Review on Toxic Effects of Arsenic with relation to Clinical Signs in Different Animals

Muhammad Zubair
Faculty of veterinary sciences, University of Poonch Rawalakot Azad Kashmir

Abstract
Arsenic is natural metalloid which is present in the universe everywhere. It is used for different insecticides and pesticides preparation. Poisoning of arsenic is a major issue that affects different species. Its occurrence is related to contamination of feed and water; therefore, it is matter of concern globally. However, its level of toxicity is increasing very rapidly in Asian countries especially Bangladesh, India and Pakistan. Its increasing level of arsenic in ground water is the major source of poisoning to human and animals. In addition, the contact of animals to arsenic lead to absorption body and accumulation in vital organs like liver and kidneys that may resulted to carcinogenic development. Elimination of absorbed arsenic in environment through excretions of animals is also one way to increase its level in water/soil. The objective of this review is to gather the information about arsenic toxicity occurrence by natural or experimentally ways and changes occurred in suffered animals related to pathological or biochemical.

Keywords: arsenic, lab animals, livestock and toxic effects

Introduction
Arsenic is a metalloid element and continuously eliminated in environment. The use of insecticides and pesticides, veterinary drugs and feed additives are the major sources for the exposure of animals (Friberg et al., 1986). Contamination of drinking water with arsenic is the principal source of exposure to livestock and human (Bode and Dong, 2002; Yih et al., 2002). The animals using the contaminated fodder and water are considered as the principal source of threat to human especially children through the secretion of arsenic in milk (Brahman et al., 2016). The laboratory animals as well as large animals suffer many digestive and nervous signs due to arsenic poisoning. Arsenic commonly accumulates in hair, skin, liver and kidneys. The major clinical signs of toxicity in livestock are manifested in the form of diarrhea, in coordination and death of animals (Neiger et al., 2004).

Exposure of arsenic causes the cancer of bladder, lungs, skin, developmental abnormalities in reproductive and pancreas cells (Benbrahim-Tallaa and Waalkes, 2008; NRC, 1999). In acute cases, abdominal cramping, in coordination in extremities, electrocardiogram may develop in animals (Franzblau and Lilis, 1989). The chronic exposure of arsenic results in rise of liver enzymes in cattle (Rana et al., 2010).

No report is available about the complete toxicity of arsenic with relation to clinical signs. The objective of this review was to review the sources of arsenic, toxicity mechanism and clinical manifestations with special focus on livestock species. The efforts were also made about the available drugs for the treatment of arsenic toxicity.

Sources of Arsenic
The high arsenic concentration can be attributed to contamination of water from industrial activities and
pesticides, in addition to other anthropogenic sources (Nickson et al., 2005). The contamination of fodder and water are considered as the common source of arsenic poisoning to livestock now a days. The frequent use of arsenic in dipping fluid to kill the ectoparasite and use as insecticides and pesticides are the major sources of arsenic contact to livestock. The use of contaminated water as well as the arsenic in natural source is also considered as the chronic source of arsenic accumulation in tissues and secretions of animals. In acute cases of arsenic toxicity, the clinical signs are manifested after 30 minutes. However, these signs can be delayed if the arsenic is given with food. The early clinical signs are present in acute cases are present in the form of muscular spasm, general weakness and flushing of skin (Franzblau and Lilis, 1989).

**Mechanism of arsenic toxicity**

After entry in body in acute cases, the first toxic signs are evidenced by severe vomiting, diarrhea, cramps in muscles and injuries in blood vessels (Rahman et al., 2001). During the chronic cases the site of actions are kidney, liver and skin. The signs are manifested in the form of hyperkeratosis of skin and damages in kidney and liver (Wu et al., 1989; ATSDR, 2000). These two organs are known as the first site of action for toxico pathologic manifestations as well as the changes in cellular morphology and functional activities (Nandi et al., 2005). The absorption of ingested arsenic takes place in gastrointestinal tract and detoxification takes place in liver. The biotransformation of this metal takes place in liver through the oxidation of methyl (Vahter, 2002). This absorbed arsenite is transferred with in liver for metabolization and excretion in urine (Vahter, 2002).

**Patho-clinical Signs due to Arsenic**

These signs vary from species to species. The prognosis of acute arsenic toxicities is limited. Pronouncing sign of arsenic toxicities is death 6–12. The diagnosis of cattle is usually made on postmortem lesions. Arsenic causes the goiter in rats and malfunction of thyroid gland in man. The chronic exposure of this metal causes the cancerous growth in skin in the form of of Multicentric basal cell and squamous cell carcinoma (Pershagen et al., 1983). The cattle suffering from arsenic toxicity results in ataxia with intense muscle fasciculation succeeding to recumbence with bloody diarrhea Valentine et al. (2007). The clinical signs were appeared after 12 hour of arsenic ingestion to cattle in this case. The toxicity of arsenic in mice and rats results in diarrhea and difficult respiratory distress (Stevens et al., 1979). The clinical signs are manifested due to direct inflammation of gastrointestinal tract and by damaging the organs with the reduction of ATP requirements. The signs of toxicity in naturally and arsenic induced are summarized in table 1.
**Table 1: Signs of Arsenic Toxicity in various animal species**

<table>
<thead>
<tr>
<th>Species</th>
<th>Dose</th>
<th>Signs</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>Not reported</td>
<td>The toxic signs were present in the form of severe diarrhea and enteritis with hemorrhages. There was loss of appetite, muscular weakness, ataxia, general weakness and recurrent convulsion.</td>
<td>(Riviere et al., 1981)</td>
</tr>
<tr>
<td>Goats</td>
<td>Sodium arsenite was fed with dose of 75 and 100 mg/kg body weight for six weeks.</td>
<td>Toxicity was present in gastrointestinal and kidney after 12 hours of feeding sodium arsenite. The general appearance of animal was dull and depressed, with reddish color of urine. The postural defects appear in the form of loss ability to rise and postural defects like (knee-based posture, Fig. 1). There was increase in respiratory and heart rate in this case.</td>
<td>(Biswas et al., 2000)</td>
</tr>
<tr>
<td>Goats</td>
<td>(NaAsO2 4 mg/kg body weight daily orally)</td>
<td>Body weight was reduced</td>
<td>(Akter et al., 2010)</td>
</tr>
<tr>
<td>Cattle</td>
<td>Arsenic pentoxide, 780 mg/kg ash</td>
<td>Toxicity appeared in the form of sudden death. The concentration of arsenic in liver, kidney and rumen was 13.9, 23.7 and 25.8 mg As /kg respectively.</td>
<td>(Thatcher et al., 1985)</td>
</tr>
<tr>
<td>Pigs</td>
<td>Arsenic was 100 mg arsanilic acid/kilogram of feed for time of 6 weeks.</td>
<td>Feed intake was decreased.</td>
<td>(Morrison and Chavez, 1983)</td>
</tr>
<tr>
<td>Pigs</td>
<td>1 gram of arsanilic acid/kilogram of diet.</td>
<td>The toxic signs were appeared in the form of loss of appetit.</td>
<td>(Hapke, 1988)</td>
</tr>
<tr>
<td>Hen</td>
<td>15 mg arsenic oxide/kg</td>
<td>Egg mass was reduced</td>
<td>(Holeman et al., 2001)</td>
</tr>
<tr>
<td>Chickens</td>
<td>As (50 mg/kg BW)</td>
<td>Decrease in body weight and feed intake. The other signs were general dull in behavior, breathing with open mouth and thirst was increased.</td>
<td>(Sharaf et al., 2013)</td>
</tr>
<tr>
<td>Quails</td>
<td>30 mg sodium arsenite/kg of feed</td>
<td>No sign reported</td>
<td>(El Begearmi et al., 1982).</td>
</tr>
<tr>
<td>Rabbits</td>
<td>Sodium arsenite with dose of 0, 0.19, 0.75 or 3.0 mg/kg body weight /day for 6-18 days of gestation and sacrificed on day 29.</td>
<td>There was loss in weight gain, diarrhea and terminal convulsions with increasing the dose of arsenic.</td>
<td>(Nemec et al., 1998)</td>
</tr>
<tr>
<td>Dogs</td>
<td>As(III) with 1.2 mg/kg body weight /day and As(V) 3 mg/kg body weight/day</td>
<td>Mortality was present without any sign.</td>
<td>(Byron et al., 1967)</td>
</tr>
<tr>
<td>Rainbow trout</td>
<td>Arsenic trioxide with dose of 180 mg /kg feed and disodium arsenate heptahydrate 137 mg /kg of feed for 56 days</td>
<td>Feed intake and body growth was reduced.</td>
<td>(Cockell and Hilton, 1988).</td>
</tr>
<tr>
<td>Buffalo</td>
<td>Buffalo 50 mg/L</td>
<td>The toxicity was present in the form of loss of body weight. The other external signs were general weakness, dehydrated, anorexic and diarrhea with blood. There was also generalized body signs were; anemia, hemorrhages and congestion was present in intestine, liver and kidneys.</td>
<td>(Rana et al., 2008)</td>
</tr>
<tr>
<td>Cattle</td>
<td>Contamination of Environment</td>
<td>Sudden death, diarrhea, ataxia, dehydration and respiratory distress and marked hemolysis were developed due to arsenic. These abnormalities lead to severe icterus as shown in (Fig 3)</td>
<td>(Bertin et al., 2013)</td>
</tr>
<tr>
<td>Sheep</td>
<td>Drinking of contaminated water with (ug/L) 310 level of arsenic</td>
<td>The average value of body weight, body temperature, heart rate, and respiration rate in As-exposed vs control sheep were (30.70 kg) vs (48.30 kg), (39.22C) vs (38.90C) and (77.60/min vs 37.46/min). The skin was severely in the form of hyperkeratonised and pustule formation (Fig. 2).</td>
<td>(Keshavarzi et al., 2015)</td>
</tr>
</tbody>
</table>
It is evident from Table 1 that different forms of arsenic manifest variety of clinical signs in different animals. The main sites for the changes of arsenic are skin, liver and kidneys.

**Fig: 1** Case of hyperkeratosis and pustule formation in the skin of sheep due to arsenic (Keshavarzi et al., 2015)

**Fig: 2** A case of severe icterus in cattle due to arsenic toxicity (Bertin et al., 2013)

**Treatment**
The administration of sodium thiosulfate with dose of 40 mg/ kg intravenous (IV) for 8 hour has the useful effects in removing the arsenic from the body and maintenance of renal insufficiency (Bertin et al., 2013). However, the antioxidants like vitamin E can also be used to ameliorate its toxic effects (Momeni et al., 2012).

**Conclusion**
This review is source of awareness to progressive livestock farmers about the clinical signs of arsenic toxicity and its management. Although, no such case is reported in Pakistan, but these reports will helpful in future for the control of toxicity. The environmental pollution is continuously increasing in the Pakistan. The source of such cases could not be overlooked in future.

**References**


arsenic prone zone in Haringhata block of Nadia District of West Bengal in India. Inter J Hematol, 4:2.


