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## Respiratory and Neurologic Sequelae Following Asphyxiation in a Storage Tank

March 30, 1983, nine men working at a Kenai Peninsula oil well drilling site were examined at Central Peninsula Hospital, Soldotna for illness after they were overcome in a petroleum storage tank that was connected to the well. Information concerning their illness was gathered by the Soldotna physician who was on call the night the patients presented at the emergency room, by an investigator from the Department of Labor, and several months after the incidently the Epidemiology Office, Division of Public Health. Given the loss of consciousness in several patients and the hurried nature of their rescue, a consistent story of events surrounding the mishap and rescue could not be clearly ascertained.

At about 9:00 p.m. on March 31, two men entered the 500 barrel storage tank through its top hatch in order to inspect what was thought to be a leak in the tubing connecting the well-head to the tank. The well-head itself had recently been purged with gaseous nitrogen. One or both of the men who entered the tank fainted, and two co-workers crawled in through the top hatch in an attempted rescue; it appears only that one of the four made his way out of the tank. Other workers then unbolted a side door allowing direct access to their fellows who were lying unconscious on the floor of the tank. At least five and perhaps more workers participated in this phase of the rescue. Some or all of them soon began to feel faint or had difficulty breathing. It is estimated that ten minutes was the most time spent by any person in the tank, and that rescuers who entered through the side door spent no more than two minutes inside.

Nine patients, 20-38 years old, were seen at Central Peninsula Hospital between 10:30-12:00 p.m., after evacuation by helicopter and road ambulance. Symptoms recorded by the emergency room physician included conjunctival and respiratory mucosal irritation, as well as weakness, nausea, and headaches (Table 1). Arterial blood gas determinations on five patients were normal. Chest radiograms on seven were unremarkable.

Table 1: Emergency Room Complaints of Nine Patients Asphyxiated in a Storage Tank

Patient	Nausea	Lightheadedness	Weakness	Fainted	Blurry Vision	Limb Pain	Headache	Chest Pain	Rapid Breathing	Sore Throat	Burning Eyes	Congestion	Wheeze	Cough	Estimated Time in Tank
1	X	X			X		X			X					2-5 min
2	X			X	X		X			X					5-10
3	X	X			X		X	X		X					6-8
4	X	X				X		X				X			2
5		X	X			X	X		X	X	X				2
6		X	X												2
7										X	X	X	X	X	?
8	X	X		X	X		X			X					5-10
9				X			X	X	X						5
Total (9)	5	6	2	3	4	2	6	3	2	6	2	2	1	1	

The following day, six of the nine patients were still symptomatic. Three of the six complained of headache and trouble concentrating; new findings included postural hypotension and incoordination. Four of the six patients (including one of the above) complained of sore throat and congestion; findings included red eyes and pharyngitis and basal crepitations. Of the six patients symptomatic the day following their asphyxiation in the tank, four remained ill for one to several months—two with memory loss and incoordination, and two with recurrent cough and bronchospasm.

With the cooperation of the petroleum company which was operating the exploratory well where this incident occurred, we were able to obtain information concerning the environment inside the tank to which the nine patients were exposed. The tank itself was about 7'x10'x39' in dimension. Before being connected to the well-head, the tank was used to mix "drilling mud", the constituents of which were soda ash, caustic soda, potassium chloride, various organic polymers, cellulose, and filler. Prior to being used at the drilling site, the tank was cleaned with steam and water. The atmosphere in the tank was sampled approximately one hour after the incident, during which time the side door was open and air exchange would have occurred. Toxic gases such as phosgene, oxides of nitrogen, and chlorinated hydrocarbons were not identified in the sample. It was inferred that during the incident, the tank contained a high concentration of nitrogen let off from the well-head, with a correspondingly low concentration of oxygen.

The "Fireman Syndrome" of multiple rescuers collapsing one after another on entering a confined space is well documented. This episode illustrates the consequences of entering a confined space in which illness is occurring without appropriate precautions and without knowledge of the atmosphere inside that space. The illness associated with entering this tank was unusual: while neurologic deficits might relate to transient hypoxia or breathing an atmosphere rich in nitrogen and correspondingly poor in oxygen, the acute and chronic respiratory findings observed have no satisfactory explanation. Simple exposure to nitrogen or to an oxygen poor atmosphere does not explain acute or chronic respiratory disease.

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