

A Retrospective Descriptive Study on Death Due to Cyanide Poisoning Over a Period of 20 Years in Government Medical College, Thiruvananthapuram

Sasikala K.¹, Vitni Fernz², Abitha Raj B.T.³, Ajith V. Asok⁴, Amritha Mathew⁵,
Karthika Thirunal P.R.⁶, Neethu Pratheep⁷, Sriji R.⁸, Aaditya R.⁹

^{1, 2, 3, 4, 5, 6, 7, 8, 9} Department of Forensic Medicine, State Medicolegal Institute,
Government Medical College, Thiruvananthapuram, Kerala, India.

ABSTRACT

BACKGROUND

Cyanide is a rapidly acting poison which has been the suicidal agent of choice since time unknown. Its notoriety also extends to homicide, and it has often been used by serial killers. It is found in nature and is used in various industries, but is difficult to obtain nowadays as a result of strict policy implementation.

METHODS

All cases of cyanide poisoning over a period of 20 years from 2000 to 2019 were studied. Samples were sent for identification and quantification by GC-MS to the chemical examiner's laboratory. Data was collected in pro forma and entered into Microsoft Excel and analysed using statistical package for social sciences (SPSS).

RESULTS

A total of 84 cases were studied over a period of 20 years. The majority of cases were recorded in the first decade of the study period. Most common age group involved was 31 to 40 years. Males comprised 84.9 % of the total. Majority were suicidal in nature, and 22.6 % were suicide pacts. The reason for committing suicide could not be found in 59.3 %. 67.9 % were found dead or brought dead to the hospital. In 24 % cases, the typical smell of bitter almonds was identified. Police were able to make out the presence of poison in 83.3 % during the preliminary investigation.

CONCLUSIONS

Males were the commonly affected. Ingestion of poison was the method of administration in all cases. Majority were suicides, and occurred in the residence of the victims. In majority of cases, police could identify the cause of death as poisoning. The characteristic smell could be identified only in a few cases.

KEYWORDS

Cyanide, Corrosion, Poisoning, Suicide

Corresponding Author:

*Dr. Vitni Fernz,
MRRA A 15, Thoppil Lane, Vanchyoor,
Trivandrum - 695035, Kerala, India.
E-mail: vitnifernz@gmail.com*

DOI: 10.18410/jebmh/2021/496

How to Cite This Article:

Sasikala K, Fernz V, Raj BTA, et al. A retrospective descriptive study on death due to cyanide poisoning over a period of 20 years in government medical college, Thiruvananthapuram. J Evid Based Med Healthc 2021;8(30):2697-2701. DOI: 10.18410/jebmh/2021/496

*Submission 05-01-2021,
Peer Review 15-01-2021,
Acceptance 07-06-2021,
Published 26-07-2021.*

Copyright © 2021 Sasikala K. et al. This is an open access article distributed under Creative Commons Attribution License [Attribution 4.0 International (CC BY 4.0)]

BACKGROUND

Cyanide has always been a fascinating poison for the common man, who has been wooed by the films showing terrorists ingesting cyanide capsules and "drawing their last breath without even telling its taste"! This is contradicted by the tale of the Russian monk Rasputin, who succumbed only after multiple methods of homicide were tried on him by the assailants. Cyanide or Scheele's acid, has always been associated with notoriety, ever since Scheele, the scientist who first isolated the compound, died from poisoning by yours truly.¹

Commonly known as Prussic acid, is an asphyxiant poison which can cause toxicity by ingestion, inhalation and by contact with skin and mucosa. It is seen naturally occurring in many plants like prunus species, sorghum species, brassicaceae and bamboo. They can be produced by combustion of silk, wool and plastics. Cyanide commonly refers to hydrogen cyanide and its salts. The gas has an odour of bitter almonds, which cannot be perceived by many due to its genetic link. The odour has also been described as that of burnt almonds and crushed tapioca leaves. However, this odour can be detected only by around 50 % people.² It is said to have a bitter, burning taste.

Cyanides have been used in laboratories, photography, in many industries dealing with extraction and processing metals, especially gold. They have been used in chemical warfare. It was used for judicial execution by gassing in some states of USA due to its extreme lethality in the gaseous form. It easily diffuses across the respiratory membrane and reaches the circulation, leading to histotoxic hypoxia.³

Any compound which releases the cyanide ion can kill rapidly in a few minutes, even as little as 1-8 minutes, if inhaled.² Even so, there have been cases where volitional activities have been performed by the victim.⁴ 50-100 mg of the liquid form and 100-200 mg of salts are fatal if ingested. Cyanide, once absorbed into the circulation, inhibits cytochrome oxidase and prevents production of adenosine triphosphate (ATP), leading to histotoxic hypoxia. This leads to metabolic acidosis due to increase in anaerobic respiration. It also causes neurotoxicity. Acute effects include headache, anxiety, agitation, confusion, hypotension, convulsions and coma. There may be corrosion of mucosa, with brick red colour of skin and mucous membranes. Later on, cyanosis develops. Circulatory collapse and pulmonary oedema precedes death. Chronic poisoning causes Parkinsonism like symptoms due to damage to the basal ganglia. Headache, vertigo, tremors, fatigue, optic neuropathy, seizures and mental impairment develop. Rhodanese is a liver enzyme which metabolises cyanide and converts it into cyanocobalamin.⁵

In a victim of cyanide poisoning, the lips may show corrosion, especially if potassium salt was ingested.⁶ Cyanide containing vomitus may cause corrosion on the face as the hydrolysis of cyanide salt produces strong alkali. If the cyanides were ingested as concentrated solution, there is purplish red discolouration in the upper part of the digestive tract. Ingestion of a dilute solution leads to hyperemia and a few petechiae on the mucosa. If capsules were ingested,

there may be residues sticking to the mucosa and corrosion at the sites.³ There may be the odour of bitter almonds. The post mortem staining is brick red and mucosae may be intensely congested. Stomach may show haemorrhagic gastritis, often described as "red, velvety" in appearance. Blood is found to have a bright red colour, the reason being the fully oxygenated red blood cells. As the tissues remain unable to extract oxygen from the circulation, both the arterial and venous blood remains relatively well oxygenated. Muscles may also appear bright red in colour.³ Cerebral and pulmonary oedema is noted. Softening of the basal ganglia, especially the thalamus, has been noted. There may be petechial haemorrhages on the surface of all organs, commonly seen in asphyxia deaths. There is congestion of all organs. Samples of the stomach, intestine and blood are preserved for chemical analysis, along with lung tissue kept in a sealed nylon bag. It has been found that the cyanide levels are highest in brain and spleen.³ Autopsy must be done with care so that the forensic surgeon does not inhale the poison as it can lead to severe headache as a result of cerebral vasodilatation.⁷

Cyanide is a poison of choice for suicide especially in people working in industries like metal workers, scientists and gold jewellers, where it is used.⁸ Terrorists have often used this for committing suicide to escape persecution.⁶ However, it is quite uncommon nowadays due to its restricted availability to the common man.² Accidental exposure may also be seen in industries and by ingestion of cyanogenic fruits, especially in children and cattle.¹ In India, the importance of cyanide as a homicidal poison has gone up in recent times due to serial killers whose modus operandi involves use of cyanide for murder. At present there are three known serial killers who used cyanide for homicide in India: Mohan Kumar aka Cyanide Mohan, K. D. Kempamma aka Cyanide Mallika and Jolly Joseph.

Cyanide is destroyed by embalming, so its detection in embalmed and exhumed remains is difficult.³ Formaldehyde destroys cyanide so that even if a lethal dose of cyanide was present, it will become undetectable.⁴ It is also produced by *Pseudomonas aeruginosa* during putrefaction, although in minute quantities.⁶ Even so, the quantity produced is so less that it cannot be estimated by analysis.⁴ False positives may occur if the samples are refrigerated for a long time. Delay in analysis may also lead to reduction in the cyanide levels in samples, leading to false negatives. Prompt analysis of the samples must be done at all costs, else the cause and manner of death may be misinterpreted.^{3,9}

Objective

To analyse the deaths by cyanide poisoning from cases brought for medicolegal autopsy over a period of 20 years from January 2000 to December 2019.

METHODS

The study was a retrospective descriptive study conducted in the Department of Forensic Medicine and Toxicology, Government Medical College, Thiruvananthapuram. The

period of study was from January 1st 2000 to 31st December 2019, spanning 20 years. The study subjects included all cases brought for autopsy to the mortuary wing of the Department of Forensic Medicine and Toxicology, Government Medical College, Thiruvananthapuram. The cases with history of poisoning and cases with findings pertaining to poison were included in the study. The Kerala Police Form (KPF 102), detailed notes, autopsy reports and chemical analysis reports of the cases were collected (10). The brief history of each case was recorded from the KPF 102.

The victim's body was identified by the charge civil police officer (CPO). External examination findings were recorded first. Dissection technique followed was modified Letulle's method. All organs were dissected, weighed and cut and findings were recorded. The stomach with all its contents and the resected part of jejunum were preserved together in a plastic bottle with saturated solution of common salt as preservative. One third of the liver and one half of each kidney were preserved in saturated solution of common salt in another plastic bottle. 30 ml of blood and 30 ml of urine (if available), were collected separately in plastic bottles and preserved in sodium fluoride (10 mg/ml), covered with a layer of liquid paraffin. All of these were signed, labelled, sealed and sent to the chemical examiner's laboratory via the charge CPO, with the forwarding letter, maintaining strict chain of custody. Colour test for screening is Steyn's test. Quantitative analysis of the samples was done by GC-MS (gas chromatography – mass spectrometry).

Statistical Analysis

Data of each case was collected in a pro forma and entered into Microsoft Excel spread sheet and analysed using appropriate SPSS (version 26) software. The qualitative variables were expressed as proportions and the quantitative variables as mean with standard deviation and mode. The variables which were studied included the trend of poisoning cases over the study period, the proportion of cases of poisoning, age groups affected, the sex ratio, the manner of poisoning, post mortem findings and chemical analysis reports.

RESULTS

A total of 84 cases of cyanide poisoning deaths were recorded in the 20-year period. Of these, 65 cases were in the first decade and 19 in the second. Maximum number of cases were in 2003, reaching a tally of 19. The total number of poisoning cases showed a declining trend from 2000 to 2019, which was mirrored by the incidence of cyanide poisoning. No case was recorded from 2016 onwards.

Maximum number of cases were noted in the jurisdiction of Parassala police station (10 cases), followed by Fort and Thiruvallam police stations, with 6 cases each.

The mean age was 37.36 years (SD = 14.4) with a range of 5 to 75 years. The age group most affected was 31 to 40 years, 21(24.4 %) cases. 58 (69 %) cases were in the age

range 21-50 years. Age was unknown for one case (Table 1).

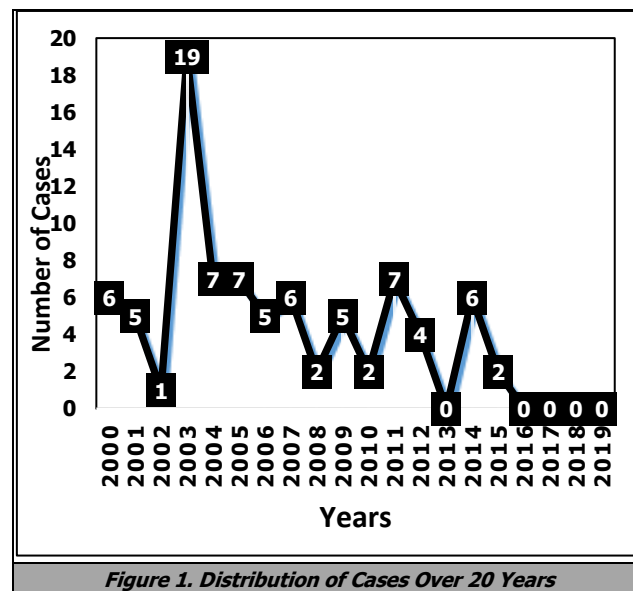


Figure 1. Distribution of Cases Over 20 Years

Age Range in Decades	Number of Cases	Percentage
0 - 10	3	3.5
11 - 20	7	8.1
21 - 30	19	22.1
31 - 40	21	24.4
41 - 50	18	20.9
51 - 60	11	12.8
61 - 70	3	3.5
71 - 80	1	1.2
Unknown age	1	1.2
Total	84	100

Table 1. Distribution of Cases Based on Age

Of the 84 cases, 73 (84.9 %) were males and 11 were females (12.8 %) (Figure 1).

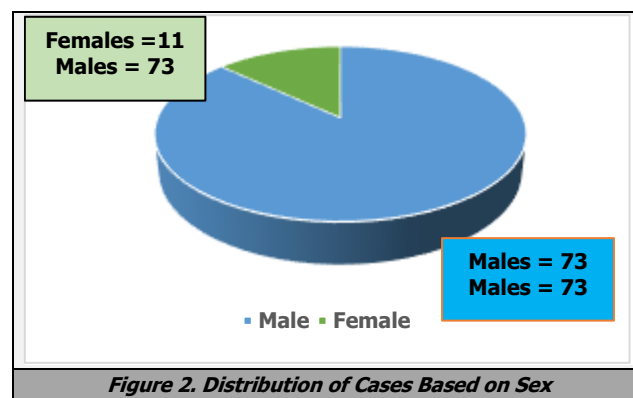


Figure 2. Distribution of Cases Based on Sex

The body of the victim was discovered at the residence in 79 % cases and at work place in 7 % cases. The initial examination of the body and the crime scene was done by the police and it was determined that there was ingestion of some poison in 70 (83.3 %) cases. Some natural cause like disease was suspected in 9 (10.7 %) cases and the cause was not ascertained in 5 (6 %) cases.

Manner of death was determined to be suicidal in 73 (86.9 %) cases and homicidal in 1 (1.1 %) case. In 23 (27.4 %) cases, the manner could not be made out. Among the cases where suicide was suspected, the reason was not known in 51 (59.3 %) cases. The most common reason was

found to be financial difficulties, in 12 cases (14 %). Depression due to disease was found to be the main factor in 6 (7 %) cases and love failure in 15 (17.9 %) cases.

In 13 (15.5 %) cases, the victims were found unconscious. 4 (4.8 %) reached hospital alive. 57 (67.9 %) were found dead or brought dead to the hospital. 10 (11.9 %) cases were in a decomposed state on discovery (Table 2).

State of the Victim When Discovered	Number of Cases	%
Found unconscious	13	15.5
Reached hospital alive	4	4.8
Found dead / brought dead	57	67.9
Decomposed	10	11.9

Table 2. Distribution of Cases Based on State of Victim on Discovery

Family members as a whole were involved in 17 (19.8 %) cases. 5 families were involved, comprising 15 of the cases. Five members of one family comprising the parents and three children was the highest number of fatalities recorded at a time. Two instances involved the parents and their daughters, contributing to six cases. 12 cases were in 2003, all of which consisted of four families. A couple of cases involved lovers, comprising 4 cases (Table 3).

Year	Relation	Number of Fatalities
2000	Mother and son	2
2003	Parents and daughter	3
2003	Parents and three children	5
2003	Husband and wife	2
2003	Lovers	2
2006	Parents and daughter	3
2009	Lovers	2
Total		19

Table 3. Distribution of Cases in Which Victims Were Related

Stomach contents were found to have the smell of crushed tapioca leaves in 24 (27.9 %) cases, and described as having an unusual smell in 41 (48 %) cases. No unusual smell was detected in 19 (22.1 %) cases. Stomach contents consisted of food particles in 71 % cases, whereas reddish mucoid fluid was present in 29 % cases. Mucosa of the stomach showed corrosion in 19 % (16 cases). The mucosa of stomach was described as crimson or velvety red in 29 (35 %) cases and as intensely congested in 37 (44 %) cases (Table 4).

Mucosa of the Stomach	Frequency	Percentage
Congested	18	21
Intensely congested	37	44
Crimson / velvety red	29	35
Total	84	100

Table 4. Distribution of Cases Based on Findings in the Stomach

Chemical analysis revealed hydrocyanic acid in all but one case (98.8 %) and the quantitative estimation was done in 59 (70 %) cases. Among the quantified cases, the highest value detected was 2.6 mg% and the lowest was 0.09 mg%. Poison was not detected in one case. Ethyl alcohol was detected in four (5 %) cases. Histopathology examination was done in 2 cases. No tests other than chemical analysis were done in 75 (89.5 %) cases. The mean time for receipt of chemical analysis report was 5.27 months (SD = 5.383;

median = 3.5 months; mode = 2 months), with minimum of less than a month and a maximum of 28 months.

The opinion was given as poisoning in 63 (75 %) cases and reserved pending investigations for 17 (20.2 %) cases. No opinion was furnished in 4 cases. The final opinion was given as death due to hydrocyanic acid poisoning in all cases.

DISCUSSION

The present study showed a mean age as 37.36 years (SD = 14.4) and minimum of 5 years to a maximum of 75 years. 255 cases of cyanide poisoning over a period of 6 years were studied retrospectively by Lee et al. and they observed that the mean age was 41.88 (SD = 13.09) and range was from 6 to 80 years. Age was unknown in 1 case in this study contrary to 7 cases among the 255 in the study by Lee. Largest number of cases were recorded in the age 40 to 49 years, contrary to this study where the maximum number of cases were in 31 to 40 age range.¹⁰ Males were dominant in all the studies reviewed. This is in accordance to Polson and Tattersall.⁴

Only 4 (4.8 %) cases were brought alive to the hospital, but they succumbed to death in a time period shorter than 2 hours, whereas 37 (14.5 %) cases received medical attention in the study done in Korea.¹⁰ It has been described that the victims who live for 4 hours after exposure to the poison may end up surviving. Poisoning by sodium nitroprusside, however may cause death at a much later date.⁴ The rest of the victims were either found unconscious or dead at the scene, or declared as dead on arrival to the hospital.

Gill. J. et al. reviewed 17 occurrences of cyanide poisoning over a decade and observed that pink colour of lividity and bitter almond smell along with haemorrhagic gastric mucosa were not prominent in majority of the cases, similar to the observations in this study. Suicide was the most common manner of death in about 93.7 % cases and 86.9 % cases in this study.⁸ Depression was found to be a major contributing factor for suicide. There were instances of depression relating to financial reasons, disease and failure of affairs.

The most common location of the victim was their own residence, similar to this study. Route of administration was oral in 98.8 % cases in the study by Gill J. et al. whereas it was oral in all cases in this study.⁸

The incidence of cyanide poisoning is, however, uncommon as there is restricted availability.² Generally, the manner of death by cyanide poisoning is suicidal, followed by accidental. Homicide by use of cyanide is relatively rare according to literature. In this study, one case of homicide was when the mother fed poison to her two sons, aged nine and six years. The elder son survived, whereas the mother and the younger child succumbed to the poison. Suicide-homicide scenario, commonly known as dyadic death, has been noted by Polson and Tattersall in two cases.⁴

In this study, the source of cyanide was determined only in one case, where the victim was an employee of a gold

jewellery. In all the other cases, the exact source could not be determined.

Quantitative estimation was done in 57 out of the 84 cases. Halstrom and Moller (1945) have conducted studies showing that the quantity detected in various organs and blood do not have any relation to the amount taken. The quantity taken becomes pertinent when the time taken for death is analysed, as death is rapid with higher dose of the poison. It is clear that the quantity of the poison and the route of exposure is more important to determine lethality than any other factors. Even the post mortem changes are influenced by the rapidity of death. There are few and subtle indicators of cyanide poisoning if the death is sudden, as caused by inhalation of the noxious gas. Poisoning by ingested alkaline cyanides, on the other hand, causes more external and internal changes.

CONCLUSIONS

The study was aimed at analysing the pattern of deaths caused by cyanide and it was concluded that:

- 1) All cases except one were suicidal in nature.
- 2) Younger and middle-aged individuals were more involved.
- 3) Males predominated.
- 4) Suicidal pacts involving family members or lovers were seen in 19 cases.
- 5) Oral route of administration was followed in all cases.
- 6) Chemical analysis of the viscera, keeping in mind a high index of suspicion, is needed for arriving at a conclusion.
- 7) Police were able to identify the presence of some poison in 83.3 % of the cases.
- 8) The typical smell of bitter almonds could be perceived only in 24 % cases.
- 9) 19 % cases showed corrosion of lips or mucosae.

Recommendations

- 1) Strict measures are needed to regulate the sale and use of cyanide compounds. This is extremely important in the current era with chemical warfare and terrorism.
- 2) Suicide is increasing at an alarming rate among all ages, sexes and races. It must be addressed and active measures must be taken to reduce this.

- 3) Cyanide, being a rapidly fatal poison, needs prompt and quick management to reduce fatality.
- 4) Research is needed to develop an antidote which can be administered effectively in case of mass casualty involving cyanide.

Data sharing statement provided by the authors is available with the full text of this article at jebmh.com.

Financial or other competing interests: None.

Disclosure forms provided by the authors are available with the full text of this article at jebmh.com.

REFERENCES

- [1] Pillay VV. Modern medical toxicology. 4th edn. Jaypee Brothers Medical Publishers (P) Ltd., 2013: p. 364-370.
- [2] Dolinak D, Marshes E, Lew E. Forensic Pathology: principles and practice. 1st edn. Elsevier Academic Press 2005: p. 250-258.
- [3] Adelson L. The Pathology of Homicide. 1st edn. Illinois: Charles C Thomas Publishers 1974: p. 742, 748, 849-857.
- [4] Polson CJ, Tattersall RN. Clinical Toxicology. London: The English Universities Press Ltd., 1959: p. 107-139.
- [5] Guharaj PV, Gupta SK. Forensic Medicine and Toxicology. 3rd edn. Universities Press 2019: p. 675-677.
- [6] Modi JP. A textbook of Medical Jurisprudence and Toxicology. 25th edn. LexisNexis Corporation, 2018: p. 310-314.
- [7] Umadethan B. Principles and Practice of Forensic Medicine. 2nd edn. Kochi: CBS Publishers 2016: p. 497-498.
- [8] Gill JR, Marker E, Stajic M. Suicide by cyanide: 17 deaths. Journal of Forensic Sciences 2004;49(4):826-828.
- [9] Reddy NKS, Murthy OP. The essentials of forensic medicine and toxicology. 34th edn. Delhi: Jaypee Brothers Medical Publishers (P) Ltd., 2017: p. 582-585.
- [10] Lee SK, Rhee JS, Yum HS. Cyanide poisoning deaths detected at the national forensic service headquarters in Seoul of Korea: a six year survey (2005-2010). Toxicol Res 2012;28(3):195-199.