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High dose, fast delivery magnesium sulphate in a 3-year-old acute severe asthmatic

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CASE STUDY

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ABSTRACT

Acute severe asthma when respiratory failure is imminent is not addressed in world asthma guidelines. Intravenous magnesium sulphate, salbutamol and aminophylline all have advocates but what order, speed of delivery or dosage is left up to the individual physician treating the patient. A child in respiratory failure was given a large, fast dose of intravenous magnesium sulphate before intravenous salbutamol which relaxed bronchial smooth muscle immediately and tracheal intubation and lung ventilation was avoided. Justification for this treatment is discussed.

Key Words

Acute severe asthma, respiratory failure, magnesium sulphate, salbutamol

Implications for Practice:

1. What is known about this subject?

No consensus exists for management of acute asthma respiratory failure.

2. What new information is offered in this case study?

Fast intravenous magnesium sulphate is a useful addition to intravenous beta2-agonists.

3. What are the implications for research, policy, or practice?

Asthmatics in extremis will benefit from fast correct doses of magnesium sulphate and salbutamol.

Background

The November 2016 cases of thunderstorm asthma in Melbourne led to nine deaths, 8,500 asthma admissions with as yet no details of emergency room management. One week later in Kuwait a five died following a thunderstorm and 850 were admitted.[1] Clues to better management are contained in this case study of a difficult - to-treat three year old asthmatic child, attended by two consultant anaesthetists and a paediatrician just prior to a respiratory arrest. Intravenous treatment reversed bronchospasm very quickly and safely etc.

Case details

A three and a half year-old 14.3kg female atopic asthmatic with seven previous hospital admissions since the age of 2½ yrs. for acute asthma provoked by upper respiratory tract infection was admitted to the paediatric ward with another infection. She began oral prednisolone 15mg daily with back-to-back salbutamol and ipratropium nebulisation. On the second day of nebulisation when in her father's arms she was noted to be lethargic and to be of a "dusky" colour, with no SpO_2 recording. Further deterioration and twitching from possible seizures led to the attendance of the arrest team; a consultant anaesthetist was unable to ventilate the lungs with oxygen through a self-inflating bag. A second consultant anaesthetist gave an intravenous (IV) 70mg.kg^{-1} bolus of $MgSO_4$ (1g) over 1 minute (RJE; with vast experience in its use). The child was able to be "bagged", began to cough and breathe before the addition of IV salbutamol 210mcg (14.7mcg.kg^{-1}) given over ten minutes.

The child became alert, coughed, began crying and asked her parents who were still present for some water. Venous blood gases just prior to the seizure showed a pH 6.96, pvO_2 7.99kPa, $pvCO_2$ 12.6kPa and a lactate 6.5mmol.L^{-1}. A second venous gas 20 min after the first showed pH 7.06, pvO_2 28.7kPa, $pvCO_2$ 11.1kPa, lactate 1.7mmol.L^{-1}. The child remained well and was discharged only to be re-admitted with acute asthma six weeks later.

Discussion

The large and fast delivered $MgSO_4$ relieved the bronchospasm by relaxing smooth muscle. Magnesium competes with calcium for access through receptor operated channels in smooth muscle cell walls. Inhaled hydroflurocarbon anaesthetic gases halothane, sevoflurane and norflurane are smooth muscle relaxants and act by inhibiting the opening of calcium channels. Norflurane is the propellant HFA134a in pressurised metered dose inhalers.[2] The usually suggested adult IV $MgSO_4$ doses in asthma of 1.2 to 2g over 20 minutes[3] (children 25–75mg.kg^{-1} over 20 min) will not reach serum levels high enough to relax smooth muscle; an indication of relaxation of skin vessels is "flushing" and a feeling of warmth. The 1.2 to 2g over 20 min dose determination for adults has no evidence base for its use in asthma, has no foundation from research for this dose and timing, and has no referenced publications. This is unlike publications in the successful treatment of adult supra-ventricular tachycardia and atrial fibrillation, when 2g IV $MgSO_4$ over 5s[4], 15s[5] and 60[6,7] seconds have been published and in eclampsia, treatment with 4g IV over 4 minutes is usual.[8] The attenuation or prevention of beta1 receptor tachycardia (following IV beta2-agonists) by a known atrial conduction-suppression effect of IV $MgSO_4$ has been observed in cases of acute severe asthma.[9]

The IV dose of salbutamol 210mcg in this child is accordance with the British asthma guideline paediatric dose of 15mcg.kg^{-1} over 10 minutes.[10]

Publications using IV drugs to treat acute asthma in emergency departments use IV salbutamol, IV, $MgSO_4$ and IV aminophylline, most often in this order,[11,12] IV terbutaline given to children in one USA study reduced the requirement for tracheal intubation and lung ventilation.[13] Using $MgSO_4$ 40mg.kg.min^{-1} over 4 minutes, and IV salbutamol 15mcg.kg^{-1} over 10 minutes is suitable management of acute severe asthma and respiratory failure for both children and adults. Even if this fails to fully reverse bronchospasm and/or respiratory failure, subsequent lung ventilation will be easier and safer.

Conclusion

Alternatives to reverse bronchospasm are intramuscular adrenaline (epinephrine) which is first line therapy of ambulance para-medical staff for respiratory compromise in acute asthma.[14] Suggested in the National Review of Asthma Deaths (NRAD) after a first episode of life-threatening asthma is the prescription of auto adrenaline injectors (AAI) to those at risk of further attacks.[15,16] There is case report evidence from the Netherlands of the successful use of IV enoximone 1 to 2mg.kg^{-1} bolus as a fast acting and safe bronchodilator in moribund and ventilated asthma patients.[17] Enoximone is a selective phosphodiesterase inhibitor used in cardiology for vascular smooth muscle dilatation. Case report publication of serum levels of $MgSO_4$ and salbutamol during IV therapy would help improve acute severe and life-threat asthma management as would a trial of slow versus rapid dosing of magnesium sulphate in acute asthmatics. $MgSO_4$ in volunteers with and without intravenous beta2-agonists will determine magnesium levels and doses adequate to attenuate tachycardia.

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PEER REVIEW

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CONFLICTS OF INTEREST

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PATIENT CONSENT

The authors, *R John Elton, Karen Mclachlan, Anujia Amarasekara, William FS Sellers* declare that:

1. They have obtained written, informed consent for the publication of the details relating to the patient(s) in this report.
2. All possible steps have been taken to safeguard the identity of the patient(s).
3. This submission is compliant with the requirements of local research ethics committees.