TITLE: Multistability and its occurrence in neurons within the Pre-Bötzinger Complex.

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INTRODUCTION: Sudden Infant Death Syndrome (SIDS) occurs in seemingly healthy infants. SIDS can be attributed to breathing disorders such as apnea, disrupting the regular breathing and leading to the infant’s death (Steinschneider et al. 1982). Comprehensive understanding of neuronal dynamics controlling breathing would lead to effective treatments protecting infants. The Pre-Bötzinger Complex (PBC) is a region of the brainstem that generates rhythms governing inspiration phase of breathing (Smith et al. 1991). The PBC consists of neurons with different properties. When isolated they exhibit bursting, tonic spiking, or silence. In PBC, these neurons act together to produce functional rhythmic bursting (Ramirez et al. 2004).

PURPOSE: Our investigation of neuronal dynamics is focused on the level of individually endogenously bursting neurons (Gray et al., 1998). We hypothesize that the coexistence of functional and dysfunctional regimes, bursting and silence, explains abrupt switches into the silent regime of PBC neurons which leads to infant apnea or death. Abnormal neuronal dynamics combined with external factors, such as temperature affect neuronal mechanisms playing key roles in SIDS. The goal of this study is to investigate which parameters would expand the range of this multistability in the PBC to increase the risks of sudden infant death.

METHODS: As a starting point we used previously developed models (Rybak et al., 2003, Oginsky & Cymbalyuk 2012, Toporikova et al., 2015). Bifurcation analysis was performed to identify through which bifurcations the dysfunctional regime appears and disappears as the controlling parameter is manipulated (Barnett et al. 2013, Malashchenko et al., 2011b).

RESULTS: The multistability found appears through a subcritical Andronov-Hopf bifurcation through a similar mechanisms to Malashchenko et al. (2011a), and Cymbalyuk et al. (2002). We found biophysical parameters critically affecting the range of multistability.

CONCLUSION: These results could open up new avenues of investigation into the biophysics behind the neural mechanisms involved in SIDS respiratory failure.

KEYWORDS: Respiratory Rhythm, Pre-Bötzinger Complex, Bifurcation Analysis, Multistability

WORKS CITED:


