THE MEDICAL ASPECT OF TANKS.

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Medical Tanks.

The revolution produced in modern warfare by the successful introduction of tanks naturally compels attention to the extent of their usefulness in other branches of the Service. The question immediately arises, why not have medical tanks? From the medical point of view, the scheme is an alluring one, and the Mark V*[1] and Mark IX offer particular attraction in this direction. These tanks are really infantry carrying tanks, with a cubic capacity of roughly 690 cubic feet, and there is no reason why they could not be mechanically designed for medical purposes.

The tank would correspond to the sick bay of a battleship. Stretchers and hammocks could be adjusted in tiers, capable of holding half a dozen lying cases, or twenty sitting cases. The doors would have to be enlarged in the mark V* for the entrance and exit of stretchers.

A dressing-table could be arranged in the centre of the tank behind the engine, and electric light is provided. There is practically no limit to the amount of stores which could be carried, and if necessary, sledges towed by the tank could be used for this purpose.

During the battle the tank would manœuvre in liaison with the field ambulances, and in fact would constitute a movable and protected advanced dressing station. In addition, it could evacuate cases at night time, direct to a spot where they could be transferred to motor ambulances. It is thus seen what an extraordinary saving would take place in the tedious work of the stretcher-bearers. Should the necessity arise of a tank brigade

[1] When the Armistice was declared a Mark V* Tank had been fitted to carry six stretchers, and arrangements had been made to give it a trial early in the following year.

operating alone in open warfare, the need of a medical tank at once becomes imperative.

Up to the present time tanks rallying from action have rendered great service in bringing back the wounded. In one instance, during the Battle of Cambrai, one tank brought back as many as sixteen wounded.

During the operation of the Australian Corps at Hamel, it is estimated that as many as 150 wounded were brought in by tanks.

Tank Satchels.

At present each tank possesses as its medical equipment one tank satchel, which is a specially arranged First-aid Bag. The contents are as follows:—

Bags Canvas Waterproof	No. 1
Shell Dressings	,, 7
Picric Acid 1 per cent. in Boxwood Cases..	8 oz.
Sal Volatile, in Boxwood Cases	8 ,,
Gauze Compressed, and Plain	2½ yd. of each
Bandages Compressed	No. 6
Ammonia Capsules	,, 52
Earthenware Measure	,, 1
Gooch Splinting 1 ft. square	,, 1

Tank Complaints.

Minor accidents stand out prominently in the daily sick parades throughout the corps, which is accounted for by the mechanical nature of their work.

An exanthematous dermatitis resembling impetigo affecting the exposed surfaces of the skin has been noticed and is attributed to the irritating effects of petrol fumes inside the tank, especially when inferior brands of petrol and oil have been used for training purposes. These fumes are sometimes oppressive and give rise to a tight feeling in the chest, and a burning sensation on the mucous membrane of the nose and throat, and smarting of the eyes.

Nature of Wounds received in Tanks.

As a rule the casualties have been light. The wounds are either severe or very slight. Severe wounds are usually the result of a direct hit or when crews are wounded in the ordinary way outside the tank. There have been instances of only slight wounds resulting from the explosion of a shell inside the tank. The vast majority are only splash wounds, due either to splinters from the inner table of the armour plating, as the result of the impact of armour piercing bullets, or splinters from ordinary bullets entering between the chinks of the armour plate fittings. As a rule these cases remain at duty. Splinters in the eye have been troublesome, and a veil made of fine steel wire has been devised for covering the face, but as a rule it is too cumbersome to be worn with comfort.

As the result of land mines and shells of large calibre exploding near a tank, some of the crew have been concussed, others have complained of pain and swelling of the ankle and knee-joints, and bruising of the os-calcis has been found. In one case the explosion of a land mine was sufficient to rupture the boot laces and puttees of one of the men. Burns are very common, generally the result of a direct hit into the petrol tank.

In some cases there has been spontaneous combustion of the tank, and the theory is advanced that it is due to red hot sparks, the blow back of a 6-pounder gun, or a red-hot exhaust pipe igniting the air inside the tank, which has become saturated with a combustible mixture of petrol vapour.

Symptoms Inside Tanks.

From the early days, it was noticed that after prolonged work inside tanks, men complained of headache and faintness. In February, 1917, crews were detailed to run their engines periodically at night to prevent freezing. In one instance this was done with the tarpaulin cover over the tank which prevented the escape of exhaust gases. The crew slept in the tank, and in the morning on coming out into the fresh air complained of headache, faintness, giddiness, and sickness, they all collapsed, two vomited, and one was slightly cyanosed, and all had weak rapid pulses. Similar symptoms were reported later, after tanks (Mark IV) had been in action.

Since the advent of the Mark V and V* these symptoms have been intensified. Information collected from all sources has established the presence of the following symptoms: Headache, giddiness, breathlessness, palpitation, vomiting, mental confusion, unconsciousness, collapse, convulsions, red complexion, rise of body temperature.

Headache comes on early; it is severe in many cases, and sometimes lasts as long as forty-eight hours. It is always present. Singing noises in the ears are usually present.

Giddiness, like headache, is always present, and is accentuated on getting out into the fresh air.

Breathlessness is prevalent, and is aggravated by wearing the box respirator and by the fumes inside the tank.

Palpitation occurs to the same extent as breathlessness. The pulse is rapid and weak. As a rule the tachycardia is only transitory.

Vomiting and nausea are prominent symptoms, and their frequency, apart from the presence of CO, and high temperature may be explained on the analogy of sea-sickness. At any rate, it is seen more in people who are not used to tanks, viz., infantrymen.

Mental Confusion is an interesting symptom. The men sit and stare in front of them and merely repeat orders without putting them into execution. The mental plane is decidedly lowered, there is drowsiness and an irresistible desire to rest or sleep. Two cases have occurred of defiance of discipline where superior officers have been attacked. In another case a man ran about shouting and cursing in an aimless manner. One case of temporary mania is reported from a Whippet Battalion.

Unconsciousness is relatively frequent. In one tank during a long approach march the driver became totally unconscious, and was found holding his controls in a convulsive grip. He was succeeded by the second driver, who after a time shared the same fate. Finally the tank commander took over until he too had to be dragged from his post unconscious.

Collapse and mental confusion occur more or less in the same proportion. Men have fainted in the tanks, but more frequently on getting out into the fresh air.

Convulsions are infrequent, and have only been reported from one source.

The red complexion associated with carbon monoxide poisoning has been reported by officers in Whippets and Mark V* Battalions. This is, however, rare, and the cases usually present a pallid or ashen grey appearance.

A Whippet Brigade reported that one of the chief symptoms was loss of power in the limbs, "making it impossible to walk or run quickly, and taking at one time two men to load a gun."

On an average it has taken three hours running in a closed tank for the symptoms to develop—in a few cases in a quarter of an hour, in others not until six hours.

In seventy-five per cent of the reports it is stated that fumes from the firing of the Hotchkiss and 6-pounders have aggravated these symptoms. Temperatures taken of men who have been inside tanks for some considerable time show that the body heat is raised anything up to 102° F. The pulse-rate is usually quickened.

One man after a three hours' run, in which the tank had developed 30° C. wet bulb, had a temperature of 101·4° F. and pulse of 168. After twenty minutes' rest the temperature was 99·4° and pulse 144. Three men from another crew after three hours' run had: Temperature 100° F.; pulse 110. Temperature 99·4° F.; pulse 112. Temperature 99° F.; pulse 112.

Taking reports in general from different sources the percentage of the symptoms noticed was roughly as follows:—

Headache	100 per cent.
Giddiness	100 ,,
Breathlessness	62·5 ,,
Palpitation	62·5 ,,
Vomiting	67·5 ,,
Mental confusion	50 ,,
Unconsciousness	60 ,,
Collapse..	48 ,,
Convulsions	12 ,,
Red complexion	12 ,,

As a rule the symptoms soon pass off, but as a result the crews are extremely exhausted.

The men are not fit for duty for a period varying from two to seven days, so that in a continuous action it becomes a serious problem as regards finding fit men to man the tanks.

Ventilation of Tanks.

The question of ventilation has attracted a great deal of attention as a result of the actions fought with the Mark V, V*, and Whippets.

The designs of the Mark V and V* have been altered considerably from that of the Mark I and IV, in which the radiator was situated across the after end, and beside this was a fan which drew air from inside the tank through the radiator and expelled it through louvres let into the armour plating behind, near the end of the exhaust pipe. This ensured tolerably good ventilation and helped to disperse the exhaust gases outside. However, the air drawn through the radiator was warmed after running; this gave rise to the mechanical defect of causing the water in the radiator to boil. To obviate this in the Mark V and the V* the radiator was placed outside on the right-hand side at the after-end of the tank. A fan was fitted to it, and drew in air through louvres on the left-hand side, blew it through the radiator and expelled it through louvres on the right-hand side.

In transit some of this air can be admitted into the tank through a slide-door let into the radiator casing.

For cooling the radiator this is efficient, but for ventilation it is most unsatisfactory in that the side of entry of the air being situated near the end of the exhaust pipe, it is possible with a following breeze for exhaust gases to be sucked into the tank.

In addition to this, further ventilation is provided for by means of a fan situated behind the point of exit of the exhaust-pipe, which sucks air from within the casing around the exhaust-pipe and the engine casing itself, and expels it through a cowl on the roof.

This serves to cool the exhaust-pipe, which, after running, tends to become red hot, and may cause starting of the exhaust joints. It is to these joints that particular care should be given, as in the experiments cited below; it has been here that the more definite traces of carbon monoxide have been found.

Ventilation in this type of tank fails because there is no continuous current of air drawn over a large surface flowing into the tank, and as a consequence pockets of carbon monoxide are likely to form.

In the Whippet ventilation is provided for on similar lines. In the fore compartment, which contains the engine, two fans suck in air from beneath the tank and expel it via the radiator through louvres on both sides.

This compartment communicates with the body of the tank, at the back of which are two fans sucking air into it. Here again the escape of exhaust gases is so directed as to make it possible for them to gain admission into the tanks.

Tank Exhaustion.

Carbon monoxide was suspected as a cause of the exhaustion of tank crews; its action would be intensified in the presence of other gases such as excess of carbon dioxide, and where there is diminished oxygen.

Furthermore, the cumulative absorption of carbon monoxide would be facilitated by the fact that the crews are exposed to much muscular exertion, anxiety, and mental excitement.

Experiments.

The following experiments were conducted:—

Tanks were run closed down to represent battle conditions, and samples of air were taken from different positions and tested by the hæmoglobin method for carbon monoxide. Readings from the wet and dry bulb temperatures were registered and individual temperatures were taken.

September 7, 1918. Mark V Tanks. Observations made during three-quarters hour run.

Time		Temperature	
		Dry bulb	Wet bulb
2.30 p.m.	Start	70° F. = 21·1° C.	64° F. = 17·7° C.
2.40 ,,	..	75° F. = 23·8° C.	66° F. = 18·8° C.
2.57 ,,	..	81° F. = 25·6° C.	68° F. = 20·0° C.
3.0 ,,	..	83° F. = 28·3° C.	70° F. = 21·1° C.
3.12 ,,	..	86° F. = 30·0° C.	72° F. = 22·5° C.
3.20 ,,	Stop	90° F. = 32·2° C.	74° F. = 23·3° C.

Samples of Air Taken.

(1) Level of induction side of engine.
(2) Level of exhaust side of engine.
(3) Driver's seat.
(4) Centre of tank behind engine.
(5) After end of tank.
(6) Above engine within casing.

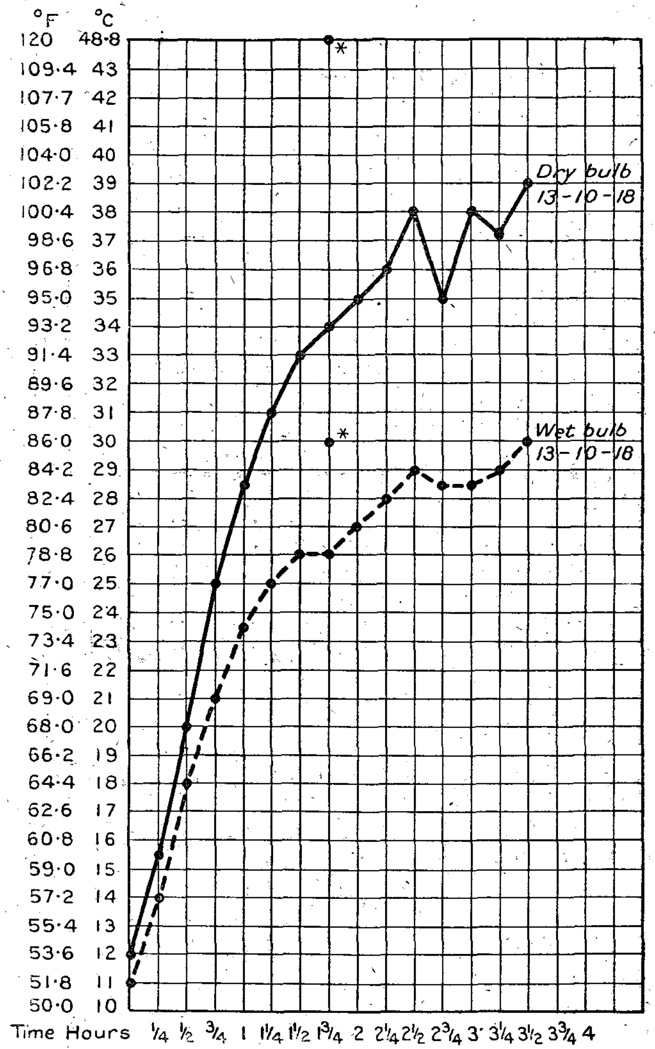
No appreciable amount of CO was found. On this occasion a strong wind was blowing and the tank could not be satisfactorily closed up so that ventilation was tolerably good.

September 13, 1918. Mark V*. After running one and a half hour. Samples taken from:—

(1) Inside engine casing.
(2) Driver's seat.
(3) After end of tank.
(4) Middle of tank.
(5) Exhaust pipe outside.

Sample 1 showed a definite trace of CO; samples 2, 3 and 4 showed less; sample 5 showed abundant CO.

"L" had pulse rate 96, and temperature 99° F.
"B" had pulse rate 88, and temperature 98·6° F.
No wet and dry thermometers were available.



Normal Mark V Chart. Autumn Day.
* Temperature at end of 1¾ hours run in a Mark V*

September 16, 1918. Mark V and V* were used, after running one and three quarter hour.

	Temperature:	Dry bulb	Wet bulb
Mark V	..	109° F. = 42·7° C.	79° F. = 22·2° C.
Mark V*	Start	118° F. = 47·7° C.	85° F. = 29·4° C.
	Finish	120° F. = 48·8° C.	86° F. = 30·0° C.

Samples Mark V.

(1) Centre of tank.
(2) Level with exhaust side of engine. (Casing closed.)
(3) Level with induction side of engine. (Casing open.)

Sample 2 showed a distinct though small amount of CO; sample 1 a trace; sample 3 practically nil.

Samples from Tank V.*

(1) Centre of tank.
(2) Level with induction side of engine. (Casing open.)
(3) Driver's seat.
(4) High up in Conning Tower.
(5) Level with exhaust side of engine. (Casing closed.)
(6) Above engine on exhaust side.

Each sample contained a distinct though small amount of CO, the greatest in six, and the least in three. In this case "B" who remained still, had a temperature of 98·8° F. "D" and the driver respectively, 100·5° F. and 100·4° F.

October 14, 1918. Mark V after running two hours. The following samples were taken with a view to calculating the amount of carbon monoxide present.

Outside Tank.

(1) Six feet from back of the tank, four feet above ground.
(2) Six feet from back of the tank, six feet above ground.
(3) Twelve feet from back of tank, four feet above ground.
(4) Twelve feet from back of tank, six feet above ground.
(5) Opposite intake louvres to radiator fan with a following wind.

Inside Tank.

(6) Behind engine.
(7) Behind engine.
(8) At driver's seat.
(9) At driver's seat.

Sample No.	CO_2 per cent	CO per cent	Wet bulb O.C.	Dry bulb I.C.
1	0·18	Nil	—	—
2	0·15	0·16	—	—
3	0·12	Nil	—	—
4	0·14	Nil	—	—
5	0·17	0·11	—	—
6	0·09	Nil	19·8	30·0
7	0·16	0·16	20·3	31·8
8	0·10	0·09	—	—
9	0·15	0·12	24·5	37·0

The figures given for CO are possibly high, as there may have been some unconsumed hydro-carbon present which would slightly affect the results.

The carbon dioxide CO_2 percentage is low and as such would have no effect, but would have been greater had a full crew been in the tank.

SUGGESTIONS FOR PREVENTING TANK EXHAUSTION.

The main considerations are to allow as much fresh air into the tank as possible, and to prevent overheating. Crews should be medically examined regularly, and if possible, should be rested before going into action. After action a minimum rest of forty-eight hours should be given to crews. In cases of severe poisoning by carbon monoxide, recourse should be had to prolonged artificial respiration, and administration of oxygen. Cordite should be used in preference to other explosives such as N.C.T. (nitro cellulose tabular) and the fitting of parabolic cups to the machine guns would help considerably, in disposing of explosion gases, which contain carbon monoxide.

Before Action.

(1) Test all exhaust pipes connexion, inside the tanks, and see that the asbestos packing is efficient, and that the engine casing is closed.

(2) Ensure fans are working satisfactorily. The fan ball bearings are apt to give trouble when overheated.

(3) Mop up all waste petrol and oil inside the tank, and prevent oil splashing on red hot surfaces.

Approach Marches.

(1) Keep all means of ventilation open as long as possible.

(2) A distance of twenty-five yards should be kept between tanks proceeding in echelon.

(3) Avoid exhaust gases from neighbouring tanks, by studying the direction of the wind. With a following wind always close slide door to radiator at the after end of Mark V and Mark V*.

(4) Driving should be done in relays of half an hour at a time, and a constant watch kept on each other by members of the crew.

CONCLUSION.

In conclusion it is clear that tanks with a full crew on board, and closed down for action after running a certain time, are liable to show both the presence of carbon monoxide, and a high wet bulb temperature.

The extent of these will depend upon the mechanical efficiency of the tanks.

It is therefore strongly urged that the subject of ventilation should receive far more consideration in future than it has in the past. Good and efficient ventilation will obviate both these defects.

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