two to six) are sometimes necessary to raise and maintain the blood pressure during the course of operations under spinal anaesthesia (Johnson, 1937; Lorhan and Oliverio, 1938; Bittrich, 1939; Brunner and de Takats, 1939; Silvers and Leonard, 1940; Lorhan and Lalich, 1940). The initial rise in blood pressure due to the drug may also be excessive, and the bradycardia which it causes has resulted in partial heart-block (Brunner and de Takats, 1939). Paredrine may also produce an excessive rise in blood pressure—e.g., to 250 mm. systolic (Loman *et al.*, 1939; Altschule and Gilman, 1939).

It would thus seem that methedrine is the most valuable of the drugs so far tested for counteracting the serious falls in blood pressure that often occur in surgical operations. The 54 cases of the series under review are summarized in the table below.

Summary of Cases showing Effect of Methedrine on Blood Pressure

No.	Operation	Dose in mg.*	Pre-operative B.P.	Lowes B.P.	Max. B.P. after Methedrine	Final B.P. in Ward
1	Excision of rectum	3 × 10 i.m.	150/90	0	120/70	?
2	Laparotomy	+2 × 10 i.m.	120/75	70/50	125/80	110/65
3		15 i.v. + 15 i.m.	120/80	60/50	115/70	110/70
4	Gastro-enterostomy	10 i.v. + 15 i.m.	120/80	70/55	120/85	105/70
5	Cholecystectomy	30 i.m. + 15 i.v.	150/90	50/45	150/100	150/85
6		+10 i.m.				
7	"	20 i.v. + 20 i.m.	130/80	60/55	150/80	115/65
8	+gastroctomy	15 i.m. + 15 i.v.	140/80	40/30	140/80	120/80
9	Hernia	20 i.v. + 20 i.m.	160/90	60/50	180/100	135/85
10	"	10 + 15 i.v.	130/70	60/50	145/90	110/70
11	"	15 i.v. + 15 i.m.	140/80	50/40	135/75	130/70
12	"	25 i.m.	140/90	70/60	130/80	125/75
13	"	20 + 20 i.m.	150/100	80/70	140/80	130/70
14	"	25 i.m.	180/90	60/50	150/80	150/80
15	"	20 i.m.	140/80	90/70	145/85	140/90
16	"	20 i.m.	180/100	70/60	160/105	130/80
17	Hydrocele	25 i.m.	120/80	75/55	180/100	120/80
18	Orchidectomy	20 i.m.	100/70	90/80	130/90	100/70
19	Varicose veins	15 i.m.	140/70	95/85	140/80	135/80
20	"	20 i.m.	120/70	100/90	135/70	120/70
21	"	20 i.m.	130/90	85/75	140/100	130/90
22	Torek?	20 i.m.	140/100	95/85	190/130	140/100
23	Steinach II	20 i.m.	120/70	70/60	120/70	120/70
24	Cholecystectomy	25 i.m.	110/60	70/50	130/70	130/80
25	"	30 + 15 i.m.	135/95	0	125/80	120/80
26	"	20 i.m.	140/70	65/35	120/60	120/75
27	"	25 + 15 + 25 i.m.	140/100	50/40	105/85	100/70
28	"	20 i.m.	170/110	110/85	170/100	170/100
29	Amputation	15 i.m.	120/70	80/60	120/70	110/70
30	Cervical sympathectomy	30 i.m.	120/70	70/55	130/80	120/65
31	"	25 i.m.	120/70	50/40	120/60	115/75
32	Excision of rectum	10 i.m.	120/80	90/75	120/60	115/75
33	Haemorrhoids	20 i.m.	160/95	50/40	150/80	140/80
34	Pilonidal sinus	30 i.m.	120/80	90/75	100/60	100/60
35	Thyroidectomy	10 i.m.	120/80	90/60	110/60	110/60
36	Hysterectomy	30 i.m.	150/90	90/60	240/150	150/90
37	Laparotomy	30 i.m.	120/70	0	150/90	120/70
38	"	25 i.m.	130/85	50/40	110/70	110/70
39	Ureter	25 i.m.	110/70	70/65	110/75	110/75
40	Bladder	30 i.m.	140/70	100/80	120/70	120/70
41	Mastectomy	3 × 15 i.m.	120/90	0	120/80	115/80
42	Kidney	30 + 20 i.m.	125/80	35/30	125/90	125/90
43	"	30 + 30 + 15 i.m.	115/80	65/60	90/65	90/70
44	"	30 i.m.	130/80	55/45	140/90	128/78
45	"	30 i.m.	130/80	65/45	135/75	120/80
46	Varicose veins	20 i.m.	140/100	95/85	160/100	140/100
47	"	15 i.m. + 15 i.v.	130/80	55/40	145/90	125/70
48	Hernia	25 i.m.	125/80	70/65	150/80	125/80
49	Excision of rectum	30 + 20 i.m. + 20 i.v.	110/70	70/65	115/75	115/75
50	Gastroctomy	20 i.m.	150/90	95/80	150/80	140/85
51	Gastro-jejunostomy	25 i.m.	110/65	80/60	130/75	110/65
52	Laparotomy	25 i.m.	120/80	80/65	135/80	120/80
53	Gastro-jejunostomy	10 i.v. + 20 i.m.	110/80	70/55	125/85	100/70
54	Hernia	20 i.v.	120/75	0	120/80	118/80

We have not had the opportunity of using methedrine in cases of traumatic shock, but we think that the outstanding properties of the drug make it worthy of trial in such cases, particularly in those which fail to respond to measures designed to increase the blood volume.

Summary

Out of 130 observed operations 54 patients were found suffering from an unduly low systolic or pulse pressure and some degree of impending surgical shock. The capacity of methedrine to meet the needs of these patients has been studied under average general hospital operating conditions. Anaesthetics included all those in common use.

Under these conditions methedrine has been found to be an effective blood-pressure-raising drug with a prolonged action.

The effective dose is from 15 to 30 mg. intramuscularly, or 10 to 20 mg. intravenously plus a depot dose of 10 to 20 g. intramuscularly.

In 97% of the cases the systolic pressure was restored to normal levels in a period varying from 2 to 18 minutes. The systolic pressure was raised from an average of 66 mm. to an average maximum of 135 mm., and settled to an average minimum of 124 mm. This last figure corresponds to 91% of the average pre-operative value (137 mm.). There is no abnormally high rise if the dose is carefully calculated. One injection was adequate in 81% of patients; repeated injections were given in 17%; 1 case (2%) did not respond.

The blood pressure was maintained throughout operation and for several hours after.

Reasons are given for considering methedrine to be superior to adrenaline, ephedrine, pholedrine, neosynephrin, and paredrine for counteracting serious falls of blood pressure in surgical operations.

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REFERENCES

- Altschule, M. D., and Gilman, S. (1939). *New Engl. J. Med.*, **221**, 600.
 Bittrich, N. M. (1939). *Anesth. & Analges.*, **18**, 29.
 Brechling, S., and Hansen, T. (1939). *Nord. Med.*, **3**, 2226.
 Brunner, R. S., and de Takats, G. (1939). *Surg. Gynec. Obstet.*, **68**, 1021.
 Dodd, H. (1940). *Lancet*, **1**, 358.
 — (1942). *Ibid.*, **1**, 498.
 — and Merton, C. (1939). *Brit. J. Surg.*, **27**, 78.
 Golla, F. L., *et al.* (1940). *J. ment. Sci.*, **86**, 48.
 Graybiel, A., and White, P. D. (1941). *Electrocardiography in Practice*, London and Philadelphia.
 Hartwell, A. S., *et al.* (1942). *J. clin. Invest.*, **21**, 409.
 Hewer, C. L. (1943). *Recent Advances in Anaesthesia*, p. 215, London.
 Johnson, C. A. (1937). *Surg. Gynec. Obstet.*, **65**, 458.
 Koster, H. (1942). *Arch. Surg.*, **45**, 696.
 Kurtz, C. M., Bennett, J. H., and Shapiro, H. H. (1936). *J. Amer. med. Ass.*, **106**, 434.
 Loman, J., *et al.* (1939). *Amer. Heart J.*, **18**, 89.
 Lorhan, P. H., and Oliverio, R. M. (1938). *Anesth. & Analges.*, **17**, 44.
 — and Lalich, J. L. (1940). *Ibid.*, **19**, 66.
 McMichael, J. (1942). *British Medical Journal*, **2**, 671.
 Schuberth, O. O. (1936). *Acta chir. scand.*, **78**, 1 (Suppl. 43).
 Silvers, H. L., and Leonard, I. E. (1940). *Amer. J. Surg.*, **50**, 79.
 Smirk, F. H., and McGeorge, M. (1942). *Lancet*, **2**, 301.

TETRACHLORETHANE POISONING

BY

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Tetrachlorethane ($C_2H_2Cl_4$) is a colourless mobile liquid with an odour resembling that of carbon tetrachloride and chloroform. It is non-inflammable, and the commercial product has a boiling-point varying from 140 to 150° C. and a specific gravity of from 1600 to 1602 (Browning, 1937). It is a solvent for cellulose acetate and nitrate, bitumen, waxes, resins, pitch, tar, sulphur, rubber, and oils.

This substance is sold under various trade names, such as "westron," "alanol," "emaillet" (Browning, 1937), and "cellon" (Willcox, 1915). It is issued to the Army as "silkcleansing fluid" for the purpose of cleaning the silk of duplicators (Hepple, 1927; Elliott, 1933). Corry's white fly fumigant, which is stocked by most nurserymen and seedsmen for sale in small quantities, is composed of nearly pure tetrachlorethane. Its sale is not controlled by the Dangerous Drugs Acts, 1920-32, and though not commonly stocked by retail chemists it may be bought from some at the price of 2s. a pint.

Commercial Uses

During the early stages of the war of 1914-18 tetrachlorethane was extensively used, both in this country and on the Continent, as a constituent of the solution employed to treat aeroplane fabric so as to render the wings of aircraft impervious to air and moisture. In July, 1916, its use for this purpose was prohibited, as by that time 70 cases of jaundice with 12 deaths had occurred as a direct result of inhalation of the vapour (Willcox, 1915), and a substitute of a non-toxic nature was

provided as a solvent for cellulose acetate. Tetrachlorethane, however, has a very wide field of application in other industries, on account of both its high solvent power and its properties as an insecticide. The following list of its commercial uses is given in the report of the Industrial Health Research Board (Browning, 1937).

1. As a dry-cleaning agent.
2. As a lacquer solvent in the manufacture of straw hats.
3. In the film industry as a celluloid solvent.
4. In the artificial silk industry, particularly in the "lustron" process.
5. In Germany and France, principally as a solvent for a mixture of acetyl-cellulose and "essence d'orient" in the manufacture of artificial pearls.
6. As a cement in the manufacture of shoes.
7. As a parasiticide, especially as a hair wash for dogs, perfumed substances being added.
8. In the estimation of the water content of tobacco and many drugs.
9. In the manufacture of tube cements, adhesives, and floor waxes.
10. As a constituent of the adhesive used in the manufacture of gas masks.
11. As a component in the contents of foam fire extinguishers.
12. For the impregnation of furs and skins.
13. In the manufacture of safety glass.
14. In the rubber industry to some slight extent.

Absorption, Distribution, and Excretion

Tetrachlorethane is mainly absorbed through the lungs, but, as shown by Schwander (1936), enough may be absorbed through the skin to produce complete narcosis. It can of course be absorbed from the alimentary canal. It is largely excreted through the lungs, but this takes place slowly, as shown by animal experiments. Part of the absorbed material is excreted in the urine (von Oettingen, 1937).

Toxicity

Tetrachlorethane is generally considered the most toxic of the chlorinated hydrocarbons (Hamilton, 1934; Browning, 1937), whether of the saturated or of the unsaturated series, not only exerting a narcotic effect but producing profound organic damage, especially atrophy of the liver. As a narcotic poison it works more slowly than chloroform, but its effects are more lasting. As it is not volatile, acute narcosis from the fumes of this substance is never very bad; but, on the other hand, chronic poisoning is notoriously severe, and affects a fairly high proportion of those exposed. Hamilton quotes Lehman to the effect that, based on experimental evidence, tetrachlorethane is four times as toxic as chloroform. Veley—according to Willcox—found that it is 2.8 times as toxic as chloroform. Von Oettingen cites Müller to the effect that tetrachlorethane is 3.5 times more toxic to mice than chloroform. Lehman and Schmidt-Kehl (quoted by von Oettingen, 1937) found that, in man, concentrations of 0.02 mg. per litre may be detected by odour, 0.09 mg. per litre may be tolerated without effect for 10 minutes, but that inhalation of 1 mg. per litre for 30 minutes or 2.3 mg. per litre for 10 minutes will cause irritation of the mucous membranes, pressure in the head, vertigo, and fatigue. According to their findings, 45 to 46% of the inhaled material is absorbed through the lungs.

Tetrachlorethane Poisoning in Man

Poisoning by this substance may be either acute or chronic. The former is rare, the latter more common.

Acute Poisoning

So far as I have been able to discover, only two cases of poisoning following ingestion of this solvent have been recorded. The reason for this is not far to seek, as tetrachlorethane is most unpalatable and has a distinctly disagreeable odour.

The first case was reported by Hepple in 1927, the second by Elliott in 1933. The two cases are very similar. In both the victims were members of H.M. Forces, and they both drank "silk-cleansing fluid." They became unconscious shortly after ingestion of the substance, with cyanosis and loss of corneal reflexes. They both died, one eight hours and the other twelve hours after taking the drug, in spite of every possible type of resuscitation treatment.

Post-mortem examinations showed hyperaemia of the gastric mucosa, and in Hepple's case small areas of superficial erosion at the cardiac and pyloric ends of the viscus. Congestion of the kidneys and acute congestion of the lungs were present. No lesions of the liver were found apart from cloudy swelling and congestion in the case reported by Hepple. From the accounts it is quite clear that death took place in both cases from central respiratory paralysis. In Hepple's case the stomach was washed out, but in spite of this an analysis of its contents recovered at the necropsy yielded 12 c.cm. of a fluid with a specific gravity of 1600 and a boiling-point of 147° C. Further tests proved this to be tetrachlorethane, and it is postulated by the author that the high specific gravity of this substance explains why so little tetrachlorethane was contained in the stomach washings. No analysis of the other organs was carried out. In Elliott's case no details are given of the results of analysis of the stomach contents or of the viscera. Elliott states that "records of poisoning by this substance show that the fatal dose may be as low as 5 c.cm." He quotes no authority for this assertion.

It appears, therefore, that in cases of acute tetrachlorethane poisoning a fatal termination is brought about by narcotic action on the vital centres, and death supervenes so quickly that no effect on the liver, kidneys, and heart, of the kind seen in fatal cases of chronic poisoning by inhalation of the vapour, has time to appear. It is likely, however, that, should the patient survive the narcosis induced by a sublethal dose of the drug taken by the mouth, then he would show the symptoms of liver damage seen in cases of chronic poisoning by inhalation.

Chronic Poisoning

Many cases of chronic poisoning by inhalation of the vapour of tetrachlorethane have been reported, but the incidence of such cases in this country has become less frequent since the use of the substance in aeroplane factories was prohibited. However, in France and Germany tetrachlorethane is employed extensively in the manufacture of artificial pearls and as a constituent of an adhesive in the manufacture of shoes (Browning, 1937), and cases are still being reported (von Oettingen, 1937). Willcox had the opportunity of studying a number of cases of toxic jaundice due to tetrachlorethane poisoning, and he gives the following description of the symptoms, which correspond closely to those observed by various other workers.

"For some days the patients complain of general malaise, drowsiness while at work, loss of appetite, nausea, retching in the morning, unpleasant taste in the throat, constipation usually, and headache. Abdominal discomfort is present in some cases. After indefinite symptoms of this kind lasting several days or even weeks definite jaundice develops, and this is associated with pale stools and bilious urine. Vomiting is now likely to become more marked. The patient may become mentally confused, stuporose, and delirious. In acute cases haematemesis or convulsions may occur. Coma supervenes and death results. In the toxic stage of the disease purpuric rash and haemorrhages may occur. Suppression of urine also occurs towards the end. There seems to be a marked variation in the susceptibility of certain persons to the poison, and this corresponds to the varying susceptibility of patients to other liver poisons—e.g., chloroform."

It is generally agreed that young girls are particularly susceptible to the drug.

In some cases nervous symptoms first manifest themselves. These consist of tremors, headache, pain in the limbs, numbness, "pins and needles" of the extremities, loss of the knee-jerks, and excessive sweating (Willcox, 1915). Some doubt as to whether these symptoms are due to tetrachlorethane alone or to that substance mixed with other toxic material is evinced by Browning.

Before obvious symptoms appear changes in the blood can be detected. From the study of 68 cases, Minot and Smith (1921) found that the blood changes in moderate poisoning consist of a mononucleosis with a marked increase of the endothelial leucocytes, and if the case progresses degenerative forms of these cells are seen. They also noted a progressive but slight anaemia and a slight increase in the number of platelets. They suggested that an increase of the large mononuclear cells to more than 12% should be regarded as the sign of a toxic action of tetrachlorethane, and that the appearance of a considerable number of young large mononuclear cells should be looked upon as indicating a severer condition than when the same number of mature large mononuclear cells was present. Parmenter (1920-1) used the changes in

the blood as an indication of subclinical poisoning in workers in a silk mill, and in this way prevented the development of a single case of jaundice.

Post-mortem Findings

In fatal cases the liver is reduced in size and severely affected by fatty degeneration. If the disease runs a rapid course there are large areas of complete disintegration with fatty degeneration in the remaining liver tissue. There may be round-celled infiltration of the necrotic areas but no fibrosis or attempts at hypertrophy of the remaining tissue. When the disease is more chronic, replacement fibrosis and active hypertrophy may be seen (Spilsbury, 1917). Fatty degeneration also affects the myocardium and the kidneys (Rolleston, 1922). According to Spilsbury the jaundice is haemohepatogenous, obstructive in nature, and due to the inflammation of the small intrahepatic bile ducts by the direct action of the tetrachlorethane on the cells. A toxic fatty degeneration thus develops in the central zones and spreads through the lobules, leading to necrosis.

Animal Experiments

In animals the acute effects of tetrachlorethane inhalations resemble those of other chlorinated hydrocarbons, and death occurs from central respiratory paralysis. The chronic intoxication produces fatty degeneration of the liver. According to Browning, Müller did not find in his experimental animals the acute yellow atrophy of the liver characteristic of the human intoxication. He suggests that this may be due to the fact that, owing to their different alimentary metabolism, death occurs in animals before the "reactive inflammation" of acute yellow atrophy has time to develop. It has been found that tetrachlorethane applied to the shaved abdomen of a rabbit produces fatty degeneration of the liver by absorption through the skin.

Lehman (according to Hamilton, 1934) found that prolonged exposure to the substance caused emaciation, with evidence of damage to the liver and kidneys and of haemolysis, as shown by a low red cell count, stippled red cells, and haemoglobinuria. She also reports that Heffter and Joachimoglu observed similar changes, with in addition fatty degeneration of the kidneys and heart musculature. These changes were also produced experimentally in animals by Spilsbury and Willcox.

Case Report

At 6.20 p.m. on June 19, 1942, a labourer aged 33 was seen by a family friend to drink some fluid from a bottle which he had brought home with him. Thereafter he promptly went to sleep on a settee. The family thought he was sleeping naturally, until, at 10.30 p.m., attempts to arouse him proving unavailing, they realized that there was something amiss and sent for assistance. The patient was removed to hospital, where he was admitted at 11.50 p.m. On admission he was found to be deeply comatose, deeply cyanosed, and with shallow respirations. His breath had a sweetish smell suggestive of chloroform. In spite of attempts at resuscitation, which were started at once, his condition rapidly became worse and respirations ceased. Quantities of frothy fluid appeared at his mouth and nose, and he died at 12.30 a.m. on June 20—i.e., about 6 hours from the time he had ingested the toxic material.

Post-mortem Findings.—A necropsy was conducted on June 22, the following being the only noteworthy features. **Alimentary system:** There were no marks of corrosion round the mouth. The tongue, lips, gums, and oesophagus were normal. The stomach contained 1½ oz. of watery fluid somewhat tinged with blood, which emitted a pungent sweetish odour. The mucous membrane along the lesser curvature showed intense congestion on the top of the rugae, the intervening areas being normal. The duodenum was also inflamed, the inflammation extending down to the upper part of the jejunum. The rest of the large and small bowels was normal. The liver showed no naked-eye evidence of fatty change or of necrosis; it was normal in size and the capsule was smooth. The pancreas was healthy. **Respiratory system:** The larynx and trachea were normal. Each pleural cavity contained some adhesions, and between these there was some serous fluid. The lungs were engorged and very oedematous, particularly at the bases, but were otherwise healthy. There were a few subpleural haemorrhages. The trachea and lungs smelt of the offending material. **Brain and meninges:** Congested. **Bladder:** This viscus contained 6 oz. of cloudy urine. **Histology:** The liver tissue was histologically normal and the lungs showed acute congestion and oedema, particularly at the bases.

The bottle from which the deceased was seen to drink was recovered, and it still contained 9 c.cm. of yellow fluid, which had exactly the same smell as the stomach contents and lungs. It was

obvious that it was the toxic agent responsible for his death. This fluid and the contents of the stomach and bowel, together with the liver, lungs, brain, and urine, were submitted to Dr. Mabel L. Hemming of the department of chemistry, Sheffield University, who very kindly undertook their analysis. She embodied her results in the following report:

"The original liquid was distilled and the boiling-point of the bulk corresponded to that of symmetrical tetrachlorethane: there was evidence of about 1 c.cm. (in a total volume of 9 c.cm.) of the lower-boiling isomer, unsymmetrical tetrachlorethane.

Symmetrical tetrachlorethane;
B.P. 147° C. (normal pressure).

Unsymmetrical tetrachlorethane;
B.P. 129–130° C. (normal pressure).

"A Carius estimation for chlorine on the distilled liquid indicated that it was probably 98% pure tetrachlorethane. Three estimations gave the following figures for the percentage chlorine in the liquid: 80.83, 81.27, 80.90, and the theoretical value for pure tetrachlorethane is 82.57%.

"Each of the samples supplied was treated in the following manner. The sample was minced up when necessary, and distilled in steam. When the liquid distilling over was no longer turbid distillation was discontinued and the steam distillate extracted with ether. The ether extract was dried over sodium sulphate and then the ether was distilled off through a Widmer column. The residue was analysed for chlorine by the Carius method, and hence the tetrachlorethane in the various parts could be calculated. The results are as follows: Stomach contents, 2.134 g.; liver, nil; lungs, 5 mg.; bowel contents, 1.47 mg.; brain, nil; urine, 4.32 mg. A blank Carius estimation was done and no measurable amount of chlorine found, suggesting that, although some of the above figures are very small, they are probably real."

Comments

Tetrachlorethane poisoning occurs as a chronic condition in which absorption takes place through the lungs or skin, and death is due to acute yellow atrophy of the liver. When seen in the acute form the poison is absorbed from the alimentary canal, and death results from central respiratory paralysis. The case reported above is similar to the two cases previously recorded by Elliott and Hepple. The results of the analysis support the view that excretion occurs partly by the lungs and partly in the urine. It will be noted that only relatively small amounts of the drug were recovered by analysis, but of course no estimation was made of the quantities in the blood, cerebrospinal fluid, muscles, etc. In addition, during the six hours which elapsed between ingestion and death an appreciable quantity of the material would have been excreted in the breath. I find it impossible, therefore, to estimate what the fatal dose was in this particular case, and unless the volume ingested is known I do not see how this would ever be possible with any degree of accuracy.

Summary

The clinical and pathological aspects of acute and chronic poisoning by tetrachlorethane are discussed.

Two previous cases of acute poisoning are reviewed and a further similar case reported.

My thanks are due to Dr. J. R. Grimoldby, resident surgical officer at the Royal Hospital, Sheffield, who supplied the clinical details reported, and to Dr. Mabel L. Hemming, of the chemistry department of Sheffield University, who undertook the analysis of the organs.

REFERENCES

- Browning, E. (1937). *Med. Res. Cncl., Industr. Hlth. Res. Brd. Rep. No. 80*, p. 186, London.
Elliott, J. M. (1933). *J. R.A.M.C.*, **60**, 373.
Hamilton, A. (1934). *Industrial Toxicology*, p. 212, Harper Brothers, New York.
Hepple, R. A. (1927). *J. R.A.M.C.*, **49**, 442.
Minot, A. S., and Smith, L. W. (1921). *Arch. intern. Med.*, **28**, 687.
Oettingen, W. F. von (1937). *J. industr. Hyg.*, **19**, 399.
Parmenter, D. L. (1920–1). *Ibid.*, **2**, 456.
Rolleston, H. (1922). *British Medical Journal*, **2**, 1056.
Schwander, P. (1936). *Arch. Gewerbepath. Gewerbehyg.*, **7**, 109.
Spilsbury, B. H. (1917). *Proc. roy. Soc. Med.*, **10**, 41.
Willcox, W. H. (1915). *Lancet*, **1**, 544.

According to G. F. Dick and C. W. Eisele (*J. Amer. med. Ass.*, 1942, **118**, 21) the rate of healing of peptic ulcer under oral treatment with milk and cream, without the use of alkalis, compares favourably with other methods of treatment. They state that it is only the exceptional case in which recovery does not take place without alkali treatment.