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ORIGINAL ARTICLE

Evaluation of 6 years use of sodium hydroxide solution to clear partially occluded central venous catheters

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Summary
Background & aims: Central venous catheter occlusion is a frequently occurring complication during home parenteral nutrition (HPN). The aim of the study was to investigate the effectiveness of sodium hydroxide (NaOH) administration to clear an occluded central venous catheter especially in HPN.
Method: Retrospective study to the use of NaOH in partially occluded central venous catheters. About 45 patients with HPN treated in the Academic Medical Center of the University of Amsterdam (AMC) were included in this study between January 1997 and April 2003. Excluded from the study were patients under the age of 18 at the start of HPN and/or patients who use parenteral nutrition for less than 3 months. Partial catheter occlusion was defined as a spontaneous flow less than 60 drops/min.
Results: In total, 130 occlusions were registered in 29 HPN patients. The other 16 HPN patients did not report any occlusion. The incidence of occlusions in fat containing total parenteral nutrition (TPN) was 1 occlusion in 167 feeding days. TPN without fat showed only one occlusion (incidence 1 in 7126 feeding days). The use of a lipid emulsion proved an important risk factor for catheter occlusion in this study ($P<0.05$, RR = 43).
Ninety-five central venous catheter occlusions were treated with NaOH 0.1 M. The remaining occlusions were total or mechanical occlusions making NaOH treatment impossible. In 73 out of 95 partial occlusions treatment with NaOH was effective ($P<0.05$). Using NaOH extended the use of 32 catheters (range 7–1592 days, mean 328). Twenty-one out of 32 catheters could be used for more than 3 months after using NaOH ($P<0.05$).

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Conclusion: We conclude that perfusion of a partial occluded central venous catheter (defined as 25–60 drops/min) used for parenteral nutrition with 0.1 N NaOH is safe and shows a significant long term improvement in catheter care, by preventing total occlusion and operative removal.

Introduction

Central venous catheter occlusion is a frequently occurring complication during home parenteral nutrition (HPN).[1] It is the most common non-infectious complication observed in long-term central venous access devices. Occlusion is a complication that often necessitates the removal of the catheter, thereby interrupting treatment and exposing the patient to the risks associated with new catheter placement.[2] Occlusion in central venous catheters can be caused by thrombus formation, lipid deposition or drug precipitation. When the occlusions are caused by thrombosis, Urokinase® is the most frequently used drug to clear the catheter from the thrombus.[1–7] When the occlusion is caused by the lipids or calcium in the parenteral nutrition hydrochloric acid (HCl) and ethanol are usually used.[1–3,5,8]

In 1993, ter Borg et al.[1] described a method to treat gradual occlusions by using a protocol involving 0.1 M sodium hydroxide (NaOH). We introduced this method after disappointing results in our home HPN program of clearing partially occluded catheters with HCl or ethanol. ter Borg et al. hypothesized that reflux of small amounts of blood into the catheter sooner or later will cause deposition of fibrin on the catheter's inner surface. When this is followed by total parenteral nutrition (TPN) infusion, lipid micelles are trapped in the fibrin. For dissolution of such a substance, the solvent should act on both proteins and lipids. Only NaOH meets these criteria. Intravenous administration of NaOH is not hazardous if done slowly. Blood pressure, pulse and temperature remained stable during the infusion. No other side effects such as catheter degeneration or laboratory abnormalities were either observed or mentioned by the patients.

So far the effects of this protocol have not been studied in detail. In this article, we evaluate the incidence and treatment of occlusion using NaOH over a period of 6 years in patients who received HPN for more than 3 months.

Materials and methods

Clinical information was collected retrospectively. The results were statistically evaluated using χ^2 testing (null hypothesis: treatment does not result in an increase in flow).

Partial catheter occlusion was defined as a spontaneous flow of less than 60 drops/min counting the flow by the drop speed. Several patients use pumps for their IV nutrition. If they feel resistance when cleaning the line, they start the IV flow count method by gravity. They connect a bag of 100 ml NaCl 0.9% to the catheter with an ordinary infusion flow system. They open the clamp and let the NaCl solution a free flow while counting the drops.

We define occlusion as a gradual reduction of the flow rate. The cut off point of 60 drops/min was chosen by us based on experience and effective in prevent further problems such as complete occlusion. No references concerning this subject were found in literature. A sudden occlusion is caused by malposition or trombosis and cannot be resolved using the NaOH protocol. Patients with complete occlusion (flow $<$ 25 drops/min) were considered ineligible.

Partial occlusion was treated as follows: before injection of NaOH, the catheter was thoroughly evaluated to eliminate mechanical occlusion and malposition. The catheter was perfused with 10 ml of sterile and pyrogen-free 0.1 M NaOH solution at a rate of 1 ml/h for 10 h followed by a 2-h lock. Rinsing was initiated by perfusion with 0.9% NaCl at the same speed for 3 h after which a quick flush of 20 ml of 0.9% NaCl was given. Following this, all external connections were renewed and 500 ml of 0.9% NaCl was given. Flow rate was measured and if it was not sufficiently improved (still below 60 drops/min) the above-mentioned procedure was repeated with a maximum of two extra procedures. This procedure takes a full day and if the patient is totally dependent on IV fluids and at risk of dehydration a peripheral IV line can be used to administer fluids during the procedure.

Patients receive once a week TPN with a shelflife of 8 days produced in our pharmacy and based on the following standard ingredients: 750 ml 40% glucose (300 g glucose), 500 ml 20% Intralipid® (100 g fat), 1000 ml Vamin® 18 (112 g protein). The glucose solution also contains electrolytes; 100 mmol sodium, 50 mmol potassium, 5 mmol calcium and 4 mmol magnesium. About 7.5 mmol phosphate included in the TPN comes from the lipidemulsion. Vitamins (Vitintra adult®, Soluvit®) and trace elements (Addamel®) are added to all bags. Changes to this standard prescription are made if the patient's condition warrants it. E.g. fat infusion is withheld when liver function is disturbed and serum calcium, magnesium, phosphate or potassium levels are corrected by adding more or less of these electrolytes to the solution. The formulation is regulary tested for stability and particle size at the Uppsala plant of Fresenius Kabi. These tests provide us with a stability range for all electrolytes to be sure the formulation will not harm the patient and the catheter. The stability range for calcium is 0–20 mmol/bag, for magnesium is 0–12 mmol/bag, for potassium 0–37.5 mmol/bag. If more than one electrolyte is needed in increased amounts we prefer to give extra electrolytes separate to the patient, before or after the TPN. We train the patient to rinse the catheter always thoroughly when using different fluids after each other.