

# Semmelweis Handwashing Article

Christina Dietrich, Tanith Norris

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## 1 Introduction

Dr. Ignaz Semmelweis is a Hungarian physician who worked at the Vienna General Hospital. He was invested in studying childhood bedfever, a disease that affects women who have just given birth. Because he lived in the 1840s, this disease killed almost 10% of women who gave birth. Dr. Semmelweis believed this deadly disease was caused by the contamination of doctors' hands. He proposed that it is necessary for doctors to wash their hands to decrease this deadly disease.

To prove his hypothesis, Dr. Semmelweis visited two separate clinics and recorded the mortality rates of mothers who had given birth in the early to mid 1840's. Our group attempted to model his findings to show the effectiveness of handwashing. We utilized the package of *library(tidyverse)* in programming language R and the pandas package in the language of Python to complete the project.

## 2 Goals

- Explore Dr. Semmelweis's hypothesis on handwashing and the effects it has on mother fatality during childbirth.
- Analyze the birth versus mortality rates from the data sets provided by clinic 1 and clinic 2 for the given years.
- Conclude how the practice of handwashing affected the mortality rates of mothers after childbirth after being instituted on June 1st, 1847.

### 3 Dataset

year	births	deaths	clinic
1841	3036	237	clinic 1
1842	3287	518	clinic 1
1843	3060	274	clinic 1
1844	3157	260	clinic 1
1845	3492	241	clinic 1
1846	4010	459	clinic 1
1841	2442	86	clinic 2
1842	2659	202	clinic 2
1843	2739	164	clinic 2
1844	2956	68	clinic 2
1845	3241	66	clinic 2
1846	3754	105	clinic 2

### 4 Clinic 1 vs. Clinic 2

After separating the data between clinic 1 and clinic 2, we were able to calculate the proportion of deaths each year in each clinic. The difference between the two clinic is that in clinic 1, medical students worked and in clinic 2, there were mainly midwives. With this in mind, there is a shocking difference when looking at the two sets of data.

Below is a set of code that allowed the graph contrasting the two clinics to be made using Python.

```
ax = clinic_1.plot(x = "year", y = "proportion_deaths", label = "Clinic 1")

clinic_2.plot(x = "year", y = "proportion_deaths", label = "Clinic 2",
ylabel = "Proportion deaths", ax = ax)\
```



Figure 1: Graph of year vs. proportion of deaths in each clinic

The graph represents the proportion of deaths when compared with the year at each of the two clinics. It can be seen that clinic 2 where many midwives worked at has a much lower proportion of deaths than clinic 1.

## 5 The Effects of Handwashing

In order to look at the effects of handwashing, we were able to pinpoint the exact day that handwashing started. With this information, we split the data into the sections of before handwashing and after handwashing. The code below demonstrates this split and uses Python.

```
# Date when handwashing was made mandatory
handwashing_start = pd.to_datetime('1847-06-01')

# Split monthly into before and after handwashing_start\
before_washing = monthly[monthly["date"] < handwashing_start]
after_washing = monthly[monthly["date"] >= handwashing_start]

# Plot monthly proportion of deaths before and after handwashing
ax = before_washing.plot(x = "date", y = "proportion_deaths",
label = "Before Washing")
after_washing.plot(x = "date", y = "proportion_deaths", label = "After Washing",
ylabel = "Proportion deaths", ax = ax)
```

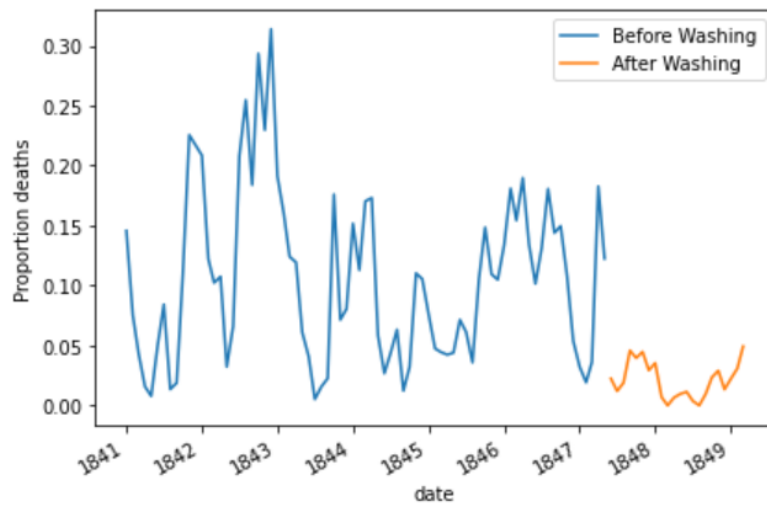


Figure 2: Graph of proportion of deaths each month over the years with a split where handwashing starts

As shown in Figure 2, the implementation of handwashing practices in June 1847 resulted in a stark, permanent decrease in the number of mothers who died during childbirth at these two clinics. Using statistical analysis, Dr. Semmelweis could calculate just how many lives were saved when doctors were recommended to wash their hands before delivering babies.

We were able to perform a t-test on the database to determine a confidence interval, ensuring that these lives saved were most likely the result of enforcing these practices. The code we used to determine this uses the R programming language and is shown below:

```
## Calculating a 95% Confidence interval using t.test
test_result <- t.test( proportion_deaths ~ handwashing_started,
  data = monthly)

## Call Test Result.
test_result
```

## 6 Conclusion

All of the information presented points to handwashing as an essential part of medical care. This is not only important when it comes to giving birth, but any other aspect of healthcare such as surgery. Dr. Semmelweis took a leap and his research led him to a novel discovery. He was able to shape the future success of hospitals and begin the increased survival rate of giving birth. Unfortunately, statistical analysis was not a popular method of proving hypothesis in this time period. Having no physical evidence to submit to his superiors, Dr. Semmelweis was fired from the hospital he worked at for pursuing "irrelevant studies."

Below is the code's final conclusion in the R programming language indicating that doctors should wash their hands as the final solution:

```
## The data Semmelweis collected points to that:  
doctors_should_wash_their_hands <- TRUE
```