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Original Research Article

DEATHS FROM GAS EXPLOSION IN SOUTHERN NIGERIA

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Abstract:

Background: The Gas explosion is usually associated with ignition of accidentally released flammable gas which mixes with air once the ignition limit is reached. The injury from the gas explosion can result from blast or burns. The burns injuries are usually the consequence of the associated flames.

Aim: To determine the cause of death of four workers involved in a gas explosion while at work in a government organization in southern Nigeria.

Methodology: This is a study of the death of four workers in a government organization in southern Nigeria in which there was a sudden explosion of a gas cylinder involving people on duty. A complete autopsy was done on all the victims at the Department of Pathology, University of Calabar Teaching Hospital, Calabar, Cross Rivers State, Nigeria. Data for all causes of death following the explosion was analyzed using simple inferential statistics.

Results: Four victims were involved in the incident. They were workers of the organization. All were male ranging from 36 to 55years of age. All the victims suffered 80% and above of third-degree burns using Wallace rule, 100% of the victims had severe pulmonary congestion/edema, 50% of the victims had soft tissue injury and 25% of the victims had a head injury. The cause of death in all the cases is adult respiratory distress syndrome (ARDS) following inhalational (gas) injury.

Conclusion: The poor safety measures in government facilities in our environment raises a lot of concern in situations like this. The implementation of proper safety measures in government organizations in this environment would definitely go a long way in safeguarding the life of the workers in such organizations.

Keywords: Gas explosion, burns, death, autopsy.

Introduction:

The right to life is the most fundamental right of man. Safety at work is both an excellent economic policy and a basic human right.[1] Gas explosions refer to an explosion resulting from a gas leakage in the presence of an ignition source. It generally constitutes a major hazard in many

workplaces requiring proper safety precautions and as such preventing the damage, injury and deaths associated with such incidents. A gas explosion is usually associated with ignition of accidentally released flammable gas which mixes with air once the ignition limit is reached.[2,3, 10] The resulting flame and burning of flammable materials in the environment leads to the destruction of the ventilation system, generation and spread of toxic gases such as carbon monoxide. The resulting flame propagation process may develop explosive combustion and damaging blast loadings.[2] In spaces containing a lot of equipment, an explosive combustion may be associated with the generation of high explosive overpressures. If the design of the facility did not put such overpressures into consideration, there may be fatal consequences.[2] The injury from the gas explosion can result from blast or burns. The burns injuries are usually the consequence of the associated flames.

According to the World Health Organisation, an estimated 265,000 deaths occur every year as a consequence of burns. The majority of these cases occur in low/middle – income countries like ours.[3] Injuries from burns whether fatal or non-fatal occur predominantly in homes and workplace.[3]

In India, over 1,000,000 people are moderately or severely burnt every year.[3] In 2008, over 410,000 burns injuries occurred in the United States of America with approximately 40,000 requiring hospitalization. [3]

Yang et al in a study of the statistical analysis and countermeasures of gas explosion accident in coal mines in China found that there have been severe/fatal accidents associated with the gas explosion in 4.2% of the incidence of a gas explosion.[4] Another study by Cao et al in 2012 in China show that the minimum ignition temperature for coal-dust was 913k and concentration is 740g/m^3 demonstrating that there are a minimum temperature and concentration favorable for an ignition/explosion of a flammable gas.[5] Another study by Chang et al which reviewed 242 accidents of storage tanks in industrial facilities for over 40years revealed that fire/explosion accounted for 85% of the accidents in refineries, oil terminal or storage. The study also revealed that 30% of the incidents were due to human errors including poor operations/maintenance, open flames, static electricity, leaks, equipment failure, cracks/rupture, sabotage and lightening.[6] Similarly, a study by Gupta of the popular Bophal gas explosion in India in 1984 revealed that the gas explosion caused 3000 deaths and disability/ lifelong-suffering in over 300,000 victims.[7] The study revealed that in order to cut down the cost of production, safety had been compromised in Bhopal long before the accident occurred. [7] A study by Blaizer et al in 1995 of the Piper Alpha Oil platform explosion show that 167 deaths resulted from the explosion and again, poor safety conditions in the platform were responsible for the explosion.[8] Also a study by Amponsah-Tawaih et al on occupational health and safety in Ghana revealed that the lack of comprehensive occupational health safety policy, poor safety infrastructure and funding, lack of qualified occupational health/safety personnel and general lack of adequate information are the drawbacks to the provision of adequate occupational health and safety services making many workers vulnerable to industrial accidents like gas explosion.[9]

There is no doubt severe losses associated with this incidence of gas explosion including human lives and properties. Renjith et al in their study in 2010 recounted the numerous loss associated with this incidence and recommended institutions/organizations focus on the provision of a preventive measure designed on the basis of a thorough qualitative and quantitative hazard analysis.[10]

In our case, we tend to evaluate the actual cause of death following the explosion in each case. Such gas explosions are unusual in our environment especially in a perceived well-organized apex organization of the government.

Materials and Methods

This is a study of the death of four workers in a government organization in south-south Nigeria who was said to have had a sudden explosion of a gas cylinder involving people on duty. There was a lot of injured people with severe burns using Wallace criteria and four deaths. A complete autopsy was done on all the victims at the Department of Pathology, University of Calabar Teaching Hospital, Calabar, Cross Rivers State, Nigeria. Data for all causes of death following the explosion was analyzed using simple inferential statistics.

Results:

The victims were said to be at their duty posts in the premises of a government organization in Calabar. The victims were staffs of the organization all were male of African descent ranging from age 36 to 55years. A fillet welder was working on the facilities of the organization when flammable gas leaking from his cylinder was ignited by his electrode and an explosion occurred. The explosion which was followed by fire engulfed the premises burning all flammable material resulting in various degrees of burns and traumatic injuries in the victims. The victims were brought to the University of Calabar Teaching Hospital where they were treated and four of them died within 24hours of admission. A complete autopsy was done on the body of the four victims. The extent of burns was examined using Wallace rule. The table1 below shows the age, sex, anatomic-pathological findings, histology and cause of death in the victims.

Table 1: Showing the age, sex, anatomic-pathological findings, histology and cause of death in the victims.

S/N	SEX	AGE (Yrs)	ANATOMIC-PATHOLOGICAL SUMMARY	HISTOLOGY	CAUSE OF DEATH
1.	Male	36	85% third-degree skin burns soot deposit in the epiglottis, larynx, and trachea, severe pulmonary edema/congestion Soft tissue injury	S	1a.ARDS 1b Inhalational injury 1c. Severe burns
2.	Male	46	90% third-degree skin burns, Subgaleal haematoma Soot deposit in the epiglottis, larynx, and trachea Severe pulmonary edema/congestion	S	1a.ARDS 1b. Inhalational injury 1c. Severe burns 11. Head injury
3.	Male	55	0% third-degree skin burns Soot deposit in the epiglottis, larynx, and trachea severe pulmonary edema/congestion	S	1a.ARDS 1b. Inhalational injury 1c. Severe burns
4.	Male	39	5% full thickness skin burns Soot deposit in the epiglottis, larynx, and trachea Severe pulmonary edema/congestion	S	1a.ARDS 1b. Inhalational injury 1c. Severe burns

S=LUNGS- Histological sections of lung tissue show alveoli containing edema fluid with red blood cells and mononuclear cells lined by a hyaline membrane composed of fibrinous exudates with the necrotic debris of cells.
The histological sections of the lungs in all cases were similar.
ARDS – Acute respiratory distress syndrome.

Table2: Showing significant clinical – pathological findings and proportion of victims affected

S/N	Significant Clinicopathological Findings	Proportion of victims (%)
1	At least 80% third-degree skin burn	100
2	Severe pulmonary edema/congestion	100
3	Soft tissue injury	50
4	Head injury	25
5	Histological findings showing ARDS	100

Figure 1: A 36years male of African descent who presented at accident and emergency department with severe burns and loss of consciousness.
The skin over the head and neck show the deposit of soot giving a dark appearance. There are an estimated 85% superficial burns (Wallace's rule) of the skin involving the head, neck, chest, back and both lower limbs.

Figure 2: The picture shows the presence of frothy fluid in the respiratory tract. The respiratory tract including the epiglottis, larynx, and trachea show the heavy deposit of soot from the fire. The lungs are heavy, buggy and wet with the right weighing 1000g and the left 980g.The cut surface reveals free flowing frothy fluid.

Histology (All the cases had similar histological findings in the lung and kidneys):

Lungs (left and right)- Histological sections of lung tissue show alveoli containing edema fluid with red blood cells and mononuclear cells lined by a hyaline membrane composed of fibrinous exudates with the necrotic debris of cells.

Kidneys (left and right) - Histological sections of the kidney show several ghost outline of renal tubule line by necrotic tubular cells with sparing of the glomeruli.

Discussion

The unfortunate preventable death of these four victims is of extreme significance. The four victims died from burns injury as had been observed in victims of the previous gas explosion.[3,4,5.6] The fire that resulted from the explosion caused burning of flammable material and causing burns injury in the skin with inhalation of soot from the flame which causes injury to the respiratory tract with the lungs. All the victims(100%) had an inhalational injury as evidenced by soot deposit in the respiratory tract. Though information on statistics on inhalational injury appears scarce in our environment, in

the United Kingdom, 0.29/1000 burns cases are admitted for inhalational injury with 250,000 new cases presenting at the primary care center yearly.[12,13] This inhaled hot soot from the fire causes damage to the pneumocytes and alveolar capillary endothelium with exudation of protein-rich fibrinous exudates and necrotic debris of cells. The development of the respiratory membrane is associated with accumulation of fluid within the alveolar sac. Following this, severe pulmonary congestion and edema results.[10,14] This results in a compromised oxygenation of blood. The consequent tissue hypoxia in the brain results in cellular injury with consequent severe cerebral edema. Cerebral edema consequently results to increase intracranial pressure causing the cerebellar tonsils to herniate through the foramen magnum. This herniation causes compression of the cardiac and respiratory centers making a cardiac and respiratory activity to seize resulting in death. Fifty percent of the victims had soft tissue injury. One of the victims had subglacial hematoma suggestive of a blunt trauma that may have occurred while the victim was trying to run away from the explosion or he may have been hit forcefully by an object as a consequence of the blast loadings from the explosion. The other victim had a laceration measuring 6cm in the medial aspect of the lower third of the right leg which suggest that the victim may have been cut while attempting to escape from harm caused by the explosion or while trying to rescue another victim. This accident could have been avoided or at least risk reduced if a better-trained welder was hired or if the facility was built putting the possibility of a gas explosion into consideration.

Conclusion:

Though gas explosion has not been known to be a common occurrence in government organizations such as this, if precautions were taken to forestall such occurrence, these deaths could have been prevented. It would, therefore, be necessary if measures are put in place to prevent these preventable deaths in any work environment. Also, it will be wise that a law is legislated by the nation that such government and not-government establishment of certain capacity must be able to provide all the necessary gadgets for prevention and staff trained effectively on the need of operating all devices in case of sudden emergency fire outbreak or gas explosion.

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