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Original Research Article

Clinical profile of a firework disaster in Kerala: lessons learnt

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ABSTRACT

Background: This study is based on the tragic firework accident, with the highest death toll in India, that occurred in Puttingal Devi Temple, Kollam District, Kerala, at 3.30 am on 10/04/2016. Around 1500 people were injured. On the spot death toll was 109 and 12 others died in hospitals later. 1039 were treated as OP case and 410 as inpatients in various secondary and tertiary care hospitals in Kollam and Thiruvananthapuram with the help of the team of experts from AIIMS, Delhi. The aim was to study the clinical profile of inpatients admitted with trauma and/or burns following the incident and to formulate a Medical action- plan of in such eventualities.
Methods: The present study is descriptive in nature with study setting in secondary and tertiary care hospitals in Kollam and Thiruvananthapuram districts. The study subjects were all the inpatient victims of the firework tragedy. The study method used analysis of relevant patient details collected from hospitals records.
Results: 410 inpatients of various hospitals were analysed. Majority of the victims were males. (95.6%) Major age group affected is 20-50 years (66.1%). 79.5% of patients were treated in wards and 20.5% in various ICUs. 54.4% in secondary care centres and 45.6% in tertiary care centres. 78.2% of patients had traumatic injuries alone, 19.8% had trauma and burn injuries and 2% had burn injuries alone. 37.3% had major injuries, 21.5% had multiple fractures and 39.1% had minor injuries. 29% of patients had to undergo various surgeries. Hospital stay -76.4% of patients <2 weeks, 16.6% 2-4 weeks and 7.1% more than 30 days. Outcome: 70.7% were completely cured, 21.5% had temporary disability, 4.9% developed permanent disability. Mortality was 2.9%.
Conclusions: Dedicated team work and inter-disciplinary care at Secondary and tertiary care centres of Kollam and Trivandrum districts with the timely help of medical team from Delhi has brought down the mortality rate to 2.9% in a major firework disaster with 1500 victims, which is comparable with the international standards.

Keywords: Disaster medicine, Disaster victims, Trauma surgery, Wounds and injuries

INTRODUCTION

Disasters can strike any area at any time which may be either natural or man-made. A disaster is defined by the Centre of Research on the Epidemiology of Disasters (CRED) as a situation or event which overwhelms local capacity, necessitating a request to a national or international level for external assistance; an unforeseen and often sudden event that causes great damage, destruction and human suffering.[1] WHO defines sudden-onset disasters (SODs) as disasters before which there is little or no warning.[2] Man-made disasters and some of the natural disasters are largely unpredictable which makes it more fatal, as the preparedness to deal with the disaster will be lacking in the public and administration.

Man-made disasters vary from collapse of a building, bridges, oil leak, gas leak, fire explosion, nuclear power plant explosion to terrorist attack. Among these, fire and bomb explosions result in very severe injuries and deaths, next only to nuclear power plant explosions.[3] This is due to the primary, secondary and tertiary injuries resulting

from the explosions. Primary blast injuries occur due to direct impact from the fire, secondary blast injuries from collision with the nearby the solid materials thrown around due to explosion and the tertiary blast injuries results from the impact of the shock or blast wave.[4] The direct effects mainly include the injuries and deaths directly related to the disaster. The impact of fire-work disasters on health care vary with the varying gravity of the disasters. The health system is often challenged by the emergency, the lack of human preparedness, resources, expertise, equipment, facilities and money to face such eventualities.

There is only limited information available from India, on the impact of such disasters on health care.[5] The use of fireworks and explosives is a traditional practice during festivals in the temples in Kerala and other states of India. In India, due to the practice of using firecrackers as a part of celebrations, the accidents from those are very common.[6] In the southern parts of India, it has been a cultural practice to conduct fireworks display as part of festivals especially in temples. As a result, many accidents had been reported, resulting from explosions in the past. According to an estimate, nearly 700-odd lives over the past two decades have been lost in Kerala, since independence, due to such competitions during festivals in different places of worship.[6]

Summary of the disaster

The disaster took place at Puttingal Devi Temple near Kollam district, Kerala at 3.30am on 10th April 2016. At this temple, there have been competitive pyrotechnics for long periods. As a part of a temple festival, a fireworks competition conducted resulted in a tragic fire cracker explosion, killing 109 people and injuring around 1500.6 The three storied concrete building near this temple was shattered into pieces in the explosion. Heavy and sharp concrete pieces were thrown around causing high impact injuries around 500mtrs in addition to extensive burn injuries. 150 kg of fire crackers that were stocked caught fire.

State's reaction to disaster

Police, fire force, medical and revenue personnel were alerted and mobilized. The state witnessed a coordinated action of the administrators, clinicians and the public soon after the occurrence of the event. Political and public support poured in irrespective of political affiliations, religion, caste. A team effort of the highest level happened, led by the prime minister of the country.

The incident has given an awakening alert to the disaster managers to consider such events as possible disaster risks and plan to avert, avoid, prevent, prepare and respond to such situations. The aim of the study was to understand the clinic-pathological profile of the disaster, and to formulate a medical action plan in such eventualities.

METHODS

Study design is that of a descriptive case series analysis using the inpatient records collected from various hospitals, both public and private located near the site of disaster.

After getting the consent from the hospital management, inpatient records of all patients were collected and studied from different hospitals of Kollam and Thiruvananthapuram during May-July 2016. The study was planned as census type and the investigators were trying to get all eligible participants to the study group. All inpatient victims of firework tragedy were taken into study irrespective of the degree of injury or days of hospital stay.

The reasons for doing a hospital-based census type of study rather than a sample survey are the following:

- There is a wide network of hospital with in 100 km of the site including a Government Medical College, three private medical colleges and multiple general as well as specialty clinics.
- The government declared compensation for all injured victims within hours of the tragedy and was communicated through all media and almost all victims sought medical care.

Exclusion criteria

- People who took care from outpatient department alone or first aid alone (based on the assumption that their injuries are minor.)

The baseline data at the time of admission and the follow-up information were collected using a structured proforma. The outcome variables of the study included various surgeries undertaken by the patients, type of hospital care required for the victims, duration of hospital stay, and health outcome categorized as death, cured or disability. The major exposure factors included the type and extent of injuries and burns.

Data were entered into MS Excel 2013 and analysis was done using SPSS 16 software. All quantitative variables were represented as percentage and quantitative variables are expressed using mean and SD.

Written informed consent were obtained from all participants, data available at records of different hospitals were collected with the permission of the hospital authorities. The study protocol was cleared by the Human Ethical Committee of Government Medical College, Thiruvananthapuram.

RESULTS

According to the available records 109 people died at the place of the disaster and 410 individuals were admitted in

different hospitals. The number of injured people sought OP care were 1039. The in-patient records from different secondary and tertiary care centres in Kollam and Thiruvananthapuram districts were analysed in the current study giving a total of 410 study subjects.

Gender distribution

Out of the 410 subjects, 392 (95.6%) were males.

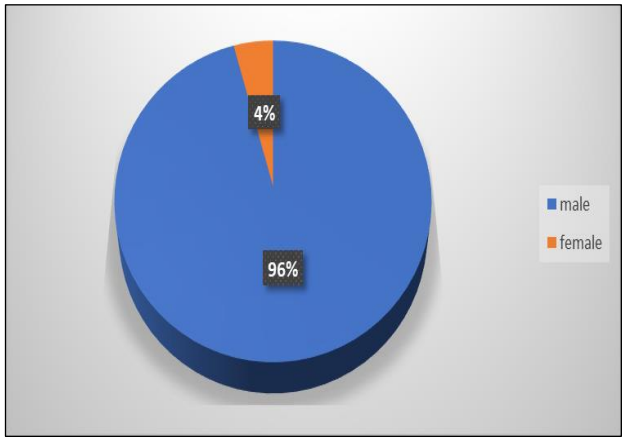

Figure 1: Gender Distribution.

Age of the study population

The mean age of the study subjects was 36.9 (±13.8) years and major age group affected was found to be 20-50 years amounting to proportion of 66.1% (n=271) (Table 1).

Table 1: Age distribution.

Age in years	Number	%	
< 10	2	0.5	
10-20	56	13.7	
20-30	71	17.3	66.1
30-40	102	24.9	
40-50	98	23.9	
50-60	58	14.1	
60-70	19	4.6	
>70	4	1.0	

Treatment centre

The injured victims needed inpatient care had been admitted to various Secondary and tertiary care hospitals in Kollam and Thiruvananthapuram districts, Kerala. (Table 2) Government Medical College, Thiruvananthapuram, located 72 kms away from the site of explosion, was the key tertiary care centre, which took care of most of the severely injured patients. 223 (54.4%) were treated in secondary care centres and 187 (45.6%) in tertiary care centres.

Among them, 326 (79.5%) of patients were treated in wards and 84 (20.5%) in various ICUs. The distribution of blast injuries sustained in the incident is given in Table 3. Major injuries were present in 153 (37.3%) subjects while 88 (21.5%) had multiple fractures.

Table 2: Treatment centre.

Treatment centre	Number	%
Secondary care centres in wards	215	52.4
Secondary care centres in ICU	8	2.0
Tertiary care centres in wards	111	27.1
Tertiary care centres in ICU	76	18.5

Table 3: Distribution of blast injuries sustained in the Puttingal fire explosion (n=410).

Injuries sustained	Frequency	%
Fracture without burns	79	19.5
Head injury without burns	32	7.8
Chest/abdominal injury without burns	11	2.7
Polytrauma without burns	12	2.9
Major soft tissue injury without burns	56	13.7
Minor injuries without burns	131	32
Fracture with burns	9	2
Head injury with burns	5	1.2
Chest/abdominal injury with burns	7	1.7
Polytrauma with burns	9	2.2
Major soft tissue injury with burns	21	5.1
Minor injuries with burns	30	7.3
Burns alone	8	2

Type of injuries

Blast injuries sustained by the subjects were various, among which 321(78.2%) patients had traumatic injuries alone, 81 (19.8%) had trauma and burn injuries and 8 (2%) had burn injuries alone (Figure 2).

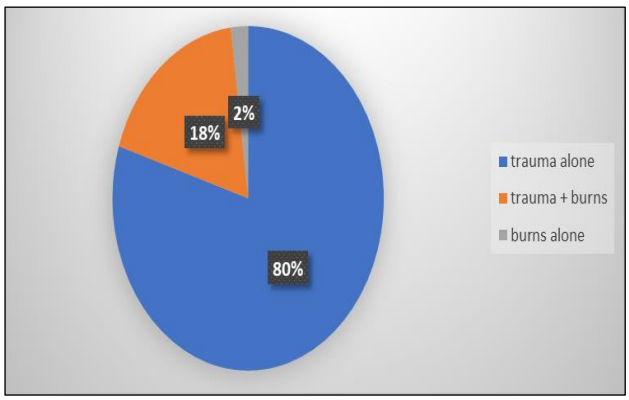

Figure 2: Distribution of type of injuries.

Extent of burn injuries

Among those who sustained burns, 6 (6.7%) of them had extent of burns more than 60% and 7 (7.9%) of them had extent in the range of 40% to 60% as shown in Table 4.

Table 4: Distribution of extent of burns among the victims of the fire accident (n = 89).

Extent of burns	Frequency	%
Less than 40%	76	85.4
40-60 %	7	7.9
More than 60%	6	6.7

Surgical intervention: (Figure 3) 28% of inpatient victims had to undergo a surgical intervention.

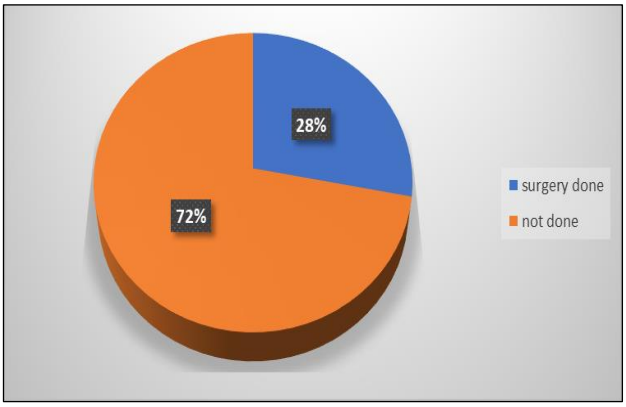

Figure 3: Surgical intervention.

Type of surgeries done

Among the 410 subjects, 115 (28.04%) underwent various surgeries among which 50 (43.5%) underwent orthopedic correction. As shown in Figure 4, 28 (24.3%) of them underwent combined surgeries, 13 (11.3%) of them underwent plastic surgeries, 13 (11.3%) had undergone neurosurgical treatment, two of them had undergone thoracic surgery and one had to undergo ophthalmic surgery. Among the subjects, 28 (6.8%) of them required multispecialty treatment and the distribution of the patients who had taken multispecialty treatment is given in Table 5.

Hospital stay

As shown in the figure 5, 29 (7.1%) had to stay in the hospital for more than 4 weeks, while 186 (45.4%) had a stay of less than one week in the hospital.

Among the 115 persons who had undergone surgery, 17 (14.8%) of them were discharged in the first week and 30 (26.1%) of them were discharged in the 2nd week. Duration of hospital stay was one week for 169 (57.3%) of the persons who had not undergone any surgery and 97 (32.9%) of the persons who had not undergone any surgery were discharged within 1 to 2 weeks.

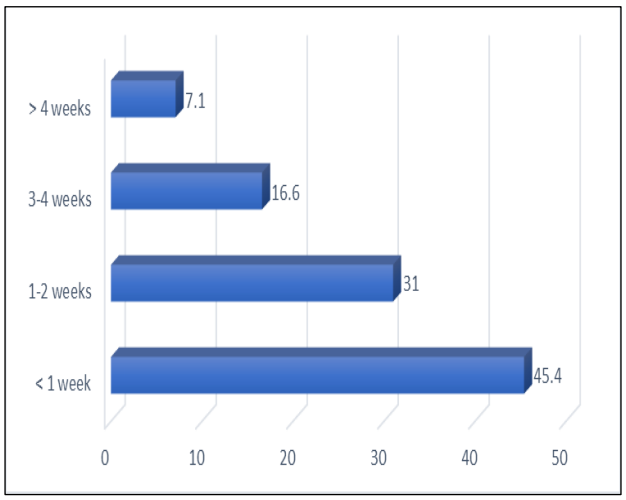

Figure 5: Hospital stay.

Table 5: Distribution of the patients who had taken multispecialty treatment (n = 28).

Combined	Frequency	%
General surgery + Orthopedics	1	3.6
General surgery +Plastic surgery	6	21.4
General surgery + Neuro surgery	3	10.7
Orthopedics + Plastic surgery	5	17.9
Maxillofacial surgery + ENT	2	7.1
Maxillofacial surgery + Plastic	3	10.7
Orthopedics + Neuro surgery	4	14.3
Maxillofacial + Neuro surgery	2	7.1
Neuro surgery + plastic surgery	1	3.6
Orthopedics + General + Plastic	1	3.6

Table 6: Distribution of study subjects based on whether they have undergone any surgery and duration of hospital stay.

Duration of hospital stay	Surgery Done		Not done	
	Frequency	%	Frequency	%
<1 week	17	14.8	169	57.3
1 - 2 weeks	30	26.1	97	32.9
2 - 4 weeks	43	37.4	25	8.5
>4 weeks	25	21.7	4	1.4

The distribution of persons based on whether they had undergone surgery and duration of hospital stay is given in Table 6.

DISCUSSION

The temple fire and blast that occurred in the Puttingal Devi temple near Kollam district of Kerala, had a death toll of around 121 and 1500 injured persons. Out of the 1500, 1039 were treated as Out Patient cases and 383 were treated as in patients as per the media reports.6 It

indicates that the current study covered almost all eligible people through the hospital-based data collection. The number of injured persons was found to be 410 which is more than the reported number by the media.

There had been similar fire cracker accidents in various temples throughout the state in the past but the death toll of the event under study was found to be higher than any of those accident.[6] The speculated reason for this huge death toll was the concrete building in which the fire crackers were stored which exploded and resulted in severe secondary blast injuries. The shock wave caused by the explosion had an impact up to 1 km radius shattering the window panes of the houses within the radius as media reported. The current study also showed that the major injuries sustained by the victims constituted fractures followed by head injuries without burns. These were the secondary blast injuries due to heavy and sharp concrete pieces were thrown around from the building due to the explosion. The injuries with burns were less than that of those without the burns.

Though there were many injured victims, only one fifth of them had required intensive care treatment as per the study. Whether inadequacy of hospital facilities to cater the patients in intensive care units is the reason for the small number is unclear from the study. Nevertheless, it has to be assumed that the victims had received adequate treatment as only 2.9% of patients died during the course of treatment.

More than half of the victims who had not undergone surgery and one fifth of the patients who have undergone surgery could be discharged within 1 week while by the end of 2 weeks, around 40 percentage of those who had undergone surgery and 90% of those who had not undergone surgery could be discharged from the hospital. This could be attributed to the swift and prompt reaction by the authorities and different departments in the hospitals towards the accident which had mobilized the required resources irrespective of the day being a holiday. 62 severely injured patients were brought along with dead bodies to government medical college, Thiruvananthapuram

The major actions taken by the hospital administration

Information was received at 4.30 am from the Police Authorities, following which all concerned specialties were alerted– General Surgery, Orthopedics, Plastic Surgery, Cardio Thoracic Surgery, Neurosurgery, Maxillofacial Surgery, Blood Bank, Anesthesia, Radiology, Nursing Staff, Laboratory services and Pharmacy. Apart from normal three emergency Operation Theatres, four elective Operation theatres were also opened for service. As it was a Sunday, staff on holiday were called in. One standby Operation Theatre was arranged in nearby General Hospital also. One ward was evacuated and kept exclusively for the victims. 1500 Blood donations were raised with in 3hours. Fourth hourly clinical review meetings were held with all concerned departments along with Experts from Delhi - All India Institute of Medical Sciences (AIIMS), RML hospital and Safdarjung hospital, New Delhi. Management plans for each patient modified accordingly.

The hospital death toll rate of 12 is found to be comparable with international standards.[3,7] The treatment outcome was found to be significantly different in the victims who sustained burns as compared to others. The burns, being the primary blast injury could have been sustained by those who were nearer to the blast and the building.

These persons would have sustained deeper burns as well as secondary injuries from the parts of the building that collapsed. The persons who were working in the building and who were nearer to it would have got severe traumatic injuries along with burns which could be the reason for poor treatment outcome among them. The extent of burns was also found to be associated with treatment outcome which is consistent with other studies.[8]

Treatment of the victims were undertaken in the secondary and tertiary care centres in the districts of Kollam and Thiruvananthapuram in Kerala. As mentioned earlier, only one fifth of the patients were treated in ICUs of the institutions. The treatment in ICU was found to be significantly associated with poor treatment outcome as well as with the presence of burns which may be due to the increase in the severity of the injuries for those admitted in the ICU.

These could have been the victims who sustained both primary as well as secondary blast injuries as mentioned earlier. The mortality pattern showed that out of 410 subjects, 12 (2.9%) had died during the course of treatment. The disabled persons constituted 106 (25.8%) among which, 20 (4.9%) had permanent disability and 86 (21%) had temporary disability. Three of them were continuing treatment and the rest had been cured of the injuries. Out of the 12 deaths, all of them had sustained major injuries and 8 of them had sustained burns along with the injuries. Eleven of these victims died during the first week of the blast in the hospital while 1 among them in the second week.

The treatment outcome of the victims was dichotomized to two categories (one category being poor outcome i.e. death or permanently disabled and the other category being good outcome i.e. temporarily disabled or completely cured) for bivariable analysis. Among the victims with trauma alone, 303 (80.2%) were either cured or temporarily disabled as compared to 75 (19.8%) of the victims that sustained burns also. This difference was found to be significant ($p < 0.002$) with an Odds ratio of 3.14 (95% CI-1.49 to 6.62).

Along with this, the extent of burns ($p < 0.0001$), and levels of care, i.e. institutions in which treatment was given for the victims ($p < 0.0001$) were found to be significantly associated with the treatment outcome. The treatment in ICUs were found to be associated with poor treatment outcome i.e either dead or permanently disabled ($p < 0.0001$) and an Odds ratio of 11.2 (95% CI-5.05 to 25.01). ICU treatment was also found to be significantly associated with presence of burns in the victims ($p < 0.045$) with an odds ratio of 1.74 (95% CI-1.01 to 2.98).

The present study was a record-based study from different hospitals across the two districts. The completeness of the records could not be ensured as this being a situation of disaster which is a limitation of the study. Though most of the details could be obtained from the records, the severity of the injuries was not available which could have been a major factor in explaining the outcome as such. Apart from all these, the study stands as an important evidence showing the ability of Kerala's health system in tackling emergencies.

As per the India Risk Survey 2012, a report prepared and published by FICCI depicted that "In India Emergency Response mechanism varies from state to state but no-where does it caters to the requirements of International best practices.[9] Central and state governments have been putting their efforts to provide for police stations, hospitals, fire stations and transport as nearest to the habitations as possible, but gaps remain.

An important question in this tragic setting is, is this fire accident another example of poor safety standard prevalent in all sectors in India? To be fair, there is ample evidence that as a nation, and perhaps even as a culture, we have a certain indifference to safety in any sphere of life. Yet, the medical management plan followed in this incident may be one of the best of its kind in the history of independent India, with a mortality rate of 2.9% in the survivors which is comparable to the best international standards. Our health system had been put to check and we could rise to the demands of the occasion. There lies the relevance of this study.

CONCLUSION

Disaster management ability of the health system is an indicator of the efficiency. The swift action towards the firecracker explosion showed the preparedness and ability of the state's health system to handle emergencies. It is highly recommendable to have SOP available in the eventuality of firework celebrations, and to have strict safety guidelines mandatory for such practices.

Recommendations

- Team work-core factor which helps in such situations
- Formation of disaster management medical team with action plan for each team member
- Multispeciality co-ordination
- High level co-ordinators – in this case by the DME, Principal, Hospital superintendent.
- Creation of more burns ICU in each district with protocols
- Creation of make-shift ICUs
- Call for help from Expert team – AIIMS, RML, Safdarjung hospital
- 4th hourly clinical review meetings – formulation of treatment protocols
- Public, media, political and religious activists across spectrum working together in the face of an adverse event.

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Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Guha-Sapir D, Hoyois P, Below R. Annual disaster statistical review 2015. Brussels, Belgium: Centre for Research on the Epidemiology of Disasters. 2016. Available at: http://www.cred.be/sites/default/files/ADSR_2015.pdf. Accessed 5 October 2017
2. WHO. Definitions: emergencies: World Health Organization. Available at: http://www.who.int/hac/about/definitions/en/.
3. Giorgadze T, Maisuradze I, Japaridze A, Utiashvili Z, Abesadze G. Disasters and their consequences for public health. Georgian Med News. 2011;194:59-63.
4. Shoaf KI, Rotiman SJ. Public health impact of disasters. Aust J Emerg Manag. 2000;15(3):58.
5. Davis JR, Wilson S, Brock-Martin A, Glover S, Svendsen ER. The impact of disasters on populations with health and health care disparities. Disaster Med Public Health Prep. 2010;4(1):30-8.
6. Parkash S. Brief Report on Reconnaissance Study of Puttingal Temple Fire Incident (Sunday, 10 April 2016). Paravur, Kollam District, Kerala State. 2016.
7. Kapur GB, Hutson HR, Davis MA, Rice PL. The United States twenty-year experience with bombing incidents: implications for terrorism preparedness and medical response. J Trauma. 2005;59(6):1436-44.
8. Rowan MP, Cancio LC, Elster EA, Burmeister DM, Rose LF, Natesan S, et al. Burn wound healing and treatment: review and advancements. Crit Care. 2015;19:243.
9. Pal I, Ghosh T. Fire incident at AMRI hospital, Kolkata (India): a real time assessment for urban fire. J Bus Manag Soc Sci Res. 2014;3:9-13.

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