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EFFECTS OF CPAP THERAPY ON RESPIRATORY CONTROL SYSTEM STABILITY

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Abstract. We investigate the effects of continuous positive airway pressure (CPAP) therapy on the stability/instability of a respiratory control system model with two control loops and two delays. We focus on CPAP induced changes in specific system parameters (such as loop gains and dead space ventilation) and the resulting changes in system dynamics in the presence of obstructive-, central-, and complex sleep apnea (OSA, CSA, and COSA). Our conclusion is that a "smart" CPAP strategy (i.e., activated only in case of a respiratory event and turned off otherwise) should be considered and implemented instead of the current procedure ("regular" ,i.e.,"always on" CPAP).

Keywords."smart" CPAP, OSA, CSA, COSA.

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1 Introduction

Respiratory control system irregularities are feedback induced instabilities which are influenced in a complicated way by many system and environmental parameters including the transport delays, the loop gains, the level of inspired oxygen, the atmospheric pressure,...,etc. (see e.g., [5],[7],[2], [10], [8], and the references therein). A mathematical model for the chemical control of respiration was considered in [8] as a system of three parameter dependent, nonlinear , delay differential equations including two negative feedback loops (i.e., central- and peripheral- control loops with transport delays τ_b and τ_p, respectively) and numerical techniques were used (see [1],[6], and [3]) to analyze stability/instability in the model.
In this paper we investigate the effects of CPAP strategies on system dynamics. Note that the activation of CPAP leads to changes in system parameter values (we will focus on changes in loop gain values (G_P, G_C) and the change