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Respiratory Arrest in a Child after Flushing of Pancuronium from the Deadspace of Intravenous Cannula

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Introduction

It is common practice for patients admitted to Intensive Care Units to have indwelling intravenous cannulae. Sometimes these cannulae are used only for the administration of drugs and are closed otherwise. Residual drugs in the deadspace of these intravenous cannulae as well as connected stoppers or 3-way stopcocks can later be flushed unknowingly. We would like to report a case in which inadvertent flushing of residual pancuronium caused complete muscle paralysis and respiratory arrest in a young child.

Case Report

A 5-month-old female child weighing 4.45 kg was admitted to Intensive Care Unit of our hospital for hypocalcemic seizures that lead to cardiorespiratory arrest. Her trachea was intubated and mechanical ventilation started. After detailed investigations, the final diagnosis of rickets was made. During the course of her ICU stay she developed acute respiratory distress syndrome (ARDS) and abdominal distention. It was difficult to ventilate her with assisted modes of ventilation so controlled ventilation was instituted using pancuronium for muscle relaxation which was administered in hourly boluses. She was treated medically for her problems and on 17th day of intubation, she was finally extubated. She remained well and active for 2 hours post extubation. Arterial blood gases done at that time showed a pH of 7.38, PCO2 38 mm Hg, P02 98 mm Hg, H2C03 23 meq/L and Sp02 98% on Fi02 of 40% via oxyhood. During that period she had two 24 G x$^{3/4\ 11}$ cannulae in each arm. The cannula on the left arm was being flushed with continuous intravenous solution, while that on the right arm had a 3 way stopcock (Nipro medical industries limited, Japan) attached to it and was closed with a heplock stopper. Two hours after extubation a nurse flushed the cannula on right arm with saline to keep it patent. The child immediately desaturated, became bradycardiac and developed complete flaccid paralysis. Intravenous atropine was given, child's trachea intubated and bagging with 100% oxygen started. Cardiac rhythm reverted back to normal within 1-2 minutes. Due to the presence of sudden flaccid paralysis without any obvious reason, inadvertent administration of muscle relaxant was suspected. A nerve stimulator demonstrated complete neuromuscular paralysis. She was connected to the ventilator to facilitate positive pressure ventilation. Neuromuscular function checked at regular intervals showed a typical pattern of gradual reversal from the effects of a non-depolarizing muscle relaxant. The patient regained full muscle power after about one hour and was uneventfully extubated the next morning and later moved to the ward. Detailed inquiry revealed that the last drug given through the right arm cannula via 3 way stopcock prior to flushing with saline was 0.5 mg of pancuronium diluted in 1 ml of water injected 6 hours ago. It was concluded that some residual drug remained in the 3-way stopcock and cannula which was later flushed into circulation resulting in apnea of the child.

Discussion

Increasing awareness about the transmission of diseases through the needlestick injuries or cuts and

abrasions on the skin has initiated the physicians today to use cannulae with attached injection ports or heplocks and 3-way stopcocks. However they have their own drawbacks. The volume of drug retained in the equipment deadspace may result in delivery of an inadequate dose of the drug to the patient. In addition, subsequent flushing of these relatively smaller drug volumes has been shown to have surprisingly active clinical effects[1].

It is a known fact that between 10 to 30% of 1 ml of intravenous injection may remain in the deadspace of a cannula or indwelling needle depending on the type and gauge of the equipment used[2]. The recommended method of calculating the deadspace of intravenous equipment is to weigh it before and after filling it with water[2] or normal saline[1] . Substraction of dry weight from the wet weight is equal to the deadspace. Weight is converted to volume by assuming 1 gm of 0.9 % normal saline at room temperature is equal to 0.995 ml while I gm of sterile water is equal to 1 ml. In order to calculate the combined deadspace of cannula and 3-way stopcock we used the method described by Maclie and filled the deadspace of the equipment with sterile water. 10 cannulae (Safelet Cath, Nipro Medical Industries limited, Japan) of 24 G x 3/4" were taken and separately connected to 10 3-way stopcocks (Nipro Medical Industries Limited, Japan). This equipment was the same as used in the clinical setting. A scale was zeroed after placing a beaker over it. Dry weight of every device was measured individually. Wet weight was calculated by filling the apparatus with sterile water. Every possible precaution was taken to remove air bubbles and the exterior of the device was carefully dried before weighing. To simulate the clinical setting, filling was carried out using 5 ml BD syringe like the one used in ICU to inject pancuronium. The syringe was removed before measurements. The difference of two weights in each device was taken as equivalent to the deadspace which was then converted to volume. Mean deadspace came out to be 0.20 ml. In our ICU, the routine is to dilute the hourly dose of a drug in 1 ml of water. In the present instance 0.5 mg of pancuronium was diluted in 1 ml of water. 0.20 ml of equipment deadspace contained 0.1 mg of the drug, which in a 4.45 kg weight child was 0.022 mg/kg. Although less than the recommended paralysing dose, it was still found sufficient to paralyze her when flushed into the circulation. Several authors have reported that low doses of muscle relaxants can cause distressing symptoms. D-tubocurarine 0.05 mg/kg[3], pancuronium 0.014 mg/kg[4], atracurium 0.025 mg/kg[5] , vecuronium 0.005-0.0 10 mg/kg[6] and suxamethonium 0.07 mg/kg[7] can cause distressing symptoms such as ptosis, blurring of vision, and difficulty in breathing in a large proportion of patients, with a measurable degree of respiratory impairment in a significant number of them. This effect may become more pronounced in a partially reversed patient or in patients who have reduced respiratory reserve.

Similar cases of muscle paralysis have been reported postoperatively in children[8] as well as in adults[9] after flushing of cannulae through which suxamethonium had previously been injected but to our knowledge, no case has been reported of a similar event in the setting of intensive care unit or where pancuronium has been used. Physicians working in intensive care units should keep this possibility in mind so that they can intervene early and prevent any fatal complications. We recommend that if 3-way stopcocks or heplock stoppers are being used for administration of drugs in pediatric patients in intensive care units, they should be flushed immediately afterwards with saline or water. We also suggest that all unnecessary intravenous lines should be removed whenever possible.

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