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Methemoglobinemia — A Problem

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Department of Health and Welfare

Methemoglobinemia — A Problem

E. W. CAMPBELL, Dr.P.H.*

Methemoglobinemia in infants has long been recognized in connection with congenital cardiac defects, but more recently it has been recognized as having been caused by the use of heavily nitrated drinking water.

A recent fatality, case P.L., age 2 years, in September 1959, again brought our attention to the necessity of careful investigation in every case of suspected methemoglobinemia. It was reported that a package of a commercial anti-rust preparation for radiators was found in the home and there was a suspicion that some of this had been consumed by the child, but none was made available for analysis. One hundred and ten milligrams of nitrite, estimated as sodium nitrite, was found in 75 grams of gastric content. Because of the possibility of nitrate poisoning it was also necessary to look into the source of drinking water, as a possibility, by reason of numerous reported cases of methemoglobinemia in infants from heavily nitrated well water supplies. No evidence was found that any abnormal drinking water was in use at the time of this fatality.

In view of the implications in the above case it would appear that a review of the problem of methemoglobinemia, particularly in infants, should be made and attention brought to the relative frequency of this problem from domestic water supplies which may be contaminated with human and animal wastes. There is also the possibility of it being mistaken for congenital heart defects in the newborn. A review of the literature indicates that the condition was first described in 1902 and for the purpose of refreshing memories it may be stated that it is accompanied by a condition of cyanosis. The early cases reported were mostly due to use of different types of drugs, and there has been described a rare condition associated with diarrhea in adults and possibly due to absorption of nitrites from the intestines. Early cases of methemoglobinemia in infancy has usually been associated with treatment of some form of nitrates in different types of disease. Treatment with

bismuth subnitrate for diarrhea was reported by Roe¹ in 1933 as a cause of this illness in a month-old baby.

In 1940 a different type of methemoglobinemia was reported by Schwartz and Rector,² which occurred in a two-weeks old infant in a small Montana town. This child had not been treated with any drugs, but was fed an evaporated milk mixture which presumably was diluted with well water. When admitted to the hospital a history was given of intermittent cyanosis, which suddenly had become severe. No evidence of disease of the heart or lungs was noted, but the cyanosis did not respond to the ordinary treatment with oxygen or with coramine. Intravenous treatment with 1% methylene blue resulted in a prompt recovery from the cyanotic condition. A study of the literature would indicate that this is probably the first reported case of methemoglobinemia due to well water.

Five years later Comly³ reported two cases of infant methemoglobinemia from rural Iowa, each giving a history of using milk formulae containing well water of high nitrate content.

Since that time numerous cases have been reported, with similar histories, from widely scattered areas of the United States and other countries. A special survey by the Minnesota State Department of Health revealed 139 cases in two and one-half years, with 14 deaths.⁴ Although most of these cases were caused by waters having relatively high nitrate contents, from 100 to even more, in a number of cases the nitrate content was much less. Georgia reported a case where the nitrate content was only 33 ppm.

In the State of Maine, following a complaint of a "whole family having kidney and bladder trouble," an investigation disclosed that the well water supply had a nitrate content of 12.5 ppm.

Another case in Maine, a baby born August 29, 1949, was removed from the hospital to the farm home in St. Albans on September 5. It received eight feedings a day consisting of 32 ounces of evaporated milk, Karo, and boiled water from the drilled well on the farm.

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Water was used in a ratio of 2 to 1. About 2½ ounces of boiled water was offered the infant three or four times a day between the daily feedings. Therefore, about 30 ounces of boiled well water was offered the infant each day. About a week after the baby was brought home a bluish color was noticed on the roof of its mouth, its gums, and under its finger nails. Later the bluish color was noticeable over the body. It would last for several hours and then fade. On October 9 the infant did not retain its feedings. It was a bluish color all day, the worst it had been. It was taken to a physician who advised calling a specialist. On the next day the specialist made a diagnosis of *probable* congenital heart disease, and possibly cyanosis due to nitrates in the well water. On removal to a hospital an x-ray examination was made without indicating any congenital heart condition. The formula or water feedings from October 9 to 11, except when small quantities of evaporated milk and Karo were given *without* water, were not retained. The mother took a bottle of the boiled drilled well water to the specialist's office and gave some to the infant in the office. This was vomited before the infant reached the hospital.

Soon after the infant arrived at the hospital it was given a feeding of dextrose-maltose and water from the hospital water supply. The baby retained the feeding. The bluish color of its skin gradually disappeared by the next day, October 12, and the infant was taken home on October 14. After returning home the formula for the baby was made with water from another well. The baby retained its feedings and its color remained normal. An exception occurred on October 16 when the father made the formula with water from the drilled well in question. The infant only took about a quarter ounce of the formula and refused to take more. The portion swallowed was regurgitated.

An analysis of the water from the drilled well at the farm disclosed a content of 30 ppm of nitrates, and 0.025 ppm of nitrites.

Another case was reported in Aroostook County, but before an investigation could be made, the child had been taken out of the state and further details did not become available.

A few further observations for those who are interested in rural water supplies should perhaps be made. These are based on the results of 267,000 well water analyses, many accompanied by inspection of the surroundings. At present there appears to be no means of eliminating nitrates from well water once it has entered it, excepting by removing the source. Boiling the water or treating with recognized chemicals will not remove the danger. In areas with similar geological conditions to those of Maine, removal of cesspools, stables, privies, subsoil sewage disposal beds, and similar sources of contamination, will eventually result in the disappearance of nitrates, but the process is slow and may require from three to five years to obtain an appreciable reduction, and even as much as ten or more

years for elimination of the underground contamination. This will be particularly true when the ground has been saturated by many years of barnyard, cesspool, and privy accumulations. Occasionally, heavy fertilization of the soil, in the pursuit of agriculture, may cause excessive nitrate concentrations.

Due to abnormal tastes and obscure symptoms, an investigation of a small water system serving approximately 70 people was found to have suddenly developed a high nitrate content of 17 ppm., contrasting to its normal content of about 2 ppm. The investigation disclosed that a few acres of potato land on an adjoining farm near the drilled well used as a source of supply, had been fertilized with the application of 2500 pounds of ammonium nitrate at a rate of about 200 pounds per acre. The use of the water for drinking and cooking purposes was temporarily banned. Fortunately, heavy rains shortly thereafter washed away most of the chemicals so that no serious difficulties developed. Any unusual increase in nitrates should receive prompt investigation to prevent irreparable damage.

People engaged in the business of providing domestic water supplies, in rural areas particularly, should inform themselves relating to the geology of the area and the detailed characteristics of the under-surface structures, so as to avoid unnecessary contamination of ground water supplies; also the principles of sanitary protection of shallow dug wells, drilled wells, both shallow and deep, and driven wells, so that safe water supplies will be obtained. If these principles are well understood and followed, both in location and construction, and proper installation of equipment for pumping water from such supplies, many needless cases of sickness will be prevented and much suffering avoided.

SUMMARY

Methemoglobinemia in infants, although associated with conventional cardiac defects, may also be caused by nitrates from medicinal preparations, from accidental poisoning, and from excessive nitrates and nitrites in well water supplies caused by contact with drainage from excessive fertilization of the soil, from animal organic material, from manure accumulations, and from private systems of sewage disposal.

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