MEDICAL ASPECTS OF PETROL FUME POISONING.

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Petrol vapour is absorbed by the respiratory and gastro-intestinal mucous membranes. In high concentration it acts as a local irritant producing a chemical pneumonia or an acute gastritis. When absorbed through the respiratory mucosa into the general circulation it acts as a cerebral toxin of an exciting or depressant nature. This latter action is of greater industrial importance than the occurrence of gastritis or chemical pneumonia inasmuch as the effects are produced by much smaller concentrations of vapour and, being in themselves less dramatic, do not lead to an interruption of exposure to the poison. Certain more insidious effects, such as cerebral degeneration, producing a condition similar to chronic (epidemic) encephalitis, are likely to follow more prolonged exposure; dramatic and grave mental upsets resembling acute schizophrenic reactions and the onset of epileptic fits will occasionally be found. These occurrences have led to an investigation of the medical aspects of intoxication by petrol fumes and the methods by which serious effects on health can be avoided. Engineering aspects will be dealt with briefly where necessary.

CONDITION OF EXPOSURE.

In the earlier phases of the war petrol was commonly dispatched to overseas ports in non-returnable 4-gallon petrol cans made of thin metal. These cans were packed in pairs, in cardboard cases, and stacked many layers deep in the holds of freight ships. Unfortunately the cans were insufficiently rigid to prevent collapse of the lower layers under the weight of the superimposed metal and petrol. Whereas the maximum depth for safety was found to be six to eight filled cans, it was often necessary to stack the cans forty deep. As a result of this, crumbling of cans in the lowest layers occurred with the escape of petrol into the hold, sometimes to a depth of two or three feet. Some of this free petrol was absorbed by the cardboard of the containers which was reduced to the consistency of wet blotting-paper. Slow vaporization from this petrol-saturated pulp presented an added difficulty in the ultimate clearing of the ship's holds of poisonous vapour.

METHOD OF APPROACH.

If the petrol loose in the hold could be pumped out by bilge pumps the position would be greatly simplified. Unfortunately the pipes attached to bilge pumps pass through the ship's boiler rooms with consequent grave risk of fire. Furthermore discharge of petroleum into certain harbours is forbidden by local Port Regulations. At the overseas port at which these observations were made the matter was dealt with by men working intermittently in short shifts, as infrequently as possible in the circumstances, no apparatus for breathing oxygen being then available. A man might find himself working twice a week on petrol-shifts of five hours each, during which period he would breathe a petrol-laden atmosphere for up to ten minutes, after which he would rest for twice that period on deck while two successive gangs of his fellows took over. On intervening days he would be employed on duties in a petrol-free atmosphere. Military circumstances, however, often necessitated more frequent exposure. This scheme was found to be most unsatisfactory from several points of view.

MEDICAL RESULTS OF THIS REGIME.

Minor symptoms of head discomfort such as dizziness, headache, ringing in the ears and faintness or a sense of intoxication as from alcohol were almost constant. Actual collapse
with loss of consciousness occurred frequently; one C.O. reported to me that as many as seven out of twelve men in one gang were rendered unconscious during one five-hour shift. It was frequently noticed that a man, unwilling to leave his post, would sit down in the hope of regaining strength; he would then pass into a state of stupor from which he could not be roused; unless carried on deck by his fellows he would sit below until he was fatally overcome by fumes. Some men were so quickly overcome by the fumes that they were unable to reach the bottom of the hold before the poison took effect. In these, the danger of a fall into the ship's hold is very real.

On removal to a normal atmosphere immediate recovery occurred both in stuporose and exhilarated subjects. Both reactions were, however, followed by a secondary deep sleep or stuporose stage from which the workers could be aroused with difficulty to undergo exposure for the second or third time. It was not found possible to spare a man from further exposure to fumes on that morning even though he might have been overcome by unconsciousness more than once earlier in the day.

Several lay observers have commented independently on the aspect of men leaving the polluted atmosphere. They describe a staring visage with ashen-grey colour, staring eyes with the eyeballs turned upwards and a muscular spasm of the hands, usually flexor in nature. One officer related how he himself experienced this uncontrollable tonic contracture of his hands on leaving the vapour atmosphere. Vomiting was frequent when outer air was reached. An unpleasant taste remained in the mouth for hours—some officers noted that their men were unfit for hard work for twenty-four to forty-eight hours afterwards. These symptoms, unpleasant as they may be, are however transient. In importance they are outweighed by certain more lasting abnormalities. Many men commented on character changes in their friends who inhaled petrol vapour; a previously cheerful companion often became morose and sullen. Most dramatic of all was one case of acute psychosis in a man described to me by his C.O. as being previously a good reliable worker with no character abnormality. His past medical history was healthy and there was no familial mental disease.

Case 1.—W. A. R., aged 24, a sapper in a Docks Operating Coy., had been working for some weeks in a heavily contaminated atmosphere, sometimes in shifts twice weekly and sometimes for days on end. On January 20, 1943, he lost consciousness in the hold and had to be brought up on deck. On February 1, while in the hold breathing petrol, he began to behave abnormally, running round the set with an axe. He was immediately helped up the ladder but collapsed on the way, and fell six feet on to his heels. He apparently recovered after breathing pure air and was passed by a Medical Officer as being in no danger although unfit for work. On waking from his secondary stupor during the afternoon he was in an agitated frame of mind with hallucinations of an incessant voice saying, "Hurry up—hurry up." After a disturbed and restless night he was admitted under me into a Military Hospital on the morning of February 2 in a fully hallucinated state, the diagnosis being Acute Schizophrenia. He was transferred on February 4 to a Base Hospital for mental observation with little improvement in his mental condition. A full investigation in that Hospital failed to show any evidence of lead intoxication. Schizophrenic phases alternated with periods of acute anxiety and, in this alternating state, he was ultimately evacuated to U.K. The association of cause and effect appears very clear.

The muscular spasm experienced by some men on leaving the polluted atmosphere suggests that petrol vapour is an epileptogenic substance and that exposure to it may bring to light a latent tendency to epilepsy or reactivate a quiescent epilepsy. The following case, in which association between cause and effect is far less clear and perhaps doubtful, may illustrate this point:—

Case 2.—L. P., aged 21, a sapper, had a short exposure to petrol on January 5, 1943, his one and only experience, developed adverse symptoms and had to leave the set. He was unwell following this and was admitted to a Military Hospital on January 8. During his stay there he described a sensation, typical of minor epilepsy, which had never been experienced before. Since then he has had several absolutely typical minor attacks, witnessed in hospital. There is a strong constitutional tendency to epilepsy as witnessed by the family history.
It is still much too early to anticipate late results of chronic exposure to petrol fumes but analogy with other intoxications, such as with manganese and the exhaust-fumes of motor cars, coupled with the character change and moroseness described by witnesses, suggests that these men are liable to that most distressing condition of neuronic degeneration known as Parkinson's Disease so often seen as the late-effect of epidemic encephalitis.

**Avoidance of Ill-effects on Exposed Personnel.**

No one is more aware of the need for the protection of dock personnel than Officers Commanding Docks Operating and Pioneer Companies who have found themselves forced to employ soldiers in conditions of work which are economically unsatisfactory and highly dangerous to health. Various methods of overcoming the difficulties have been tried. These include the following, ranked in descending order of success: 

(a) The employment of the Smoke Hood, such as used by Pioneer Companies carrying out smoke screen work, the hood being connected with a rubber tube of 1 to 1½ inch bore leading to the outer atmosphere. These hoods are often difficult to obtain during active operations. R.E. officers estimate that a man can work in safety for twenty minutes wearing this hood, after which time he is forced to rest through heat-exhaustion. 

(b) Use of bilge pumps; this is highly dangerous and furthermore contravenes Port Regulations by contamination of the sea with oils. 

(c) Replacement of atmosphere by pumping in compressed air or steam or more simply by the use of a canvas wind sail which directs the prevailing wind, through a canvas tunnel, into the ship's hold. Attempts at ventilation are however unsatisfactory for three reasons: (1) Air, being lighter than petrol vapour, rapidly rises to the top, washing out with it only a small quantity of poisonous fumes. (2) As with all heavy gases, pocketing in corners and in closed spaces tends to occur. These spaces are not easily reached by pumping in compressed air. (3) Once the atmosphere is cleared, rapid vaporization from free petrol once more renders the atmosphere highly polluted. 

(d) Use of selected (tolerant) personnel; observers agree in the marked variation in the tolerance to petrol vapour shown by different subjects. The use of personnel which has been found to tolerate the fumes well and the exclusion of all who have once experienced toxic symptoms is precluded by the shortage of personnel for work of the utmost military priority.

**Occurrence of Toxic Effects Under Other Conditions.**

While poisoning by petrol fumes of stevedores working in the holds of petrol ships is the most common cause of symptoms, exposure may occur under other circumstances from bulk-stores on the lines of communication. Dermatitis among exposed personnel is common. A Surgeon Lieutenant, R.N.V.R., encountered the cerebral effects under the following unusual circumstances:—

During 1940, a naval vessel in the South Atlantic was summoned to the aid of a petrol-tanker which had been split in two, but not set on fire, by enemy action. The atmosphere around the sinking ship was heavily charged with petrol while a layer of petrol covered the surface of the ocean. As the rescuers approached the damaged vessel a lifeboat was sighted bearing merchant navy personnel, many of whom were singing uproariously and behaving in a drunken manner. Some had sunk in stupor in their seats while the heads of others had rolled over the gunwale of the overloaded boats so that they were drowned as they sat. The crew had had no access to alcohol and acute alcoholism could be excluded. Many of the rescuing personnel complained of headache on leaving the petrol-laden atmosphere.

The occurrence of a chemical pneumonia by direct inhalation of liquid petrol is illustrated by the following case history:—

**Case 3.**—Serjeant J. R. W. was admitted to a military hospital at 23.00 hours on 27.12.42 with a history of having swallowed and inhaled liquid petrol through a blow-back from a carburettor which he was cleaning at 17.30 hours that evening. He was seen immediately by a M.O. who found him collapsed and cyanosed and complaining of upper abdominal
pain. At 20.15 hours, in spite of stimulants, he was still in a collapsed state; there was respiratory distress with expectoration of red frothy sputum. On admission to hospital he was still distressed and excitable. A few crepitations were heard in both lungs. The temperature was 100° F. The following day he had a maintained fever of 101° F. with extensive crepitations in both lungs. The temperature had settled by the sixth day and, by the tenth day, the chest was free from abnormal signs. He returned to light duty on the fourteenth day.

Direct access of liquid petroleum or of a high concentration of fumes to the skin leads to drying and cracking of the epithelium. Secondary infection readily occurs. Unless this is prevented by scrupulous cleanliness, and the application of a cream composed of one part of lanoline and two parts of olive oil to the exposed skin, much loss of time from cutaneous sepsis is likely to occur.

**General Observations.**

The ill-effects from exposure to petroleum fumes, as recorded above, tally well with previous observations under industrial conditions. The ill-effects produced under conditions of active service should, however, be strongly emphasized and borne in mind by medical officers and officers of technical and pioneer units whose personnel handles petrol.

The only satisfactory method to avoid highly dangerous exposure of workers in ships' holds is the use of an oxygen apparatus worn on the worker's back. If it should ever be necessary again to export petrol, in the manner described earlier, oxygen masks should if possible be provided for the use of docks-operating companies engaged in unloading.

Conditions of active service made estimations of concentration of petroleum vapour in ships' holds impossible. For the same reason routine estimation of lead absorption could not be carried out except in Case 1 where the base hospital reported "Investigation failed to show any evidence of lead intoxication so that the tetra-ethyl lead in the petrol can hardly have been a causative agent."

**Summary.**

The ill-effects arising from exposure to high concentrations of petroleum vapour under conditions of active service are discussed. Methods of combating them are described and the need for portable oxygen apparatus for use of personnel working in ships' holds, where dangerous concentrations may be found, is stressed.

It is suggested that the serious toxic effects of petrol fumes is at present insufficiently appreciated by officers in medical charge of exposed personnel.

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**Reference.**

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