AWM4

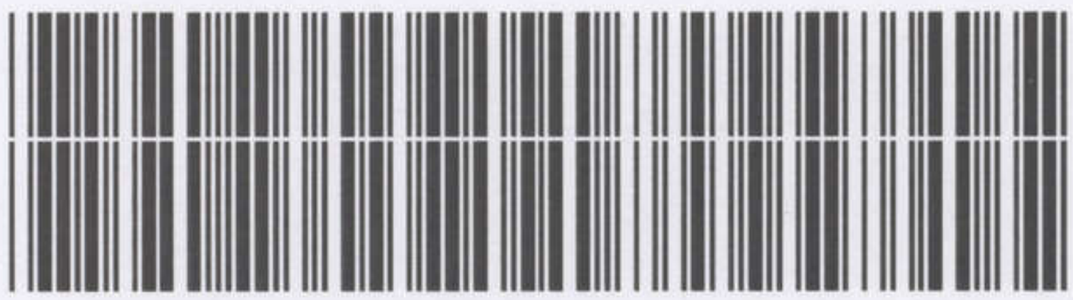
Australian Imperial Force unit war diaries, 1914-18 War

Medical, Dental & Nursing

Item number: 26/17/6

Title: Deputy Director of Medical Services, Australian Corps

June 1918



AWM4-26/17/6

1.20,000—5/18—11069.

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ORIGINAL.
~~DUPLICATE.~~
~~TRIPLICATE.~~

Australian Imperial Force.

WAR DIARY

OF

D. D. M. S. - Australian Corps.

FOR

June 1918.

Signature of Officer compiling .....

Signature of Officer Commanding ..... COLONEL D.D.M.S. AUSTRALIAN CORPS.

Instructions regarding War Diaries and Intelligence Summaries are contained in F. S. Regs., Part II. and the Staff Manual respectively. Title pages will be prepared in manuscript.

WAR DIARY
or
INTELLIGENCE SUMMARY.

(*Erase heading not required.*)

Army Form C. 2118.

Place	Date	Hour	Summary of Events and Information	Remarks and references to Appendices
Bertangles	June	1st	Issued Standing Orders to the A.A.M.C. to all concerned (Australian Corps.) Copies attached	Appendix1
		2nd	Inspected No. 3 Australian Sanitary Section and Corps Reinforcement Camps.	
		3rd	Inspected No. 2 Corps Relay Post and Main Dressing Station at Les Alencons.	
		4th	Inspected Gassed Patients at C.C.S., St. Ricquier.	
	5/6th		Nothing to report.	
		7th	Inspected Prisoners of War Cage and Field Punishment Compound.	
		8th	Nothing to report.	
		9th	Inspected No. 1 and No. 5 Australian Sanitary Sections and 5th Australian Field Ambulance.	
		10th	Nothing to report.	
		11th	D.G.M.S., Australia and D.M.S., A.I.F. inspected Medical Units of the 5th and 2nd Australian Divisions.	
		12th	D.G.M.S., Australia and D.M.S., A.I.F. inspected Medical Units of the 3rd and 4th Australian Divisions, and Nos. 1 and 2 Corps Relay Posts. D.A.D.M.S. visited 49th C.C.S. re too early return to duty of gas patients to reinforcement camp and arranged that only those fit within five days should be sent.	
		13th	D.G.M.S., Australian and D.M.S., A.I.F. visited Australian Surgical Team at No. 3 British C.C.S. D.M.S., A.I.F. left for Fifth Army.	
		14th	Nothing to report.	
		15th	D.G.M.S., Australia left Corps Area and proceeded to G.H.Q., B.A.in F.	
		16th	Inspected Prisoners of war Cage and Field Punishment Compound. Sanitation now satisfactory.	
		17th	Inspected Advanced Dressing Station Vecquemont Road. Deep dugouts workings satisfactory.	
		18th	Visited 8th Field Ambulance Transport Lines. Horses not good. Found that Q.M. was transport Officer and strongly advised that Medical Officer be appointed. Visited 5th Australian SanitarySections new workshops which was satisfactory.	
		19th	Corps Commander inspected 1st Australian Sanitary Section, Main Dressing Station n.10.a.9.4. (15th Australian Field Ambulance, Divisional Collecting Station, Petit Camon (8th Australian Field Ambualnace) and Main Dressing Station, Les Alencons (4th Australian Field Ambulance).	
		20th	Inspected delousers(improved Russian) at 12th Brigade nucleus, which was very badly constructed by engineers, at 13th Field Ambulance, well constructed, and 4th Brigade nucleus, well constructed. Visited 178th R.G.A. re epidemic of Influenza, and evacuation of patients which they wished to avoid as the British do not always send back men from the Base to their own Units, a practice which must conduce to loss of efficiency, morale, and esprit de corps in the British Army. This Corps considers that the tactical situation requires that all men unlikely to be well within 48 hours should be evacuated to the nearest Field Ambulance and all units have been so instructed.	

Instructions regarding War Diaries and Intelligence Summaries are contained in F. S. Regs., Part II. and the Staff Manual respectively. Title pages will be prepared in manuscript.

WAR DIARY
or
INTELLIGENCE SUMMARY.

(*Erase heading not required.*)

Army Form C. 2118.

Place	Date	Hour	Summary of Events and Information	Remarks and references to Appendices
	June 20th		Casualty Clearing Stations are holding cases likely to be well in ten days but have not got the necessary accommodation. I am, as I have always been, of opinion that a Stationary Hospital should be located in the Army Area for these light cases. The accommodation at C.C.Ss could then be reduced and they could perform their proper duties of clearing the sick and wounded.	
	21st		Inspected delouser of 13th Brigade nucleus and advised that Canadian Stoves should be replaced by oil drum type. Frame for sliding door was badly constructed.	
	22nd		Visited 4th & 13th Brigade nucleus. Sanitation unsatisfactory and wrote to 1st Australian Sanitary Section.	
	23rd		Visited 12th Brigade nucleus and conferred with A.D.M.S. re delousers.	
	24th		Visited Colonel Moseley who was wounded at Bussy now at No. 5 C.C.S.	
	25th		Visited No. 3 Australian Sanitary Section and O.C. Corps Reinforcement Camp.	
	26th		Conferred with A/A.D.M.S., 4th Australian Division, Lt. Col. McGregor.	
	27th		Visited C.C.S., Crouy and 14th A.D.M.Stores, also No. 1 Corps Relay Post.	
	28th		Visited Advance Dressing Station N.4.c.9.2. with C.E. and C.R.E. 4th Australian Division and arranged for the erection of nissen huts for walking wounded. Inspected 8th Australian Field Ambulance. Section Commanders did not know their drill and Ambulance improperly drawn in some details. A few bearers did not look physically capable of bearing. A.D.M.S., and O.C. willl see that Sections Commanders are trained. Inspected new type Russian delouser at 5th Australian Sanitary Section, the stove being fed from outside. This seems to be an improvement and is very successful.	
	29/30th		Nothing to report.	

Colonel,
D.D.M.S., Australian Corps.

D. D. & L., London, E.C.

20,000—5/18—11,069

WAR DIARY

OF

D.D.M.S., Australian Corps

FOR

June 1918

LIST OF APPENDICES.

No.	Subject.
1	Medical Instruction No. 25.
2	Medical Instruction No. 26.
3	Medical Instruction No. 27.
4	Army Wastage Returns week ending 1st., 8th., 15th., 22nd and 29th.
5	Standing Orders for A.A.M.C., Austrialian Corps.
6	Memorandum re Vadencourt Chateau omitted from war Diary of May.
7	Memorandum on Gas Poisoning.
8	Manual of Injuries and Diseases of War.
9	

297

APPENDIX 14

Copy No. 6

SECRET

AUSTRALIAN CORPS

Medical Instructions No.25.

In accordance with Australian Corps Order No. 112, d/12-6-18 and the relief of the 2nd Australian Division by the 5th Aust. Division, the following medical re-arrangements will take place-

1. The A.D.M.S. 5th Australian Division will take over from the A.D.M.S. 2nd Australian Division the medical arrangements for the clearance of "C" Divisional Sector and area.
   ii. The relief will be completed by 10 am 16th June 1918, details being mutually arranged between A.Ds.M.S. concerned.
   iii. Medical Units of the 2nd Australian Division thus relieved will be at the disposal of A.D.M.S. 5nd Aust.Division.

2. Acknowledge.

G.W. Barber

COLONEL
D.D.M.S. Australian Corps.

Headquarters
13th June 1918

Distribution :-
Copy No. 1 A.D.M.S. 2nd Aust.Div.
2 A.D.M.S. 5th Aust.Div.
3-5 "AQ" Aust.Corps
6-8 War Diary
9-10 File.

Copies for information to :-
D.M.S. Fourth Army
"G" Aust.Corps
"Q" Aust.Corps
A.Ds.M.S. 3rd 4th Aust.Divs.
O.C. 3rd M.A.C.
O.C. 1st Aust.San.Sect.

297

APPENDIX 2

SECRET

Copy No. 7

A U S T R A L I A N C O R P S

Medical Instructions No.26.

In accordance with Australian Corps Order No. 116, d/24th June 1918 and the relief of the 3rd Australian Division by the 2nd Australian Division, the following medical re-arrangements will take place :-

1. i. The A.D.M.S. 2nd Australian Division will take over the medical arrangements for the clearance of "A" Divisional Sector and area, from the A.D.M.S. 3rd Australian Division.
ii. Relief will be completed by 10am 29th June 1918, details being mutually arranged between A.Ds.M.S. concerned.
iii. Medical Units of the 3rd Australian Division so relieved will be at the disposal of the A.D.M.S.

Clement Chapman May. COLONEL
D.D.M.S. Australian Corps.

Headquarters
24th June 1918

Distribution :-
Copy No. 1 A.D.M.S. 2nd Aust.Div.
2 A.D.M.S. 3rd Aust.Div.
3-5 "AQ" Aust.Corps
6-8 War Diary
9-10 File.

Copies for information :-
D.M.S. Fourth Army
"G" Aust.Corps
"Q" Aust.Corps
3rd M. A. C.
A.Ds.M.S. 4th.5th Aust.Divs.
O.C. 4th Aust.San.Sect.

397

SECRET

APPENDIX 3 1

Copy No.... 8

A U S T R A L I A N C O R P S

Medical Instructions No.27

In accordance with Australian Corps Order No. 120,d/28th June 1918 -

1. The A.D.M.S. 3rd Australian Division will place 11th Australian Field Ambulance,and in addition four large ambulance cars at the disposal of the A.D.M.S. 4th Australian Division. Time and place of reporting to be arranged by A.D.M.S. 4th Australian Division.

2. O.C. 3rd Motor Ambulance Convoy will arrange to reinforce cars at Main Dressing Stations St.Acheul and Les Alencons by Zero hour.

3. The A.D.M.S. 4th Australian Division will arrange for the Advanced Dressing Station at N.4.c.9.2. to also act as a Main Dressing Station for Walking Wounded.

4. Full use will be made of returning empty mechanical transport and LO lorries will be provided to convey Walking Wounded from M.D.S. N.4.c.9.2. direct to C.C.S.

5. Zero day and hour will be notified.

6. Acknowledge.

G.W.H. Manders

COLONEL
D.D.M.S. Australian Corps.

Headquarters
28th June 1918

Distribution :-
Copy No.1 A.D.M.S.3rd Aust.Div.
2 A.D.M.S.4th Aust.Div.
3 O.C. 3rd M.A.C.
5-7 "AQ" Aust.Corps.
8-10 War Diary
11-12 File.

Copy for information :-
D.M.S. Fourth Army
"G" Aust.Corps
"Q" Aust.Corps
A.D.M.S. 2nd Aust.Div.
A.D.M.S. 5th Aust.Div.

297

SECRET.
RETURN NO.8.

APPENDIX 4
HEADQUARTERS,
AUSTRALIAN CORPS.
174/770

F O U R T H A R M Y.

WASTAGE RETURN FOR WEEK ENDING, MIDNIGHT, SATURDAY, 1st JUNE, 1918.

****

Formation.	Cases evacuated to the Base.						Sick Wastage % per week.
	Officers		O.Ranks		TOTALS.		
	Sick	W'ded	Sick	W'ded	Sick	W'ded	
Corps & Army Troops	23	20	551	175	577	195	.49
IIIrd Corps							
3.Cav.Division	2	-	45	3	47	3	.56
18th Division	7	-	77	30	84	30	.55
47th Division	9	4	158	68	167	72	1.04
58th Division	12	2	176	46	188	48	1.33
Australian Corps.							
2.Aus.Division	7	14	197	301	204	315	1.13
3.Aus.Division	5	19	135	286	140	305	.83
4.Aus.Division	9	1	109	116	118	117	.73
5.Aus.Division	8	1	86	81	94	82	.55
TOTALS.	85	81	1534	1106	1619	1167	.87

XIXth Corps & Divisions are evacuating direct to Base Hospitals.

C.J.Foulkes
Major-General,
D. M. S.

H.Q.,Fourth Army.
4th June, 1918.
C.
To:- Fourth Army "G", "A" & "Q".
D.Ds.M.S. for distribution to A.Ds.M.S.
"A" Corps & "A" Divisions, Fourth Army.
Officer in Medical Charge, Fourth Army Headquarters.
Ds.M.S.,First, Second, Third & Fifth Armies.

Copy AQ
Q

297

APPENDIX 4

SECRET.
RETURN NO.9.

F O U R T H A R M Y.

WASTAGE RETURN FOR WEEK ENDING, MIDNIGHT, SATURDAY, 8th JUNE, 1918

****

Formation.	Cases evacuated to the Base.						Sick Wastage % per week.
	Officers		O.Ranks		TOTALS		
	Sick	W'ded	Sick	W'ded	Sick	W'ded	
Corps & Army Troops	16	5	500	109	516	114	.47
IIIrd Corps.							
3.Cav.Division	-	-	33	2	33	2	.39
18th Division	3	4	127	33	130	37	.76
47th Division	7	2	156	61	163	63	1.02
58th Division	6	-	143	48	149	48	.98
Australian Corps							
2.Aus.Division	3	9	113	193	116	202	.63
3.Aus.Division	3	5	189	140	192	145	1.23
4.Aus.Division	1	6	135	117	136	123	.83
5.Aus.Division	5	2	102	56	107	58	.62
*XXIInd Corps.							
*37th Division	-	-	-	-	-	-	-
TOTALS	44	33	1498	759	1542	792	.66

*Joined Fourth Army during week.
Note:- Divisions of the XIXth Corps & Corps Troops are being evacuated direct to Base Hospitals.

E.A. Fiaston
Major-General,
D. M. S.

H.Q.,Fourth Army.
11th June, 1918.
C.
To:- Fourth Army "G", "A" & "Q".
D.Ds.M.S. for distribution to A.Ds.M.S.
"A" Corps & "A" Divisions, Fourth Army.
Officer in Medical Charge, Fourth Army Headquarters.
Ds.M.S., First, Second, Third & Fifth Armies.

397

APPENDIX 4 19

SECRET.
RETURN NO.10.

F O U R T H A R M Y.

WASTAGE RETURN FOR WEEK ENDING, MIDNIGHT, SATURDAY, 15th JUNE, 1918.

****

Formation	Cases evacuated to the Base.						Sick Wastage % per week.
	Off.		O.Ranks		TOTALS		
	Sick	W'ded	Sick	W'ded	Sick	W'ded	
Corps & Army Troops	34	12	659	90	693	102	.60
IIIrd Corps							
2.Cav.Division	1	-	53	-	54	-	.64
18th Division	11	1	119	36	130	37	.83
47th Division	10	2	199	65	209	67	1.26
XXIInd Corps.							
37th Division	4	-	54	1	58	1	.39
58th Division	11	-	161	7	172	7	1.15
Australian Corps							
2.Aus.Division	12	22	228	492	240	514	1.33
3.Aus.Division	8	7	153	177	161	184	1.01
4.Aus.Division	8	-	118	97	126	97	.77
5.Aus.Division	3	2	92	42	95	44	.54
TOTALS.	102	46	1836	1007	1938	1053	.79

Note:- Divisions of the XIXth Corps & Corps Troops are being evacuated direct to Base Hospitals.

E. Powell
Major-General,
D. M. S.

H.Q., Fourth Army.
18th June, 1918.
C.

To:- Fourth Army "G", "A" & "Q".
D.Ds.M.S. for distribution to A.Ds.M.S.
"A" Corps & "A" Divisions, Fourth Army.
Officer in Medical Charge, Fourth Army Headquarters.
Ds.M.S., First, Second, Third & Fifth Armies.

297

APPENDIX 4 1/10

SECRET.
RETURN NO.11.

F O U R T H A R M Y.

WASTAGE RETURN FOR WEEK ENDING, MIDNIGHT, SATURDAY, 22nd JUNE, 1918.

****

Formation.	Cases evacuated to the Base						Sick Wastage % per week.
	Officers		O.Ranks		TOTALS.		
	Sick	W'ded	Sick	W'ded	Sick	W'ded	
Corps & Army Troops	26	5	629	75	655	80	.52
IIIrd Corps							
3.Cav.Division	-	-	19	1	19	1	.22
18th Division	3	-	75	34	78	34	.49
47th Division	5	1	104	41	109	42	.69
58th Division	8	-	132	5	140	5	.92
VIIIth Corps							
8th Division	-	-	7	-	7	-	.12
21st Division	-	-	3	-	3	-	.02
XXIInd Corps							
37th Division	2	-	57	1	59	1	.38
Australian Corps							
2.Aus.Division	4	4	135	84	139	88	.79
3.Aus.Division	7	2	141	78	148	80	.82
4.Aus Division	4	3	110	92	114	95	.68
5.Aus.Division	14	7	164	113	178	120	.99
TOTALS.	73	22	1576	524	1649	546	.58

Note:- Divisions of the XIXth Corps & Corps Troops are being evacuated direct to Base Hospitals.

E.J. Poulton
Major-General,
Director of Medical Services.

H.Q.,Fourth Army.

25th June, 1918.

C.

To:- Fourth Army "G", "A" & "Q".
D.Ds.M.S. for distribution to A.Ds.M.S.
"A" Corps & "A" Divisions, Fourth Army.
Officer in Medical Charge, Fourth Army Headquarters.
Ds.M.S., First, Second, Third & Fifth Armies.

297

APPENDIX 4 11

SECRET.
RETURN NO.12.

F O U R T H A R M Y.

WASTAGE RETURN FOR WEEK ENDING, MIDNIGHT, SATURDAY, 29th JUNE, 1918.

****

Formation.	Cases evacuated to the Base						Sick Wastage % per week.
	Officers		O.Ranks		TOTALS.		
	Sick	W'ded	Sick	W'ded	Sick	W'ded	
Corps & Army Troops	37	3	795	49	832	52	.67
IIIrd Corps.							
3.Cav.Division	13	-	128	2	141	2	1.63
18th Division	13	1	142	22	155	23	.98
47th Division	13	-	79	22	92	22	.59
58th Division	11	6	184	38	195	44	1.29
66th Division	-	-	2	-	2	-	.06
33.Amer.Division	2	2	52	1	54	3	.32
Australian Corps.							
2.Aus.Division	14	4	163	37	177	41	1.00
3.Aus.Division	7	6	127	80	134	86	.83
4.Aus.Division	8	4	133	71	141	75	.89
5.Aus.Division	8	3	129	101	137	104	.76
TOTALS.	126	29	1934	423	2060	452	.78

Note:- Divisions of XXIInd Corps & Corps Troops are being evacuated direct to Base hospitals.

E. H. Poulton
Major-General,
Director of Medical Services.

H.Q.,Fourth Army.

2nd July, 1918.
C.

To:- Fourth Army "G", "A" & "Q".
D.Ds.M.S. for distribution to A.Ds.M.S.
"A" Corps & "A" Divisions, Fourth Army.
Officer in Medical Charge, Fourth Army Headquarters.
Ds.M.S., First, Second, Third & Fifth Armies.

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297

42

Appendix I.

297

STANDING ORDERS

297

A.A.M.C.

Australian Corps

297

12

Appendix 1.

297

June 1st 1918

Standing Orders for A. A. M. C. :: AUSTRALIAN Corps

Issued.....

A.I.F. Print. Sect.—In the Field.

297

42

Appendix 1.

297/DMS

Standing Orders
for A. A. M. C. ::
AUSTRALIAN Corps

Issued

A.I.F. Print. Sect.—In the Field.

STANDING ORDERS FOR A.A.M.C.

Australian Corps.

I. D.D.M.S.

Will receive and transmit orders and instructions from Corps and higher formations. Issue instructions approved by Corps and Circular Memoranda on technical subjects.

II. A.Ds.M.S.

1. Will receive and transmit orders from Divisions and higher formations, and issue instructions in the form of Routine and A.A.M.C. Orders, Medical Arrangements, Circular Memoranda on Technical Subjects, and draft Orders relating to the health of the troops, Prevention of Disease, and Medical Arrangements for insertion in Divisional Routine Orders with the approval of the G.O.C.

2. Will make himself acquainted with and apply the principles outlined under the heading Medical Arrangements in "The Training and Employment of Divisions, 1918," S.S.135, issued by the General Staff.

3. Will ensure that Medical Officers on first joining the Division are in possession of these Standing Orders, and such Circular Memoranda and Instructions as he deems necessary for the proper performance of their duties, *e.g.*, Instructions for Medical Boarding, Treatment of Gas Poisoning, Orders relating to the disposal of Mental Cases, Epileptics, N.Y.D.N. Cases, etc.

4. Will inspect the Field Ambulances under his command when the Division is in rest, and also, by courtesy of the Brigade Commander, the Regimental Stretcher Bearers, Sanitary Detachments, Water Details, Maltese Carts with Medical Equipment, and Water Carts of the Brigade.

5. Will ensure that Field Ambulances and the Regimental Service undergo courses of training on the lines suggested in Appendices 1 and 2. A minimum course of 14 days per annum will be carried out in the order indicated, but not necessarily consecutively.

6. Will hold a conference of Quartermasters of Field Ambulances on the second day of each month. C.Os. of units concerned may attend if they so desire.

297

42

Appendix 1.

297

7. Will ensure that Dental Inspections of all troops are carried out regularly as opportunity offers.

8. Will arange when the Division is at rest for accommodation for 50 patients per Field Ambulance, and at least five patients per Rest Post of units with Medical Officer attached, and so obviate the necessity of forming a Rest Station.

9. Will post Medical Officers joining the Division for the first time, and without previous experience in the field, to a Field Ambulance in order that they may undergo training to fit them to take Medical Charge of a Battalion. As a rule Regimental Medical Officers who have served from six to twelve months with a Battalion will be transferred to a Field Ambulance and trained for Command. When possible Officers will be interchanged between Brigades and their respective Field Ambulances, and thus promote efficiency and harmonious working which is so essential to the successful evacuation of sick and wounded.

10. Will ensure that the D.A.D.M.S. is fully conversant with everything passing through the office.

III. Commanding Officers of Field Ambulances

1. Will ensure that an Officer, in addition to himself, sees everything that passes through the office.

2. Will ensure that Officers, and particularly newly joined Officers, make themselves acquainted with all orders affecting them, and particularly those concerning Field Medical Cards and the disposal of patients. A file of such orders will be kept in the orderly-room, and will be initialled by each Officer.

3. Regulations regarding Surgical Operations will be strictly observed. No major operations will be performed at Main Dressing Station without the consent of the Officer Commanding, who will be responsible.

4. Will instruct Medical Officers in charge Bearer sub-divisions to accompany the same into action unless otherwise ordered. In the event of a Regimental Medical Officer becoming a casualty the nearest Bearer Medical Officer will take his place and notify O.C. and A.D.M.S. promptly. When casualties are heavy Bearer Medical Officers will assist R.M.O's.

IV. All Medical Officers

1. Will make themselves conversant with:—

(a) F.S. Regs. Part ii, Chap. xi. (Medical Services).

(b) K. Regs. paras. 1841-1485, 1857-1860.

(c) R.A.M.C. Training 1911, particularly Parts ii., iii.

(d) Regulations for the Army Medical Service, particularly Appendix 51.

Those not in possession of these books can view the first two at the orderly-room of the unit to which they are attached, and the two latter at the nearest Field Ambulance.

2. Returning from leave will report to the A.D.M.S. If unable to report personally owing to unit being too far from Divisional Headquarters, report will be rendered by wire. Officers will not proceed on leave until relieved.

3. Will make a practice of reading Divisional Routine Orders *daily*. Orders are frequently issued which affect them, their patients, or the health of their unit. They will also make themselves acquainted with G.R.O's., A.R.O's., and C.R.O's. in so far as they affect the Medical Service.

4. Will render returns called for promptly, on correct date and signed.

5. In charge of R.A.P's. and Relay Posts will be responsible for maintaining authorised supply of blankets and stretchers at their posts.

V. Regimental Medical Officers

1. Will indent on nearest Field Ambulance for Medical Equipment, Drugs, Dressings, Comforts, etc.; if any difficulty is experienced in obtaining the same, they will at once report the fact to the A.D.M.S.

2. Unless specially ordered:—

(a) Regimental Stretcher Bearers in action will not be allowed in rear of R.A.P's.

(b) Field Ambulance Stretcher Bearers in action will not be allowed in front of R.A.P's.

(c) Relay Stretcher Bearers in action will not be allowed in front of Relay Posts.

297

42

Appendix 1.

3. In event of an advance will instruct bearers with Companies to form Advanced R.A.P., and, when necessary move the R.A.P. to that point. R.A.P's., normally, will be in the vicinity of Battalion Headquarters. As a rule the 16 trained Stretcher Bearers will follow the Companies. The 16 surplus Bearers will be held in reserve.

4. Stretcher Bearers will be instructed to collect patients under cover during severe shelling, and to remove them when safe. Shell holes so used should be marked. A rifle with fixed bayonet, stuck in the ground near shell hole makes a good marker.

5. When the front is narrow R.M.O's. will arrange for their R.A.P's. to be in close proximity in order that they may relieve one another. Two or more R.M.O's. will not occupy the same R.A.P. unless perfect safety is assured.

6. During action applications for reinforcements, equipment, etc., will be forwarded to O.C. Advanced Dressing Station or to A.D.M.S. through Battalion or Brigade Headquarters.

7. Will at once inform A.D.M.S. and O.C. Ambulance i/c. Evacuation, of the location or change of location of R.A.P's.

8. Will at once notify regimental A.M.C. casualties to the A.D.M.S.

9. Will apply to the C.O. for the necessary material and labor for the construction of R.A.P's., which is a regimental matter.

10. Will forward broken stretchers and damaged equipment to the Field Ambulance, as these can be exchanged for new. All Medical Equipment must be accounted for and will not be disposed of without reference to the competant authority.

11. Will not retain patients in Rest Posts who are unlikely to be fit for duty within the period laid down in D.R.O.s. Before a move or anticipated action all Rest Posts and R.A.P's. will be cleared at least 24 hours previously.

12. Are responsible that Medical Equipment, Stretchers, Maltese and Water Carts are complete, and will at once report any deficiency or damage to same to the A.D.M.S. Water Details will always accompany Water Carts.

13. Will, after an action, at once indent to complete equipment and arrange with C.O. to complete establishment of stretcher bearers.

14. Will ensure that the infected blankets are sent with infectious patients to the Field Ambulance, others being drawn from the Field Ambulance to replace them.

15. Will train all the stretcher bearers in First Aid and Stretcher Drill, the Regimental Sanitary Detachment in Sanitation, and instruct the Water Details in the use of Poison and Water Test Cases on the lines laid down in Appendix 2.

16. Will make a daily sanitary inspection of the units to which they are respectively attached, and include any necessary remarks in the Daily Sick and Sanitary Reports, point out defects and suggest remedies to the Orderly Officer. If no action results report in writing to the C.O., duplicate copy of report to A.D.M.S.

17. Will make arrangements for the Prophylactic Treatment of V.D. when the Division is at rest, and at all other times when possible.

18. When posted to a unit are under the orders of the C.O., and at the disposal of the A.D.M.S. Official correspondence will be forwarded through the C.O. Correspondence on technical subjects direct to the A.D.M.S.

19. Attached to Artillery Brigades will be disposed in action as follows: One at the wagon lines, and one forward with the guns, and arrange for mutual relief.

VI. Field Ambulances.

1. When moving in back areas will normally be ordered to move with and under the orders of Brigades with which they are grouped, who will billet them and their patients. When Brigades are employed tactically in forward areas, Field Ambulances will be disposed of to the best advantage by the A.D.M.S., after consultation with the "G" branch of the Division. When Field Ambulances are moving with the Division or a detached Brigade in enemy country, the following is the normal disposition:—

The Bearer Division with horsed ambulance wagons, one G.S. wagon, one water cart, and (if considered necessary) a proportion of a tent sub-division marches with and under the orders of their respective Brigades.

The Tent Divisions with transport less that detached to the Brigade, march with and in front of baggage sections of the Divisional Train and in rear of Divisional Ammunition Columns, and billets with the former

Appendix 1.

The Motor Ambulances move up to the Brigade to clear patients at stated hours.

2. The composition of a Bearer Division if ordered on detached duty will be as follows, unless as otherwise stated :—

Bearer Division, less 7 wagon orderlies, 120 all ranks (less sick and men on leave)			
Batmen	...	...	3
Transport Drivers	...	...	5
TRANSPORT.			
Horsed Ambulance Wagons		...	3
G.S. Wagon or Limber	...	...	1
Water Cart	...	...	1

VII. Sanitary Sections.

Sanitary Sections are normally administered by Corps and will be allotted fixed areas. In event of an Australian Division moving out of the Corps area, it will be accompanied by a Sanitary Section detailed by the D.D.M.S., and will be under the command of the A.D.M.S.

A Sanitary Section may be attached to an Australian Division within the Corps area, and will then move with and under the orders of the Division, and be responsible for the sanitation of the Divisional area.

When attached to Divisions, will be employed as follows:—

Personnel allotted to Brigades and Groups of units within the Divisional area as inspectors who will inspect, advise, and report daily to O.C. Sanitary Section.

Personnel allotted for the inspection, marking and testing of water supplies within the Divisional area, and the examination of storage tanks and water carts.

When possible a workshop will be instituted where instruction will be given in methods for the construction and improvisation of sanitary appliances from material readily available to the troops.

Cases of non-compliance with Sanitary Regulations will be reported to the A.D.M.S., who will obtain action by forwarding the report with his comments to the "A" Branch of the Division.

VIII. Dental Units

Attached to Field Ambulances and Div. Artillery:—

1. Will be disposed to the best advantage by the A.D.M.S., and as far as possible be always allotted to the same Brigades or groups of Units.

2. Attached to Divisions will move with a maximum equipment weight of 350 lbs. Such surplus stores and equipment as are accumulated during stationary warfare will be disposed of under the directions of the S.O.A.D.S.

IX. Special Returns and Reports

Will be rendered as follows:—

Pro-forma.	Detail.	By Whom rendered.	To Whom rendered	When.	Appendix.
A.	Regimental and Field Ambulance Equipment	Q.Ms. Fd. Amb.	A.D.MS. Through C.O.	Last day of Month.	3
B.	Distributipn Report.	O.C. Fd. Amb. i.c. evac. from line.	A.D.M.S.	Within 3 days of taking over line.	4
C.	Ambulance Wagons.	O.C. Fd. Amb.	A.D.M.S.	Daily.	5
D.	Surplus Blankets and Stretchers.	A.D.M.S.	D.D.M.S.	Within 3 days of taking over line.	6
E.	Medical Arrangements.	A.D.M.S.	D.D.M.S. and Copies to all concerned	Within 3 days of taking over line.	7
	Fd. Amb. R.O. (Copy)	O.C. Fld. Amb.	A.D.M.S.	Daily.	
	Sick and Sanitary Report (Pro-forma at discretion of A.D.M.S.)	R.M.O.	A.D.M.S.	Daily.	

For the purpose of Return Pro-forma A.A.D.M.S. will affiliate units of the Division in proportion to Field Ambulances in addition to their respective Brigades.

X. Training

Will be carried out on the lines suggested in Appendices 1 and 2 and para. 7 of these orders.

Appendix 1.

297

APPENDIX I.—Suggested Syllabus of Training for Field Ambulances of the Australian Corps.

Day	Morn. 7—7.30	FORENOON 9.30—11	FORENOON 11.15—12.15	AFTERNOON 2—4.30
1st	Phys. Exer.	Stretcher Drill R.A.M.C. Tg., Par. 380-394	Squad & Com. Drill, Guard & Picquet Duties.	Practical Instruction First Aid R.A.M.C. Tg., Ch. 30-33 (Bandaging, etc.)
2nd	Ditto	Stretcher Drill R.A.M.C. Tg., Par. 384-397.	Squad and Company Drill Signalling.	Ditto
3rd	Ditto	Stretcher Drill R.A.M.C. Tg., Par. 397-399.	Squad and Company Drill Signalling.	Ditto R.A.M.C. Tg., Ch. 34, (Bleeding, etc.)
4th	Ditto	Stretcher Drill R.A.M.C. Tg., Par. 397-401.	Squad and Company Drill Signalling.	Ditto R.A.M.C. Tg., Ch. 35, (Fractures, etc.)
5th	Ditto	Stretcher Drill R.A.M.C. Tg., Par. 401-405.	Squad and Company Drill Signalling.	Ditto Ch. 35-36 and application of Thomas Splint.
6th	Ditto	Stretcher Drill R.A.M.C. Tg., Par. 401-406.	Squad and Company Drill Signalling.	Tent pitching and preparation of tents for Patients. R.A.M.C. Tg. Part IV. Ch. 25, Section 416-430.
7th	Ditto	Stretcher Drill, R.A.M.C. Tg., Par. 377-405.		Lecture, First Aid, R.A.M.C. Tg., Ch. 37-42.
8th	Ditto	Stretcher Drill, R. A. M. C. Tg. Par. 377-405.	Lect. & Practical Demonstration R.A.M.C. Tg. Transport of Wounded. Ch. 18, Par. 295-300.	Checking equipment and examining contents. Water and Poison Testing cases, and explanation of Sanitary Methods in the Field.
9th	Ditto	Stretcher Drill, R. A. M. C. Tg. Par. 377-405.	Ditto Chapter 18, Par. 303-321.	Practical Instruction First Aid R.A.M.C. Tg. Ch. 30-33. (Bandaging, etc.)
10th	Ditto	Formation and Movement of Ambulances R.A.M.C. Training, Ch. 21.		Ditto R.A.M.C. Tg., Ch. 34-35, and application of Thomas Splint.
11th	Ditto	Stretcher Drill, R.A.M.C. Tg. Par. 377-405.	Squad and Company Drill.	Tent Pitching, Guard and Picquet Duties, and preparation of operating tent and tents for sick.
12th	Ditto	Prep. of G.S. wagons, etc. for patients. R.A. M.C. Tg. Ch. 18, 337-348.	Pract. Dem. of Fld. C'k'g. R.A. M.C. Tg. Ch. 26.	Practical Sanitation R.A.M.C. Tg., Ch. 12.
13th	Ditto	Packing and loading Field Ambulance Equipment. Equiping Field Amb. Wagons.		Formation of Dressing Stn. and laying out of Fld. Amb. encampment for reception of wounded. Preparation of D.C.S., Bivouacs and Shelters, Chapter 15.
14th	Ditto	Route March—Formation and Movement of Ambulances. R.A.M.C. Training, Ch. 21.		

This Course should be carried out in the order indicated, but need not be carried out consecutively, but as opportunity offers
The training should be a minimum course of 14 days per annum. The C.O. will detail Officers, W.O's., & N.C.O's. to carry out the training. In addition to this Course, Lectures should be arranged for on Duties of N.C.O's. Clerical Duties. Evacuation of Wounded. Field Medical Organization, Sanitation, and Elementary Anatomy and Physiology, and by members of the D.H.Q. Staff to Officers on Military Law, Geneva Convention, Care of the Horse, Supplies, etc. Arrangements should be made for the attendance of R.M.O's.

APPENDIX 2.

Suggested Training for REGIMENTAL MEDICAL SERVICE.

—— TEXT BOOK ——

R.A.M.C. TRAINING - 1911.

STRETCHER BEARERS.

			Reference.
(a) **First Aid.**			
PRACTICAL	(1)	Application of Splints.	Part V., Chap. 35.
	(2)	Application of Dressings.	Part V., Chap. 32, 33.
	(3)	Checking of Hæmorrhage.	Part V., Chap. 34.
	(4)	Bandages & Bandaging.	Part V., Chap. 30.
	(5)	Improvisation.	Part V., Chap. 44.
LECTURES	(1)	First Aid.	Part V., Chap. 27, 28, 29
	(2)	Transport of Wounded.	Part III., Chap. 18, especially Para. 306.
(b) **Stretcher Exercises** - -			Part IV., Chap. 22, Paras. 380 to 402, Para. 405.

REGIMENTAL SANITARY DETACHMENT.

PRACTICAL	Improvisation of Sanitary Appliances.		
	Latrines.	Grease Traps.	
	Refuse Pits.	Incinerators.	
	Destructors.	Ablution Places.	
	Urinals.		
LECTURES	Sanitation of Camps, Bivouacs, Billets.		Part II, Chap. 12.

WATER DETAILS.

PRACTICAL	(1)	Water and Poison Testing.	
LECTURES	(1)	Principles of Disease, Prevention.	Part II., Chap. 6.
	(2)	Control of Infection.	Part II., Chap. 7.
	(3)	Water Supplies.	Part II., Chap. 8.
	(4)	Purification of Water.	Part II., Chap. 9.
	(5)	Infectious Cases.	Part V., Chap. 46.
	(6)	Care of Feet.	Part II., Chap. 11, Para. 114.

C.O's. Field Ambulances will furnish Drill Instructor on application by R M.O.

APPENDIX 4. Pro-forma B.

Distribution Report ..... **Australian Field Ambulance.**

Date .....

(..... Left Sector .....) (..... Right Sector .....)

Post.	Map Location.	Blankets.	Stretchers	Ambulance Personnel at present at Posts	Ambce. Personnel wanted in case of heavy casualties.	Evacuation Routes.
R.A.P.						
R.A.P.						
R.A.P.						
Bearer R.P.						
Bearer R.P.						
Bearer R.P.						
Bearer R.P.						
A.D.S.						
R.A.P.						
R.A.P.						
R.A.P.						
Bearer R.P.						
Bearer R.P.						
Bearer R.P.						
A.D.S.						

N.B.—When necessary add columns for M.D.S., Motor Posts, D.C.S., etc.

C.O., ... Lieut.-Col., Australian Field Ambulance

APPENDIX 3. Pro-forma A.

.....AUSTRALIAN FIELD AMBULANCE.

Monthly Report of Quartermaster on Medical Equipment of.....Field Ambulances and affiliated Uuits for Month Ending..... .....

UNIT.	Water Bottles (medical)	Medical Companions.	Surgical Haversacks.	Field Medical Panniers.	Reserved Field Med. Panniers.	Field Surgical Panniers.	Field Frac. Boxes.	Res. Dressing Boxes.	Hav'sacks with shell dressings	Cases, Water-testing poisons.	Cases, Water-testing Sterlization.	"S.B." Armlets.	Ammonia Capsules.	Thomas' Splints	Suspension Bars.	Wheeled Stretchers.	Oxygen Cylinders.	Oxygen Masks.	Primus Stoves.	Stretchers with Slings complete	Remarks. Such as under:— "All Shortages Indented for." "F.M.P.aniers destroyed by shell fire." 9.10.17 "1 Med. Companion unaccounted for."	
Scale for Reg. Unit.	2	1	1	prs. 1	prs.	prs.			8	1	1	20	10%	2	2				1	10		
....A.I. Bn.																						
.... "																						
.... "																						
.....Div. Train																						
....D.A.C.																						
.....San. Sec.																						
Scale for Field Amb.	27	6	21	3	1	3	3	6	18	2	2			22	22	7		1	6	72	Tents O.P. 3	Tents circ. 12
.....Field Amb.																						

.....Q.M. .....Aust. Field Amb.

Lieut.-Colonel,
C.O., ...Aust. Field Amb.

N.B.—Scale s to be amended when necessary. Scale for Sanitary Sections need not be shown.

297

APPENDIX 5. **Pro-Forma C.**

Australian Field Ambulance,

Daily Return of Ambulance Wagons.

DATE.....

	FORDS	SUNBEAMS	HORSE WAGONS	MOTOR CYCLES.	REMARKS.
Fit for duty	1	4	1	1	1 Ford } In Workshops 1 Sunbeam }
Unfit for duty	1	1	2	1	2 Horse Amb. incomplete
					1 Cycle proceeding to Workshops.
TOTAL	2	5	3	2	

.....Lieut.-Colonel,

C.O.....Australian Field Ambulance.

297

APPENDIX 6. **Pro-forma D.**

.....AUSTRALIAN DIVISION.

Return of Stretchers and Blankets held by.....Australian Division.

Surplus to Mob. Table Equipment.

	STRETCHERS.	BLANKETS.
.....Field Ambce.		
.....Field Ambce.		
.....Field Ambce.		
TOTALS.		

Headquarters,

.....1918.

Colonel,

A.D.M.S.,.....Australian Division.

Appendix

42

42

Appendix 1.

APPENDIX 7. Secret. **Medical Arrangements..... Aust. Div.** **Pro-forma E.**

LINE HELD ..... TO ..... MAP REFERENCES .....

LINE.	R.A.P's.	Relay Posts.	Motor and Wagon Posts.	Adv. Dressing Station.	Main Dressing Station.	Div. Collect'g Station.	Evacuation.
Left Bde.							Routes, Alternative Routes, and Method of Evacuation from R.A.P's. to C.C.S. will be shown here.
Right Bde.							

DISTRIBUTION:

.....Aust. Fd. Amb.
.....Aust. Fd. Amb.
.....Aust. Fd. Amb.
Dental Unit No.....
Dental Unit No.....
Dental Unit No.....
Dental Unit No.....with.....D.A.C.
A.D.M.S.

.....Motor Ambce. Convoy
.....Adv. Depot Med. Stores
No.....Mobile Lab.
No.....C.C.S. Infectious Cases.
No. ....C.C.S. Opthlamic, N.Y.D.N., N.Y.D. Gassed, S.I.W.
No. ....C.C.S., Sick and wounded
Aust. Branch B.R.C.S. at.....

Headquarters,
.....1918.

Colonel,
A.D.M.S., ... Australian Division.

N.B.---Map Locations and distinctive names (if any) required, e.g. Under Column headed A.D.S. "I.9.c.66. Menin Road."
Under Column headed R.A.P. "J.2.d.1.1., The Tunnels."
Columns will also be added for D.R.S. or C.R.S., etc., when necessary.
Under Distribution, Headquarters of Units will be shown *e.g.*---"Aust. Fld. Ambulance, A.D.S., Menin Road Evacuation, from Div'l. Front." No..... Adv. Depot Medical Stores---Picquigny.

APPENDIX 6

D.D.M.S. Aust.Corps

The Director Medical Services

Fourth Army

I think it my duty to report that I still consider VADENCOURT CHATEAU, handed over to Vth Corps by orders of Fourth Army, vital to the evacuation of wounded from "G" Divisional Sector and area in the event of severe fighting. The contention of the D.D.M.S. Vth Corps that it is unnecessary as the Vth Corps did not use this Dressing Station while occupying the northern part of this sector has no bearing on the matter, as it is and has been required for the evacuation of the southern portion of this sector held by the 4th Australian Division with VIIth Corps and transferred from that Corps to the Australian Corps and now held by the Vth Corps.

When held by the 4th Australian Division the Main Dressing Station WARLOY sustained two direct hits while full of patients and it was necessary to retire to Vadencourt Chateau, and the same may again happen.

The case is somewhat similar to that of Kemmel and La Clytte Dressing Stations and you will remember that I reported that Kemmel Main Dressing Station would be untenable directly serious fighting began, which was exactly what happened.

I now know that Warloy may become untenable and that therefore Vadencourt Chateau should be available to the Division occupying "G" Divisional Sector and area.

The principle which allows artificial boundaries designed to give another Corps access to water and billeting accomodation to interfere with the safety of the sick and wounded and Medical personnel, appears to me to be tactically bad.

Headquarters
4th May 1918

COLONEL
D.D.M.S. Australian Corps

[S.S. 452.]

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NOTE.

The information given in this Handbook is not to be communicated, either directly or indirectly, to the Press or any person not holding an official position in His Majesty's Service.

Memorandum on Gas Poisoning in Warfare

with notes on its

Pathology and Treatment.

NOTE.

This Memorandum has been drawn up by a Committee of Consultant Physicians and Physiologists for the information of Medical Officers. IT IS TO BE TREATED AS CONFIDENTIAL AND SHOULD ON NO ACCOUNT BE TAKEN INTO THE TRENCHES.

A. T. SLOGGETT,
Director-General Medical Services,
British Armies in France.

GENERAL HEADQUARTERS,
1/4/18. 2ND ECHELON.

The Original Edition of S.S. 452, "Memorandum on Gas Poisoning in Warfare," published in July, 1916, is hereby cancelled.

Printed by the Avenue Press (L. Upcott Gill & Son, Ltd.), 55/57, Drury Lane, W.C.2
P 18/214

Attention is drawn to S.S. 534 (Revised Edition), "Defence Against Gas," where information will be found regarding the use of the Respirator, Gas Alarms, Construction of Gas-Proof Dug-Outs, Methods of Clearing Gas from Dug-Outs, and of Dealing with Ground, &c., contaminated with Gas.

CONTENTS.

Memorandum on Gas Poisoning in Warfare

with notes on its

Pathology and Treatment.

GENERAL CONSIDERATIONS.

The primary action of poisonous gases and vapours may be complex, a number of different organs in the body being simultaneously affected to degrees that vary with the concentration of the gas and the duration of exposure. Frequently, however, their action tends to be specific, in the sense that it is mainly limited to some particular part of the body, at least when the concentration of the gas is low. It is possible, therefore, to group these gases, as shown below, into classes according to the most prominent physiological effect that they cause, though it must be recognised that this grouping is only a rough one, as the different classes overlap one another a good deal.

(1) **Lung irritants.**—The main characteristic of these is that they cause irritation and damage of the deeper respiratory passages, and especially of the alveoli of the lungs, with resulting inflammatory exudation of fluid, and the production of acute pulmonary œdema and death by asphyxia. Some of these gases are quite effective lachrymators.

(2) **Nasal irritants.**—These cause sneezing and irritation of the nose and throat, even in very low concentrations, without causing any material effect on the lungs.

(3) **Lachrymators.**—Extremely low concentrations exert an intense irritant action on the eyes, and cause so profuse a flow of tears and so much pain that vision becomes impossible. In stronger concentrations they may act as lung irritants.

(4) **Vesicants.**—These cause inflammation and blistering of the skin, associated with acute conjunctivitis, and intense inflammation of the respiratory passages.

(5) **Direct poisons of the nervous system.**—In sufficient concentration these act with great rapidity, causing a cessation and finally a total abolition of the functions of the central nervous system.

(6) **Gases which act by interfering with the respiratory properties of the blood.**—These may act in various ways. Thus arseniuretted hydrogen causes destruction of the red corpuscles, accompanied by hæmoglobinuria and jaundice; some gases cause the alteration of hæmoglobin into methæmoglobin; carbon monoxide takes the place of oxygen in combining with hæmoglobin.

Some poisonous gases produce their effects with great rapidity. Thus the secretion of tears provoked by lachrymators, the loss of consciousness induced by a direct poison of the nervous system, and the sneezing caused by a nasal irritant may ensue almost immediately after exposure to the gas. In such cases recovery is often fairly rapid when the subject gets away from the poisonous atmosphere. In other cases a marked period of delay, often amounting to hours, may elapse after exposure to the gas before symptoms of material severity show themselves. This delay is shown typically in the development of acute pulmonary œdema in the case of many of the lung irritants, and in the onset of the inflammatory changes caused by the vesicants.

It must be remembered that, quite apart from the direct damage caused by any of these gases, secondary effects resulting from this damage may subsequently show themselves in other parts of the body. Interference with the oxygen supply to the tissues such as may occur in the acute stage in cases of poisoning with the lung irritants, or with carbon monoxide, may have a serious effect on the circulatory organs, the nervous system, or other organs in the body, these secondary effects not infrequently being a factor of considerable importance in the later history of the cases. Again, bacterial infection of organs damaged by gas may lead to the most serious consequences.

THE USE OF GASES AND VAPOURS FOR OFFENSIVE PURPOSES.

The gases and liquids which have hitherto been used by the Germans for offensive purposes are as follows :—

	Formula.	Boiling point, degrees Centigrade
Lung Irritants.		
Chlorine	Cl_2	—33.5
Phosgene	$COCl_2$	8
Chlor-methyl-chloroformate	$CH_2Cl.COOCl$	77
Tri-chlor-methyl-chloroformate	$CCl_3.COOCl$	127.5
Chloropicrin	$CCl_3.NO_2$	112
Phenyl-carbylamine-chloride...	$C_6H_5.N:C:Cl_2$	210
Nasal irritant.		
Di-phenyl-chlor-arsine ...	$(C_6H_5)_2.As.Cl$ ... ... (Melting point 43° C.)	333
Lachrymators.		
Benzyl Bromide	$C_6H_5.CH_2Br$	198
Xylyl Bromide	$C_6H_4.CH_3.CH_2Br$	185
Brom-acetone	$CH_2Br.CO.CH_3$	137
Mono-brom-methyl-ethyl-ketone	$CH_2Br.CO.CH_2.CH_3$ ...	145
Di-brom-methyl-ethyl-ketone	$CH_3.CO.CHBr.CH_2Br$ ...	53
Vesicant.		
Di-chlor-ethyl-sulphide ...	$(CH_2.Cl.CH_2)_2S$	217

Cloud Gas.—In the original gas attacks in April and May, 1915, when clouds of gas liberated from cylinders installed in the German trenches drifted forward on the wind, it is probable that chlorine was the sole poisonous gas employed. From December, 1915, onwards the Germans used a mixture of chlorine and phosgene for the purposes of cloud gas attacks upon us, the phosgene being added with

297

a view to increasing the toxicity of the cloud. At the same time there was an increasing tendency to aim at a higher concentration of gas in the air by liberating the available gas in the shortest possible time. A cloud gas attack has, however, obvious limitations, since it is entirely dependent on a favourable wind.

Gas Shells.—In the early days of gas warfare the only form of gas shells that was used contained lachrymator substances. The commencement of the battle of the Somme coincided with the first appearance of German gas shells containing lung irritants. Since that date there has been a great development of the use of " lethal " shells—that is, shells whose contents are capable of causing deaths as opposed to the temporary disability resulting from exposure to the lachrymator substances.

All the substances enumerated above, with the exception of chlorine, have been used as fillings for artillery shells or trench-mortar bombs. The gas-shell bombardment is not nearly so limited by meteorological conditions as is the attack with cloud gas, for owing to the great range of gas shells the gas, even if it should be blown back upon the user's position by an adverse wind, will have been rendered innocuous by dilution with the air.

The general practice of the Germans is to employ several different kinds of gas shells simultaneously, no doubt with a view to rendering it difficult for their opponents to estimate the real danger of the gases to which they are exposed. The mixture of lachrymator gas with a lung irritant may, for instance, lead troops to believe that lachrymator only is being used, and that it is unnecessary to put on their respirators so long as their vision is not materially interfered with. Ordinary high explosive shells are nearly always fired with shells containing di-chlor-ethyl-sulphide (a substance with very little odour and no immediate irritant effects) in order that the troops exposed to its action may be prevented from noticing the characteristic small explosion of the gas shells, which would otherwise warn them of their danger. Di-phenyl-chlor-arsine was introduced by the Germans in the hopes (which have proved unjustified) that it would penetrate our respirator and cause so much sneezing and irritation as to prevent the respirator from being worn, and thus render troops vulnerable to a lethal gas such as phosgene. Not only are different kinds of gas shells used simultaneously, but a single gas shell may contain a mixture of toxic substances. The main types of artillery gas shell that have been used by the Germans since July, 1917, are as follows :—

Distinctive marking on the shell.	Contents.
Green Cross	Tri-chlor-methyl-chloroformate.
Green Cross 1	Tri-chlor-methyl-chloroformate, Chloropicrin.
Green Cross 2	Phosgene, Tri-chlor-methyl-chloroformate, Di-phenyl-chlor-arsine.
Yellow Cross	Di-chlor-ethyl-sulphide.
Blue Cross	H.E., Di-phenyl-chlor-arsine.
?	Phenyl-carbylamine-chloride.

Ordinary lachrymators (*e.g.*, xylyl bromide) are now only used to a small extent. Minenwerfer bombs usually contain phosgene. Bombs used by the Germans in " projector " attacks, when a very large number of bombs are fired simultaneously, may contain either phosgene or a mixture of this with chloropicrin.

When substances of high boiling point and great chemical stability, such as the lachrymators or di-chlor-ethyl-sulphide, are employed in shells, a considerable amount of the charge impregnates the soil in the vicinity when the shell bursts, and vapour may subsequently be given off in poisonous quantities from the ground for hours or even for days. Symptoms of gas poisoning may therefore be caused in unprotected persons who traverse or occupy ground thus contaminated, long after the actual bombardment has ceased. Chlorine and phosgene (which is a gas at ordinary temperatures) do not impregnate the ground in this way, but they may lurk for a considerable time in such places as trenches, and especially dug-outs and cellars, from which situations they are only slowly dispelled by the wind.

The introduction of such substances as di-chlor-ethyl-sulphide and di-phenyl-chlor-arsine is evidently prompted by a desire to circumvent our protective measures, and no doubt there will be a further development of gas warfare along these lines. Medical Officers must therefore be prepared for the appearance of new poisons in warfare causing symptoms different from those detailed below, and must be ready to use their discretion as to the lines of treatment to be adopted. It is their duty under such circumstances to forward as soon as possible to the D.G.M.S. a brief report giving an accurate statement regarding the symptoms they have observed, suggestions regarding treatment, and the results of post mortem examination if such should be available. Information of this character is absolutely essential if timely warning is to be given to Medical Officers in parts of the field which have not yet experienced the new poison.

POISONOUS GASES NOT USED DELIBERATELY FOR OFFENSIVE PURPOSES, BUT LIABLE TO BE ENCOUNTERED IN WARFARE.

Carbon Monoxide.

This gas is formed in large volumes on the explosion or detonation of explosives, also when the combustion of carbonaceous material takes place in a limited supply of air. It may be met with under the following circumstances :—

(a) **Mining Operations.** The galleries may be flooded with the gas after the explosion of either our own or a hostile mine or camouflet, or as the result of the explosion or burning of a blasting charge. The gas is liable to be driven into the ground disturbed by the explosion and to come welling out later, especially if the barometer commences to fall after the explosion, or it may be met with in the form of pockets of gas when new galleries are driven through ground disturbed by a previous explosion. Carbon monoxide has even been known to be driven out of the shafts into adjacent trenches after the explosion of a mine.

(b) **Fumes from high explosive shells.** When a high explosive shell penetrates the soil and bursts in the neighbourhood of a deep dug-out, or other relatively confined space, the carbon monoxide generated in

the explosion may find its way into the dug-out and poison the occupants.

(c) **Fumes from the firing of guns.** Cases of carbon monoxide poisoning sometimes occur in closed machine-gun emplacements or in gun pits owing to the blow-back from the gun.

(d) **Burning Buildings, etc.** There is a considerable risk of carbon monoxide poisoning in the interior of burning buildings. Very serious amounts of carbon monoxide may be formed if the timbering of deep dug-outs or mine galleries catches fire.

(e) **Billets.** A burning coke brazier gives rise to carbon monoxide, and is a great source of danger in a small, ill-ventilated billet or dug-out.

Nitrous Fumes.

If cordite or other nitro-explosives are set on fire and continue to burn without explosion, considerable quantities of orange-yellow nitrous fumes (nitric oxide and nitrogen peroxide) may be evolved. The danger of these should always be remembered if ammunition gets on fire, especially if this occurs in a fairly confined space.

Nitrous fumes are formed in mining operations when a blasting charge does not detonate, but in part merely burns. Since the fumes are quickly absorbed by moist ground, cases of poisoning are seldom met with under these circumstances unless men are exposed to the fumes immediately after the burning of the charge. The possibility of the simultaneous occurrence of carbon monoxide should be remembered.

LUNG IRRITANTS.

All the gases that act as lung irritants cause essentially the same type of pathological effects. The damage to the alveoli of the lungs which results from their action is followed by the rapid onset of acute pulmonary œdema, and it is the accumulation of fluid in the lungs which constitutes the immediate danger to life, since it interferes with the respiratory exchange in the lungs and leads to severe want of oxygen, which is indicated either by deep cyanosis or by pallor and collapse. The deeply cyanosed or leaden coloured facies, the quickened respiration, rapid pulse, restlessness, cough and frothy expectoration make a clinical picture which is characteristic in the majority of the severe cases.

PHOSGENE.

This gas is one of the most intense lung irritants known.

(a) **Symptoms.**

Exposure to an atmosphere containing phosgene causes immediate sensory irritation of the respiratory passages accompanied by smarting and watering of the eyes. The irritation of the respiratory passages causes catching of the breath, coughing and a sensation of tightness and constriction in the chest. With low concentrations, which may, however, be quite sufficient to cause serious symptoms in the end, the immediate irritant sensation in the respiratory passages and the tendency to cough may diminish gradually during exposure to the gas, and disappear almost entirely when the case is moved to pure air. With stronger concentrations the sensory irritant effect is proportionally violent, the breathing being at once spasmodically

checked and the chest feeling as if gripped in a vice; burning pain is experienced in the chest. After the initial check the breathing continues, but is gasping in character and interrupted by violent fits of coughing. Even in such cases the impulse to cough may be considerably reduced after reaching pure air, but may increase again as more urgent symptoms arise. On the whole, however, coughing is not a very prominent feature in phosgene poisoning. After getting out of the poisonous atmosphere the respiration remains rapid and shallow, any attempt to draw a deep breath giving rise to painful discomfort and provoking a fit of coughing.

As a rule, nausea, retching, and vomiting are prominent features in the early stages of poisoning, especially in those who are severely affected by the gas.

If the case has been exposed to a serious concentration of the gas, exudation of fluid into the alveoli of the lungs soon commences, and as the quantity of fluid increases asphyxial symptoms begin to appear, since the fluid interferes with the respiratory exchange between the blood and the air in the lungs. Want of oxygen becomes, in fact, the dominating feature. Of the severe cases some exhibit extreme restlessness and anxiety, others a semi-coma with a muttering delirium, from which, as a rule, they can be aroused to answer questions. Often consciousness is retained till quite near the end. Headache, pain behind the sternum and in the epigastrium are practically invariable. The breathing remains rapid (from 40 up to even 80 per minute) and laboured, but it is, as a rule, fairly shallow; it may be accompanied by occasional fits of coughing and retching. More often than not expectoration is scanty even though the lungs are full of oedema, but occasionally there is an abundant discharge of thin, watery fluid which is often streaked with blood. Even if there is no expectoration during life, foam almost invariably issues after death from the mouth and nostrils, where it may dry to a white efflorescence.

The cases in which pulmonary œdema develops to a serious extent tend to fall into two groups. The first group comprises cases which show definite venous engorgement; the face is congested and deeply cyanosed, the lips and tongue are a full blue colour, and there may be visible distension of the superficial veins of the face, neck or chest. The breathing is increased in frequency, and may be deeper than normal. Cough may be present, and expectoration of large quantities of thin, frothy fluid is more likely to occur in this group than in the other. The pulse rate is usually little over 100 per minute, and is full and of good tension.

Cases in the second group show an ashen pallor rather than deep cyanosis, the lips being pale and leaden coloured, and they are in a general state of collapse. Respiration is rapid, but more shallow in character. Though the lungs are intensely œdematous, there is often little expectoration, and cough is infrequent. The pulse is very rapid (130-140 per minute), weak and running. The prognosis is much worse than in the first group.

Cases of the second group predominate in phosgene poisoning, but many intermediate types are seen. Sometimes a case who at an earlier stage has shown congestive cyanosis with a full pulse, will gradually assume a grey pallor, while the pulse accelerates and weakens.

(b) **Physical signs.**

The percussion note may remain resonant over the chest, notwithstanding the existence of marked pulmonary œdema. In many cases, however, the note is impaired, especially over the back. The breath sounds are weakened, especially behind; they may also be harsh in character, but are not otherwise altered, and are never tubular. Fine rales are heard, more especially in the axillary region, and the back and sides of the chest. Rhonchi are also occasionally heard. With the development of inflammatory complications the physical signs become those of pleurisy, bronchitis, or broncho-pneumonia.

In the early acute stage, however, the physical signs on examination of the chest give little indication of the very serious extent to which the lungs may be damaged. The colour, the pulse, and the character of the respiration are the chief guides to prognosis.

(c) **The delay in the appearance of severe symptoms.**

Though acute pulmonary œdema may develop with great rapidity after exposure to a very strong dose of phosgene, it is of the utmost importance to recognise that in the case of less massive doses a very definite and striking delay, even amounting to hours, frequently elapses between exposure to the gas and the onset of severe symptoms, and that during this interval the patient may complain of only slight discomfort and may appear to be in good condition. In experiments with animals œdema may not appear in the lungs until an hour or more after exposure even to a severe dose of phosgene. This delay in the development of œdema and of its consequent symptoms characterises many of the lung irritant gases.

Cases have not infrequently been reported in which men who have been exposed to gas have been able to carry on their work for an hour or two with only trivial discomfort, and even to march from the trenches to their billets, and then have become rapidly worse, and passed into a condition of collapse with progressive œdema of the lungs that may prove rapidly fatal. In such cases the ingestion of a heavy meal seems sometimes to have had a prejudicial effect. At other times men who have passed through a gas attack and have subsequently complained of only slight cough, nausea, and tightness of the chest whilst resting in the trenches, have collapsed and even died abruptly some hours later on attempting to perform some vigorous muscular effort. A minor degree of the same effect is sometimes shown when men who have been slightly gassed find on trying to walk down from the trenches that they get unusually "done in" and breathless, and are obliged to rest frequently. In these cases the deficiency of oxygen, the result probably of pulmonary œdema already existing, has not been felt until muscular exertion increased the need for oxygen.

One very striking example of this delayed effect may be cited in which the patient was observed from start to finish after only a brief exposure to a strong concentration of phosgene. The greatest care was taken to prevent any muscular exertion, so that no complicating factor was introduced. The immediate irritant symptoms and coughing that were produced during the exposure soon diminished in fresh air, and an hour and a half later there was no coughing and the patient seemed practically well, the pulse being normal. The condition remained quite good till four and a half hours after exposure

to the gas, when the patient became bluish about the lips. Coughing then recommenced with the expectoration of frothy sputum. Soon the lips and face became of a grey ashen colour, though the pulse remained fairly strong. About four pints of clear, frothy, yellowish liquid were coughed up from the lungs in the next hour and a quarter, and at the end of this time the patient expired. At no time was there any great struggle for breath, nor did the patient realise at all how bad he was.

(d) **The pathological changes.**

Respiratory Organs.

The essential lesions are pulmonary œdema, rupture of the pulmonary alveoli, and concentration of the blood, together with thrombosis.

In one case when death had occurred two hours after exposure to the gas the lungs were smaller than normal, heavy, uniformly airless and purple, and completely waterlogged. There was no emphysema. Thin serous fluid ran abundantly from the surface of the lung when it was cut across.

When death occurs in the latter part of the first day, the trachea is moderately congested, and this congestion becomes more marked in the smaller bronchial tubes. Occasionally there is remarkably little inflammation in the larynx, trachea, and larger bronchi. The lungs are voluminous, heavy, œdematous, and much congested with blood. Aerated patches of emphysema, which sometimes culminate in actual bullæ, especially at the edges of the lung, alternate with depressed patches of collapse. On section frothy serous fluid mingled with dark blood drips abundantly from the lung tissue. Air that has escaped from the lung is sometimes seen as chains of bubbles below the visceral pleura, along the interlobar fissures, and even occasionally penetrating the tissues of the mediastinum. Sometimes petechial hæmorrhages are visible on the surface of the lungs. The pleural cavities almost invariably contain a quantity of serous, perhaps bloodstained effusion; the amount may vary from an ounce or two up to 20 ozs. on each side of the chest, but it is uncertain how much of this is a post mortem accumulation. The heart is sometimes dilated, sometimes fairly normal in volume. The veins are greatly distended with blood that often clots rapidly after death.

In the case of deaths on the second and third day the general appearance of the thoracic viscera is much the same as on the first day, the main difference being that aeration of the lung is distinctly greater, while serous fluid does not drip so freely from the cut surface of the lung. The aerated condition is greatest in the lower lobes of the lungs where they are in contact with the diaphragm, the oedema persisting longest in the upper lobe.

On the fourth day serous fluid no longer drips from the lung on section, but commencing broncho-pneumonia and pleurisy may indicate that secondary bacterial infection has set in.

The earlier that death ensues the greater is the degree of pulmonary œdema. The greater aeration of the lungs of cases dying on the second and third days, taken in conjunction with the clinical history of the severe cases that survive, makes it pretty evident that the fluid is rapidly absorbed from the lungs from the second day onwards.

Blood.

In severe cases a remarkable concentration of the blood may be present, the hæmoglobin percentage rising as high as 140 per cent., with a corresponding increase in the red cell count. This is brought about partly by the passage of œdema fluid into the lungs, and partly as a sequel to the condition of " shock " and want of oxygen. Associated with this concentration is the occurrence of thrombosis in the blood vessels of the lung, and also to a variable extent in those of other organs of the body.

Occasionally thrombosis takes place in the larger blood vessels, for rare instances are known in which the peripheral arteries to the limbs have become occluded. As a rule the threatening gangrene has cleared up in these cases without amputation of the limb proving necessary.

It seems probable that the primary cause of the thrombosis in these different situations is the same, viz., damage of the vascular endothelium, coupled with some slowing of the general circulation and perhaps with increased tendency of the blood to clot.

In some cases where death has occurred after two or three days of persistent cyanosis and unconsciousness, the white matter of the brain has been found to be peppered with tiny petechial hæmorrhages. Microscopic examination shows that the hæmorrhages are of spherical shape, with a small area of necrotic brain tissue traversed by a capillary blood vessel in the centre. They appear to be dependent on local damage of the vessel wall, associated with the formation of capillary thrombi and stasis of the blood. Precisely similar punctate hæmorrhages have been found in severe cases of carbon monoxide poisoning, as well as in other conditions, so their occurrence cannot be regarded as a specific effect of the gas. As a general rule symptoms caused by these punctate hæmorrhages are unnoticeable owing to the extreme gravity of the patient's general condition. In one or two instances large cerebral hæmorrhages have occurred on the first or second day in case of deep cyanosis, just as may occur in very severe and prolonged poisoning with carbon monoxide.

Petechial hæmorrhages and a slight superficial ulceration are frequently seen post mortem over the inner surface of the cardiac fundus of the stomach. How far these may owe their origin to the direct irritant effect of swallowed gas, and how far they may be dependent merely on the general venous congestion of the abdominal viscera and on the asphyxia is uncertain. In rare instances there has been serious hæmorrhage into the stomach owing to an extension of the ulcerative process.

The kidneys may be found to be enlarged and congested at autopsy, and in some instances capillary thrombi are found in the glomeruli. This change, however, rarely leads to any clinical features of renal trouble. It is very unusual for albuminuria to develop later.

(e) **The sequence of pathological events.**

When the gas reaches the lungs it produces after a certain interval an inflammatory effusion which rises into the smaller bronchi. The lung capillaries are thus separated from the outer air by a layer of fluid which obstructs both the intake of oxygen and the output of carbon dioxide. In addition thrombosis is often seen in the capil-

laries themselves, which by obstructing the circulation increases the difficulty. To meet the need respiratory effort is exaggerated, and this leads in these cases, as in ordinary broncho-pneumonia, to collapse of some areas of the lung and distension of others, with rupture of the alveolar walls (emphysema).

The congested, cyanotic cases show the effect both of deficiency of oxygen and of excessive retention of carbon dioxide, the latter factor being responsible for the venous congestion. The collapsed, ashen-coloured cases are due chiefly to want of oxygen. This factor alone is sufficient to produce cardiac failure, and there is no evidence that phosgene has any other direct effect upon the heart. Haldane (Brit. Med. Jl., Feb. 10, 1917) has suggested an ingenious explanation of the two classes (see also pamphlet of instructions issued with the Haldane apparatus). In either class the want of oxygen is far more dangerous than the excess of carbon dioxide.

(f) **The progress of the cases.**

Four-fifths of the deaths occur in the first twenty-four hours. Very few succumb after the third day. A man who at first seemed to be lightly gassed may, towards the end of the first day, develop cyanosis and die; but from the end of the second day onwards there is no danger to be apprehended for the less grave cases. If the sputum has been abundant on the first day it diminishes in quantity on the second, and becomes more viscous and yellow tinted. The dyspnœa persists and the temperature is raised.

Broncho-pneumonia may develop as the result of secondary bacterial infection of the damaged lung, and is responsible for the occasional deaths that occur later than the end of the first week, but it is not so common as might be expected. It usually sets in about the fourth or fifth day (occasionally earlier), and manifests itself by a persistence or a further increase of the fever, by a purulent sputum, and by signs of broncho-pneumonic consolidation.

As a rule the patient recovers rapidly after the third day, and at the end of a week he is fully convalescent. So rapid and complete may be the reabsorption of fluid from the lungs that a patient who has in the acute stage shown the usual signs of extensive pulmonary œdema, such as deep cyanosis and even unconsciousness, may present hardly any physical signs in the chest eight or nine days after exposure to the gas. The pulse is often slowed for a time (to 48-54 per minute) as the acute stage subsides, and this may give an indication of approaching convalescence. This transitory bradycardia may also be shown by mild cases.

Though the case may soon be out of immediate danger, complete recovery of cases of even moderate severity may take a very considerable time. Convalescent cases usually show for some time a certain amount of digestive disturbance, associated with pain in the epigastrium, which is frequently accentuated after taking food, and loss of appetite. As a rule the dyspeptic symptoms subside under simple treatment. Bronchitis and pain in the chest occur in a number of the cases, but yield readily to treatment. Pharyngitis and laryngitis are rare. Lassitude is common. Other symptoms, however, are liable to occur which are far more persistent and troublesome to treat than the foregoing.

A fair number of men exhibit precordial pain, dyspnœa, exhaustion and persistent tachycardia after exercise. After a brief period of quite moderate exercise the patient looks exhausted and is obviously suffering from respiratory distress, while his pulse rate remains for many minutes far higher than would be the case with a normal person.

Another type of case, which is less frequent than the last, is characterised by the occurrence of attacks of spasmodic dyspnœa. These attacks may occur every night or may be separated by an interval of a week; more than one attack may occur in the same night. During the attack, which may last for 5 to 30 minutes, the patient sits up in bed, his respiration is shallow and rapid, but not difficult, being very different from that shown in an ordinary asthmatic attack. Slight cyanosis may be present, but usually the colour remains natural and the patient appears anxious rather than acutely ill. During the attack the pulse is sometimes slow and full, sometimes rapid and almost impalpable.

Some cases exhibit the mixed symptoms of tachycardia and spasmodic dyspnœa.

A hopeful view of the ultimate recovery of even severe cases of phosgene poisoning can be taken, for a number of cases are known in which men who were at one time deeply cyanosed and gravely ill have, after the lapse of some months, recovered so completely as to be fit for full duty in the field. But in a certain number of cases recurrent bronchitis and emphysema may follow.

Symptoms during convalescence.

The precise explanation of the persistent symptoms that may occur during convalescence is at present obscure. In the great majority of patients who exhibit tachycardia and undue breathlessness after exertion during convalescence the heart is of normal size, and physical examination reveals no gross defects. Functional murmurs are common, but afford no guide as to the severity of the case. It is quite clear, however, that if muscular exercise is pushed too far in such a case or is begun too early, the tachycardia and dyspnœa after exercise are aggravated, and a definite condition of " disordered action of the heart " or " irritable heart " is liable to be established, and to persist for a very long time. Though neurasthenia may sometimes enter into the picture, care must be taken not to confound a definite abnormality with neurasthenic symptoms.

The cases which are subject to attacks of nocturnal dyspnœa nearly always show an abnormal increase in the percentage of hæmoglobin (usually in the neighbourhood of 110 per cent.) and a proportional increase of red corpuscles in the blood, and this may persist for many weeks.

There are not enough observations available to establish in the case of man the precise connection of this polycythæmia during convalescence with the blood concentration which occurs during the acute stage. In animals, however, when the same phenomena can be shown to occur, the polycythæmia during convalescence is more or less continuous with that of the acute period. The rapidity of onset of the initial polycythæmia makes it pretty certain that we have to deal at

this stage with a simple concentration of the blood owing to loss of plasma, but there is little doubt that later on the polycythæmia is due to actually excessive production of red corpuscles. That the polycythæmia during convalescence is in some way dependent on slight want of oxygen is shown by the fact that if animals in this condition are kept for a day or two in a chamber in which the atmosphere contains 40 per cent. of oxygen, the polycythæmia gradually diminishes till the red cell count becomes normal, but it slowly reappears again when the animals are transferred back to normal air. In the case of men similar continuous treatment with oxygen in a chamber for some days leads to a reduction of the polycythæmia, and to a diminution in the symptoms of nocturnal dyspnœa. The improvement persists for a considerable time after the oxygen treatment has been stopped. Symptoms of tachycardia and breathlessness after exertion are also benefited considerably by the same treatment.

The long-lasting polycythæmia in these cases is analogous to that met with under other conditions of chronic oxygen want, *e.g.*, the polycythæmia that occurs at high altitudes, or that found in congenital heart disease.

The actual cause of the chronic oxygen want in the convalescent gas cases which show polycythæmia is not yet clear, as data are lacking as to the histological condition of the lungs during convalescence (examination of the chest reveals no abnormal physical signs), while it is by no means clear whether cardiovascular derangements dependent on the preceding acute asphyxia may not play an accessory part.

CHLORINE.

A much stronger concentration of this gas is needed to cause severe pulmonary œdema, or even lachrymation, than is the case with phosgene. It is, however, far more irritant to the respiratory passages than is phosgene. A very marked feature in the early attacks, when chlorine alone was used, was the paroxysmal and violent coughing, which not only occurred during the exposure but also persisted for a long time afterwards. Emphysematous changes were pronounced, and subcutaneous emphysema of the neck and chest occurred in a number of instances. As a general rule the cases exhibited deep cyanosis rather than pallor and collapse, with a fairly full pulse and much dyspnœa. Copious frothy expectoration was common.

Delay in the onset of serious symptoms is not evident in chlorine poisoning. Though exudation of fluid into the lungs may not perhaps start at once, the violent paroxysms of coughing, the painful dyspnœa, and the repeated attacks of vomiting convey the impression that the case is severely ill from the start.

CHLOR-METHYL-CHLOROFORMATE AND TRI-CHLOR-METHYL-CHLOROFORMATE.

Both these gases give rise to effects similar to those produced by phosgene. Tri-chlor-methyl-chloroformate has about the same toxicity as phosgene, but greater lachrymatory power; chlor-methyl-chloroformate has a toxicity of the same order as that of chlorine.

CHLOROPICRIN.

This is a stronger lachrymatory agent than is tri-chlor-methyl-chloroformate, though it is a good deal inferior in this respect to the true lachrymators. For such lengths of exposure as are likely to occur in the field, chloropicrin must be at distinctly higher concentration than phosgene to cause severe pulmonary œdema, but it is much more deadly than chlorine. It causes greater sensory irritation of the respiratory passages than does chlorine. Pain in the chest and epigastrium, abdominal discomfort, and violent attacks of vomiting are exceptionally marked. Brief exposure to strong concentrations may cause temporary unconsciousness.

Unlike phosgene, chloropicrin is a substance of considerable chemical stability when in contact with animal tissues, and it is cumulative in action, for experiments on animals have shown that prolonged exposure to very low concentrations may still give rise to serious toxic symptoms, while equally low concentrations of chlorine or phosgene may be quite ineffective.

Frequent exposure to small doses of chloropicrin, which would have only a trivial effect in themselves, may gradually lead to a greatly increased susceptibility to the gas. A man who has acquired this susceptibility is liable to attacks of " asthma " whenever he has been exposed to a trace of chloropicrin in the air. The attacks usually occur at night, and are characterised by the sudden onset of a rapid, shallow type of breathing associated with a feeling of tightness of the chest and a sensation of suffocation, which causes considerable distress. There is usually a short, dry cough at intervals, which is occasionally followed by the expectoration of a small quantity of tenacious mucus. The attacks may last for as long as a couple of hours, and appear to resemble, though in exaggerated degree, the attacks of " nocturnal dyspnœa " which have already been described as occurring during convalescence from phosgene poisoning.

PHENYL-CARBYLAMINE-CHLORIDE.

This substance has a very offensive mustard-like smell, and is very liable to cause immediate nausea when inhaled. It is a lung irritant of only moderate power, and is apt to cause bronchitis. In addition, it is a moderate lachrymator.

NITROUS FUMES.

From the point of view of the production of pulmonary œdema nitrous fumes are somewhat less toxic than chlorine.

The great danger of nitrous fumes arises from the fact that in the concentrations usually met with there is comparatively little sensory irritation of the eyes or upper respiratory passages, and a man working in such an atmosphere will not recognise its deadly nature. Air which contains enough nitrous fumes to cause irritation in the nose or air passages must be regarded as very dangerous.

Delay in the onset of acute symptoms is very pronounced unless the concentration of the gas is high, when fatal asphyxiation may rapidly ensue. As a rule a period of four to eight hours elapses after exposure, during which time the patient may, and usually does, feel quite well, and has no hesitation in taking a meal, but symptoms of acute pulmonary œdema may then come on with alarming rapidity, death often ensuing in a few hours.

THE TREATMENT OF POISONING CAUSED BY THE LUNG IRRITANT GASES.

Cases of all degrees of severity may occur, and sometimes it is not easy for the Medical Officer to decide whether or not a man has really been gassed. The fact that delayed action is liable to be exhibited by the lung irritants introduces another factor of uncertainty.

In these doubtful cases the patient should be made to give his own account of the occurrence, in order to see whether it suggests that he may have been exposed to a significant dose of gas. He should be allowed to describe his own symptoms. No leading questions should be put to him. Some definite objective symptom such as vomiting may have occurred. He may have been unduly exhausted by trying to walk to the aid post, and have had to be helped down; evidence in support of this may possibly be furnished by the pallor of his face and by a rapid pulse. Careful examination should be made to see if there is any lachrymation, any sign of cough, or unduly short and rapid breathing. It should be ascertained whether he can take a deep breath without affording any evidence that this gives rise to discomfort or provokes a cough.

The benefit of the doubt must be given to the patient, but it should be borne in mind that if no objective symptoms have arisen after the lapse of 48 hours, the degree of gassing must have been very slight, and the case can be returned to duty with little delay.

Treatment in the acute stage.

(1) **Rest.**—The importance of rest cannot be exaggerated. In the earlier stages undue muscular exertion is liable to lead to great aggravation of the symptoms. When pulmonary œdema is well established, and the respiratory exchange in the lungs is seriously interfered with, it is of importance to keep the oxygen consumption as low as possible, and activity of the muscles is by far the most potent cause of increased oxygen consumption.

All gas cases should be evacuated as soon as possible to the point at which arrangements have been made for effective treatment (a Field Ambulance Gas Centre or a Casualty Clearing Station according to circumstances). Whilst waiting for evacuation care should be taken that the cases do not undergo any undue muscular exertion. All except the lightest cases should, as far as possible, be evacuated lying down, and walking cases should be given every assistance whilst going back along the trenches, so that they may avoid physical effort as much as possible. Walking cases should not be allowed to carry their equipment. If any walking case shows signs of increasing severity in his symptoms (marked breathlessness, palpitation, loss of power in the limbs, or a feeling of being " done in ") arrangements should at once be made to carry him.

Care should be taken that the breathing of any cases showing material symptoms is not impeded by tight belts or braces.

When cases reach the point where they can be retained for treatment they should be kept lying down until any obvious symptoms due to the gassing have subsided. Those who show definite symptoms should not be allowed to leave their bed or stretcher for any purpose whatever.

297 (2) **Removal of Clothing.**

Sometimes clothing gets sprayed with liquid gas when a shell bursts near at hand, and considerable quantities of gas may adhere to the clothes for some time. Gas may thus get carried into an aid post or dressing station. Any clothing which smells strongly of gas should be removed as soon as practicable, otherwise there is a great risk that the patient will be subjected to an additional dose of gas, and that the medical staff may be affected. Orderlies engaged in this task should wear respirators and protective gloves.

(3) **Warmth.**

The greatest care should be taken to keep the cases warm, and attention must be particularly directed to this point if any of the clothing has to be removed. Warmth will not only help to combat shock, but will diminish any tendency to the muscular movements of shivering.

(4) **Oxygen.**

As deficiency of oxygen is the essential pathological result of poisoning by a lung irritant, treatment must be fundamentally devoted to supplying the deficiency by administration of oxygen. Whenever there is cyanosis (whether of the deep congested or the pallid, leaden-hued type) this may be combated by increasing the percentage (and therefore the partial pressure) of oxygen in the air in the lungs, for this will accelerate the rate at which oxygen diffuses through the layer of liquid into the blood. As the pulmonary œdema and cyanosis last for many hours, it is clearly desirable to keep up the administration of oxygen as continuously as possible for an equally long period. The aim should be to tide the case over the critical period of the first two days.

The apparatus used for nitrous oxide anæsthesia affords one method for the administration of pure oxygen. There are, however, but few cases which require pure oxygen to relieve their cyanosis; it is nearly always possible to obtain the desired result with a far lower concentration of oxygen in the air in the lungs (*e.g.*, 30-40 per cent. of oxygen). The nitrous oxide apparatus is therefore a wasteful method of using oxygen in these cases. Moreover, long continued administration of pure oxygen is liable to exert an irritant effect on the lungs. If the nitrous oxide apparatus has to be employed, it will be best to give the oxygen intermittently, say for five or ten minutes at a time, with intervals of ten minutes, so as to make the best use of available supplies. The valve of the apparatus should be so set that the patient inhales oxygen from the bag and expires to air; he must not breathe backwards and forwards into the bag, for that will imply breathing air with an accumulating percentage of carbon dioxide.

The Haldane oxygen apparatus, which is now frequently employed, allows of continuous administration of oxygen at any required concentration over long periods. It is designed so that oxygen only passes to the face mask during inspiration, the oxygen being therefore used with the greatest possible economy. In practice the oxygen supply is increased until the patient's face becomes of a normal colour, and then the supply is kept constant at this level. Relief of the cyanosis shows that the hæmoglobin in the blood is properly

oxygenated, and no additional advantage will be obtained by increasing the oxygen supply further.

If the Haldane oxygen apparatus is not available, or the patient, as sometimes happens, refuses to tolerate the mask, the best method to adopt is to administer oxygen through a nasal tube. A soft rubber catheter should be lubricated and gently introduced into the nostril until its extremity lies in the naso-pharynx; it can be secured in position by adhesive plaster. A continuous stream of oxygen is allowed to pass from a cylinder through the nasal tube. This method is more wasteful of oxygen than is the Haldane apparatus, since oxygen continues to pass during expiration, and is lost to the patient at this time, and consequently a far greater rate of flow of oxygen is necessary to get a given result with the nasal tube than with the Haldane apparatus.

Subcutaneous injection of oxygen has proved valueless, neither have efforts to introduce oxygen intravenously met with any success.

The index of the effectiveness of the oxygen treatment is afforded by the colour of the patient's face; the aim should be to keep the cyanosis relieved. In some cases it is difficult to appreciate a change of colour, especially by lamplight, but in such cases a marked improvement in the pulse very often shows that the oxygen is producing a beneficial effect.

A feeble pulse with a rate of 140 per minute may be slowed by 20 beats or more per minute soon after commencing administration of oxygen, and become of much better volume and tension, the improvement being kept up so long as the oxygen administration is continued.

The oxygen frequently gives obvious relief to the general conditions of the patients. They become less anxious and restless, so that they are sometimes unwilling to have the administration interrupted when they have once got used to the apparatus. At first they may be very unwilling to tolerate any method of administration, and every effort should be made to gain their confidence.

If panting is present, this usually persists even when the cyanosis has been relieved, since it is mainly due to retention of carbonic acid. Sometimes in very severe cases administration of oxygen increases the panting. This is probably due to the fact that the respiratory centre itself has begun to fail from want of oxygen, and is responding inadequately to the natural stimulus of carbon dioxide. On relieving the want of oxygen the respiratory centre regains its normal irritability and reacts fully, but hyperpnœa will be exaggerated until the carbon dioxide which has accumulated in the body owing to the relatively deficient breathing has been washed out by the increased respiration. If it is feared that such hyperpnœa may in itself do harm to the patient, oxygen should be given intermittently for a time, and continuous administration can be started later on.

(5) **Venesection.**

There is no doubt that cases of deep cyanosis with a full pulse and signs of venous engorgement may be greatly benefited by a venesection up to 20 ounces, the blood being withdrawn slowly. The headache often disappears, dyspnœa and restlessness are somewhat diminished, and sleep follows. By this procedure relief may be

afforded at a critical period when the right side of the heart is beginning to give way under the strain.

Venesection is contraindicated in those cases which show pallor and collapse with a very rapid, thready pulse.

Apart from its effect on the circulation, venesection has been advocated in cases of phosgene poisoning as a measure likely to diminish the amount of fluid exuded into the lungs. Early venesection as soon as pulmonary œdema is recognised has been recommended by Medical Officers attached to the South African mines in cases of poisoning with nitrous fumes, and there is an impression amongst Medical Officers at the Front, and this is supported by French opinion, that similar early venesection is beneficial in cases of phosgene poisoning and the like.

(6) **Drugs.**

Ammonia.—The inhalation of ammonia vapour often gives some relief in the earliest stages of chlorine poisoning to at least the milder cases, but care must be taken that the vapour is not too strong. If the dyspnœa is increased or cough aroused it must be discontinued. It probably acts more as a stimulant than in any other way.

Atropine has been used under the impression that it will relieve bronchial spasm and check the output of œdema fluid. There is, however, no clear evidence that it has any beneficial action in practice, and as it may lead to acceleration of the heart it should not be used.

Cardiac Stimulants.—On the whole brandy has proved one of the most effective stimulants. Pituitrin 0.5 c.c. hypodermically at intervals of not less than three hours has certainly been of value in some serious cases. Hypodermic injections of camphor (*e.g.*, camphor gr. 1, olive oil min. 5, ether min. 5, minims 10-20 for a dose), or of caffeine (*e.g.*, caffeine gr. 10, sodium salicylate gr. 17, distilled water to one drachm, minims 10 for a dose) have also proved of value. Neither digitalis nor strychnine have shown themselves of much use in our experience.

Oxygen is far the best cardiac stimulant. When once oxygen treatment has been started, and the major disadvantage under which the heart is labouring has been removed, the cardiac stimulant drugs may have a valuable additional effect.

Morphia is a dangerous drug to use when the respiration is seriously affected. Its use should therefore be restricted to severe cases where restlessness is extreme, and can be controlled in no other way. The dose should be small, gr.$\frac{1}{4}$, followed if necessary by gr.$\frac{1}{6}$, or 15-20 minims of tinct. opii.

Expectorants.—These should not be given to severe cases during the first two days for fear of increasing the tendency to cough, and so augmenting the damage in the lungs. An ordinary expectorant mixture containing ammon. carb. and vin. ipecac. may with advantage be given to the milder cases, as well as to severe cases when the acute symptoms have definitely begun to abate.

Aspirin and Phenacetin should not be used for the relief of the headache that usually occurs. They are somewhat liable to bring on collapse.

(7) **Methods of aiding the discharge of exudate from the lungs.**

(a) **Vomiting.**—Repeated vomiting frequently occurs spontaneously in cases of poisoning with the acute lung irritants. In the earlier stages of acute pulmonary œdema this may prove of considerable benefit in promoting the discharge of fluid from the lungs. If vomiting does not occur naturally, it may be encouraged at this stage by simple measures, *e.g.*, salt and water and tickling the back of the throat, but neither apomorphine nor ipecacuanha should be used for this purpose because of the great depression that they produce subsequently. As the effort of vomiting is very exhausting, it should not be encouraged when the patient at a later stage begins to fail.

(b) **Posture.**—If much thin fluid is being expectorated, good results are sometimes obtained by turning the head of the patient sideways and raising the foot of the bed or stretcher three or four feet, or even higher, for a few minutes at a time, with the idea of draining fluid from the chest.

(c) **Schäfer's artificial respiration** has occasionally proved of service in expelling fluid from the chest, but it is necessary to watch the effect on the patient very closely lest disaster ensue owing to a large amount of fluid being suddenly forced into the bronchial tubes.

(8) **General Treatment.**

Open air treatment is good under favourable conditions of weather, but the slight gain from a fresher atmosphere is more than counterbalanced by the difficulties of nursing the patients and of keeping them warm so as to counteract the effects of shock. It is therefore preferable to treat at least the more severe cases in a well-ventilated ward. In bad weather tents and marquees are apt to be very dark, which makes it difficult to appreciate the degree of cyanosis shown by the patients.

Bad cases should if possible be put to bed, rather than left on stretchers. The cases should be allowed to assume the posture that they find most comfortable; some prefer to lie down, others to be propped up.

Food should only be given in fluid form and sparingly in the acute stage, and the diet should be kept light until the patient is definitely convalescent. Pain in the epigastrium sometimes yields to small doses of sodium bicarbonate. Measures should be taken to keep the bowels open.

Severe cases complain greatly of thirst in the acute stage. There appears to be no valid reason for withholding fluids, and water (brandy may be added if desired), or tea may be given; the fluids should, however, be given in small quantities at a time.

The mouth usually becomes dry and foul, and attention should be paid to this, as it is a source of great discomfort to the patient.

So far as circumstances permit, no case should be evacuated to the L. of C. until definite cyanosis or serious symptoms have disappeared. A note must be made on the Field Medical Card of the symptoms of those who have passed through a condition of gravity for the guidance of the Medical Officer on the L. of C. in his disposal of the cases

Treatment during the convalescent stage.

A large proportion of the casualties sent to the L. of C. is likely

to become fit for duty after a short rest. Bronchitis and gastric disturbance as a rule subside quickly with ordinary treatment. Patients who develop secondary broncho-pneumonia, and the rare cases showing actual dilation of the heart, will naturally be regarded as serious and treated accordingly.

The cases which show tachycardia and dyspnœic symptoms offer a problem of much greater difficulty. In practically all these cases examination of the chest reveals no obvious physical signs to account for the symptoms, and the cases usually look surprisingly well while they are resting, though the occurrence of attacks of nocturnal dyspnœa may call attention to the fact that the case is definitely abnormal.

In order to differentiate these cases recourse may be had to the reaction after exercise. The ultimate standard of a man's fitness for duty must be his capacity to perform muscular exercise without undue exhaustion, tachycardia, or breathlessness. The effect of exercise ought to be tried on all cases before they are sent from hospital or the convalescent camp to duty.

Cases of moderate severity which have been confined to bed for some days require testing carefully in this respect. Some such method as the following may be employed :—After the patient has been allowed out of bed for four days he is made to walk half a mile at a steady and moderate pace. If the panting and pulse rate diminish with normal rapidity after stopping the walk, a walk of one mile is taken the next day, and if this is not too much, a walk of three miles without stopping is taken on the following day. If, however, the test exercise results in undue tachycardia and breathlessness, the best method of treatment to adopt is a course of carefully graduated exercise, and the greatest care must be taken not to overdo this exercise at the start.

There is a good deal of evidence that those cases showing tachycardia, nocturnal dyspnœa, or polycythæmia, may be greatly benefited by prolonged treatment with oxygen, especially if this is coupled with graduated exercise. The details of this line of treatment still require working out, as it presents considerable practical difficulties.

The mildest cases, who are perhaps only retained in a medical unit for a day or two (as well as other convalescents who are well on the way to recovery), should be allowed the opportunity of resting lying down during the daytime, if they desire to do so, so as to prevent them from unduly exhausting themselves and possibly doing themselves harm.

NASAL IRRITANT.

DI-PHENYL-CHLOR-ARSINE.

This substance is practically odourless.

Minute concentrations in the air cause burning pain in the nose, mouth and throat, repeated sneezing, a burning sensation of the face, aching pain in the eyes and frontal headache, watering and inflammation of the eyes, copious watery discharge from the nose, tightness and burning pain in the chest, pain in the stomach, salivation, nausea and vomiting. Sometimes sneezing does not occur. Intense pain in the nose, throat and chest is a very characteristic feature.

The limbs, especially arms and hands, sometimes feel numbed for a short time, the numbness subsequently giving place to slight aching pain.

Very similar symptoms may arise from using water contaminated with di-phenyl-chlor-arsine from shell holes for washing in, or for drinking. The poison is not destroyed by boiling the water.

So high is the boiling point of this substance that it is difficult to get more than an extremely low percentage in the air, and the symptoms experienced in the field have usually been quite slight, and have subsided fairly rapidly on leaving the poisonous atmosphere. Inhalation of chloroform for a few moments gives temporary relief from the pain in the nose and throat.

No serious toxic effects have been noticed in the field up to the present, though under appropriate experimental conditions with higher concentrations in the laboratory it has been shown that the substance is capable of exerting a powerful lethal effect on animals, death being due to pulmonary œdema and pneumonia, accompanied by destructive inflammation of the trachea and bronchi and a marked fibrinous bronchitis.

LACHRYMATORS.

The immediate effect of a trace of the vapour of such a lachrymator as benzyl bromide in the air is to cause profuse watering of the eyes, accompanied by smarting. If the concentration is somewhat greater, the smarting and pain in the eyes may become intolerable, so that it is impossible to keep the eyes open. The smarting and watering of the eyes will be quite sufficient to put a man completely out of action, by preventing vision, unless the eyes are protected.

With increasing concentrations of the vapour, other effects show themselves. The vapour is irritant to the lungs and upper respiratory passages, and this leads to a burning sensation in the throat and coughing. Nausea is often present and not infrequently leads to vomiting, accompanied, it may be, by pain in the epigastrium. If it is impossible to withdraw from exposure to the fumes, slight confusion of mind and torpor may show themselves.

Under ordinary conditions the symptoms do not develop further, and though the case may become somewhat collapsed as a result of the vomiting and general discomfort, this is only temporary. Within an hour or two after getting into air free from the lachrymator there may be very little amiss with the man. The nausea and irritation of the throat soon pass off, though the eyes may remain sore for some little time, and even after the lapse of twelve hours redness of the eyelids and slight injection of the conjunctiva may still be evident. There are no subsequent toxic effects, and the man will be fit for duty as soon as the primary effects have passed off.

The majority of the lachrymators have a powerful effect on the eyes at a concentration of one part in a million, or even less. Strong concentrations have an irritant effect on the lungs, and cause pulmonary œdema, but in this respect they are distinctly less toxic than the lung irritant gases described previously. As the lachrymators are liquids of high boiling point, it is difficult in practice to attain concentrations sufficient to give rise to this serious toxic effect, and the symptoms observed in the field very rarely attain a

degree of severity greater than those described above. It must, however, be again emphasised that some of the lung irritants are in addition quite effective lachrymators (*e.g.*, chloropicrin).

The smell of benzyl or xylyl bromide when in great dilution suggests the flavour of mustard and cress; bromacetone and brom-methyl-ethyl-ketone have aromatic pungent odours.

VESICANTS.

DI-CHLOR-ETHYL-SULPHIDE (THE SO-CALLED "MUSTARD GAS").

This substance has only a very faint odour, usually likened to that of mustard or garlic, and it does not produce any immediately irritant effects. But after a delay of a few hours, the eyes, the mucous membrane of the air passages, and the skin become severely inflamed. So far as life is concerned the action upon the respiratory organs is by far the most important, but the conjunctivitis is one of the chief invaliding effects from the point of view of army casualties.

The liquid is almost insoluble in water, slightly soluble in paraffin or vaseline, but freely soluble in animal and vegetable oils and fats. It vapourises very slowly at ordinary temperatures, so that ground that has been splashed by the liquid after the burst of a shell is a source of danger for a number of days. Men may unwittingly carry the poison with them into dug-outs on their clothing or on their boots.

Di-chlor-ethyl-sulphide is very slowly decomposed by alkaline solutions such as that of sodium bicarbonate, but it is rapidly destroyed by dry chloride of lime (bleaching powder). Chloride of lime may be scattered thickly over contaminated ground at places which it is important to keep free from the poison, *e.g.*, entrances of dug-outs.

Contaminated clothing may be freed from the poison by exposing it in the open air for 48 hours, or longer if the weather is cold, or it may be treated for 3 hours in a steam disinfecting chamber, if such is available.

The box respirator affords complete protection to the eyes and lungs if properly worn, but if the mask is allowed to remain hanging down so as to permit better vision severe conjunctivitis will develop though the lungs escape completely. Prolonged exposure to a very low concentration of the vapour may cause only a delayed laryngitis; but a higher concentration, though almost imperceptible, may cause a man to become a serious casualty, if, for example, he goes to sleep without his respirator on in a contaminated dug-out.

History of a typically severe and unprotected case.

On exposure to the vapour or to a finely atomised spray of the substance nothing is noticed at first save the faint though characteristic smell.

After the lapse of two or three hours the eyes begin to smart and water, and they are soon reddened with an acute conjunctivitis. The nose also runs with thin mucus as from a severe cold in the head, and sneezing is frequent (earlier sneezing in the field after exposure to gas shells is probably due to the simultaneous use by

the enemy of di-phenyl-chlor-arsine). Nausea, retching, and vomiting associated with epigastric pain commence at about the same time as the pain in the eyes, and they recur in attacks at frequent intervals for several hours.

During the next few hours the conjunctivitis increases in intensity and the vessels are deeply injected. The throat feels dry and burning; the voice becomes hoarse, and a dry harsh cough develops. Inflammation of the skin now shows itself in a dusky red erythema of the face and neck, which look as though they had been scorched but are almost painless, while the inner surfaces of the thighs, genitals, and other sheltered parts of the body are similarly affected. This is rapidly followed by the development of small blister blebs in the same areas.

At the end of 24 hours a typical appearance is presented. The main distress is caused by the pain in the eyes, which may be very great. The patient lies virtually blinded, with tears oozing from between bulging œdematous eyelids over his reddened and slightly blistered face, while there is a constant nasal discharge and an occasional harsh, hoarse cough. The respiration is fairly normal both in rate and depth. There may be frontal headache associated with pain in the eyes, and photophobia with blepharospasm is always a marked symptom. Death practically never occurs during the first 24 hours.

During the second day the condition is aggravated by the development of the vesicles into large blisters over the erythematous areas, while the scrotum and penis become œdematous and painful. Bronchitis now sets in, with abundant expectoration of muco-pus in which there may be found actual large sloughs from the inflamed tracheal lining. The temperature, pulse rate, and respiration rate are all increased, and secondary infections of the necrotic mucous membrane in the respiratory tract soon lead to the development of a broncho-pneumonia with slight cyanosis, cardiac dilation, and death at any date from the second or third day to the third or fourth week in the more lingering cases.

The main features of the casualties from the action of this poison are therefore as follows :—

Delay of the irritant effect for at least two or three hours and often longer.

Conjunctivitis to an extreme degree.

Erythema of exposed surfaces and of the moist protected skin areas, followed by blistering, excoriation and brown staining.

Inflammation of the trachea and bronchi with necrosis of the mucous membrane, and the development of secondary bronchitis or broncho-pneumonia.

Morbid Anatomy.

The most important changes are found in the respiratory tract. From the arytenoid cartilages down to the smallest tubes the mucous membrane is intensely inflamed and irregularly covered with a thick yellowish white false membrane or slough, on the removal of which a red granulating surface is exposed, which may in later cases be pitted here and there with tiny ulcers. The lumen of the trachea is partly filled with a thin fluid pus, which also wells up from the

bronchioles on section of the mass of the lung; but no œdema fluid drips from the cut surface.

The lungs are slightly voluminous, but they do not exhibit the "drowning" with œdema fluid that characterises phosgene poisoning. In early deaths there will be found areas of emphysema alternating with collapse, and patches of petechial hæmorrhage. After the second day small areas of consolidation appear and pleurisy commences. As this pulmonary infection continues to spread by gravitation of pus from the bronchial tubes, the whole of the lower lobe may become imperfectly consolidated in a septic broncho-pneumonia that breaks down here and there into small abscesses. This later sepsis will naturally be associated with œdematous changes in the lungs; but primary œdema, apart from the effect of a simultaneous use of phosgene shells side by side with di-chlor-ethyl-sulphide rarely, if ever, occurs.

The microscope bears out the naked eye observations. Necrosis of the epithelial lining of the trachea and bronchi is succeeded by the formation of a false membrane composed of fibrin and leucocytes together with masses of bacteria. Blockage of bronchial tubes with débris and pus leads to collapse of the small areas of lung which they supply, and compensatory emphysema develops between these collapsed areas.

There is a characteristic ring of hæmorrhage into the submucous tissue around the smaller bronchioles. The alveolar capillaries are congested, and many of the air sacs contain necrosed epithelial cells, but there is at first no œdema, for the poison does not seem to excite this inflammatory reaction from the capillary blood vessels. The spread of infection from the bronchioles is soon followed by septic broncho-pneumonia with its various histological complications.

Petechial hæmorrhages are often found in the submucous tissues of the stomach, and sometimes in the duodenum, but rarely lower down the intestinal canal. Other organs show nothing of note.

Punctate hæmorrhages in the white matter of the brain can sometimes be found microscopically, but they are not nearly so evident as in phosgene poisoning. Strings of ante-mortem clot in the cardiac chambers have been occasionally reported, but apart from this there is no evidence of intravascular thrombosis.

Di-chlor-ethyl-sulphide therefore differs entirely from the lung irritants previously described. Phosgene kills directly and speedily by flooding the lungs with œdema fluid. Di-chlor-ethyl-sulphide kills later and rarely; and death, when it does occur, is an indirect result of secondary lung infection, except in a very few examples where the man is asphyxiated by obstruction of his trachea with bronchial sloughs.

General Pathological Action.

Experiments with animals have proved that di-chlor-ethyl-sulphide may be absorbed after subcutaneous injection; the substance then appears to be excreted on the mucous surfaces, for lesions of the bronchial tree together with conjunctivitis are produced closely resembling those in men who have been poisoned by inhalation of the vapour. But there is this marked difference, that with such animals intense diarrhœa is common, and that after death there is found in the intestinal wall a hæmorrhagic inflammation and epithelial

necrosis exactly like that of the bronchial mucous membrane. The kidneys, liver and general blood vessels show no material changes in experimental animals, but there is some evidence of a general toxic action in muscular weakness, tremors, convulsions, or paralysis.

Patients at the outset may show some slight effects that might be ascribed to a general intoxication, but it is more likely that their lethargy is the result of fatigue, or that their restlessness follows from pain. Intestinal irritation is most rare. Therefore it appears probable that any absorption of the poison through lungs or through skin, and its subsequent excretion on the mucous surfaces is of no practical importance. At the most such delayed excretion might be held responsible for the occasional recurrence of conjunctivitis or for the development of a late erythema.

Very widespread lesions of the skin have been observed in men who have worn their respirators properly, and they showed no trace of subsequent conjunctivitis or bronchitis, so that absorption of the poison through the skin at any rate must be extremely slight. The poison appears to be simply an irritant of the skin and of mucous membranes. As remarked above, it has no harmful action when passing through the blood vessels, and this, perhaps, is the reason why it does not cause pulmonary œdema upon inhalation.

Detailed effects and treatment of various injuries produced.

Eyes.

Conjunctivitis of such intensity as to incapacitate a man may develop in from 2 to 48 hours after exposure. In very low concentrations of the vapour conjunctivitis is mild and develops so slowly that several days may elapse before the man is rendered a casualty. Severe cases are temporarily blinded by swelling and spasm of the eyelids. At first there is profuse lachrymation with pain and headache, and from the second day onwards this is often succeeded by a muco-purulent discharge from secondary infections. The cornea may become steamy, especially in the line of exposure, but actual ulceration is rare.

The conjunctivitis clears up quickly and the injection as a rule disappears in less than a month. But the inflammation is liable to be succeeded by photophobia, which, if improperly treated, may delay a man's return to duty even up to the second or third month. The condition is apt to assume a neurasthenic character and irritation is sometimes maintained, consciously or unconsciously, by frequent rubbing of the eyes, and in such cases it will be found that the ocular conjunctiva opposite the lower lid is red while the conjunctiva above is quite white.

In the acute stage the eyes should be frequently irrigated with warm boric lotion, or 2 per cent. solution of sodium bicarbonate, followed by the installation of liquid paraffin. Castor oil is more irritating than paraffin, but it can be used if the latter is unobtainable. If the cornea is affected, sterilised atropine ointment (1 per cent.) should be substituted for paraffin, and repeated sufficiently to keep the pupils dilated. Hot boracic bathing will give relief if there is much pain. If there is muco-purulent discharge, a 2 per cent. solution of argyrol or protargol should be used once a day.

Cocaine should not be used, for its anæsthetic properties are transient, while its use leads to exfoliation of the corneal epithelium.

The eyes must never be bandaged, but they should at first be protected from the light by dark glasses or a shade. Yellow oxide of mercury ointment should be avoided.

When the inflammation has subsided, zinc sulphate drops should be used three times a day (zinc sulphate gr. 1, boric acid gr. 10 to 1 of water). Photophobia in the later stages may be checked by repeated douching with cold water, or by blisters to the temples. The eye shade should be abolished as soon as possible, and the man given occupation preferably in the open air.

Nose.

Inflammation of the mucous membrane is accompanied by profuse watery secretion, which later may be purulent and associated with the separation of large sloughs. Ulceration and epistaxis are rare, A warm alkaline douche should be poured, not insufflated, through the nose thrice daily.

Pharynx and Larynx.

Inflammation and erosion of the posterior pharyngeal wall may be sufficient to interfere with swallowing. The larynx is sometimes œdematous, but never so seriously affected as to necessitate tracheotomy. There is later a mild laryngitis or even ulceration. Prolonged exposure to a very low concentration of the vapour may often cause a laryngitis and a loss of voice to develop slowly even when there is no conjunctivitis at all.

Relief to the laryngeal discomfort is obtained by the inhalation of steam from a pint of boiling water, with which is mixed a teaspoonful of a mixture of tinct. benzoin co., 1 oz., menthol gr. 10. Irritable cough from the larynx or pharynx requires lozenges of menthol and cocaine.

The laryngitis should be completely cured in a fortnight. It is apt to be succeeded by a functional aphonia that requires the ordinary strict methods in treatment.

Trachea and Lungs.

The main pathological features have been described above. Death comes only by the action of the poison on the respiratory tract; and in severe cases it may ensue in 36 hours from this necrosis, or even be asphyxial by blockage of the lower airways with loosened membrane before secondary infections have had time to develop.

In the first 24 hours there may be only hoarseness of the voice, substernal pain, and a slight cough; but soon the rising temperature and quickening pulse herald the onset of infections that introduce bronchitis, dyspnœa, and a fatal broncho-pneumonia. In the more protracted cases there is profuse thin purulent expectoration, and at autopsy the septic pneumonia is found to be confined to the lower lobes. Perhaps this might be diminished by frequent inversion of the patient head downwards from the hips, as is done for bronchiectasis, but this method requires most careful attention to the patient lest a sudden fatality result.

At first the tracheitis may be eased by breathing through a perforated metal mouth mask (Burney-Yeo) moistened with drops of some antiseptic mixture, such as menthol, gr. 20, tinct. iodine min. 30, oil of eucalyptus min. 20, creosote dr. 1, chloretone dr. 1, alcohol to 1 oz. Venesection or oxygen may be useful in the cyanosis

of secondary broncho-pneumonia, but such treatment is *never* needed in the early stage of poisoning by "Mustard Gas."

The bronchitis clears up in a month or less in the non-fatal cases; and the use of expectorant mixtures should not be continued after the sputum has ceased to be purulent.

Alimentary Tract.

The early vomiting rarely persists for more than a day, and the epigastric pain vanishes shortly afterwards. Hæmatemesis is exceedingly rare. Warm draughts with bicarbonate of soda may be given to relieve pain. There is no need to induce vomiting.

There are no lasting after effects in the stomach, and the bowels are not affected at any time.

Urinary Organs.

Albuminuria has been described in the first 24 hours in cases of early fatality, but it is not found at a later date. Very rarely an acute hæmorrhagic nephritis has been observed. Pain with micturition and even retention of urine may result from the œdema and blistering of the penis.

Circulatory System.

The blood is unaltered; the heart is unaffected at first, except by the changes associated with pulmonary infection.

During early convalescence some of the cases complain of headache, giddiness after exercise, and of shortness of breath associated with precordial pain and tachycardia. These symptoms are chiefly due to a nervous debility, and they yield quickly to tonics and graduated exercises under firm discipline. They are much less evident than those seen after poisoning by chlorine or phosgene, and they are never associated with the objective polycythæmia that may be found with some examples of "D.A.H." from the true lung irritants.

The Skin.

The cutaneous effects of this irritant poison may be caused either by direct contact with the liquid substance, as in splashes or from mud, or by the vapour which diffuses through clothing. The typical distribution of the consequent injury will vary accordingly. Certain areas of the skin, particularly those parts where moisture and sebaceous excretion are excessive, are much more sensitive than the rest to the irritant action of the vapour.

The successive effects are :—

1. An *erythema* which extends over the face, neck, and on to the chest; the axillæ and the flexures of the elbows; the inner surface of the thighs, and the scrotum and penis. This may appear in from two to 48 hours, or be delayed, either locally or generally, for several days. In such cases it has even been mistaken for scarlet fever, though the condition is afebrile.

2. Very *superficial blistering* over the same areas, either in small vesicles or in large blebs. These develop as painless collections of yellow or reddish serum just beneath the epithelium. If the latter is removed, a raw weeping surface is left, and such burns may then become the seat of secondary skin infections, and lead to a very painful eczematisation. This change is particularly frequent in blisters of the scrotum and penis.

The blisters may appear in the second day; but there may be an outcrop of them even in the second week after exposure, and long after the patient has been carefully washed and his clothing changed.

3. *Staining* of the skin with a dark brown or brownish-purple tint, usually in areas that had previously been erythematous. The staining is of no consequence, and it vanishes in two or three weeks as the cuticle desquamates.

All skin lesions heal quickly and there should be no residual trouble at the end of a month, except in the rare instances where a severe burn of the second degree has been caused by direct contact with the liquid. Pain is felt chiefly when the dermatitis is followed by infection, and every effort should be made to prevent this trouble. As soon as possible after exposure the clothing should be changed and the skin, especially the thighs and scrotum, washed with soap and water, so as to remove any poison retained in the grease on the skin and to cleanse the surface from present infection. This may be followed by washing with 1 per cent. solution of sodium bicarbonate.

Fatty ointments with lanoline give no protection against the poison, and indeed their prophylactic application only tends to dissolve and concentrate the vapour on the skin and so increase the inflammation. A dusting powder of zinc oxide mixed with boracic acid, chalk, and starch, or a calamine lotion with lime water may be used after the bath to allay skin irritation. The blisters may be evacuated by pricking. Small burns heal well under Lassar's paste with 2 per cent. salicylic acid. Larger areas of excoriation or of pyogenic infection may require a brief treatment with boracic soaks, which should then be followed by zinc ointment or zinc ointment containing ammoniated mercury, in accordance with the state of the sepsis. Ordinary desquamation may be hastened by alkaline baths and the inunction of salicylic acid ointment.

General principles of treatment and progress of the cases.

All true casualties from "Mustard Gas" exhibit some definite objective symptoms, and serious features do not develop until some time later. These cases therefore do not present the difficult problem in diagnosis that may arise with mild forms of phosgene poisoning, and complete bodily rest is not an essential factor in the treatment during the first twelve hours, nor is oxygen needed.

Residual traces of the poison must be removed from the surface of the patient as soon as possible by changing his clothes and washing him with soap and water, and then with a 1 per cent. solution of sodium bicarbonate. Orderlies engaged in the removal of clothing should wear protective gloves and respirators for their own protection.

Subsequently the chief aim must be that of minimising secondary infections of the inflamed areas either on the skin, in the eyes, or down the trachea and bronchi. Individual patients will be affected in different ways in accordance with the manner in which they are exposed to the irritant substance. The details of treatment for the various organs have therefore been given in separate paragraphs above. Patients stand transport well except when pulmonary infections are commencing. These are indicated by a rise in temperature,

pulse and respiration rate, and patients with these features should not be sent long journeys during the second day after exposure.

The death rate is highest from the second to the tenth day, but it is always inconsiderable. There are no after effects from the poison, and the men are soon fit again for duty.

DIRECT POISONS OF THE NERVOUS SYSTEM.

HYDROCYANIC ACID.

This gas, though it has not been used by the Germans for offensive purposes, is taken as a type of a poison which has a direct paralysing action on the nervous system. It is a general tissue poison, but the nervous system is specially susceptible to its action.

In the case of hydrocyanic acid, concentration of the gas is of far more importance than duration of exposure, *i.e.*, it has practically no cumulative effect, unlike chloropicrin, for example, when duration of exposure and concentration of the gas are of equal importance. The consequence is that when a certain concentration of hydrocyanic acid is attained the action of the gas is very rapid, but if the concentration is low it may be borne for a considerable time without serious results. Unless the dose is a fatal one recovery from the toxic effects is rapid, and no serious after effects need be feared.

Symptoms.—These follow one another in rapid sequence:—giddiness, confusion, headache, indistinct sight, palpitation and pain in the chest and over the heart, laboured respiration, unconsciousness, convulsions, failure of the respiration and finally of the heart. In large doses, immediate unconsciousness, dilatation of the pupils, a few gasping respirations, and death with or without convulsions.

The gas paralyses the respiratory centre very quickly, and the heart may continue to beat for a brief time after the respiration has ceased. With larger concentrations the heart may be stopped almost at once by the direct action of the poison.

When death is caused by inhalation of hydrocyanic acid gas, it is unlikely that the smell of the gas will be detected at autopsy, as may be the case when poisoning is due to the ingestion by the mouth of a large dose of prussic acid.

Treatment.—Immediate treatment is the only measure of any avail if a man falls unconscious from hydrocyanic acid poisoning. The case must be at once dragged into fresh air, and if the respiration has stopped, or is very weak and gasping, artificial respiration must be instantly applied by Schäfer's method. It is possible by this means to resuscitate a case, and if this is so recovery will be perfect. Cold water may be splashed on the face and chest and friction applied to the limbs, but time should not be wasted on these measures before commencing artificial respiration. The same immediate treatment holds good for any other gas that causes rapid unconsciousness from its effects on the central nervous system.

GASES WHICH INTERFERE WITH THE RESPIRATORY PROPERTIES OF THE BLOOD.

CARBON MONOXIDE.

This gas owes its poisonous action to the fact that it combines with hæmoglobin to form a dissociable compound and thereby takes the place of oxygen. Carbon monoxide has about 300 times the

affinity for hæmoglobin that oxygen has. If, therefore, a small proportion of carbon monoxide is present in the air breathed, the hæmoglobin in the body will divide itself between the two gases, the final partition being determined by the relative concentration of the two gases. The oxygen carrying power of the blood is progressively diminished as the hæmoglobin becomes more and more saturated with carbon monoxide, and symptoms arise owing to the interference with the oxygen supply to the tissues from this cause.

The great danger of carbon monoxide arises from the fact that the gas is colourless, odourless, and non-irritant, and that the onset of symptoms is so insidious that very often the first warning that a man may receive is failure in the power of his limbs which will prevent him from retreating into safety. The box respirator does not give protection against carbon monoxide; protection can only be attained by the use of special oxygen breathing apparatus (Proto or Salvus sets).

Pathological changes.—At the autopsy, the blood may be red in colour instead of dark if there is a considerable degree of saturation of the hæmoglobin with carbon monoxide. If the case has continued to breathe for some time after reaching an atmosphere free from carbon monoxide, this gas will have been partly or entirely displaced from the hæmoglobin and the blood after death will have its normal colour.

The simplest method of detecting the presence of carbon monoxide in blood is to compare the colour of a dilute solution of the suspected blood with a similar solution of normal blood. Take a drop or two of blood from the finger of a normal person and dilute it in a test tube very considerably with water (a ½ per cent. solution is a convenient strength) so that when examined by transmitted daylight the colour of this solution is a reddish yellow. Then take a drop or two of the suspected blood and dilute it similarly with water so that the *depth* of colour of the solution is the same as that of the solution of normal blood when both are viewed by transmitted light. On examining the quality of the colour it will be found that the solution made with the suspected blood, if it contains carbon monoxide hæmoglobin, is definitely pinker than that made with the normal blood; though it will not have the full pink tint of the same normal blood solution if the latter be shaken with coal gas so as to saturate it quite completely with carbon monoxide.

The lungs show no abnormal changes in cases of rapid death. Small punctate hæmorrhages may be found in the white matter of the brain and sometimes ecchymoses in the meninges and even large cerebral hæmorrhages, if the case has been exposed to a concentration of carbon monoxide sufficient to cause prolonged unconsciousness.

Symptoms.—Except with very massive doses, when loss of consciousness is very rapid, the symptoms develop very gradually, as the gas is only absorbed slowly. If a man is at rest in a concentration of the gas of 1 part in 1,000 it will take about 2 hours before definite giddiness appears, and he will not be definitely disabled until the lapse of 2½ hours. The rate of absorption of the gas is much quickened when the breathing is deepened during muscular exercise, and the exercise also leads to great accentuation of the symptoms. With a concentration of 2 parts in 1,000 a man will be seriously affected in half-an-hour if he is performing a moderate amount of

muscular work, and this concentration may prove fatal with prolonged exposure.

Small animals are far more quickly affected by carbon monoxide than man is, owing to the natural great ventilation of their lungs and the rapidity of their circulation. A mouse or a canary will show definite symptoms of carbon monoxide poisoning in a tenth of the time that a man will. If small animals are used to give an index of the presence of carbon monoxide in a suspected atmosphere, it must be remembered that though they show symptoms long before a man feels any effects, the man will in the end be reduced to the same condition as the animal, and he ought therefore to leave the dangerous atmosphere directly the animal shows signs of being affected, unless he is protected by special apparatus.

The first sign that tells a man that something is amiss is very frequently a feeling of loss of power in the limbs. Giddiness, slight confusion of mind, and breathlessness and palpitation on the least exertion also show themselves. The confusion of mind and loss of power in the legs frequently preclude a man from withdrawing from danger, even though he is dimly aware that safety is only a few yards distant. The failure of power in the limbs and mental confusion rapidly increase, and the man may appear drunk, shouting incoherently, laughing, swearing, or praying. Apathy and complete helplessness supervene, and failure of the intellectual powers gradually passes into complete unconsciousness, which may finally terminate in a painless death.

The symptoms may remain stationary at any stage, since the degree of saturation of the hæmoglobin with carbon monoxide reaches a final end point which is determined by the relative concentrations of the carbon monoxide and the oxygen which are simultaneously trying to combine with the hæmoglobin.

Even in cases of mild gassing with carbon monoxide a severe headache accompanied by nausea is very likely to develop.

Treatment.—The symptoms detailed above are due to the gradual diminution of the oxygen-carrying power of the blood. It is clear that any increase in the oxygen demands of the body is to be avoided, and any man, therefore, who shows definite signs of gassing should be carried to a place of safety. If he attempts to walk himself he is quite likely to fall down unconscious. When a moderately gassed case reaches fresh air he sometimes falls unconscious, while other cases may commence to shout and struggle, in which case their movements need to be controlled.

Any case showing definite symptoms should be removed as soon as possible to some place of safety where he can remain at rest for an hour or two before evacuation. Rest is essential.

As carbon monoxide hæmoglobin is a dissociable compound, the carbon monoxide is gradually driven out of its combination with hæmoglobin by the oxygen of the air as soon as an atmosphere free from carbon monoxide is reached. In fresh air it will take an hour or two before the blood is entirely freed from carbon monoxide, but the process can be rendered five times as rapid by giving the patient pure oxygen to breathe. It is important therefore to begin the administration of oxygen by some efficient method *as soon as possible* after the case has been removed from the poisonous atmosphere. Pure oxygen may be administered either by means of the

Novita oxygen apparatus that is kept at mine rescue stations, or by means of the nitrous oxide anæsthesia apparatus; as an alternative the Haldane oxygen administration apparatus may be used with the oxygen delivery set at 8 or 10 litres per minute. Administration of oxygen should be kept up as continuously as possible for half an hour to an hour, depending on the severity of the symptoms. It should be remembered that if a case can be kept at rest for half an hour and oxygen administered immediately after being removed from the poisonous atmosphere, he will be in far better condition to travel than if he has to be removed to a more distant point before treatment. If the breathing is very shallow, administration of oxygen may be combined with artificial respiration.

Collapse should be combated by external warmth and by friction of the limbs.

In cases of poisoning with the lung irritants the pulmonary œdema and damage to the lungs, and the consequent interference with the gaseous exchange taking place between the blood and the air in the lungs, persist for some time and may necessitate the administration of oxygen for several days. In carbon monoxide poisoning the structure of the lungs is not interfered with and oxygen is administered with the deliberate intention of accelerating the discharge of carbon monoxide from the blood. When once this has been accomplished, *i.e.*, after half an hour's or an hour's administration, there is no need to continue the oxygen administration, as the oxygen-carrying power of the blood has now become normal again. Any symptoms that persist are due to effects that were produced while the blood was charged with carbon monoxide, and are unlikely to be influenced by oxygen administration when once the carbon monoxide has been got rid of. Further oxygen administration is therefore required only if cyanosis begins to develop subsequently from secondary cardiac or respiratory failure.

Cases of carbon monoxide poisoning have been known to recover, even when they have remained unconscious for so long as 48 hours after removal from the poisonous atmosphere. In cases that have been severely gassed, the possibility of subsequent cardiac dilatation must not be lost sight of, and cases of severe gassing should not be returned to duty until confidence is felt that the circulation has recovered from the strain. As a result of damage to the nervous system while the blood was charged with carbon monoxide, paralysis of single muscles, or of groups of muscles, or different forms of mental disturbance are sometimes found as sequelæ.

For further information on carbon monoxide poisoning, *see* S.S. 308. "Memorandum on Gas Poisoning in Mines."