MEDICAL PRACTICE

*Medical History***Vitamin A and Sir Douglas Mawson**

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The era of Antarctic exploration at the turn of this century was overshadowed by the deaths of Scott, Wilson, and Bowers only 11 miles from food at One Ton Depot on 29 March 1912. Their bodies were found on 12 November 1912. Two days earlier, a thousand miles away on the ice of Adelie land, three members of the Australian Antarctic Expedition had left their winter quarters on a programme of exploration and scientific observation which was to claim for the Crown a large area of the continent. Sir Douglas Mawson, aged 30, leader of the expedition (fig 1), survived against incredible odds; Lieutenant Ninnis, aged 23, and Dr Xavier Mertz, aged 28, died. The facts were given by Mawson in his diary and in his book *The Home of the Blizzard* first published in 1915.¹ The description is terse and low key, perhaps the product of a Yorkshire parentage and birth and a tough physical training in the bush of South Australia. Mawson died in 1958. A decade later research at the University of Adelaide showed that Mertz and Mawson suffered hypervitaminosis A from eating the livers of husky dogs. This article analyses Mawson's illness further and places his incredible journey in perspective.

FIG 1—Sir Douglas Mawson.

The outward journey

The outward journey of the Australian Antarctic Expedition lasted for 33 days from 10 November to 14 December (fig 2). There were three sledges pulled by dogs; the explorers travelled on foot or occasionally on skis. Progress was slow because of the uneven surface of the ice ridges which occurred every few feet, the many crevasses, and high winds. They would travel in winds of up to 40 mph (64 kph) (called a "breeze" by Mawson) and temperatures ranging from freezing point to -6°F (-21.1°C). They were physically fit, for Mawson describes how he jogged for two and a half miles (4 km) in front of the leading sledge. The sledges capsized many times on steep slopes and there were several episodes when they fell partly into crevasses. It is therefore surprising that Mawson made his one fatal mistake.

One sledge had been abandoned earlier because of their ability to lighten the load as supplies were consumed. On 14 November nearly all the food was packed together on the rear sledge in readiness for leaving it behind for the return journey, while a final effort was made to extend the explored distance. Mawson reasoned that the lead sledge, pulled by the weaker dogs, would come to grief first if a snow bridge collapsed into a crevasse. In fact the second sledge, pulled by the stronger team of dogs, together with Ninnis, who was walking beside it, dropped without a sound into a crevasse. One dog with a broken back could be seen lying on a ledge 150 feet (46 m) down, but Ninnis, the dogs, and the sledge had gone for ever. In his diary (all the following quotations are from Mawson's diary, unless shown otherwise) Mawson summarised their plight:

Reviewed our position—practically all the food has gone down—spade, pick, tent—Mertz's Burberry trousers and helmet, cups, spoons, mast, sail etc. We had our sleeping bags, a week and $\frac{1}{2}$ food—the spare tent without poles—and our private bags and cooker and kerosene. The dogs in my team were very poorly and the worst and no feed for them—the other team comprised the picked dogs, all dog food and almost all man food. We considered it a possibility to get through to winter quarters by eating dogs—so 9 hours after the

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accident started back but terribly handicapped. . . . May God Help us.

They were 315 miles (507 km) from the hut.

Death of Mertz

Xavier Mertz died 23 days later. During the 23 days they travelled 200 miles (322 km) and each consumed, on Mawson's estimate, about 14 ounces (400 g) of food per day, in contrast to the "normal" ration of 34 ounces (960 g) of dried food. Much

FIG 2—A camp site of the expedition.

of the 14 ounces was made up of dog meat, however, which had to be eaten as each dog died. From 15 to 28 December six dogs were killed and eaten, although some meat was retained by Mawson and eaten later. Some parts were fried and others stewed or made into soup. The liver was eaten: "It was a happy relief when the liver appeared, even if little else could be said in its favour, it was easily chewed and demolished."² In contrast to the outward journey, the sledge was pulled by Mertz and Mawson: weak and dying dogs were carried until they were killed and eaten.

On 30 December Mawson commented in his diary on Mertz: "Xavier off colour." In his book he enlarged: "I suddenly became aware that Mertz was not as cheerful as usual. I was at a loss to know the reason, for he was always such a bright and companionable fellow"¹; on the next day, "keeping off dog meat for a day or two as both upset by it." It is made clear in the book that Mertz made this suggestion because he was the more affected. On 1 January the weather was bad and they decided to rest. "[Mertz] admitted that he had pains in the abdomen. As I had a continuous gnawing sensation in the stomach, I took it that he had the same, possibly more acute."¹ Between 1 and 6 January Mertz was very weak and only a few miles were covered.

On 3 January, "Mertz had suddenly developed dysentery."² On 6 January, "I think he has a fever—he does not assimilate his food." "He appeared to be depressed."¹ "He was troubled from time to time with recurrences of dysentery and had no power to hold in his stomach the broth which he was prevailed upon to swallow at intervals."² At the same time both were suffering from peeling skin and loss of hair; the skin on Mawson's ears came off in casts. Both lost all skin from their legs and genitals. At 8 am on 7 January Mawson was desperate to move on, but Mertz was too weak and suffered faecal incontinence. Two hours later "I . . . find him in a kind of fit. Coming round a few minutes later, he exchanged a few words and did not seem to realise that anything had happened."¹ Mertz deteriorated

through the day with incontinence, fits, delirium, and raving. He died at 2 am on 8 January.

Mawson's illness: the final 100 miles

When Mertz died Mawson realised his own predicament:

My physical condition was such that I felt I might collapse at any moment. The gnawing in the stomach had developed there a permanent weakness, so that it was not possible to hold myself up in certain positions. Several of my toes commenced to blacken and fester near the tips and the nails worked loose.

Outside the blizzard raged, and he realised that he would not have the strength to break and pitch the tent singlehanded under these conditions. He remained in the tent; to reduce his load, he cut the sledge in half with a penknife (fig 3) and abandoned all but the bare necessities; he made a sail for the sledge and on 11 January he marched.

From the start my feet felt lumpy and sore. They had become so painful after a mile of walking that I decided to make an examination of them on the spot. . . . The sight of my feet gave me quite a shock, for the thickened skin of the soles had separated in each case as a complete layer. . . . The new skin underneath was very much abraded and raw. I did what appeared to be the best thing under the circumstances: smeared the new skin with lanoline . . . and with bandages bound the skin soles back in place.

He marched on. That night he noted: "My whole body is apparently rotting from want of proper nourishment—frost-bitten fingertips festering, mucous membrane of nose gone, saliva glands of mouth refusing duty, skin coming off whole body." With bad weather, progress was slow and on 14 January he noted that 82 miles (132 km) remained to be travelled to the ice cave that had been dug five miles (8 km) from winter quarters. His rations were meagre and he continued to eat dog meat. On 17 January, in a state of great weakness, he faced death: trudging onwards in falling snow he tumbled into a crevasse to hang on the rope 14 feet (4 m) from the surface; he was held by the weight of the sledge stuck in the snow. In the deep-freeze of the crevasse, with his strength ebbing away, he

FIG 3—Mawson's sledge after he had cut it in half.

struggled to climb the rope only to fall in again when he reached the mouth of the crevasse. He climbed out at the second attempt. Exhausted, he pitched his tent, lay in his bag, and constructed a rope ladder from an alpine rope so that he could climb out of the next crevasse. He was indefatigable.

He reduced his rations on 18 January and noted: "Several festerings broken out again." On 19 January "I took off all clothes to get at boil on leg and stuck it." Again he struggled on through exhaustion, soft snow, ice fields, and blizzards that capsized his sledge. Usually he travelled three to four miles (5-6.5 km) per day. He continued to shed skin, and his hair fell out in handfuls. On 29 January, 21 days after Mertz's death, exactly on course, he found a food cache left by the rescue party 21 miles (34 km) from the ice cave. He reached

base camp 10 days later on 8 February. He weighed 8 stone (51 kg) compared with his normal weight of 15 stone (95 kg).

Subsequent comment on his health was sparse, but clearly all was not well. On the day of arrival he commented: "My internals overthrown—legs swollen, etc," and three days later, "My legs have now swollen very much." On 23 March he wrote: "I find my nerves are in a very serious state and from the feeling I have in the base of my head I suspect that I may go off my rocker very soon," and even after a further two months, "I have a boil on left temple forming. Am quite down in general health." On 30 July he was suffering a boil on the right side of his face.

Hypervitaminosis A

A dose of vitamin A of 1 000 000 IU or more is likely to produce acute toxic symptoms; this could be contained in as little as 100 g of husky dog liver, although up to 400 g might have to be eaten to obtain a toxic dose because of variation between dogs.³ As suggested originally by Cleland and Southcott,⁴ Mertz almost certainly died from hypervitaminosis A. The question of scurvy does not arise, because no other member of the expedition suffered from it. Desquamation, vomiting and diarrhoea, weakness, and convulsions have been recorded after a meal of seal liver,⁵ which also contains a large amount of vitamin A; and raised intracranial pressure, resulting in headache and neurological symptoms, occurs in chronic hypervitaminosis A.^{6,7}

Most of the six dog livers were probably eaten by Mertz and Mawson, and each liver would contain many toxic doses of vitamin A. The interesting question is why Mawson did not die also: he certainly suffered from hypervitaminosis A, with desquamation, loss of hair, and weakness. Possibly Mertz ate much more of the liver; he was a near-vegetarian and the tough smelly dog meat may have been repulsive to him. Thus while Mertz and Mawson usually divided all items of food, Mertz may have found the liver less repulsive and they may have struck a "bargain" on this issue.

Mawson's illness was characteristic of the chronic form of hypervitaminosis A rather than acute vitamin A poisoning. The symptoms of the chronic condition have been recorded after only six weeks' ingestion of the vitamin,⁸ although in most cases many months of ingestion are required. Hillman⁹ induced symptoms of chronic intoxication on two occasions by giving 1 000 000 IU daily for 14 and 25 days. While desquamation occurs in both acute and chronic cases, persistent skin infections are a feature of the chronic form.⁷ Mawson was troubled with boils for the following six months. Some of the clinical features of chronic vitamin A poisoning are now known to be due to induced liver disease. Patients suffer hepatomegaly. Vitamin A is stored in the Ito cells that line the hepatic sinusoids; an increase in the size of these cells narrows the lumen of the sinusoids, and there is also considerable perisinusoidal fibrosis.¹⁰ Portal hypertension leading to ascites then develops, and raised liver enzyme concentrations without jaundice and hypoalbuminaemia are well documented. Presumably these features resolve slowly once the vitamin A is mobilised, as the hepatomegaly disappears after several months.

Initially Mawson had abdominal pain related to posture, which might have been due to a swelling liver, and on returning to base camp he developed pronounced swelling of the legs, although there was no mention of ascites. This peripheral oedema might have been due to either starvation or liver dysfunction. During the subsequent months, however, he mentioned weakness, headache, nervous symptoms, sleep disturbance, and urinary symptoms—all features of chronic vitamin A intoxication.⁷ Most difficult to explain is the diarrhoea, which persisted for two months. His prolonged poor general health and slow recovery was in keeping with features in other recorded cases of chronic intoxication.

Personal reflections

In the words of Sir Edmund Hillary, Mawson's was "probably the greatest story of lone survival in Polar exploration."¹¹ Indeed Mawson's survival would have been remarkable even if he had not had a painful and debilitating illness. To those of us who have savoured, however transiently, the Alpine blizzard and crevasse, the story is stunning.

One cannot help comparing the expedition with that of Scott, who had in fact wanted Mawson in his team. With Mawson's organisational ability and unique improvisation, that story might have been different. The psychology of the two expeditions also bears comparison: Scott was defeated in his prime aim, which must have affected the high morale necessary to keep going. Mawson, on the other hand, was a scientist and he drove himself to deliver his wealth of scientific observations. On 9 January 1913 he wrote in his diary: "As there is little chance of my reaching human aid alive, I greatly regret my inability to set out the coastline as surveyed for the 300 miles we travelled and the notes on glaciers and ice formations etc—the most of which latter is of course committed to my head." Finally, with the recent publication of *This Accursed Land* by Lennard Bickel,¹¹ adequate recognition of Sir Douglas Mawson, scientist and explorer, is at last underway. He was a great Australian.

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References

- 1 Mawson, D, *The Home of the Blizzard: Being the Story of the Australasian Antarctic Expedition, 1911-1914*. London, Heinemann, 1915.
- 2 Mawson, D, in *The Home of the Blizzard*, 6th edn. London, Hodder and Stoughton, 1938.
- 3 Southcott, R V, and Chesterfield, N J, *Medical Journal of Australia*, 1971, **1**, 311.
- 4 Cleland, J, and Southcott, R V, *Medical Journal of Australia*, 1969, **1**, 1337.
- 5 Cleland, J B, and Southcott, R V, *Medical Journal of Australia*, 1969, **1**, 760.
- 6 Stimson, W H, *New England Journal of Medicine*, 1961, **265**, 369.
- 7 Muentner, M D, Perry, H O, and Ludwig, J, *American Journal of Medicine*, 1971, **50**, 129.
- 8 Shaw, E W, and Niccoli, J Z, *Annals of Internal Medicine*, 1953, **39**, 131.
- 9 Hillman, R W, *American Journal of Clinical Nutrition*, 1956, **4**, 603.
- 10 Russell, R M, et al, *New England Journal of Medicine*, 1974, **291**, 435.
- 11 Bickel, L, *This Accursed Land*. Melbourne, the MacMillan Company of Australia Pty Ltd, 1977.

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ONE HUNDRED YEARS AGO Every good thing is liable to spurious imitations. The provident dispensaries which are now being multiplied all over the country, to the advantage both of the poor and the medical profession, are being followed by a plentiful crop of "shilling dispensaries." The latest example of this class of dispensaries to which out attention has been drawn, is at Dorchester. From a recent number of the *Dorset County Chronicle*, we learn that "Mr E J Day, surgeon, has opened an institution of this useful and commendable character at his residence on Fordington Green." The third rule states that, "by paying 1s. when patients attend the first time in each week, advice will be given, and one, two, or three bottles of medicine, as the case may require, provided the three visits are within the seven consecutive days." The fourth rule informs us that "all pills will be coated, in order to render them perfectly tasteless." The eighth rule states that "maternity cases are attended in Dorchester and Fordington for 7s. 6d." The tenth rule says: "The fee for removal of a tooth is 1s.; but, on payment of 2s. 6d., it will be extracted without pain by means of laughing gas (nitrous oxide)." The fewer that we have of these "useful and commendable" institutions the better. They are sure to degrade the medical profession, and to pauperise the patients. We wonder that Mr E J Day is not afraid that all the old women in Dorchester who attend midwifery cases will rise up against him for infringing their prerogative. (*British Medical Journal*, 1878.)