of poison from the gut. Continued subcutaneous absorption from skin can be hazardous even if the treating doctor removes poison from the gut. This paper deals with the current status of various decontamination procedures relating to the gut, including emesis, gastric lavage, catharsis, activated charcoal, whole bowel irrigation and surgery/endoscopy. While the approach to many decontamination procedures have seen some radical changes over the last decade, it is unfortunate that most physicians in India still follow outdated concepts. As a result, victims of poisoning are often subjected to useless or even hazardous decontamination procedures causing more harm than would have been caused by the poison itself. An attempt has been made in this paper to emphasize the reasons for replacing some of the harmful conventional methods with updated, effective and efficient decontamination methods in cases of poisoning.

Keywords: Activated charcoal; Catharsis; Diuresis; Emesis; Endoscopy; Gastric lavage; Gut decontamination; Poisoning; Stomach wash; Whole bowel irrigation; Whole gut lavage

INTRODUCTION

The incidence of poisoning in India is among the highest in the world, and it is estimated that more than 50,000 people die every year from toxic exposure.[1] The causes of poisoning are many - civilian and industrial, accidental and deliberate. The commonest agents in India appear to be pesticides *(organophosphorus compounds, carbamates, chlorinated hydrocarbons, and pyrethroids),* sedative drugs, chemicals *(corrosive acids and copper sulfate),* alcohol, plant toxins *(datura, oleander, strychnos, and gastro-intestinal irritants such as castor, croton, calotropis, etc.),* and household poisons *(mostly cleaning agents).*[2-5] Aluminium phosphide is commonly involved in suicidal and accidental poisoning in some northern Indian states.[6,7] One recent study pertaining to poisoning statistics demonstrated more of such differences between northern and southern Indian states.[8] Among children the common culprits include kerosene, household chemicals, drugs, pesticides, and garden plants.[9,10]

DISCUSSION

Decontamination Methods

This review will discuss changes with regard to gut decontamination procedures that have been brought in over a period of time, with suggestions on their implementation in practice, while doing away with outdated methods and procedures.

The various methods of poison removal from the gastrointestinal tract include –

- Emesis
- Gastric lavage
- Catvharsis
- Activated charcoal
- Whole bowel irrigation
- Surgery and endoscopy

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1. Emesis

The only recommended method of inducing a poisoned patient to vomit is administration of **syrup of ipecacuanha (**or **ipecac),** and ironically it is not easy to procure it in India. However, the initial enthusiasm associated with the use of ipecac in the 1960s and 1970s in Western countries has declined substantially in recent years owing to doubts being raised as to its actual efficacy and safety. A study using the 2003 Toxic Exposure Surveillance System (TESS) database evaluated the effect of home use of syrup of ipecac on the rate of referral to Emergency Departments (EDs) across the United States. The study found that there was no reduction in ED use nor any improvement in patient outcome from home administration of syrup of ipecac.[11] Based on these findings and other data, the American Academy of Pediatrics published its policy statement on poison treatment in the home, concluding that syrup of ipecac should no longer be used as a standard home treatment in cases of poisoning.[12] The current consensus is that syrup of ipecac must NOT be used, except in justifiable circumstances.

Other Emetics

The only other acceptable method of inducing emesis that is advocated involves the use of **apomorphine.** Given subcutaneously, it causes vomiting within 3 to 5 minutes by acting directly on the chemoreceptor trigger zone. The recommended dose is 6 mg (adult), and 1 to 2 mg (child). Since apomorphine is a respiratory depressant it is contra-indicated in all situations where there is likelihood of CNS depression. Apomorphine is not widely available in India. In some cases, **stimulation of the posterior pharynx** with a finger or a blunt object may induce vomiting by provoking the gag reflex. Unfortunately, such mechanically induced evacuation is often unsuccessful and incomplete, with mean volume of vomitus about one third of that obtained by the other two methods.

Obsolete Emetics

The use of **warm saline or mustard water** as an emetic is not only dangerous (resulting often in severe hypernatraemia), but also impractical since many patients, especially children refuse (fortunately) to drink this type of concoction and much valuable time is lost coaxing them to do so. One tablespoon of salt contains at least 250 mEq of sodium, and if absorbed can raise the serum level by 25 mEq/L in for instance, a 3 year old child. It is high time that the use of salt water as an emetic be deleted once and for all from every first-aid chart or manual on poisoning.

Copper sulfate induces emesis more often than common salt, but significant elevations of serum copper can occur leading to renal and hepatic damage. It is also a gastrointestinal corrosive.

Zinc sulfate is similar in toxicity to copper sulfate, and has in addition a very narrow margin of safety.

2. Gastric Lavage (Stomach Wash) -

The American Academy of Clinical Toxicology, and the European Association of Poison Centres and Clinical Toxicology have prepared a draft of a position paper directed to the use of gastric lavage, which suggests that gastric lavage should NOT be employed routinely in the management of poisoned patients.[13] There is no certain evidence that its use improves outcome, while the fact that it can cause significant morbidity (and sometimes mortality) is indisputable.[14,15] Lavage should be considered only if a patient has ingested a life threatening amount of a poison and presents to the hospital within 1 to 2 hours of ingestion. But in India, very often caution is thrown to the wind and the average physician in an average hospital embarks on gastric lavage with gusto the moment a poisoned patient is brought in and this often leads to complications including cardiac arrest and aspiration of fluid.[16] This is a sad commentary on the existing lack of awareness and a reluctance to change old convictions in spite of mounting evidence against the routine employment of such "established procedures." With the advent of Poison Control Centres, and provision of enhanced emphasis on Toxicology in the new undergraduate medical curriculum framed by the Medical Council of India, there is hope of a change in attitude in the years to come.[17]

Indications

Gastric lavage is recommended mainly for patients who have ingested a life-threatening dose, or who exhibit significant morbidity and present within 1 to 2 hours of ingestion. Lavage beyond this period may be appropriate only in the presence of gastric concretions, delayed gastric emptying, or sustained release preparations. Some authorities still recommend lavage up to 6 to 12 hours post-ingestion in the case of salicylates, tricyclics, carbamazepine, and barbiturates.

Precautions

Never undertake lavage in a patient who has ingested a non-toxic agent, or a non-toxic amount of a toxic agent. Never use lavage as a deterrent to subsequent ingestions. Such a notion is barbaric, besides being incorrect.

Contraindications

a) Relative: Haemorrhagic diathesis, oesophageal varices, recent surgery, advanced pregnancy, ingestion of alkali, coma.

b) Absolute: Marked hypothermia, prior significant vomiting, unprotected airway in coma, and ingestion of acid or convulsant or petroleum distillate, and sharp substances.

Procedure

Explain the exact procedure to the patient and obtain his consent. If refused, it is better not to undertake lavage because it will amount to an assault, besides increasing the risk of complications due to active non-cooperation. Endotracheal intubation must be done prior to lavage in the comatose patient. Place the patient head down on his left lateral side (20° tilt on the table). Mark the length of tube to be inserted (50 cm for an adult, 25 cm for a child). The ideal tube for lavage is the lavacuator (clear plastic or gastric hose). In India however, **Ewald's tube** (Fig 1) is most often used which is a soft rubber tube with a funnel at one end. Whatever tube is used, make sure that the inner diameter corresponds to at least 36 to 40 French size. A nasogastric tube used for gastric aspiration is inadequate and should never be used. In a child, the diameter should be at least 22 to 28 French. **Ryle's tube** may be sufficient (Fig 2). The preferred route of insertion is oral. Passing the tube nasally can damage the nasal mucosa considerably and lead to severe epistaxis. Lubricate the inserting end of the tube with vaseline or glycerine, and pass it to the desired extent. Use a mouth gag so that the patient will not bite on the tube. Once the tube has been inserted, its position should be checked either by air insufflation while listening over the stomach, or by aspiration with pH testing of the aspirate, (acidic if properly positioned). Lavage is carried out using small aliquots (quantities) of liquid. In an adult, 200 to 300 ml aliquots of warm (38° C) saline or plain water are used. In a child, 10 to 15 ml/kg body weight of warm saline is used each time. Water should preferably be avoided in young children because of the risk of inducing hyponatremia and water intoxication. It is advisable to hold back the first aliquot of washing for chemical analysis. In certain specific types of poisoning, special solutions may be used in place of water or saline (Table 1). Lavage should be continued until no further particulate matter is seen, and the efferent lavage solution is clear. At the end of lavage, pour a slurry of activated charcoal in water (1 gm/kg), and an appropriate dose of an ionic cathartic into the stomach, and then remove the tube.

Complications

1. Aspiration pneumonia.
2. Laryngospasm.
3. Sinus bradycardia and ST elevation on the ECG.
4. Perforation of stomach or oesophagus (rare).

3. Catharsis

Catharsis is a very appropriate term when used in connection with poisoning, since it means purification. It is achieved by purging the gastrointestinal tract (particularly the bowel) of all poisonous material. The two main groups of cathartics used in toxicology include

Ionic or Saline

These cathartics alter physico-chemical forces within the intestinal lumen leading to osmotic retention of fluid which activates motility reflexes and enhances expulsion. However, excessive doses of magnesium-based cathartics can lead to hypermagnesaemia which is a serious complication.

- The doses of recommended cathartics are as follows:
- Magnesium citrate- 4 ml/kg
- Magnesium sulfate- 30 gm (250 mg/kg in a child)
- Sodium sulfate- 30 gm (250 mg/kg in a child)

Saccharides

Sorbitol (D-glucitol) is the cathartic of choice in adults because of better efficacy than saline cathartics, but must not be used as far as possible in young children owing to risk of fluid and electrolyte imbalance (especially hypernatraemia). It occurs naturally in many ripe fruits and is prepared industrially from glucose, retaining about 60% of its sweetness. Sorbitol is used as a sweetener in some medicinal syrups, and the danger of complications is enhanced in overdose with such medications when sorbitol is used as a cathartic during treatment.

Dose of sorbitol- 50 ml of 70% solution (adult)

Efficacy of catharsis

While cathartics do reduce the transit time of drugs in the gastrointestinal tract, there is no real evidence that it improves morbidity or mortality in cases of poisoning.[18] At present there is no indication for the routine use of cathartics as a method of either limiting absorption or enhancing elimination. A single dose can be given as an adjunct to activated charcoal therapy when there are no contraindications and constipation or an increased gastrointestinal transit time is expected.

Contraindications

- Corrosives
- Existing electrolyte imbalance
- Paralytic ileus
- Severe diarrhoea
- Recent bowel surgery
- Abdominal trauma
- Renal failure

Oil based cathartics should never be used in poisoning since they increase the risk of lipoid pneumonia, increase the absorption of fat soluble poisons, and inactivate medicinal charcoal's effects when administered along with them. The last mentioned reason also applies to conventional laxatives, and hence they are also not recommended in poisoning.

3. Activated (Medicinal) Charcoal

A number of recent studies have documented clearly the efficacy of activated charcoal as the sole decontamination measure, while emesis and lavage are increasingly associated with relative futility.[19,20] But overall, as is true for the other methods of gastrointestinal decontamination, there is a lack of sound evidence of its benefits as defined by clinically meaningful end points. This opinion is reflected both in the consensus statements and in the overall trend toward no decontamination as shown in TESS data.[21] The consensus opinion concluded that a single dose of activated charcoal should not be administered routinely in the management of poisoned patients and, based on volunteer studies, the effectiveness of activated charcoal decreased with time, providing the greatest benefit within 1 hour of ingestion. There was no evidence that the administration of a single dose of activated charcoal improved clinical outcome. Additionally, it is generally accepted that unless either airway protective reflexes are intact (and expected to remain so) or the patient's airway has been protected, the administration of activated charcoal is contraindicated. Activated charcoal is a fine, black, colourless, tasteless powder made from burning wood, coconut shell, bone, sucrose, or rice starch, followed by treatment with an activating agent (steam, carbon dioxide, etc). The resulting particles are extremely small, but have an extremely large surface area. Each gram of activated charcoal works out to a surface area of 1000 square metres. Recently in the USA, a new superactivated charcoal has been introduced in the market with a surface area nearly double the current formulations.[22]

Mode of action

Activated charcoal decreases the absorption of various poisons by adsorbing them on to its surface. It is effective to varying extent, depending on the nature of substance ingested (Table 2).

Dose

The optimal activated charcoal dose is theoretically the minimum dose that completely adsorbs the ingested xenobiotic and, if relevant, that maximizes enhanced elimination. The results of in vitro studies show that the ideal activated charcoal-to-xenobiotic ratio varies widely, but a common recommendation is to deliver an activated charcoal-to-xenobiotic ratio of 10:1 or 50-100 g of activated charcoal to adult patients, whichever is greater (1 g/kg of body weight). This amount from a theoretical perspective will adsorb 5-10 g of a xenobiotic, which should be adequate for most typical poisonings. In children, the recommended dose is 0.5-2 g/kg of body weight.

Procedure

Activated charcoal is most effective when administered within one hour of ingestion. Administration in the prehospital setting has the potential to significantly decrease the time from toxin ingestion to activated charcoal administration, although it has not been shown to affect outcome.[23] Add four to eight times the quantity of water to the calculated dose of activated charcoal, and mix to produce a slurry or suspension. This is administered to the patient after emesis or lavage, or as sole intervention. The slurry should be shaken well before administration.

Multiple-dose Activated Charcoal (MDAC)

The use of repeated doses (amounting to 150 to 200 gm of activated charcoal) has been demonstrated to be very effective in the elimination of certain drugs such as theophylline, phenobarbitone, quinine, digitoxin, phenylbutazone, salicylates, carbamazepine, methotrexate and dapsone.[24] This can be accomplished safely by giving the activated charcoal through a nasogastric tube over 4 to 8 hours. The actual dose of activated charcoal for multiple dosing has varied considerably in the available medical literature, ranging from 0.25 to 0.5 gm/kg every 1 to 6 hours, to 20 to 60 gm for adults every 1, 2, 4, or 6 hours.[24] The total dose administered is more important than frequency of administration. A fairly recent single-blind, randomized, placebo-controlled trial was designed to assess the efficacy of MDAC in the treatment of patients with yellow oleander poisoning. This clinical study demonstrated that MDAC (defined as 50 g of activated charcoal every 6 hours for 3 days) effectively reduced life-threatening cardiac dysrhythmias, deaths, and the need for ICU admission.[25]

Disadvantages :

- Unpleasant taste
- Provocation of vomiting
- Constipation/diarrhoea
- Pulmonary aspiration
- Intestinal obstruction (especially with multiple-dose activated charcoal)

Contraindications :

- Absent bowel sounds or proven ileus
- Small bowel obstruction
- Caustic ingestion
- Ingestion of petroleum distillates

4. Whole Bowel Irrigation (Whole Gut Lavage)

This is a method that is being increasingly recommended for late presenting overdoses when several hours have elapsed since ingestion. It involves the instillation of large volumes of a suitable solution into the stomach via a nasogastric tube over a period of 2 to 6 hours producing voluminous diarrhoea. Previously, saline was recommended for the procedure but it resulted in electrolyte and fluid imbalance. Today, special solutions are used such as PEG-ELS (i.e., polyethylene glycol and electrolytes lavage solution combined together, which is an isosmolar electrolyte solution), and PEG-3350 (high molecular weight polythylene glycol) which are safe and efficacious, without producing any significant changes in serum electrolytes, serum osmolality, body weight, or haematocrit.[24]

Indications

1. Ingestion of large amounts of toxic drugs in patients presenting late (> 4 hours post-exposure).
2. Overdose with sustained-release preparations.
3. Ingestion of substances not adsorbed by activated charcoal, particularly heavy metals.
4. Ingestion of foreign bodies such as miniature disc batteries (button cells), cocaine filled packets (body packer syndrome), etc.
5. Ingestion of slowly dissolving substances – iron tablets, paint chips, bezoars, concretions, etc.

Procedure

Insert a nasogastric tube into the stomach and instil one of the recommended solutions at room temperature, at a rate of 2 litres per hour in adults, and 0.5 litre per hour in children. The patient should preferably be seated in a commode. The use of metoclopramide IV, (10 mg in adults, 0.1 to 0.3 mg/kg in children) can minimise the incidence of vomiting. The procedure should be continued until the rectal effluent is clear, which usually occurs in about 2 to 6 hours. There is some evidence against the simultaneous administration of activated charcoal with whole bowel irrigation, since PEG-ELS has been shown to reduce the adsorptive capacity of activated charcoal in vitro.

Complications

- Vomiting
- Abdominal distension and cramps
- Anal irritation
- Contraindications -
- Obstruction, ileus, haemorrhage, or perforation (gastrointestinal pathology).

5. Endoscopy and Surgery

Over the years, a few case reports have presented mixed results for the endoscopic removal of drug packets from the stomach of (cocaine or heroin) body packers.[26] At present, this method is not generally recommended because of concerns about packet rupture. However, under exceptional circumstances, there is certainly a precedent for attempting this procedure in

a highly controlled setting such as an ICU or operating room.In rare cases of massive iron overdoses where emesis, orogastric lavage, and gastroscopy failed, gastrotomy was performed. The significant clinical improvement and postoperative recovery indicated that surgery in these particular cases was the correct approach.[27]

CONFLICTS OF INTEREST

Declared none.

Table 1: Solutions for Gastric Lavage

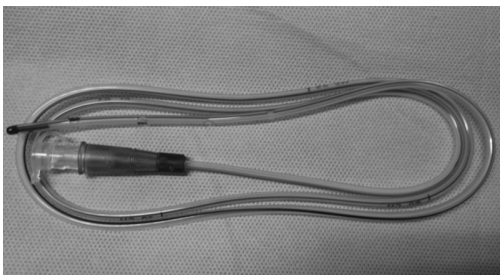
POISON	SOLUTION
1. Most poisons (known or unknown)	Water or saline
2. Oxidizable poisons (alkaloids, salicylates, etc)	Potassium permanganate (1 : 5000 or 1 : 10000)*
3. Cyanides	Sodium thiosulfate (25%)
4. Oxalates	Calcium gluconate
5. Iron	Desferrioxamine (2 gm in 1 litre of water)

Table 2: Adsorption of toxins to activated charcoal.

Well Adsorbed		Moderately Adsorbed	Poorly Adsorbed
Aflatoxins	Cimetidine	Antidiabetic drugs	Alcohols
Amphetamines	Dapsone	Kerosene	Carbamates
Antidepressants	Digitalis17	Paracetamol	Corrosives
Antiepileptics	NSAIDs	Phenol	Cyanide
Antihistamines	Opiates	Salicylates	Ethylene glycol
Atropine	Phenothiazines		Heavy metals
Barbiturates	Quinine, Quinidine		Hydrocarbons
Benzodiazepines	Strychnine		Organophosphates
Beta blockers	Tetracycline		
Chloroquine	Theophylline		

Fig 1: Ewald's tube

Fig 2: Ryle's tube



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