Brief Reports

Acute Iron Poisoning: Clinical Picture, Intensive Care Needs and Outcome

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In this retrospective study, we examined the prevalence of acute iron poisoning among children attending Pediatric Emergency service of a teaching hospital, and studied their clinical profile, treatment and outcome to define intensive care needs. During the 5 years' study period of 27125 patient visits to Pediatric Emergency, 337 (1.2%) were for accidental poisoning. Of these 21(7%) patients had iron poisoning; 18 were transferred to PICU. Three patients were asymptomatic, others had vomiting (n =15, 83%), diarrhoea (n =13, 72%), malena (n = 8, 44%), and hemetemesis (n=6, 33%) generally within 6 hours of ingestion. Nine progressed to shock and/or impaired consciousness; two had acute liver failure. Dose of ingested iron and clinical signs were most useful guide to iron toxicity and management decisions; serum iron did not help. Gastric lavage yielded fragments of iron tablets in 10 patients. On desferrioxamine infusion Vin-rose colour urine was not seen in 31% even in presence of high serum iron. Shock responded to normal saline (33 ± 15 mL/kg) and dopamine (10 ± 4 µg/kg/min) within 4-24 hours in 7 of 9 patients. Presence of shock or acute liver failure with coagulopathy and/or severe acidosis predicted all the four deaths. Desferrioxamine infusion and supportive care of shock was the mainstay.

Key words: *Acute iron poisoning, Critical care.*

Accidental poisoning continues to be an important pediatric emergency(1). Iron is among the leading causes of accidental poisoning in USA, especially among pre-school children(2,3). The extent of the problem in our country is not fully documented. Though it appears to form a significant proportion of drug related poisoning(1), there is little published data on the subject from India(4,5). In this study, we present prevalence of iron poisoning among patients attending our Pediatric Emergency and their clinical profile, treatment and outcome.

Subjects and Methods

This was a retrospective descriptive study covering a period of 5 years from July 1993 to June 1998. Patient records of Pediatric Emergency Departmet (ED) and Pediatric Intensive Care Unit (PICU) were reviewed to identify patients brought with a history of iron-overdose and to retrieve the data on age, sex, description of iron ingested, presenting symptoms and signs, clinical course, laboratory characteristics, serum iron levels, treatment details, complications and outcome.

Results

27,125 children attended ED during the study period; of these 337 (1.2%) were for accidental poisoning. twenty-one children were brought for alleged ingestion of iron tablets. Of these 3 patients were discharged after gastric lavage and observation in ED and 18 patients (boys 12, girls 6) were admitted to PICU. Three were under one year of age, 10 (56%) were in second year of their life and five were between 6-12 years of age. Twelve (67%) children were from urban and 6 from rural area. Fifteen (83%) patients arrived in ED within 6 hours of ingestion (mean ± SD: 9.3 ± 16.2 hours; range: 2-72 hours); one patient was brought on day 4. Six patients had received gastric lavage before arrival to ED.

Thirteen patients had ingested elemental iron in excess of 60 mg/Kg body weight (range 65- 270 mg/Kg), one had ingested 30 mg/Kg body weight; details were not available on 4 patients. All had ingested bright coloured sugar coated iron tablets that were meant for use of mothers for anemia prophylaxis and were received under Reproductive and Child Health programme (RCH). Each tablet contained 100 mg of elemental iron.

Clinical features

Three patients were asymptomatic at admission, and remained so during hospital stay. Two had ingested 100 mg/Kg or more elemental iron, and one had a serum iron 750 µg/dL. Among 15 symptomatic children, the interval between ingestion of iron tablets and onset of symptoms varied from 30 mins to 2 hours (mean ± SD, 51 ± 27 min). The common presenting symptoms were vomiting (*n* = 15, 83%), diarrhea (*n* = l3, 72%) and abdominal pain (*n* = 10, 65%); followed by malena (*n* = 8, 44%), hematemesis (*n* = 6, 33.3%), shock (*n* = 5, 27.7%), impaired consciousness (*n* = 4, 22%) and jaundice and encephalopathy (*n* = 1).

Six children did not have any progression beyond gastrointestinal stage. All had either leukocytosis (WBC count ³15,000/mm^3) or hyperglycemia (blood sugar ³150 mg/dL), or both. Abdominal radiograph showed iron tablets in three. Their iron intake ranged between 80-270 mg/Kg. Serum iron, which could be obtained in two of these six children, was in non-toxic range (131 mg/dL) in one.

Nine patients either presented in (*n*= 6) or progressed (*n* = 3) to stage of mitochondrial toxicity characterized by shock (hypotension and poor peripheral perfusion) and/or impaired consciousness. One child developed generalized seizure. Most of them had leukocytosis (*n* = 6), hyperglycemia (*n* = 6), elevated liver and/or serum bilirubin (*n* = 6), coagulopathy (PTI <50%, *n* = 3), and metabolic acidosis (*n* = 3). The elemental iron ingested by these children ranged between 65-200 mg/Kg. Serum iron could be obtained at admission in 4 of them; 3 had values >150 mg/dL.

Two children had acute liver failure. One patient was brought on day 4 after iron ingestion of about 200 mg/kg with features of shock, and stage 3 hepatic encephalopathy. Another child presented within 6 hours of iron ingestion (≥ 200 mg/Kg) with shock and progressed to hepatic failure in next 36 hour despite decontamination and chelation therapy.

Treatment

Four patients vomited out some(1-12) tablets spontaneously, and in one patient ipecac-induced emesis at home brought 10 tablets out before arrival to hospital Gastric lavage with a large bore tube yielded fragments of tablets in 10 patients.

Whole body irrigation with Peglac®

(followed by chelation therapy) was done in one patient. This patient had severe toxicity-shock and respiratory failure requiring fluids, inotropes and manual ventilation in ED. He stabilized rapidly and recovered fully.

Continuous intravenous infusion of desferrioxamine at a rate of 15 mg/Kg/hour in saline was given to 16 (two asymptomatic and 14 symptomatic) patients. It was not given to two patients. One was asymptomatic (ingested iron 30 mg/Kg) and in another instance, desferrioxamine could not be procured. Vinrose colour of urine, attributed to desferrioxamine-iron complex excreted in urine, was seen in 11 (69%, one asymptomatic and 10 symptomatic) patients. One asymptomatic child with serum iron 141 µg/dL had vin-rose color urine while another asymptomatic child with markedly raised serum iron concentration (750 µg/dL) did not. Desferrioxamine infusion was continued for 24 hours after patients were symptom free and/or disappearance of vin-rose color of urine. Duration of chelation therapy ranged between 24-75 hours (mean ± SD: 40 ± 4.3 hours.)

All the 9 patients in shock were given normal saline boluses (mean, 33.3 ± 15 mL/kg; range, 10-60 mL/Kg). Blood pressure (BP) normalized in 3 children with normal saline alone. In other six though central venous pressure (CVP) was stabilized between 10-12 cm H_2O, BP did not improve. They received dopamine at rate of 5-15 µg/Kg/min (mean ± SD, 10 ± 3.8 µg/Kg/min). In 7 of 9 children BP and perfusion stabilized within 4 to 24 hours. Two patients had frequent falls in CVP and BP; one due to frequent hematemesis and another due to malena. They received blood transfusion in addition to colloids and saline. In one of them, dobutamine (15 µg/Kg/min) was added to dopamine. Both these patients succumbed to uncontrolled shock at 18 and 27 hours of admission respectively.

Two patients required ventilatory support. One patient was given manual bag ventilation in emergency room for shock and poor respiratory effort; he could be extubated after 4 hours of initial management. Another patient who had hepatic encephalopathy was put on controlled, mechanical ventilation because of poor respiratory effort and respiratory failure.

Complications

Four patients (22%) developed hospital-acquired sepsis. One had *Klebsiella pneumoniae* and Methicillin-resistant *Staphylococcus aureus* blood stream infection on day 3, second one developed infective colitis and third one had pneumonia on day 5. All the three recovered after appropriate antibiotics. The fourth patient who made full recovery from acute iron toxicity succumbed to polymicrobial (*Klebsiella, Enterococcus fecalis* and *Candida*) sepsis on day 10 of admission.

Four (22%) patients died. They had shock ($n = 4$), coma ($n = 3$) acute liver failure ($n = 4$), with a hyper-or hypo-glycemia ($n = 3$) leucocytosis ($n = 3$) and severe acidosis (serum bicarbonate <12.5 mEq/L). A combination of two or more of the factors was present in five children and four of them died. None of the patients had any long-term sequelae on a follow-up over a 6 months to 3 years period.

Discussion

A marked increase in prevalence of accidental iron-poisoning among children was seen in our hospital over last few years compared to 80's and 70's. Previously published data from our hospital had shown a much lower prevalence during 1970's (one out of 84 cases in 10 years) and 1980's (6 out of

217 cases in 9 years) in contrast to current series(6,7). Earlier reports on pediatric poisonings from various hospitals of India had not identified it as an important agent(6-11).

Only a recent multicentric survey has identified iron as one of the common causes of accidental poisoning(1). It is possible that better implementation of Maternal Anaemia prophylaxis under RCH program and resultant increased availability of iron tablets at home has led to increased frequency. All the patients in this study had consumed iron tablets given to the mother for anemia prophylaxis.

We had several symptomatic patients with a serum iron level on admission <350 µg/dL while an asymptomatic child had a serum iron level of 750 µg/dL. A serum iron >350 µg/dL within 3-6 hours of ingestion has been suggested as one of the most useful predictor of toxicity and >500 µg/dL a guide to chelation therapy(12). However, if the patients come early or late serum iron may not be in toxic range in spite of severe intoxication. Moreover, to be of value in therapeutic decision making serum iron report should be available within 60 minutes, but in our set up it is not possible to get the report of serum iron within a short period. It appears that serum iron level may not be very helpful in our setting to diagnose or treat serious intoxication. A recent study failed to correlate serum iron value at arrival with clinical toxicity, even when samples were obtained within 2-9 hours(13).

We depended on triage based on amount of iron allegedly ingested to begin decontamination and chelation therapy(12,14). If the information on ingested dose was not fully available, clinical and laboratory features and desferrioxamine challenge were used. We found that any combination of significant vomiting or diarrhea, shock, coma, iron tablets on abdominal radiograph, hyperglycemia (blood sugar >150 mg/dL), and development of vinrose color urine on desferrioxamine challenge were useful guide to need for chelation therapy. Concurrent presence of coma, radio-opacities, leukocytosis and an elevated anion gap had a 100% positive predictive value for a serum iron >500 µg/dL(15).

Lavage with a large bore nasogastric tube must be done in all cases. The fact that we recovered fragments of iron tablets in several patients who had received gastric lavage before arrival at our hospital at a peripheral health facility, supports this. Whole body irrigation (WBI) using Peglac® was very effective in the only patient that we used. It has been recommended that children in whom abdominal *X*-ray reveal tablets beyond the pylorus or throughout the gastrointestinal tract, may benefit from it(14,16). In situations, where abdominal *X*-ray is not possible, it is better to give WBI after gastric lavage for rapid and effective cleansing of gut. Peglec® is safe for children and does not cause fluid and electrolyte changes(16,17).

Iron chelation therapy with desferrioxamine is indicated when iron ingestion exceeds 60 mg/Kg or serum iron is in toxic range(12) and has been shown to reduce mortality to 10%(18). Desferrioxamine-iron complex that is excreted in urine imparts it a vin-rose color. Disappearance of vin-rose urine is traditionally considered as end-point of therapy. However, some of our patients had normal urine colour in spite of signs of severe toxicity and/or high serum iron, as has been reported by others too(14). This made the decision regarding the end point difficult. We believe that urine colour alone may not be a reliable indicator. Clinical improvement of the patient combined with disappearance of vin-

Key Messages

- Frequency of childhood iron poisoning has shown an increase in our region.
- Early symptoms (vomiting,diarrhea), shock, hyperglycemia, coma and presence of iron tablets on abdominal radiograph were useful guide to therapy. Serum iron level did not help.
- Acute liver failure, coagulopathy (PTI <50%), shock and severe acidosis (serum bicarbonate <12.5 mEq/L) were poor prognostic indicators.

rose urine colour is probably the most appropriate end-point in our set-up.

Shock has been closely linked to the outcome and had led to death in all patients if left untreated(18). All children with iron-overdose exceeding 60 mg/kg, or GI symptoms therefore, should receive careful monitoring for vital signs, gastrointestinal hemorrhage, fluid loss, acidosis, blood gases and electrolytes preferably in an ICU. Our data suggest that most of the patients in shock required both, fluids and inotrope-dopamine. These are likely to be effective within 24 hours, if the patient is on chelation therapy and had no other complication or organ failure. The need for inotropes is understandable in view of toxic damage to myocardium induced by iron-overload(9). Blood transfusion is required to replace the blood loss in hematemesis and malena. Later, patients may need hepatic and/or renal support. Mechanical ventilation is needed occasionally.

In all the instances brightly coloured sugar coated tablets meant for use by mother were the cause of overdose. Attention should therefore, be given to use of childproof containers, use of non-sugar coated, and subdued black or white coloured iron tablets for adults(4).

In conclusion, frequency of childhood iron poisoning has shown an increase in our region. Early symptom (vomiting, diarrhea), shock, hyperglycemia, coma and presence of iron tablets on abdominal radiograph were useful guide to therapy. Serum iron level did not help. Vin-rose color urine after desferrioxamine chelation therapy may not be seen sometimes. Acute liver failure, coagulopathy (PTI <50%), shock and severe acidosis (serum bicarbonate <12.5 mEq/L) were poor prognostic indicators. Use of childproof containers, and non-sugar coated tablets may help in prevention.

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REFERENCES

1. Dutta AK. Seth A, Goyal PK, Aggarwal V, Mittal SK, Sharma R, *et al*. Poisoning in children: Indian scenario. Indian J Pediatr 1998; 65: 365-370.
2. Morris CC. Pediatric Iron poisonings in United States. South Med J 2000; 93: 352-358.
3. McGuigan MA. Common culprits in childhood poisoning: Epidemiology, treatment and parental advice for prevention. Pediatr Drugs 1999; 1: 313-324.
4. Kulkarni ML, Najeeb KP. Colored and

sweetened death trap. lndian Pediatr 1998; 385-386.

5. Mehta M, Gharpure V, Raghavan K. Acute iron poisoning. Indian J Pediatr 1997; 64: 485-493.
6. Singh S, Narang A, Walia BNS, Mehta S, Kumar L. Accidental poisoning in children: 10-year experience. Indian Pediatr 1981; 18: 163-166.
7. Singh S, Singhi S, Sood NK, Kumar L, Walia BNS. Changing pattern of childhood poisoning (1970-1989). Experience of a large North Indian Hospital. Indian Pediatr 1995; 32: 331-336.
8. Singhal PK, Kumar H, Rastogi V, Saili A, Patwari AK, Mullick DN. Accidental poisoning. Indian Pediatr 1998; 25: 350-355.
9. Khadgawat R. Garg P, Bansal P, Arya A, Choudhary B. Accidental poisoning. Indian Pediatr 1994; 31: 1555-1557.
10. Kumar V. Accidental poisoning in south west Maharashtra. Indian Pediatr 1991; 28: 731-735.
11. Buch NA, Ahmed K, Sethin AS. Poisoning in children. Indian Pediatr 1991; 28: 521-524.
12. Anderson AC. Iron poisoning in children. Current Opin Pediatr 1991; 6: 289-294.
13. Chyka P A, Butler AY, Holley JE. Serum iron concentrations and symptoms of acute iron poisoning in children. Pharmacotherapy 1996; 16: 1053-1058.
14. Schauben JL, Augenstein WL, Cox J, Sato R. Iron poisoning: Report of three cases and a review of therapeutic intervention. J Emergency Med 1990; 8: 309-319.
15. Chyka PA, Butla AY. Assessment of acute iron poisoning by laboratory and clinical observations. Am J Emerg Med 1993; 11: 99-103.
16. Tenenbein M. Whole bowel irrigation in iron poisoning. J Pediatr 1987; 111: 142-145.
17. Sakolover N, Rachmeal A Whole body irrigation in infants for acute iron poisoning. Harefuah 2000; 138: 837-841.
18. Eisen IF, Lacouture PG, Lovejoy FFJ. Iron. *In:* Haddad LM, Winchester JF, eds. Clinical Management of Poisoning and Drug Overdose. 2nd edn. Philadelphia: WB Saunders; 1990; p . 1010-1017.
19. Bartfay WJ, Hou D, Lehotay DC, Luo X, Bartfay E, Backx PH, *et al*. Cytotoxic aldehyde generation in heart following acute iron-loading. J Trace Elem Med Biol 2000; 14: 14-20.