

THE AFTER-EFFECTS OF CHLORINE GAS POISONING*

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IT is now over four years since the enemy first used chlorine gas as an offensive measure of warfare. Whatever the immediate effects may have been, it has seemed of importance to determine what the eventual effect might be on the health of the soldier. The first chlorine gas attack was in April, 1915, in the Ypres salient, where the First Canadian Division was holding part of the line. This division suffered severely, and many of their casualties were due to gas poisoning. As they were unprotected with respirators or any other means of defence against this type of warfare, a maximum effect was obtained. This was both of a physical and mental character. The unusual and uncanny appearance of this first drift gas made a great impression on the soldiers' minds. This was further accentuated by the distress and agony produced in those who were severely gassed. Therefore, it has been difficult, some months later, to determine with accuracy from the history of the individual whether he had been exposed to the gas in sufficient concentration to produce symptoms or not. It is unwise to accept, without more evidence than the soldier's own statement, the fact, that every one who states he was gassed in this attack, really was.

In order to obviate this difficulty, the cases, upon which this report is based, were collected in the following manner. The admission and discharge books, of the field ambulances operating behind the area occupied by the 1st Canadian Division in the latter part of April and first part of May, 1915, were examined for cases of gas-poisoning, and seven hundred consecutive cases have been followed through all the records obtainable. Of these, two hundred

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and twenty-two (31·7 per cent.) do not have any further mention of gas-poisoning made in their records. It is therefore presumed that the majority of these cases were returned to duty without further medical treatment than that received at the field ambulance. The remaining four hundred and seventy-eight were evacuated to the base, where they were under treatment for varying periods. Of these one hundred and forty-six (20·8 per cent.) were treated to a finality at the base hospitals. There were six deaths and the others returned to duty. No further evidence is found in their records of their having suffered from the effects of the gas poisoning. The remainder, three hundred and thirty-two (or 47·4 per cent.) were evacuated to the United Kingdom for further treatment.

It is with the last group of cases that the present investigation is concerned particularly. They were presumably soldiers who had suffered considerably from the effects of gas, and it would be in such cases that the most pronounced after-effects might be looked for.

In these three hundred and thirty-two cases careful records have been sought in regard to their further symptoms and movements. They were disposed of in three main directions: (1) Returned to France. (2) Retained in England. (3) Invalided to Canada. In so far as the symptoms and signs as observed in the United Kingdom are concerned, we will take them up under these main divisions.

I. RETURNED TO FRANCE. Eighty (24·1 per cent.).

(a) Full duty—seventy-two.

(1) Average time in hospital—nine weeks.

(2) Average time home service—ten months.

(3) Principal symptoms while in hospital—

| | |
|--|----|
| Irritable heart (neurasthenia) | 36 |
| Bronchitis | 6 |
| Gastric symptoms | 4 |
| No definite symptoms | 26 |
| | — |
| | 72 |

(b) Base duty—eight.

(1) Average time in hospital—fourteen weeks.

(2) Average time home service—fifteen months.

(3) Principal symptoms while in hospital—

| | |
|---------------------------|---|
| Irritable heart | 4 |
| Bronchitis | 4 |

Of these cases, eight were subsequently killed in action; six were severely wounded; and eight were reduced in category on account of shell-shock, or nervousness. The case reports of a number of these cases gave distinct indications that they were suffering from a very severe condition. But in spite of this the average duration of their stay in hospital was not conspicuously long, nor was the period they spent in home service

II. RETAINED IN UNITED KINGDOM—Forty-eight (14·4 per cent.).

Subsequently classified as follows:

(a) Class A—Eight cases.

- (1) Average time in hospital—eleven weeks.
- (2) Average time on home service—thirty months.
- (3) Principal symptoms while in hospital—

| | |
|--------------------------|---|
| Irritable heart. | 4 |
| Nil. | 4 |

(b) Class B—Forty cases.

- (1) Average time in hospital—fourteen weeks.
- (2) Average time on home service—thirty-three months.
- (3) Principal symptoms while in hospital—

| | |
|---|----|
| Irritable heart. | 30 |
| Bronchitis. | 7 |
| Other conditions (hernia, gun-shot wounds, eye-sight). | 3 |

The histories, obtained in regard to these men, indicated very strongly that they were inherently of a much poorer calibre, both physically and nervously, than were those who returned to France. There was no evidence that their symptoms, while in hospital, were of a severer type, although the average period of stay in hospital was much longer than in the case of those who returned to full duty in France (as fourteen is to nine). However, those cases which were sent to France on base duty showed a stay in hospital of a similar duration to those retained in England, namely, fourteen weeks.

III. INVALIDED TO CANADA—Two hundred and four (61·4 per cent.).

- (1) Average time in hospital—seventeen weeks.
- (2) Average time on home service—five and a half months.
- (3) Principal symptoms necessitating invaliding to Canada:—

| | |
|-----------------------------|-------|
| Irritable heart. | 118 |
| Bronchitis and pneumonia... | 30 |
| Hæmoptysis. | 4 |
| Asthma. | 22 |
| Neuroses. | 20 |
| Indefinite. | 30 |
| | <hr/> |
| | 204 |

Of the thirty cases who were suffering from indefinite symptoms of gassing, sixteen were invalided to Canada for conditions other than gas poisoning.

The physical condition, four years after exposure to chlorine, in the one hundred and eighty-eight cases invalided to Canada, was as follows—

| | |
|------------------------------|-------|
| No appreciable disease. | 54 |
| Irritable heart. | 78 |
| Neuroses. | 18 |
| Bronchitis, etc. | 18 |
| Asthma. | 8 |
| Unable to trace. | 14 |
| | <hr/> |
| | 188 |

Deaths. In this series of cases there were five deaths. This, of course, does not indicate the mortality from chlorine poisoning, as all of these deaths occurred after the cases had arrived at the base—four in France and one in United Kingdom. Three of the cases that died in France were in hospital but a few days. Death was apparently due to the acute pneumonic condition consequent on such a powerful irritant. The other case died comparatively suddenly, five months after exposure to the gas. No record was obtainable as to the physical examination, or the exact cause of death. The symptoms recorded were pain in the left chest, dyspnoea, orthopnoea and pronounced cyanosis.

In the case dying in the United Kingdom, death occurred with equal suddenness eleven months after the date of gassing. The notes were as follows:—"Found dead in bed. Death was due to heart failure, the result of chronic bronchitis and pulmonary congestion, the result of gas poisoning." This man was a rather elderly soldier who had not been very severely affected by the gas, as his

stay in hospital amounted to only eighteen days. The evidence at hand is not conclusive that death was necessarily the result of gas poisoning.

Of the cases invalided to Canada there is no record as yet of any having died.

Symptoms.—(1) Irritable heart. Symptoms of this syndrome are by far the most common of all the after-effects of chlorine poisoning. The severity of this condition varies considerably. Certain of the cases are evidently very much disabled, while others have a comparatively slight disability. The evidence is clear that a slow but conspicuous improvement occurs in these cases as a considerable number of them are free of symptoms after four years. It is to be hoped, that with firm but sympathetic handling, these cases will recover eventually. The most pronounced symptoms in these cases is the shortness of breath, especially on exertion. This is more conspicuous than in those who complain of the symptoms of "irritable heart", which have followed the various infectious processes.

(2) Bronchitis. The comparatively few cases which exhibit signs of bronchitis is most striking. In consideration of the nature of the initial lesion it was to be expected that a considerable number of cases of chronic bronchitis would result. Further, it would seem probable that such cases would be of a more or less progressive nature. This, however, is found not to be the case. Many of those who had signs of bronchitis while in the United Kingdom reveal no evidence of a pulmonary lesion three years later. On the other hand a certain number of cases in whom there were no appreciable signs in the lungs, when they left the hospital in the United Kingdom, are now suffering from various forms of chronic pulmonary disturbance. (See table.)

A COMPARISON OF CERTAIN CASES SHOWING PULMONARY SIGNS IN UNITED KINGDOM OR IN CANADA

| No. | PULMONARY SIGNS IN UNITED KINGDOM | No. | PULMONARY SIGNS IN CANADA |
|-----|--|-----|---|
| 57 | Lungs normal. | 57 | Asthma functional secondary to gassing. |
| 125 | Emaciation—lungs nil. | 124 | Signs of bronchitis. |
| 268 | Asthma—recurrence from civil life. | 268 | Asthma continues. |
| 67 | Rales and hæmoptysis. | 67 | No record. |
| 68 | Hæmoptysis—lungs nil. | 68 | Recovered completely. |
| 118 | Condition poor, moist rales. | 118 | Perfectly well. |
| 174 | Many rales—purulent sputum—laryngitis. | 174 | Laryngitis persists—lungs normal. |
| 240 | Right apex dull—no Tuberculosis | 240 | Chronic cough—asthma. |
| 286 | Lungs nil. | 286 | Emphysema—many piping rales. |
| 287 | Bronchitis. | 287 | Lungs nil. |
| 299 | No pulmonary signs—cough. | 299 | Rt. apex expansion diminished—rales left base—sputum copious. Temperature 99° at 4 p.m. |
| 319 | No pulmonary signs. | 319 | Many fine rales in both lungs—expansion poor—apices dull. Morning cough. |
| 322 | Bronchitis—copious expectoration. | 322 | Asthmatic attacks. |
| 325 | Bronchitis. | 325 | Emphysema, cyanosis, no rales. |
| 305 | Bronchitis. | 305 | Lungs—nil. |
| 337 | No physical signs. | 337 | Emaciated—Lungs show fibroid condition. |
| 343 | No physical signs. | 343 | Expansion poor—rales over upper right chest. |
| 344 | Bronchitis. | 344 | Lungs nil. |
| 345 | No physical signs. | 345 | Expansion poor—prolonged expiration—rales at right apex—night sweats. |

In 1918, Achard and Flaudin, in their report on the sequelæ of poisoning by suffocating gases, drew attention to the occurrence of certain cases which they called pseudo-tuberculosis. These cases occurred particularly after chlorine poisoning. They were characterized by a prolonged course, with low fever, profuse expectoration, loss of weight and pulmonary symptoms suggestive of a tuberculous lesion. The sputum at no time, however, showed tubercle bacilli, the albumen reaction of the sputum was not positive, and the *x*-ray examination was not indicative of tuberculosis. A number of cases similar to those described by them have been found in the present series. Continued observation of these cases will be carried out.

No cases of proved pulmonary tuberculosis have been encountered in this series. Several have been diagnosed "clinical tuberculosis," but in none of them have tubercle bacilli been found in the sputum, nor were the physical signs conclusive of this condition. Achard and Flaudin had a similar experience. In their series only three cases of tuberculosis were found, and these they classified as "secondary complications". It may be stated, therefore, that there is no evidence to date, that chlorine gas poisoning render the patient more liable to pulmonary tuberculosis.

Considerable interest is being taken at the present time by insurance companies in regard to the influence of gas poisoning on the expectation of life. Too short a time has elapsed, as yet, to warrant any observations on this point. In addition, the number of cases which have been thoroughly followed is too small to allow of any definite statement on this matter.

(The facilities for following the records of the cases reported in this series were provided by the Medical Research Committee, the Canadian Record Office, and the Board of Pension Commissioners of Canada. To all of these we wish to express our thanks.)