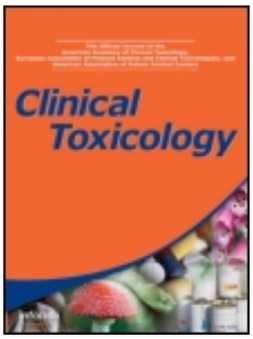

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Hypertonic saline: An alternative therapy in TCA overdoses failed to respond sodium bicarbonate

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may be, their research supported the conclusion that intoxicating hydrocarbons formed the "active ingredient" in the *pneuma* described by the ancient writers. Additionally, within the last year a study by a team of archaeologists and geologists has documented a second oracular shrine at a Temple of Apollo in Hierapolis, Turkey constructed by the Greeks directly over an active geological fault with a gaseous vent from a cavern (the *Plutonion*) (4). Again ancient writers linked these toxic emissions to the religious cult. Ground penetrating radar has identified a previously unknown man-made subterranean chamber under the temple on the fault line, interpreted to be an entrance to the cavern. While in the case of Hierapolis the gaseous vent emits carbon dioxide, it again demonstrates the ancient tradition of locating oracular buildings and temples of Apollo on specific geological phenomenon. Foster and Lehoux are also unfamiliar with basic geology and plate tectonics. Plutarch claimed that the emission had weakened through time. Natural changes in the flow rate of springs and associated gases are a common phenomenon, especially in highly seismic areas. Emission rates following earthquakes remain high for years and slowly decrease over time. In any case, the permeability and porosity of fault zones in limestone complexes are reduced by the formation of calcite and travertine crusts laid down by springs. Spaces are then frequently opened up again as a result of vibrations caused by strong earthquakes elsewhere in the tectonic zone. The recurrence rate for quakes with magnitude around 6 in the Corinth rift zone has been estimated at between 100 and 150 years. Therefore, Delphi has been shaken repeatedly through the centuries with related consequences for gas emissions.

For a full understanding of ancient writers, it is important to visit and study the sites that they described. For example, Foster and Lehoux make much of the small amount of water currently flowing from the Kerna spring above the temple. If they were familiar with Delphi, they would see that while the water presently seeps from a minor crack and collects in a small reservoir, its flow has been significantly reduced due to a major diversion that has affected all springs along the Kerna fault. In recent years, local engineers have drilled several holes and constructed reservoirs in the Kerna fault zone above the oracular site. From there, the water that used to flow through the sanctuary is now piped to modern Delphi. Additionally, the flow in the past was clearly greater than today as evidenced by the existence of thick travertine curtains that cover the retaining wall beside the temple. These deposits indicate clearly that the volume of groundwater and associated gases was significantly larger in the past.

The archaeological evidence of the temple itself shows that the design and layout was adapted to accommodate certain geological features. The asymmetrical inner space of the temple provided for an alcove on the southern side where a spring must have emerged, since a series of tunnels and conduits was constructed through the massive stone foundations to drain the spring water out of the *adyton*. The ancient architects would not have constructed such a feature if it had not been necessary.

In conclusion, ancient authors referred to geological phenomena at the site of the Delphic Oracle – a fissure, a spring, and a gaseous emission – and two recent scientific surveys including our own have demonstrated that these features exist. In our view, the burden of proof now rests with the detractors of Plutarch and the other sources, rather than with those who take their testimony seriously.

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Hypertonic saline: An alternative therapy in TCA overdoses failed to respond sodium bicarbonate

To the Editor:

I would like to thank Dr. Bebarta et al. for their interesting case report of a tricyclic antidepressant (TCA) overdose presenting with a Brugada pattern that failed to respond sodium bicarbonate and discuss the use of hypertonic saline (7.5%) as an alternative therapy in TCA overdoses that fail to respond the classical therapy.

The evidence supporting the usage of hypertonic saline is limited and contradictory. One study showed no improvement when hypertonic saline was added to sodium bicarbonate therapy (3). In two recent studies (4,5) hypertonic saline corrected hypotension and QRS prolongation in experimental swine models. In the first study, 7.5% saline and 6% dextran were found to be effective in TCA overdose while normal saline was not (4). In the second study, 7.5% saline was found to be superior to both sodium bicarbonate and hyperventilation in reversing QRS prolongation and hypotension (5). However, hypertonic saline failed to establish an alkaline pH, which was shown to prevent cardiac arrhythmias (3). A more recent publication reported a 29-year-old 78 kg woman who presented to the emergency department after ingesting approximately 8 g of nortriptyline. The patient was hypotensive and had a QRS duration of 124 msec. She transiently improved following a bolus 3 L normal saline and 200 mL (4 ampoules, 8.4% $NaHCO_3$) of sodium bicarbonate. However, in the intensive care unit she had recurrent hypotension resistant to an additional 5 L normal saline and to vasopressor therapy (dopamine 20 mcg/kg per minute and norepinephrine at 22 mcg/minute). Hypertonic saline (200 mL, 7.5% NaCl) was administered and the QRS prolongation and hypotension improved within three minutes. In another study, $NaHCO_3$ was found to be more effective in reversing the cardiac effects of TCA than alkalinazation and sodium chloride alone (8).

The patient reported by McKinney (6) improved after the administration of 200 ml of 7.5% NaCl (approximately 175 mEq of sodium) despite the lack of response to 200 ml NaHCO3 (approximately 200 mEql of sodium). Dr. Bebarta et al. administered a total of 300 mEq sodium by giving NaHCO3, with no response in the Brugada pattern. It would be interesting to know if the Brugada pattern would have responded to the administration of hypertonic saline.

The side effects of hypertonic saline (hypernatremia and hyperchloremic acidosis) should be considered. Hypernatremia developed in the swine group treated with hypertonic saline (pre-treatment sodium levels of 138 ± 5 mEql/L vs post-treatment levels of 157 ± 4 mEql/L) whereas there was no hypernatremia in the other groups (5).

In conclusion, recent experimental studies support the effectiveness of hypertonic saline, but the data proving the best therapy in TCA overdoses are conflicting. Further studies are needed to identify the clear effects of hypertonic saline, alkalinization, and $NaHCO_3$.

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