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Vishweshwaraiah Iron Steel Limited (VISL) fire disasters following steel converter blast, 30 July 2003

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ABSTRACT

A fire disaster occurred in Vishweshwaraiah Iron Steel Limited (VISL), Bhadravathi, India on 30 July 2003. The steel converter containing 24,000 kg of liquid metal (pig iron) at very high temperature exploded. A total of 30 workers became victims. Seven persons died on the spot. Twenty-three victims were transferred to the VISL hospital; of these, six were transferred to the burns unit of the Kasturba Hospital, Manipal (180 km from VISL). All six treated at the burns unit suffered 3–65% total body surface area (TBSA) burn, two had external injuries and two had eye involvement. Out of the six patients admitted at the burns unit, two expired (one due to refractory shock and another due to pulmonary embolism). Out of four survivors, one underwent tangential excision; another underwent operation for removal of foreign body from both soles and the remaining two were managed conservatively. Of the four survivors, two who had eye injuries, one developed minute corneal opacities within 2 months. The total duration of hospital stay of survivors at the burns unit varied from 8 to 43 days. All the victims were counselled by VISL psychiatrists before resuming their duties. Except the one who developed mixed anxiety–depression disorder, all survivors returned to work. The article describes the mechanism of the incident, injuries sustained and suggestions in relation to future safety measures.

Disasters involving multiple burn casualties result from a large variety of causes. Natural disasters, man-made disasters as well as acts of warfare are included. The most common incidents usually happen with commercial or domestic fires, at transportation crashes (e.g., plane crashes), at the transportation or storage of inflammable materials (e.g., gas explosions), in the context of industrial non-incidental events terrorist attacks and events with mass gatherings. Not only because of the threat of terrorist attacks, but also the possibility of a 'normal' catastrophe, it is meaningful for burn surgeons to examine the treatment planning for a mass disaster of mass burn casualties [1].

The present disaster is being recorded for future reference, improvement in similar disaster prevention plan and better planned care in future.

1. The disaster

Vishweshwaraiah Iron and Steel Limited (VISL) is the first steel industry (in India) of pre-independence era (established in 1922), situated at Bhadravathi, Karnataka, India. VISL produces cast iron from iron ore in three steps. The first step is the preparation of molten metal (pig iron, an intermediate product) from iron ore in blast furnace. The second step involves transportation of molten metal to the converter area and removal of dissolved impurities (such as silicon) from molten metal by oxidation. During oxidation, a strong current of air (oxygen) is directed over melted pig iron while it is being stirred or agitated in a large container called a converter. The converter produces purified molten metal called a ladle. The ladle is transported by ladle cars and

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cranes at 40-ft height to the ladle-refining area. During the third step, excess oxygen of the ladle is removed in ladle-refining furnaces by adding coke and alloys, and adjusting the carbon content and removing undesirable contaminants. The metal is then cast into molds to produce cast iron. A major burn disaster can occur at the blast furnace area, at the converter area, during transportation of the ladle and at the ladle-refining furnace area.

On 30 July 2003 at about 11.00 p.m. (local time) a blast occurred in the steel converter causing seven immediate deaths, while 18 workers, who had minor burns due to walking over scattered hot metal pieces or by flying hot metal pieces, were treated at VISL hospital, six were transported to the burns unit of the Kasturba Medical College, Manipal (Table 1). At the burns unit, two victims underwent surgery (tangential excision and split-skin grafting), one victim required removal of foreign body from the sole and remaining received conservative treatment. One patient was transferred to the multidisciplinary ICU and expired within 48 h due to refractory shock, and another died suddenly due to pulmonary embolism on the 4th postoperative day (9th day after admission) following tangential excision and split-skin grafting. The author later visited the incident site, prepared a line diagram of the site with the relative position of the victims and interviewed the eyewitnesses and co-workers. The case records of the admitted patients were reviewed. The whole incidence was recorded as below:

1. Site of the incident:
   (i) The site of the accident was at a 15-ft high platform where the production team was working (Fig. 1).
   (ii) The steel converter (oval shape, height 5 m, with a maximum cross-sectional diameter 2.5 m), where the blast occurred, had the capacity to handle 24,000 kg of molten metal (pig iron) at 1630–1640 °C. Its opening (mouth) had a diameter of 1.5 m and occupied the top position while work is in progress. During operation, the liquid metal was never filled more than half of the total capacity of the converter. The wall consisted of two layers: an inner ceramic layer 400-mm thick and an outer 25-mm thick metal (iron) layer.
   (iii) At the time of the incident: for removing impurities like manganese, sulphur, carbon and silica from molten metal (obtained from treating iron ore in a blast furnace) by burning; oxygen was being blown from the top over the surface of the molten metal at a speed of 2 mach (twice of the speed of sound) while it was being stirred or agitated in a large container called converter. Three hours prior, its tilting mechanism was not working and was being repaired.
   (iv) The gases produced were being collected and sent to its destination by a chimney, collecting ducts and exhaust fans. The chimney had a cooling system that consisted of ducts with continuous flow of water.
2. The magnitude of the blast (by eye witnesses from a safe distance):

Examination of the converter that was tilted to one side showed an explosion at its mouth (opening) like a cannon. Metal pieces scattered at a distance of a few meters. The

Table 1 – Details (including THS = total hospital stay) of all the VISL fire disaster victims treated at Burns Unit of Kasturba Hospital, Manipal.

Case No	Diagnosis	Treatment given	Out come
Victim 1, 51 years male	65%TBSA burn with multiple fractures with eye involvement with hypotension and renal failure (fractures: fracture both bones left forearm, Type IIIB fracture distal shaft right humerous, Type IIIA fracture lateral condyle right humerous)	Successful CPR within 12 h managed conservatively	Expired within 48 h due to refractory shock THS = 30 h
Victim 2, 43 years male	12% TBSA burn	Conservative	Survived THS = 19 days
Victim 3, 52 years male	40%TBSA burn	TE and SSG on 5th day 100% graft take on 8th day	Expired due to pulmonary embolism after 8 days (confirmed by postmortem) THS = 9 days
Victim 4, 53 years male	18% TBSA burn with eye involvement	Conservative	Survived within 2 months developed nuclear sclerosis both eyes with localized corneal opacity left eye THS = 10 days
Victim 5, 35 years male	25% TBSA burn with laceration of left ala of nose with monocortical fracture right radius and right femur and eye involvement with closed head injury (concussion)	TE and SSG on 5th day 100% graft take	Survived; developed psychiatric problems; did not return to work THS = 43 days
Victim 6, 42 years male	3% TBSA burn (transferred after 3 days of initial treatment at VISL Hospital)	De-roofing of infected blisters and removal of metal particles embedded in soles	Survived THS = 8 days