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Unexpected detection of phosphine gas in non-poisoning circumstance-Role of medical jurist: A case series.

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ABSTRACT

We evaluate three case reports, wherein death reported in alleged Accidental, Natural and Homicidal manner; but on chemical analysis of submitted viscera in Forensic Science Laboratory (FSL), phosphine gas was detected and creates dilemma to opine prudent cause of death. In such cases, some doctors blindly follow the FSL report and issued mystified opinion and invalidate the role of medical jurist.

But in present case series, doctors refute irreverent FSL result, on the basis of their findings. We analyze and reviewed on both aspect in depth and conclude that merely detection of any toxic material without evidence of its lethal effect on target organ does not provide sufficient evidence for the cause of death. We also enlighten their legal status and suggest how can be, these medico-legal mystifications can be conquer in a more concrete way.

Keywords: phosphine; silver nitrate test; FSL report; prudent opinion

Introduction

Judiciary is a main pillar of democracy and forensic analysis is an important tool for deliver justice to the people. Judiciary always seeks guidance from the forensic medicine experts regarding interpretation of complex issues of a medical–technical nature. During any medico-legal

investigation, Forensic Medicine expert provide medico-legal opinions after receiving the concern ancillary investigation result, so that judiciary can make valid judgments in time. In the FSL forensic scientist provides important contribution, to the Forensic medicine expert and their observations usually the core of investigation of case.

As per approved manual of Directorate of Forensic Science M.H.A. Govt. of India, New Delhi; FSL detects the specific chemical/poison in chemical analysis of viscera of the deceased. But sometimes, doctors find themselves entangled in a situation, where neither clinical and post-mortem findings nor the inquest reports are evocative of death due to poisoning; but on chemical analysis FSL report states that poison has been detected.

In such cases, some doctors either gave mystified opinion or follow FSL report blindly. Such ill framed opinions not only mislead the investigating agency but also expose the deceased's family to the social consequence of poisoning. This creates a double hardship for the family, as they have to cope with lapse of the due financial benefits from life insurance companies, plus the psychological trauma to accept the suicide, as a false reality.

The main reason for this undesirable condition of the doctors is their inability to elucidate the enacted laws and their perception for FSL report as a conclusive proof, even if based on qualitative test.

In this case series, we attempt to enlighten the doctors with their lawful power and documented three cases, wherein doctor opine cause of death, based on all medical findings, not exclusively on FSL report.

Case report no.1: A 45-years-male brought to casualty with alleged history of (h/o) accidently fall from height, on arrival his vitals were BP-144/118mm Hg, PR-88/minute, RR-22/minute, RFT-normal and Glasgow coma scale was 5/15**.** Injuries noticed on forehead and face, associated with bleeding from mouth. CT scan of head was suggestive of multiple contusions in brain stem, involving Pons along with fracture of right zygomatic bone. Autopsy conducted four hours after his death and all external injuries consistent with record. On gross examination pontine hemorrhage on right side and diffuse sub-arachnoids haemorrhage (SAH) involving brain-stem was present. Stomach contains about 150 ml brownish fluid, emanate abnormal odour and mucosa found congested. Kidneys were also congested but lungs and other internal organs were pale. Viscera were preserved, to rule out any alcoholic intoxication as contributory factor to fall. Police submitted viscera to FSL after eleven days, wherein they analyzed it after thirty-seven days and FSL report stated that phosphine gas has been detected. But concerned doctor opine, head injury as cause of death.

Case report no.2: A 52-years-male, habitual alcoholic and smoker admitted in hospital with complain of sudden onset of pain in abdomen from last two days. Pt. was diagnosed as a case of acute generalized peritonitis with shock because of duodenal perforation. His wife raised suspicion on his death and alleged that, his condition could be related to scuffle, which had been occurred few days ago. During autopsy, minor scab at nose, left thigh regions and surgical injuries were noticed and visceral organs like brain, lungs were found congested and edematous. A duodenum perforation was noticed and associated with about one liter of foul smelling fluid in peritoneal cavity. Stomach contains about 100 ml foul smelling fluid; gastric mucosa was also congested and eroded. On histopathology examination features of duodenal perforation and chronic pylonephritis

were found. Viscera were preserved, to rule out any alcoholic intoxication but unexpectedly, phosphine gas was detected. Doctor opined cause of death “shock due generalized peritonitis.”

Case report-3 A 59 year-old-male, brought dead, for autopsy, with alleged h/o found dead in work field. On external examination, skin at back found peeled off, abraded-contusions noticed at forehead, neck and shoulder region. Brain showed gross SAH, lungs were congested and edematous. Liver, spleen, kidneys also found congested but stomach mucosa was neither congested nor evident any peculiar smell. Decomposition changes present in small and large intestine. But in chemical analysis of viscera, phosphine gas was detected. In this case, doctor opined, head injury as cause of death in a case of phosphine gas poisoning which leads to asphyxia and pulmonary edema.

In this case doctor, confused with FSL result and gave Mystified opinion, in our opinion cause of death would be head injury; and congested organs, bluish coloured nails could be consequences of respiratory failure in Neurogenic pulmonary edema as a result of SAH and phosphine produced in decomposition changes may leads to false positive silver nitrate test.

Discussion

In a medico-legal investigation, phosphine gas poisoning suspected by alleged history of ingestion of metal phosphide, examination of crime scene (if intact- for sample collection of vomitus, container of metal phosphide), clinical findings (if hospitalized), and if person died than postmortem examination, toxicological analysis of retained viscera and histopathological examination of target organs. But in most of the cases clear history of poisoning not available as no one interested to be involve in medico-legal cases, that’s why crime scene usually not reported / intact.

Aluminium phosphide (ALP) is a frequently used grain fumigant; once administered in the body, it gets decomposed by dilute hydrochloric acid in stomach, and liberates highly toxic phosphine gas. Each tablet of ALP (3 gm) liberates 1 gm. of phosphine, [1] which acts as respiratory and mitochondrial poison. Phosphine inhibits mitochondrial cytochrome “c” oxydase enzyme; inhibit protein synthesis, denatured oxy-hemoglobin, and various enzymes involved in cellular respiration and metabolism and result in free radical cell damage and cell death.[2]

Chugh et al. reported that the most common signs and symptoms in case of ALP poisoning are gastrointestinal haemorrhages and shock which results in congestive cardiac failure and acute respiratory arrest; [3] And also found that abdominal pain, palpitation, sweating, tachypnea, cold clammy skin, metabolic acidosis, un-recordable blood pressure and shock as the most common symptoms following ingestion of zinc phosphide. [4] Various studies find that phosphine gas produces a multi organ failure like hepatic failure, renal failure, cardiac failure, clotting abnormalities and pleural effusion.

In laboratory analysis, leucopenia indicates severe toxicity, Increased SGOT or SGPT and metabolic acidosis indicate moderate to severe ingestional poisoning. Electrolyte analysis shows decreased magnesium while potassium may be increased or decreased. Measurement of plasma renin is significant as its level in blood carries a direct relationship with mortality and is raised in direct proportion to the dose of pesticide. The serum level of cortisol is usually found to be decreased in severe poisoning. Chest X-ray may reveal hilar or perihilar congestion if ARDS develops. ECG shows various manifestations of cardiac injury (ST depression or elevation, bundle branch block, ventricular tachycardia, ventricular fibrillation).Wall motion abnormalities, generalised

hypokinesia of the left ventricle, decreased ejection fraction and pericardial effusion can be seen in echocardiography.[5]

In postmortem examination, bluish coloured nails and whitish froth evident at nostrils. Irritant effects finds in upper digestive tracts, include superficial erosions, congestion and haemorrhagic mucosa. On opening, the body cavities garlicky odor usually present and visceral organs found congested; and pulmonary edema is a consistent feature.

In histopathological examination varying degree of congestion, edema and leucocytic infiltration, suggesting the features of cellular hypoxia. In the histo-pathology of heart, features of toxic myocarditis with fibrillar necrosis, in lungs features of ARDS and/or Pulmonary edema and in the liver and kidneys, necrotic changes present.[6]

In toxicological examination, phosphine gas is qualitatively detected by silver nitrate test and quantitatively by gas chromatography and mass spectrometry (GC-MS). As GC-MS technique is not available at every FSL, forensic chemical examiner still used silver nitrate test for phosphine gas detection, and which is a simple, reliable and sensitive method.[7] Its specificity is also high except some time silver nitrate produces blackening due to reaction with hydrogen sulfide in the air.[6]

Raina et. al. studied validity of the qualitative test in medico-legal autopsy cases and reported that 65% of human tissues in saturated solution of common salt show positivity for phosphine gas on the first day of autopsy even though there was neither any suspicion of consuming ALP nor any clinical findings. No postmortem findings or circumstantial evidences were evocative of poisoning.[8]

Bansal YS et. al, also reported fallacies with silver nitrate test and find out that hydrogen sulfide librated during decomposition can react with silver nitrate, giving a false positive reaction for ALP and recommended use of lead acetate in every case of suspected ALP poisoning and if result is inconclusive, the confirmatory ammonium molybdate test should be carried out.[9]

Various studies have been conducted on the possible sources of phosphine gas and find that phosphine along with other gases like, hydrogen sulphide, methane, ammonia, marsh and carbon dioxide gas is produced in human body during putrefaction.[10]

Certain mixed acid fermentors bacteria like Escherichia coli, Salmonella gallinarum, Salmonella arizonae and solvent fermentors like Clostridium sporogenes, Clostridium acetobutyricum are able to generate phosphine through anaerobic fermentation.[11] Phosphine emits from sewage treatment plants and from sediments of shallow water[12] and from the human flatus.[13]

Various studies confirm that phosphine gas could be produced in above mentioned non-poisoning circumstances. In our views, research should be promoted for its quantitative and specific detection in the biological materials. Anger F et al reported an ALP suicidal poisoning case; wherein victim was discovered ten days after consumption of ALP and find that Phosphine gas was absent in the blood and urine but present in the brain (94 mL/g), the liver (24 mL/g), and the kidneys (41 mL/g). High levels of phosphorus were found in the blood (76.3 mg/L) and liver (8.22 mg/g). Aluminum concentrations were very high in the blood (1.54 mg/L), brain (36 µg/g), and liver (75 µg/g) compared to the usual published values. [14] Brunner U et al presented a Gas Chromatographic method, which can distinguish phosphine with hydrogen sulphide and other possible head space gases of anaerobic cultures. [15]

However, in above mentioned cases, phosphine gas was detected by silver nitrate test or may be other confirmatory tests. But still these tests are only investigative tools to detect the active in-

gradient only with high sensitivity but are not indicative of its source i.e. due to poisoning, putrefaction or other processes. And mere presence of toxic material in the viscera of the deceased, regardless of the quantity does not provide sufficient evidence as to the cause of death and it is necessary to demonstrate that absorption of the toxicant has occurred and then it is transported by the general circulation to the target organ in order to exerts its lethal effect.[16]

Moreover, in these case reports, presence of congested viscera and pulmonary edema could be explain by neurogenic pulmonary edema (NPE) as a result of intracranial space occupying lesion like, SAH in 1st and 3rd case reports. NPE an acute, protein-rich lung edema occurring shortly after cerebral lesions associated with an acute rise of intracranial pressure and known in patients after cerebral trauma, intracranial hemorrhage, stroke, intracranial tumor or seizures. Studies suggested that NPE is a known complication in intra-cerebral insult, such as SAH and brain tumors and also associated with respiratory failure.[17-20]

However, in reported cases, expert's opined cause of death on the basis of available medical findings and gross pathology; but their opinion may be more concrete if they refute irrelevant FSL results by the histopathological findings of organs. In future, it could be improved, if doctors preserve at least heart, lungs and kidney for histopathological examination either in every case or at least in those cases, where they preserved viscera for chemical examination. And if found necessary, re-chemical examination of retained viscera or quantitative analysis of detected poison, may be consider.

Legal status- Section 46, Indian Evidence Act, 1872; *Facts bearing upon opinions of experts;* make clear to the doctors that *"Facts, not otherwise relevant, are relevant if they support or are inconsistent with the opinions of experts, when such opinions are relevant.*

Illustrations-(a) the question is, whether "A" was poisoned by a certain poison. The fact that other persons, who were poisoned by that poison, exhibited certain symptoms which experts Affirm or deny to be the symptoms of that poison, is relevant."

Doctors are not bound to opine as per FSL reports, they should opine on the basis of their medical findings only; Interpretation of said section also empowered doctors that, report of FSL (Facts) may be consider as irrelevant, when it is inconsistent with (opinion of experts) case history, clinical and postmortem examination findings noted by doctors (experts).

Conclusion

We can conclude that, mere detection of phosphine gas in chemical analysis**,** with-out its lethal effect in body, its source cannot be attributed, exclusively to poisoning only. Forensic doctors must realize the importance of histopathological examination in every case. In FSL, methodology may be improved for specific detection and quantitative analysis of phosphine gas, and research should be promoted for fixed fatal quantitative limit of either phosphine gas or metal ions in the viscera of the deceased.

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