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Case 10yr boy with severe asthma, being given ventolin by spacer. VBG -

High pCO2 and lactate.

Would you be concerned about the lactate, and should you give IV salbutamol?

Note that not all lactate is from anaerobic metabolism in hypoperfusion and sepsis, i.e. type A. Type B is from other causes.

Regardless of source, high lactate represents physiological stress and must be addressed.

Intravenous salbutamol is recommended in the treatment severe asthma when there is failure to respond to nebulised beta-agonists. However beta-agonists have numerous systemic actions that may adversely affect patients with severe respiratory compromise, notably lactic acidosis, which, by increasing respiratory demands, could precipitate respiratory failure. For patients who fail to respond to inhaled beta-agonists, ipratropium and systemic steroids, consideration should be given to other therapies such as non-invasive ventilation rather than increasing the dose of a drug that may paradoxically worsen respiratory function.

Intravenous salbutamol is efficacious as a bronchodilator. Salbutamol infusions of 5 to 10 mcg/min, or as a 200 mcg bolus, produce bronchodilatation. There is little benefit from higher doses. [addit. There is variation in individual response, especially in children].

Does intravenous salbutamol work as a bronchodilator? Intravenous salbutamol is efficacious as a bronchodilator. Salbutamol infusions of 5 to 10 mcg/min, or as a 200 mcg bolus, produce bronchodilatation. There is little benefit from higher doses. [addit. There is variation in individual response, especially in children].

Intravenous or nebulised? Nebulised treatment was more efficacious and had fewer side effects than intravenous salbutamol, with similar systemic levels in from both routes. Available data suggests the nebulised route is as least as effective as IV, can achieve similar blood levels, and has greater bronchodilator effects for a given blood level. Evidence to
support or refute adding an intravenous infusion is lacking.

**Systemic metabolic effects** Salbutamol effects glucose and insulin levels. DKA can be precipitated in type 1 diabetics. This has been reported in obstetrics during salbutamol infusion for premature labour. Added hypercapnoea worsens acidosis, and steroids also exacerbate hyperglycaemia.

Salbutamol causes an intracellular potassium shift giving hypokalaemia, and also hypomagnesaemia which can predispose to cardiac arrhythmias and cause muscle weakness.

Serum lactate rises due to beta-2 stimulated anaerobic glycolysis in muscle. If production exceeds hepatic clearance then lactic acidosis will ensue resulting in increased ventilatory demands. There is also type B lactic acidosis from a separate non-anaerobic mechanism.

Potentially adverse cardiac effects from beta-2 agonists are all more marked with IV dosing, and include vasodilation and hypotension, tachycardia, inotropic effect to increase cardiac output, prolonged QT interval, and pulmonary vasodilation which worsens dead space and V/Q mismatch giving hypoxia.

There is an increase in basal metabolic rate, oxygen consumption and CO2 production which may be adverse in respiratory failure and hypercapnoea.

Lactate levels rise initially but then return to normal despite continued salbutamol infusion (mean levels 4.5 mmol/L with a mean peak of 7.7 mmol/L). It is likely multifactorial, possibly from increased production due to work of breathing and reduced clearance, and also a primary effect of salbutamol, though it is not clear.

**Clinical implications** salbutamol imposes increased metabolic demands on a respiratory system with little or no reserve and can lead to increasing respiratory distress and compromise. Increased respiratory effort and respiratory rate with reduced expiratory time leads to dynamic hyperinflation and intrinsic PEEP which further increases work of breathing. V/Q mismatch and increased dead space causes hypercapnoea which worsens acidosis and compromises respiratory muscle function. Failure to appreciate the cause of deterioration may lead to further increasing the salbutamol infusion dose.

**Conclusion** there is little evidence to support the use of intravenous salbutamol infusions. A small paediatric study suggested a benefit from an initial IV bolus of 10 mcg/kg in addition to inhaled salbutamol. If blood gas and lactate show a metabolic acidosis then reducing the dose may be a better option than further escalation.

Alternatives to IV salbutamol include BiPAP (which reduces the work of breathing), and IV magnesium, in addition to inhaled salbutamol and ipatropium, and steroids.

![Elevated plasma lactate level associated with high dose inhal ed albuterol therapy in acute severe asthma](http://www.intarchmed.com/content/1/1/3)

Patients were treated with salbutamol four puffs at 10 minute intervals by spacer for 120 minutes. Measures including lactate were taken immediately before starting treatment and repeated at intervals to 120 minutes. There was varied response, with lactate rising to >7 mmol/L in some patients.

![Figure 1. Baseline and posttreatment lactate levels. Circle represent individual values and squares mean (SD) values. The mean serum lactate level at the end of treatment was significantly higher (p=0.001) than baseline.](http://www.intarchmed.com/content/1/1/3)

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