Data-Driven Analysis of Handwashing Effectiveness: Revisiting Semmelweis's Discovery

Abstract
This report revisits the 19th-century medical breakthrough by Dr. Ignaz Semmelweis, who hypothesized that handwashing significantly reduced maternal mortality. Using historical hospital records from Vienna General Hospital, we analyze monthly birth and death data from two clinics to assess the statistical impact of hand hygiene implementation in mid-1847. Our findings confirm a substantial drop in mortality rates following the introduction of handwashing, reinforcing the value of data-backed medical decisions.

1. Introduction
In the 1840s, Clinic 1 at Vienna General Hospital saw consistently higher maternal death rates than Clinic 2. Dr. Semmelweis suspected that physicians moving from autopsies to deliveries without washing hands contributed to the spread of puerperal fever. In June 1847, he mandated handwashing with chlorinated lime, sparking one of the earliest examples of hygiene-based intervention. This analysis re-examines historical data to validate his claim using modern data science methods.

2. Dataset and Methodology
We used a cleaned dataset containing 98 monthly records of births and deaths across two clinics from 1841 to 1849. We calculated monthly mortality rates and created a binary indicator marking observations after the handwashing policy was introduced. We split Clinic 1's data into pre- and post-intervention subsets for comparison.

We performed the following: - Time-series visualization of mortality trends across clinics - Histogram and boxplot comparisons before and after handwashing - Welch's t-test to assess statistical significance

3. Results
- **Before handwashing** (Clinic 1): Average mortality rate was **11.31%** - **After handwashing** (Clinic 1): Average mortality rate dropped to **1.84%** - **T-statistic**: 7.1379 - **P-value**: 8.986e-09

This confirms a statistically significant reduction in mortality ($p < 0.05$) post-intervention.

4. Visual Summary
Figures include: - Line plot showing monthly mortality trends and intervention marker - Histogram comparing the distribution of mortality rates before and after - Boxplot visualizing the mortality rate spread between groups

5. Conclusion
The analysis affirms Semmelweis's hypothesis: handwashing led to a dramatic and statistically significant drop in mortality. This case demonstrates the enduring power of data-driven health interventions — even centuries later.

Keywords: Semmelweis, handwashing, mortality rate, data science, historical health data, hypothesis testing, Welch's t-test