Local warming and insertion of peripheral venous cannulas: single blinded prospective randomised controlled trial and single blinded randomised crossover trial

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Abstract

Objective To determine whether local warming of the lower arm and hand facilitates peripheral venous cannulation.
Design Single blinded prospective randomised controlled trial and single blinded randomised crossover trial.
Setting Neurosurgical unit and haematology ward of university hospital.
Participants 100 neurosurgical patients and 40 patients with leukaemia who required chemotherapy.
Interventions Neurosurgical patients' hands and forearms were covered for 15 minutes with a carbon fibre heating mitt. Patients were assigned randomly to active warming at 52°C or passive insulation (heater not activated). The same warming system was used for 10 minutes in patients with leukaemia. They were assigned randomly to active warming or passive insulation on day 1 and given alternative treatment during the subsequent visit.
Main outcome measures Primary: success rate for insertion of 18 gauge cannula into vein on back of hand. Secondary: time required for successful cannulation.
Results In neurosurgical patients, it took 36 seconds (95% confidence interval 31 to 40 seconds) to insert a cannula in the active warming group and 62 (50 to 74) seconds in the passive insulation group (P=0.002). Three (6%) first attempts failed in the active warming group compared with 14 (28%) in the passive insulation group (P=0.008). The crossover study in patients with leukaemia showed that insertion time was reduced by 20 seconds (8 to 32, P=0.013) with active warming and that failure rates at first attempt were 6% with warming and 30% with passive insulation ($P < 0.001$).
Conclusions Local warming facilitates the insertion of peripheral venous cannulas, reducing both time and number of attempts required. This may decrease the time staff spend inserting cannulas, reduce supply costs, and improve patient satisfaction.

Introduction

Insertion of intravenous cannulas is probably the most commonly performed invasive medical procedure. Insertion is usually technically easy and causes patients only mild distress, but sometimes it is problematic and time consuming.[1] Cannula insertion is notoriously difficult in intravenous drug users and patients having repeated courses of chemotherapy. Once an initial attempt has failed, nearly all patients experience a degree of sympathetic activation that makes subsequent attempts increasingly difficult.

To facilitate insertion the hand and lower arm can be warmed with various techniques such as wrapping in towels moistened with hot water[2] or immersing in hot water. Carbon fibre resistive heating has been used for warming patients before admission to hospital and before and after operations.[3 4] We developed a special "warming mitt" designed to warm the hand and lower arm (see bmj.com). We examined whether such warming speeds venous cannulation and improves success rates.

Methods

We initially studied 100 neurosurgical patients who had a physical status score of 1 or 2 (healthy or mild and well controlled systemic disease, American Society of Anesthesiologists) in a parallel group trial. Then we carried out a crossover trial in patients with leukaemia who were scheduled for at least two sessions of chemotherapy, at least one week apart.

Protocol

A carbon fibre warming mitt (Thermamed, Bad Oeynhausen, Germany), consisting of a carbon fibre resistive heating element covered with cloth, was placed over the left hand and forearm of the neurosurgical patients in the preoperative area. The mitt is closed on three sides, leaving the fourth side open for insertion of the cannula.

Participating neurosurgical patients were randomly assigned to passive warming (mitt not heated) or to active warming (mitt warmed to 52°C). The mitt was removed after 15 minutes and patients were asked to clench the hand. A tourniquet was then applied 10 cm proximal to the wrist and the patient relaxed his or her hand. A nurse anaesthetist, blinded to treatment group, then attempted to insert an 18 gauge cannula into a vein on the back of the left hand. The nurse anaesthetist was not otherwise involved in the study and was not

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told that local warming was the basis for our hypothesis. The same nurse anaesthetist attempted all cannulations.

In the patients with leukaemia the warming mitt was positioned over the hand and lower arm for only 10 minutes as the physician in charge of the ward would not permit a longer delay. This allowed us to determine if a shorter and therefore more practical period would be adequate. Patients were initially randomly assigned to either passive insulation (mitt not heated) or to active warming (mitt warmed to 52°C); the alternative treatment was then applied at their next chemotherapy visit. A resident in haematology, blinded to treatment, then attempted to insert an 18 gauge cannula using the same procedure as described above.

Measurements

We measured the time from the start of searching for an appropriate vein (after the tourniquet was applied) to successful insertion of the cannula. Successful cannulation was confirmed by administration of a crystalloid solution without any signs of infiltration. Likewise, we recorded the number of failed first attempts. We examined the treated hand and arm for burns or skin irritation after the cannula had been inserted. We asked the neurosurgical patients if they had experienced any thermal discomfort related to the treatment.

Results

Neurosurgical patients

The success rate for insertion of the intravenous cannula was 94% (44/50) in the active warming group versus 72% (36/50) in the passive insulation group (P=0.008). Cannula insertion took about half as long with active warming (36 seconds (95% confidence interval 31 to 40 seconds) versus 62 seconds (50 to 74 seconds), P=0.002). We did not observe any skin irritation nor did any patients report any discomfort.

Patients with leukaemia

We enrolled 42 patients with leukaemia. Two failed to return for their subsequent course of chemotherapy or declined to participate further in the study; both had initially been assigned to passive insulation. Thus 40 patients completed both study days. Only these patients were included in the data analysis.

On the day patients were assigned to active warming, the success rate for insertion of the cannula in these patients was 95% versus 73% in the passive warming group (P < 0.001). The time elapsing from beginning to search for an appropriate vein until successful cannulation was 20 seconds (8 to 32) shorter with active warming than with passive insulation (P=0.02). We did not observe any skin irritation.

Discussion

Percutaneous intravenous cannulation is usually rapid, but because the procedure is so common even modest reductions in the time required could be clinically important. Cannulation is easier when the veins are more visible and this can be helped by warming the hand, having the arm hanging down, applying tourniquets, and tapping the site. In our patients local warming of the hand with a carbon fibre warming increased vein size, which reduced insertion time by about 50%.

What is already known on this topic

Insertion of peripheral venous cannulas may be difficult because of severe vasoconstriction

Vasoconstriction can be overcome by local heating

What this study adds

Active local warming facilitates the insertion of peripheral venous cannulas, reducing both the time and number of attempts required

Local warming will decrease the amount of time staff spend inserting cannulas, reduce supply costs, and improve patient satisfaction

Possible bias

Arteriovenous shunt blood flow and hand venous tone is not normally under conscious control. Furthermore, patients were not informed that we were testing warming (as opposed to passive insulation or some other aspect of the device). It thus seems unlikely that our results were biased by responses under the patients' control.

The nurse anaesthetist and residents who attempted to insert the intravenous cannulas were blinded to treatment and were also not told that we were testing warming. Obviously, they could feel that in some patients the hands were warmed, and to this extent our blinding was unavoidably incomplete. However, we consider that the observed differences in cannula insertion time and success rates result from local warming rather than investigator bias.

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Competing interests: DIS is a consultant for ThermaMed.

1 Cleary M. Peripheral intravenous cannulation. *Aust Fam Physician* 1991;20:1285-8.
2 Mbamalu D, Banerjee A. Methods of obtaining peripheral venous access in difficult situations. *Postgrad Med J* 1999;75:459-62.
3 Greif R, Rajek A, Laciny S, Bastanmehr H, Sessler D. Resistive heating is more effective than metallic-foil insulation in an experimental model of accidental hypothermia: a randomized controlled trial. *Ann Emerg Med* 2000;35:337-45.
4 Kober A, Scheck T, Fulesdi B, Lieba F, Vlach W, Friedmann A, et al. Effectiveness of resistive heating compared with passive warming in treating hypothermia associated with minor trauma: a randomized trial. *Mayo Clin Proc* 2001;76:369-75.

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Endpiece

A stout heart

A heart is never really stout until it has broken and mended at least once.

Robertson Davies (1913-95), *What's bred in the bone*, London: Penguin, 1986