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Comfortable Breathing Duration (CBD) of Fentanyl Using a Three-Compartment Mc
Computational Biology & Bioinformatics

1. The Research Plan/Project Summary should include the following:

a. RATIONALE: Opioid-related overdoses and deaths are a major issue in today's world, with thousands of people dying every year from these drugs. Respiratory depression, which ultimately leads to no breathing at all (apnea), is a significant contributor to this epidemic. Balancing the ability to breathe with pain relief becomes a challenge with high variability, and it is hard to find the ideal variation that benefits patients in the most optimal way, which is also known as the comfortable breathing duration. This research would focus on the comfortable breathing duration as an index for efficacy, and it would impact society by helping measure patients' responses to drug variations in a holistic way and would target the 'entire' patient.

b. RESEARCH QUESTION(S), HYPOTHESIS(ES), ENGINEERING GOAL(S), EXPECTED OUTCOMES: The research question I ask is, "How can the comfortable breathing duration be used as an index of efficacy for opioids?" The hypothesis for this question would be that by applying the comfortable breathing duration to a one compartment model could provide insight into the degree and variability of risk and benefit. Throughout this project, I hope to analyze the opioid epidemic in a new way and expand my Python coding abilities.

c. Describe the following in detail:

• Procedures: The literature will be reviewed to obtain published data regarding opioids. The Miller Textbook has tables which list the C_{50} for apnea and analgesia, as well as half times and volumes of distribution. These data will be applied to a one-compartment model and integrated into a nested loop. Using my previous derivation for the CBD, a nested loop program in Python could calculate four times corresponding to four different concentrations. The odd numbers would represent the upper interval for concentration associated with apnea, and the even numbers would represent the lower concentrations associated with analgesia. After the nested loop is generated and the output is reviewed for accuracy, statistical tests will be performed on the data to analyze the results.

• Risk and Safety: There are minimal to no risks in this computer-based research. One possible risk would be eye strain from exposure to computer screens for lengthy periods of time, and this could be prevented by taking frequent breaks and minimizing computer use at night or in the dark.

• Data Analysis: After the compartment model is generated using Python, there will be various statistical tests performed to analyze the results. For example, a T-test could be used.

d. BIBLIOGRAPHY:

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Addendum:

The research will be expanded into a three-compartment model more consistent with published clinical experience, in addition to the one compartment model, and this three-compartment model will could demonstrate that increasing dose may not only prolong apnea time and analgesia time, but also the comfortable breathing duration. A nested loop Python model will be coded based on additional mathematical derivations and a tri-exponential function, which is a piece-wise model of three curves (alpha, beta, and gamma) which are separated by two intersections (alpha-beta intersection and beta-gamma intersection).