



# CALIFORNIA SCIENCE & ENGINEERING FAIR 2018 PROJECT SUMMARY

<b>Name(s)</b> <b>Kamran Ansari</b>	<b>Project Number</b>  38607
<b>Project Title</b> <b>Mathematical Modeling of Intracranial Pressure Response to Inversion Therapy for Dural Leak Headaches</b>	
<b>Objectives/Goals</b> The objective of this project was to create a mathematical model to predict the duration of response to administering inversion therapy to those with dural leak or low intracranial pressure (ICP) positional headaches. <b>Abstract</b> <b>Methods/Materials</b> When researching to see what mathematical models existed that predicted intracranial pressure (ICP), I found that they all relied on physiological models that fail to account for a phenomenon called a jugular vein collapse, a variable from the venous system where the jugular vein in the upright position contracts, on ICP. I then took existing mathematical and biological equations and modified them to account for a craniospinal fluid volume loss from a dural leak as well as pressure changes from inversion therapy. I then programmed my equation into MATLAB to produce graphs that predicted the relationship of ICP over time after inversion therapy in the setting of a dural leak. <b>Results</b> To see if my model correctly predicts ICP in a normal upright patient, I set variables in the model to reflect a normal patient's physiology. My model correctly establishes the initial ICP pressures of a normal person, in accordance with current values published in the literature. I then tested my model at an initial ICP of 1, 2, and 3mm Hg, which corresponds to a patient with a dural leak and, as a result, a very low supine ICP. Finally, I set variables in the model to reflect an abnormal patient's physiology that was then inverted to achieve an ICP of 12, and ran the model for 60 and 400 minutes. My model shows that, although the effect wore off as time progressed, as expected, inversion delivers sustained relief (in the form of an upright ICP in a normal 0 to 2 mmHg range) well past a few minutes (as predicted by convention) and upwards of 3-4 hours. <b>Conclusions/Discussion</b> My results have large implications for how dural leak patients are conventionally treated. My model shows that inversion therapy, using a simple low-cost inversion table, can provide pain relief for dural leak headaches for 3-4 hours. This runs counter to the conventional wisdom which states that any positive, ICP increasing effects of inversion therapy would dissipate within minutes. Replacing or at least augmenting conventional pain medications with inversion therapy could result in decrease in opioid use or invasive treatments for dural leak headaches, which effect 500,000 individuals in the US every year.	
<b>Summary Statement</b> I created a new mathematical model to predict intracranial pressure after inversion therapy for those with dural leak headaches, showing that inversion therapy results in relief of these headaches.	
<b>Help Received</b> None. I learned how to solve differential equations using derivative calculus videos on Khan Academy. I taught myself MATLAB using the MATLAB website and forums.	