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CLINICAL PAPER

Comparison of 30 and the 100% inspired oxygen concentrations during early post-resuscitation period: a randomised controlled pilot study☆

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Summary
Objectives: High oxygen concentration in blood may be harmful in the reperfusion phase after cardiopulmonary resuscitation. We compared the effect of 30 and 100% inspired oxygen concentrations on blood oxygenation and the level of serum markers (NSE, S-100) of neuronal injury during the early post-resuscitation period in humans.
Methods: Patients resuscitated from witnessed out-of-hospital ventricular fibrillation were randomised after the return of spontaneous circulation (ROSC) to be ventilated either with 30% (group A) or 100% (group B) oxygen for 60 min. Main outcome measures were NSE and S-100 levels at 24 and 48 h after ROSC, the adequacy of oxygenation at 10 and 60 min after ROSC and, in group A, the need to raise FiO_2 to avoid hypoxaemia. Blood oxygen saturation <95% was the threshold for this intervention.
Results: Thirty-two patients were randomised and 28 (14 in group A and 14 in group B) remained eligible for the final analysis. The mean PaO_2 at 10 min was 21.1 kPa in group A and 49.7 kPa in group B. The corresponding values at 60 min were 14.6 and 46.5 kPa. PaO_2 values did not fall to the hypoxaemic level in group A. In another group FiO_2 had to be raised in five cases (36%) but in two cases it was returned to 0.30 rapidly. The mean NSE at 24 and 48 h was 10.9 and 14.2 μg/l in group A and 13.0 and 18.6 μg/l in group B (ns). S-100 at corresponding time points was 0.21 and 0.23 μg/l in

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group A and 0.73 and 0.49 μg/l in group B (ns). In the subgroup not treated with therapeutic hypothermia in hospital NSE at 24 h was higher in group B (mean 7.6 versus 13.5 μg/l, $p = 0.0487$).
Conclusions: Most patients had acceptable arterial oxygenation when ventilated with 30% oxygen during the immediate post-resuscitation period. There was no indication that 30% oxygen with SpO_2 monitoring and oxygen backup to avoid $SpO_2 < 95\%$ did worse that the group receiving 100% oxygen. The use of 100% oxygen was associated with increased level of NSE at 24 h in patients not treated with therapeutic hypothermia. The clinical significance of this finding is unknown and an outcome-powered study is feasible.

Introduction

Ventilation with 100% oxygen during cardiopulmonary resuscitation (CPR) is recommended because ''short-term therapy with 100% oxygen is beneficial and not toxic''.[1] After the return of spontaneous circulation (ROSC) clinical practice has been to continue administration of 100% oxygen during the early post-resuscitation period. Patients are likely to receive 100% oxygen until they are connected to a ventilator in an intensive care unit. This period is undefined and may vary from ~30 min to several hours.

Oxidative damage has a role in neuronal injury during the reperfusion after global ischaemia. Animal studies have shown that hyperoxygenation during CPR or the early post-resuscitation period is no better than ventilation with room air[2,3] and even may have detrimental effects in terms of raised marker levels of neuronal injury or worse outcome.[4–7] Hyperoxaemic reperfusion after global cerebral ischaemia has also been related to histopathological changes in the brain.[8] Randomised human studies on adult patients are lacking. In a Norwegian observational study hospitals which did not use hyperoxygenation during the first hour after ROSC reported the best outcome data.[9] Recent meta-analysis of resuscitation of term or near-term infants with 100% oxygen or air indicated the superiority of air. One death would be prevented for every 20 babies resuscitated with air rather than 100% oxygen.[10]

The purpose of this human pilot study was to compare the effects of two different inspiratory oxygen concentrations during the early post-resuscitation period on the oxygenation of blood and on the level of two serum markers (NSE, S-100) of neuronal injury. We were particularly interested to find out if ventilation with 30% oxygen is adequate for avoiding hypoxaemia.

Material and methods

Study setting

The ethical committee approved the study plan. The study was conducted in the emergency medical services (EMS) of Helsinki. The EMS serves the capital city of Finland (population 560,000). The EMS system is three tiered and the Rescue Department provides the services. The first tier consists of eight basic ambulances and eight fire engines used as first responding units (FRU) and is manned by emergency medical technicians. In the second tier there are three advanced life support (ALS) ambulances manned with paramedics and one medical supervisor unit. The physician staffed mobile intensive care unit (MICU) makes up the third tier. In cardiac arrest calls, a FRU or a basic ambulance plus the MICU or the medical supervisor unit are dispatched. In this study the MICU was the only enrolling unit. The ambulance response times were calculated from the beginning of the emergency call in the dispatching centre to the arrival of the ambulance at the patient's side. After CPR patients were stabilised in the field before transportation to a hospital emergency department. The decision to give prehospital thrombolysis was based on the 12-lead ECG taken 20 min after ROSC. Active cooling was not used before arrival at hospital. During the study period post-resuscitation intensive care was given in two hospitals. The choice of the receiving hospital was based on the local patient referral instructions.

Study design

The study was a randomised controlled trial. Patients with a bystander witnessed out-of-hospital ventricular fibrillation treated by the MICU were eligible to be included. Patients were randomised by a MICU physician either to receive 30 or 100% oxygen during the early post-resuscitation period, i.e. 60 min after ROSC. If ROSC was sustained for