Faulty sausage production causing methaemoglobinaemia

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Abstract
A family outbreak of methaemoglobinaemia following ingestion of sausages made using 'saltpetre' is reported. Saltpetre is a generic term for several potassium and sodium based compounds. On this occasion imprecise ordering led to the use of sodium nitrate rather than the usual potassium nitrate, with extremely serious consequences.

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Case report
Two previously well boys (10 and 14 years) presented as an emergency with a two hour history of increasing headache, dizziness, nausea, and pallor. Their 19 year old brother was taken to a neighbouring hospital with similar though more severe symptoms. Their father (a kosher butcher) said they had all eaten a new batch of his sausages two hours earlier.

The examination findings were similar for both children, who had profound central cyanosis, patent airway, good air entry bilaterally, normal respiratory rate, and normal breath sounds. The oxygen saturation in air was 70–80% and improved to only 85% in 15/min oxygen. Both children were tachycardic with a capillary refill time greater than 3 seconds. They were alert with normal posture and pupillary reactions.

Central cyanosis in the absence of significant cardiovascular or respiratory distress, together with a poor response to high flow oxygen led to a clinical diagnosis of methaemoglobinaemia.

Investigation results of the 10 year old who had eaten four sausages were as follows: pH 7.42, carbon dioxide tension 4.3 kPa, oxygen tension 48.9 kPa, base deficit −1.2, bicarbonate 24 mmol/l, methaemoglobin 40.5% of total haemoglobin. The results of the 14 year old who had eaten three sausages were similar (methaemoglobin 34.5%).

Each child received a bolus of methylene blue (1 mg/kg over 10 minutes), and of colloid (20 ml/kg). Ten minutes later both had oxygen saturations of 100% in air.

Their elder brother who had eaten 10 sausages was hypotensive and confused on arrival at a neighbouring hospital and so was paralysed and ventilated. His methaemoglobin level was 45%. He required two doses of methylene blue to correct his oxygen saturation. Despite initial evidence of cerebral oedema secondary to a hypoxic insult (short generalised seizure and hypertension) he made a full recovery following elective ventilation for 48 hours.

An investigation by the environmental health department ensued. The sausages had been marinated in 'saltpetre' several days before consumption. This is used as a preservative and colouring agent.1 The children's father used a new supply of saltpetre to make this batch of sausages, and had been concerned about its quality, as the meat turned green rather than the usual red colour. Saltpetre is a generic term for several potassium or sodium based compounds. The form used in catering is usually potassium nitrate. However, laboratory analysis of the saltpetre used in these sausages revealed 50% sodium nitrate and 50% sodium nitrite. High concentrations of both compounds were found in the sausages. The order for the saltpetre had been made verbally with the normal supplier and had not specified the exact compound required. The supplier had potassium nitrate and sodium nitrate/nitrite in stock, both of food grade quality. The three boys had been the only people who had eaten the sausages.

Discussion
Acquired methaemoglobinaemia is the result of an overload of oxidant. The ferrous iron in deoxyhaemoglobin is oxidised to ferric iron. The resulting methaemoglobin molecule is incapable of binding oxygen, in effect reducing the oxygen carrying capacity of the blood. Naturally occurring methaemoglobin is reduced to haemoglobin by NADH cytochrome-b5-reductase (NCR) enzymes. Levels greater than 1–2% are considered abnormal. Infants have lower NCR activity than children or adults and are therefore at higher risk of developing methaemoglobinaemia.2

Symptoms and signs such as headache, lethargy, tachycardia, hypotension, and cyanosis occur with levels greater than 15%, and levels over 70% are generally fatal. The patients appear pale and deeply cyanosed but are often paradoxically alert and unperturbed (one of our casualty staff described the boys as the 'living dead'). The cyanosis is out of keeping with the degree of cardiovascular or respiratory distress and there is only a limited response to high flow oxygen. The spectral properties of methaemoglobin are different from those of deoxy- and oxyhaemoglobin, and it interferes with pulse oximeter readings which are characteristically very low or unrecordable. However, the arterial blood gas partial pressure of oxygen...
is usually very high because of high flow oxygen therapy.\(^2\)

In addition to intravenous fluids and high flow oxygen treatment, intravenous methylene blue (1–2 mg/kg given over five minutes) is recommended for those with methaemoglobin levels over 20–30%. Early recognition and prompt treatment usually leads to a full recovery. Severe cases may improve with hyperbaric oxygen or exchange transfusion.\(^2\)\(^3\)

Nitrates and nitrites can both cause methaemoglobinaemia but nitrites are more toxic as they have greater oxidative potential. Methaemoglobinaemia in children has been recognised following ingestion of nitrates or nitrites in fertilisers, contaminated well water, amyl nitrite, sublingual glyceryl trinitrate, dapsone, silver polish, mothballs, industrial inks, and many other substances.\(^3\)\(^–\)\(^6\) We have found only one similar case of methaemoglobinaemia in an adult following ingestion of sausages, reported in 1967.\(^6\)

Saltpetre is used rarely now in food preservation because of the availability of cheaper alternatives, although its use as either sodium nitrite/nitrate or potassium nitrate is permitted under the provisions of the Preservatives in Food Regulations, 1989. This case highlights the need for food manufacturers to order ingredients specifically, in writing and preferably by their approved chemical name. On this occasion a verbal order for an unspecified compound resulted in confusion and the use of a potent and dangerous substance, with very serious consequences.

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