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1984 BHOPAL GAS TRAGEDY : AN AUDIT OF ANOMALIES IN THE CRANIOFACIAL REGION OF THE CROSS GENERATION SURVIVORS OF TRAGEDY.

Pathology

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ABSTRACT

BACKGROUND: 1984 Gas tragedy was a result of the release of Methyl isocyanate from a pesticide plant in Bhopal accounting for death of millions. The health effects were recorded from the survivors ranging from ocular, respiratory, reproductive system, psychological to genetic damage. Chromosomal aberrations have also been reported exposed to the gas and experimental studies exposed to methyl isocyanate revealed changes in developing foetus including reduction in length of mandible. However, cross generational study of the effects of the exposure to methyl isocyanate have been far and few.
AIM: This study was an attempt to study the prevalence of craniofacial deformities in the first-generation survivors of Bhopal gas tragedy and to evaluate the possible role of methyl isocyanate in the causation of cross-generational craniofacial anomalies.
MATERIAL & METHODS: The present study was based on a survey of the tragedy survivors comprising of 500 subjects of the first- or second-generation tragedy survivors and 200 subjects of non-exposed areas taken as the control group.
Interpretation and conclusion: The results obtained showed the disastrous chemical nature of MIC, its association with Orofacial clefts, the prevalence of mental retardation in relation to exposure of MIC and a higher male predilection of these anomalies.

KEYWORDS

Bhopal Gas Tragedy, Craniofacial Anomalies, Cross Generation Effect, Methyl Isocyanate.

Abbreviations – MIC – Methyl isocyanate, WHO – World Health Organization, CSE – Centre for Science and Environment

What is Re-search? As defined by eminent statistical scholars, Research is "the systematic investigation into and study of materials and sources in order to establish facts and reach new conclusions." The precise intention to take the industrial disaster of Bhopal as a research project was to reach to a new conclusion but never to reach such remorseless conclusion. The results of observation, methodology and conclusion of my study would have been epical from research perspective but are regrettable on human grounds.

As an Oral health professional, the idea of choosing this topic was to put an insight on the oral health conditions of the survivors of the tragedy and to evaluate the aftermath on craniofacial features of second and third generation survivors. But the wrecking health conditions of today and the prevailing environment for the cross generational survivors left in ambiguity and shudder of how the general and oral health conditions for years to come are in peril.

BACKGROUND

December 2018 marked the thirty-fifth anniversary of the world's nastiest industrial debacle which happened to occur in a pesticide plant in Bhopal, the capital city of heart state of India, Madhya Pradesh. It was one of the most horrific industrial calamities in Human history that took place due to the leakage of Methyl Isocyanate gas. Thousands of people died immediately and some died after prolong illness. That live to tell the tale developed various ailments and incident was so called the "Nagasaki and Hiroshima of peace time". The scarcity of data on the toxic effects of MIC let to incongruous pronunciamiento ranging from "no long-term effects" to "effects that may last for generation to come". [1]

During the early epoch following the accident, treatment of the clinically injured took priority over the planning but later on epidemiological studies were also conducted then but few and far between situations. 3000 people died of pulmonary oedema on the day of accident and the results of the studies done then, evidenced immediate killing of at least 38,000 people (fairly far more than indicated in records) and caused significant morbidity and premature death for many thousands more. Widespread environmental degradation with noteworthy undesirable human health consequences continues to occur throughout the city since then.[2,3,4]

Pathology & Toxicology - The research outlining symptomatology and clinical indisposition in the survivors have been conducted to testify mortality, overall morbidity, general health effects which includes pulmonary, reproductive, immunological, ocular and neurological toxicity. The pathophysiological patterns were distinctive suggestive of diverse toxicity. The chemicals released generated 'acute and severe', 'subacute and moderate' and 'chronic and mild reactions'. The initial studies would suggest that the toxic effects were manifestation of direct cyanide poisoning but actually it was combined effect of MIC-HCN adduct that happen to occur after the pyrolysis of methyl isocyanide leading to imparity of cytochrome oxidase activity. [5,6,7]

The exposure of the population to methyl isocyanate (MIC) has brought about genetic damage where development and maintenance of chromosomal aberrations can be evidenced in generations. Chromosomal aberrations have been reported in both males and females exposed to the gas and experimental studies on pregnant mice exposed to MIC revealed changes in developing foetus including reduction in length of mandible. Substantial studies on speckled aspects, especially on pulmonary, non-pulmonary, obstetrical, gynaecological with various other cross-sectional studies outlining symptomatology and clinical indisposition in the survivors have been conducted. However, cross generational study of the effects of the exposure to MIC have been far and few. Moreover, data pertaining to prevalence of craniofacial deformities in first generation survivors of Bhopal Gas Tragedy are less. [6,7,8,9]

The water contamination by this gas and its aftereffects on next generation needs to be estimated. Considering the mortalities and disabilities of the sufferers, it was necessary to conduct clinical and epidemiological study to understand the etiopathogenetic mechanism of the leaked gas (MIC) so as the future complications can be avoided.
So, this study attempts to study the prevalence of craniofacial deformities in the first- and second-generation survivors of Bhopal gas tragedy and to find the prevalence of oral and dental anomalies (if any) in the same. [9,10,11]

MATERIAL & METHODS: -

The present study was based on a house to house survey of the Bhopal gas tragedy survivors in exposed and non-exposed areas. The study population comprised of 506 subjects of the first or the second-generation survivors in the tragedy. 273 subjects, children of people not exposed to the gas formed the control group. The exposed areas

included J.P Nagar, Teela Jamalpura, Shakti Nagar, Indira sahayata vihar, Kenchi Chchola (within the geographical location of 0.5 -2.5 km of the pesticide plant). The non-exposed areas were 6-8 km away from the carbide plant and included Malviya Nagar, Nehru Nagar, Jawahar Chowk and Shahjehanabad. Informed consent was taken from the subject or their parents. Questionnaire was filled and an interview was taken to record the subject's clinical data. General oral examination as was done as per WHO guidelines. Any 3 existing medical records of the subject were also included. The inclusion and exclusion criteria

INCLUDED - INCLUSION CRITERIA:

1. Study populations included the first or the second-generation members of the Bhopal gas tragedy survivors of 1984.
2. At least one parent was a survivor of the gas tragedy.
3. The survivors of the tragedy should be registered with the "Bhopal gas tragedy relief and rehabilitation department, Government of Madhya Pradesh, Bhopal".
4. The addresses of the subject and/or the parent during 1984 were ascertained as per ICMR number or ration card.
5. The study population should be the permanent residents of Bhopal.

EXCLUSION CRITERIA:

1. Patients above the age of 25 were not included.
2. Any craniofacial anomaly with a known cause other than the gas tragedy like forceps delivery, administration of known teratogens during pregnancy, maternal tobacco or alcohol consumption, familial cases existing irrespective of 1984 gas tragedy - Endocrinal, hematological, occupational or neoplastic, and trauma. Subjects who have undergone maxillofacial reconstructive surgery for causes other than gas tragedy were also be excluded.
3. Subjects with no parents registered with the "Bhopal gas tragedy relief and rehabilitation department, Government of Madhya Pradesh", Bhopal and subjects with no proper/ inadequate history were also excluded.

RESULTS:

Total 506 subjects were examined in the exposed areas out of which 396 belonged to the first generation and 110 to the second generation (Figure 1). The exposed population included 119 males and 387 females including both the first and second generation (Figure 2). The reason of higher number of females in study group was the methodology adapted which included a house to house survey showing greater availability of females at home. From the total exposed subjects examined during the study, 36 subjects were found to be positive with some anomalies. The anomalies included cleft lip/palate, mental retardation, physical disability and other disorders like deafness, blindness and dumbness (Figure 3). Among the non-exposed population, 273 subjects were examined in the control group out of which 205 belonged to the first generation and 68 to the second generation, (156 females and 117 males). Only a single patient was found positive with both physical disability and mental retardation. The results showed the higher prevalence of craniofacial anomalies in exposed areas to MIC as compared to non-exposed area. The affected subjects belong to first generation indicating the cross generational effect of MIC on the exposed generation (Figure 4). Selective growth retardation and anomalies were found more in boys as compared to girls who were exposed as toddlers or born to exposed parents.

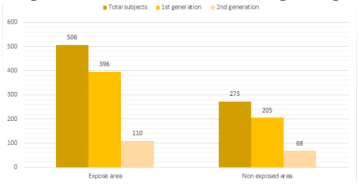

Figure 1 – Total Subjects examined in Exposed and Non – Exposed Population

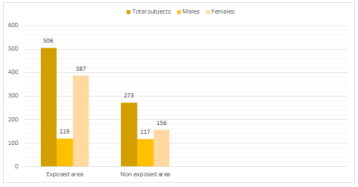

Figure 2 – Gender Predilection for total subjects examined in the Exposed and Non- Exposed Population

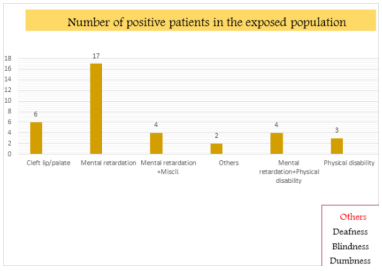

Figure 3– Total Number of positive patients in the exposed population with defect types

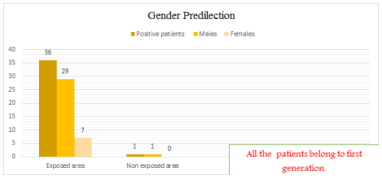

Figure 4 – Gender predilection in positive Patients with positive predilection in males.

DISCUSSION:

Union Carbide Plant was customized to manufacture diverse kinds of pesticides. Those manufactured then were "Carbaryl (the trade name - Sevin), Aldicarb (the trade name - Temik), and a formulation of Carbaryl and gamma-hexachlorocyclohexane (γ-HCH)". All these pesticides fall under carbamate group of insecticides; these were abstemiously persistent, highly noxious; water soluble and itinerant in soils. The health impact of the methyl isocyanate gas proves lethal effect causing immediate deaths and diseases in the near and distant future. Because of the toxicity caused by the chemical gas, there is increased possibility of pregnancy complications, abortions, congenital abnormalities and still births. The results obtained put emphasis on certain points like the Chemical nature of MIC, its association with Orofacial clefts, the prevalence of mental retardation in relation to exposure of MIC and a higher prevalence of these anomalies in males. [1,2,3]

A. CHEMICAL NATURE OF METHYL ISOCYANIDE

MIC retort the biological molecules like amino acids, alcohol or sulfhydryl groups, and react with water to form two chemicals namely carbon dioxide and methylamine. When the by-product of pesticide plant MIC is pyrolyzed between the temperature range of 427 °C and 548 °C, it crumbles to hydrogen cyanide and carbon dioxide. MIC infuriates the skin, eyes, and respiratory mucus membranes. It even reacts with water to stab the tissues including skin. Previous human and animal-based studies have suggested that MIC and its hydrolytic products like Trimethylamine after inhalation or when admixed in ground water is reported to produce reproductive toxicity. Teratological experiments showed that MIC causes decrements in the crown-rump length, diameter of the yolk-sac, length of the head and reduced the survival rate of the embryo. Moreover, a recent report given by CSE has suggested that this chemical laced ground water can be a probable cause of birth defects and other craniofacial anomalies most likely to affect first generation survivors. [1,2,3,5,6,7]

B. ASSOCIATION OF OROFACIAL CLEFTS WITH MIC

Prevalence of orofacial clefts in India is 1 in 800 in contrast to which the present study showed a prevalence of 6 in 506 subjects examined in exposed areas which is very high and significant with its predilection in females, involving left side. The presence of clefting is non-syndromic suggesting its origin being polygenic, strongly suggesting the association of these clefts with MIC. Chromosomal studies have shown involvement of some important chromosomes in 6 metaphase among gas exposed areas like chromosome 5, 9, 11, 14 and 16. Moreover trisomy of chromosome 9p causes an erratic chromosomal ailment characterized by mental retardation and craniofacial malformations. All these evidences suggest a direct relation of MIC in the causation of these head and face abnormalities. [12,13,14,15]

C. PREVALENCE OF MENTAL RETARDATION IN EXPOSED INDIVIDUALS.

The most common anomaly seen in the first-generation survivors

observed was the mental retardation. The most common cause of mental retardation is Robertsonion translocation in acrocentric chromosomes 13 and 21, which was also seen in MIC exposed individuals. The chromosomal dysjunction and terminal duplication in chromosomes 14 leads to phenotypic features like mental retardation, growth deficiency, hearing loss and congenital malformations, which was experimentally proved to be caused by MIC in several documented studies.[12,13,14,15,16,17]

D. REASON FOR PREDILECTION IN MALES

The results of the present study showed the prevalence of Orofacial defects higher in females whereas the growth retardation was found to be more significantly associated with males. The reason for its prevalence in males was one of the dilapidation products of MIC, named trimethylamine, reported to produce growth retardation in the male progeny, allied with a decrease in the serum levels of testosterone[2,3,5,6,7]

CONCLUSION:

There is no safe womb even today but the pierce of the Biochemical Lesion of MIC toxicity to the foetus is still left to be untangled. Any advanced investigation for each of these defects was out of the scope of the study so a wider continuation of study involving second generation is advised to ascertain the hereditary pattern of the disease. Scholars state that the health ailments of the affected people need to be trailed for a firm timeframe to have a vibrant understanding of the long-term outcomes of this noxious gas. So, painstaking chromosomal studies are needed to know the long-term effects of MIC and to understand how and why these defects are caused.[18,19]

The authors of this article intend to conduct the cytogenetic alteration study on the positive patients found in this study.

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