

# AnesthesiaDotCalm Newsletter



News You Can Use

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## How Low Can You Go

Suppose you wanted to provide spinal anesthesia to two groups of parturients for a c-section. One group received 10 mg of bupivacaine 0.75% while the other group also received the same amount of bupivacaine mixed with 30 mcg of fentanyl and 0.3 mg of duramorph. Since you obviously changed the density and hence the baricity of the local anesthetic by adding narcotics would you expect the group that received this mixture to have a lower or higher level of block?

Before we answer this question I think it would be to our advantage to revisit the mechanisms which influence the spread of local anesthetics within the cerebral spinal fluid.

As the local anesthetic solution is injected, it will spread initially by displacement of CSF and by any currents created within the CSF. The next stage, which may well be the most crucial, is spread due to the interplay between the densities of both CSF and local anesthetic solution under the influence of gravity. But the key factors are the physical characteristics of CSF and the solution injected.

Let's taken a moment to define the terms which describe these characteristics.

Density is the ratio of the mass of a substance to its volume. It varies with temperature and is indicated by a small excript representing the temperature at which measurments are made. For example the density of distilled water at 37°C would be written as 0.9934 (37°C) or the density of cerebral spinal fluid (CSF) at 37°C would be indicated 1.00010 (37°C). CSF density is lower in women than in men,(1) in pregnant than in non-pregnant women,(2) and in premenopausal women compared with postmenopausal women and men(.3) . So the bottom line is that men are more dense. That's what my wife has been telling me for years. Theoretically, these differences could lead to differences in the movement of a particular solution (e.g. a solution that is isobaric in men may be hyperbaric in pregnant women), but the differences between groups are small and are usually clinically unimportant.

Specific gravity is the ratio of the density of a substance to a standard. It is usual to relate local anaesthetic solutions at 20°C to water at 4°C. Since specific gravity compares the density of one substance at a specific temperature to the density of another substance at a certain temperature, the calculated number would have two ex-criptsed numbers. For example the specific gravity of CSF (which is calculated by comparing the density of CSF to the density of water) would be written as 1.0076 (37°)/(37°C) if the density measurements of both CSF and water were made at 37°C.

In anesthesia, we don't compare the density of a local anesthetic to water. Rather we compare the density of a local anesthetic to the density of CSF. This comparative ratio is termed baric gravity or baricity. Like specific gravity, the derived number is portrayed with two temperature ex-cripts. Lypholized (powdered) tetracaine, for example, can be prepared using sterile water, a dextrose solution, or with CSF. When prepared with sterile water to a concentration of 0.1%, its baricity is 0.9933 (37°C)/(37°C) and is termed hypobaric because its baricity is less than CSF(i.e. 1.0000 (37°C)/(37°C)). Similarly, a 0.5% concentration of tetracaine prepared with 0.45% saline and 5% dextrose has a baricity of 1.0127 and thus is termed hyperbaric because its baricity is greater than that of CSF. And if tertacaine is prepared with CSF to a final concentrarion of 1.0% then it will have a baricity very similar to CSF. In final analysis we can say that baricity is analogous to specific gravity, but the ratio is the density of the local anaesthetic to that of the CSF calculated at 37°C. Yes, temperature is important. Most glucose-free solutions used intrathecally are just hypobaric(4,5)but behave in a hyperbaric manner if cooled to 5°C before injection.(6, 7)

At this point you should be asking yourself two questions: What's on television and is there anything good to eat in the refrigerator? Although these are very good questions, which I frequently ask myself while trying to study this stuff, they are certainly not germane to the issue at hand. The two questions you should be asking yourself are: 1) What's the importance of baricity of the local anesthetic to the dermatomal level? and 2) How does the concentration relate to the level of block?

Almost 100 years ago, Barker was the first to study systematically the factors affecting intrathecal spread. Using glass models of the spinal canal and colored solutions, he deduced that gravity and the curves of the vertebral column could be used to influence the spread of solutions made hyperbaric by the addition of glucose.(8 )Over the years other substances such as alcohol and strychnine were added to change the baricity of the local anesthetic but given the neurotoxic effects of such agents, it is not surprising that the addition of glucose remains the substance of choice (9,10 ). Today, most commercially available hyperbaric local anesthetics contain up to glucose 8%. However evidence shows that any concentration in excess of 0.8% will produce a solution that behaves in a hyperbaric manner , but with somewhat less extensive spread if the glucose concentration is at the lower end of the range.(11, 12, 13 ,14, 15 ,16,17)

But in and of itself baricity only plays a small part in the spread of local anesthetic within the csf. And here is crux of this discussion. The most significant factor is the total amount or mass of drug that is delivered. In essence, I can give 10 mg of bupivacaine in 14 ml of fluid (.07%) or in 2 ml of fluid(0.5%) and still achieve the same dermatomal spread(18, 19, 20, 21, 22 ,23) Volume only becomes important when an isobaric solution is injected(68).

It stands to reason, therefore, that the addition of narcotics to the injectate should make no difference in the total spread of the drug despite the fact that such additions usually reduce the density of the local anesthetic (24, 25, 26, 27,28) which, to my way of thinking, makes the change in the density of the local anesthetic insignificant. This seems to be a truism despite variations in patient demographics. Norris, for example, injected 52 women scheduled for c-section with 15 mg of hyperbaric bupivacaine and found that despite variations in patients' age (20-42yrs) height (146.9-174.0 cm) weight (55.5-136.4 kg), body mass index (19.2-50.0 kg.m<sup>2</sup>) and vertebral column length (49.6-67.0cm) no difference was found in the maximum cephalad extent of sensory analgesia and anesthesia (29). Others have substantiated this finding and have verified that the changes in the baricity of the local anesthetic by the addition of small doses of narcotics makes no difference to the extent of the sensory level nor in the regression of the sensory or motor components of the block. However, the addition of the narcotic increased the duration of analgesia in the early postoperative period compared with plain hyperbaric bupivacaine(30).

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