NITRATE INDUCED ANAEMIA IN HOME DIALYSIS PATIENTS

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Summary

Many home dialysis patients in Florence and the surrounding area suddenly showed an unusual anaemia. All used a softener for water treatment. They demonstrated methaemoglobinemia, Heinz bodies and reduction in plasma haptoglobin indicating Hb oxidation. Tap water analysis showed excessive nitrates. The substitution of the softeners with deionisers solved this important and unusual clinical problem.

Introduction

A deterioration in the anaemia of home dialysis patients is a well known problem often due to the pollution of dialysis water. Chloramines seem to be the toxic compound most frequently found [1,2]; however, cases of severe anaemia due to nitrites or nitrates are well known [3,4]. In particular these last compounds are frequently encountered in rural areas and in home dialysis patients using well water for the dialysis treatment.

We report here an outbreak of anaemia in home dialysis patients in a large city and its surrounding area, probably due to an excessive nitrate concentration in the tap water.

Materials and methods

The present study concerns 40 home dialysis patients: 14 using deionisers and carbon filters for water treatment, and 26 using softeners and carbon filters. All patients had been on home dialysis treatment for between 8 and 48 months. All the patients were previously well with varying degrees of anaemia in relation to their renal failure.

In all patients blood counts, serum iron, serum haptoglobin, methaemoglobin (by spectroscopic method), and erythrocyte Heinz bodies (in blood smears)
were regularly measured. In the dialysis water we repeatedly checked: chlorine, chloramines (by DPD colorimetric method), nitrates, nitrites, and trace elements such as copper, lead, and zinc (by atomic absorption). Nitrates were estimated by U.V. spectrometric examination at 210nm.

Results

In the summer of 1983 during a serious water shortage we observed an important and significant deterioration in the anaemia of 26 patients on regular home dialysis in Florence and surroundings. All patients used softeners for water treatment. We did not observe any change in the anaemia of 14 patients who used deionisers (Figure 1). Together with the worsening of the anaemia we observed

![Figure 1. Mean haematocrit values during 1983](image)

the presence of methaemoglobin in the blood, of Heinz bodies in the erythrocytes and a significant decrease of haptoglobin (Figure 2).

Water analysis repeatedly showed no chlorine, chloramines or toxic trace
elements but in many cases we observed a nitrate concentration exceeding the maximum safe standards proposed by AAMI [5,6].

Nitrate concentration in the water was most severe in rural areas and in those parts of the city where well water was added to tap water, usually during dry spells (Figure 3).
Figure 4. Mean haematocrit changes (percentage) during the last two years

The substitution of the softeners with deionisers solved the clinical problem with a sudden increase of haematocrit, the disappearance of methaemoglobin and Heinz bodies and with a return to normal of the haptoglobin values (Figures 1 and 2). Further, we observed haematocrit values more than exceeding the mean values previously observed in the same patients (Figure 4).

Discussion

Our results show that during the summer of 1983, at the same time as an unusual water shortage in our country, many home dialysis patients who used softeners for the water treatment had a serious worsening of anaemia. This was not the case in patients using a deioniser.

The serum methaemoglobin (always absent in patients with deionisers), the presence of Heinz bodies and the decrease (sometimes total disappearance) of haptoglobin in the blood is evidence of an oxidation and denaturation of haemoglobin with subsequent lysis of the erythrocytes [7], events frequently ascribed to the presence of chlorine or chloramines in tap water: in only a few cases have nitrates or nitrites been found in well water. The repeated analysis of tap water suggests that in our patients the presence of nitrates may have been responsible for these clinical problems. The concentration of nitrates, even if lower than those described in some serious intoxications, were often higher than the suggested maximum values of the American National Standard of AAMI.

Softeners are ineffective for nitrate removal, so high values in the dialysate water supply might exert a chronic toxic effect on the erythrocyte production of our patients.

Three points confirm such a hypothesis:

1. The presence of methaemoglobin and Heinz bodies and the reduction in plasma haptoglobin were found only in patients with softeners. No abnormal
finding was present in patients with deionisers. The abnormal amounts of methaemoglobin, even if not very high, are probably due to two main causes. First our blood samples always refer to the interdialytic period when most of the haemoglobin will have been reduced by enzymatic systems [8]; second, we think that in most of our patients a chronic rather than an acute illness, happened due to the abnormal, even if not very high, nitrate values.

2. The substitution of the softeners suddenly solved the clinical problems. The mean haematocrit of the patients reached values 30 per cent higher than the mean preceding value. In our opinion this means that some toxic substance not extracted by the softeners steadily produced a worsening of anaemia in our patients. Such compounds are in higher concentration during the summer but probably are always present in other months.

3. The water analyses show that nitrates, more than other substances, may have caused these problems.

We consistently found no chlorine, no chloramines, no toxic trace elements except for nitrates and, in two patients also nitrites. We found higher nitrate concentrations in rural areas, where they are probably due to the use of fertilisers. Dangerous nitrate values were also found in some areas of the city where, usually in dry times, some well water is added to tap water. In such instances we think that nitrates may have come from waste seepage into well water.

Conclusion

In our opinion three main points arise from these observations:

1. In dialysis great attention must be paid to water quality. Probably concentrations of solutes even slightly higher than those proposed by AAMI may be dangerous over long periods.

2. Water treatment is better with deionisers or reverse osmosis than with softeners.

3. The reduced quality of the environment causes water pollution so that the tap water of a large city may be dangerous for dialysis treatment.

References

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