Cancellations of Planned Operations in the Scottish NHS

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1 Overview

Analyzing hospital cancellations is crucial for understanding the efficiency and effectiveness of any healthcare systems. The NHS is known to have problems with significant delays, so operation cancellations, a potential reason for increased waiting times, could provide insight into resolving these issues.

This report examines data gathered on cancelled operations in the Scottish NHS between June 2015 and Jan 2024. More specifically, it concentrates on identifying trends in the number of planned operations/cancellations, as well as examining various reasons for cancellation, both overall and by region.

To analyse the data, visualisations and various statistical techniques were used, such as OLS Linear Regression and hypothesis testing. We make the following main conclusions: the predominant reasons for cancelling operations are patient cancellations and clinic-related cancellations, collectively accounting for over 70% of all cancellations. The NHS Borders health board is identified as being severely more at risk of nonclinical capacity related cancellations. Regression applied to the cancellation rate over time shows a slight downward trend, and a two-sample t-test shows no meaningful difference in the mean cancellation rates before and after COVID-19.

Research from this report could be taken further by analysing any seasonal trends that could potentially be found in the data. A pattern that could be investigated is seasonal illness related cancellations, since for example, cases of the flu are more prevalent in winter.

2 Introduction

Context and motivation NHS Scotland, a part of the broader National Health Service (NHS) in the United Kingdom, is the publicly funded healthcare system responsible for providing healthcare services to the population.

The COVID-19 pandemic, caused by the coronavirus SARS-CoV-2, was a global pandemic starting in late 2019 and still impacting the world to this day. It put a lot of strain on healthcare systems around the world, causing overcrowded hospitals and shortages of medical supplies.

The area of this data science study is healthcare analytics, focusing on the cancellation of operations across Scotland, both overall and broken down by health board. Investigating this topic can help us understand where the weak spots lie in NHS Scotland's current health system, and see what regions require special attention. Analysing operations in Scotland could also provide valuable insight into how external factors have affected the Scottish NHS, such as the COVID-19 pandemic.

Previous work Various articles/statistical reports have been carried out on operation cancellations across the United Kingdom.

The Royal College of Surgeons of England published an article [7] stating that over 17,000 operations were cancelled last minute operations in the three month period leading up to the end of June 2023, and that out of those cancellations, 3,954 patients were not treated within 28 days, a breach of NHS standard.

The BBC published an article [1] stating that there was a 35% drop in planned operations in Scotland when comparing December 2019 and December 2020. In December 2020, 7.5% of planned operations in Scotland where cancelled either the day before or on the day.

Objectives The objectives of this study are as follows:

- Analyse the prevalence of cancelled operations in Scotland and identify any predominant cancellation reasons.

- Examine cancellation statistics of various NHS boards across Scotland to determine what regions are most impacted, and by what cancellation reason.

- Determine if there is any overall trend in the operation cancellation rate across the whole of Scotland.

- Determine if the COVID-19 pandemic had a significant effect on the average operation cancellation rates.

3   Data

Data provenance The author of the cancellation datasets used is the PHS (Public Health Scotland) Waiting Times Team, and the data was provided by various NHS Boards. The author of the health board information dataset is the Scottish Government.

All the data was obtained from the OpenData.scot website and is licensed under the OGL (Open Government Licence) [8]. This license allows us to freely access, use, modify and distribute the data, as long as we acknowledge the source of the information [6].

Data description Three datasets where used in the study. The datasets are all in the form of .csv files. Two of the datasets contain information on cancelled operations: cancellations in Scotland and cancellations by NHS board. The other dataset is a data sheet containing details about NHS boards in Scotland. It was used to match the NHS board's identifier codes to its corresponding region name.

The cancellation datasets contain data by month for the period June 2015 to January 2024, and contains the number of planned operations, number of total cancelled operations, and the number of cancelled operations for a series of reasons. The cancellations are divided into four categories: cancelled by patient, cancelled by clinical reason (e.g. patient unwell), cancelled by nonclinical capacity reason (e.g. beds not available) and cancelled by other reason (e.g. fire alarm). The difference between the two datasets is that one contains monthly data for the whole of Scotland, while the other contains monthly data by NHS board.

Data processing The first step in cleaning was removing the empty QF columns from both the cancellation datasets. It was ensured that the data contained no invalid/missing values or duplicate entries. The cancellations by board dataset contained data on a health board with the identification code SB0801. This health board is a singule hospital (Golden Jubilee University National Hospital) and not a regional board like the others in the dataset, so it was was dropped. The cancellations by board and health board datasets were merged, assigning each board identification code its corresponding name.

A totals dataset was created for both cancellations in Scotland and cancellations by health board, summing the values over the entire time period.

Since the different NHS boards will have varying capacities and patient intakes, a percentage cancellation rate variable was added to make comparisons more fair. It was calculated by dividing the number of planned operations by the number of cancellations for every month. The same was done to the totals dataset.

4 Exploration and analysis

We define the COVID-19 period as between 03/2020 and 04/2022, as those are the dates of the start and end of COVID restrictions in Scotland [4].
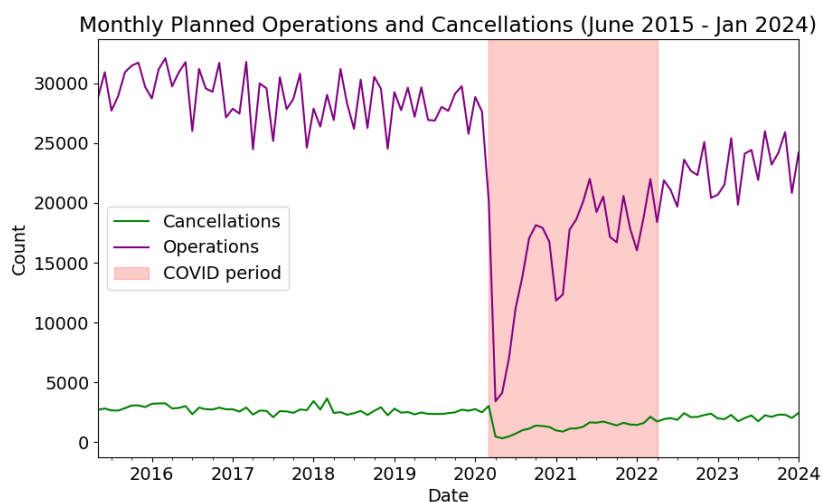

Figure 1: Planned operations and cancellations by month.

Figure 1 shows a steady average of 30,000 planned operations from 2016 to March 2020, the start of the COVID-19 period, where the number of planned operations rapidly plummet to around 5000. Over the next four years, they climb back up to 25,000. A similar pattern can be seen in the cancelled operations, which also has a sudden drop in numbers at the start of the COVID-19 period. The start of COVID-19 appears to have a significant impact on both how many operations were planned and cancelled.

Table 1: Proportions of total cancellations by reason (%)

Cancellation reason	% of total cancellations
Cancelled by patient	36.13
Clinical	35.23
Nonclinical capacity	24.02
Other	4.62

Table 1 shows that the most common reasons for a cancellation are either patient-initiated cancellations or those arising from clinical reasons, being the cause for just over 70% of all cancelled operation. A patient being sick is included under the clinical reason for cancellation, so it is possible that the high amount of clinical cancellations are due to COVID-19. Other is the least significant reason for cancellation, causing only 5% of overall cancelled operations.

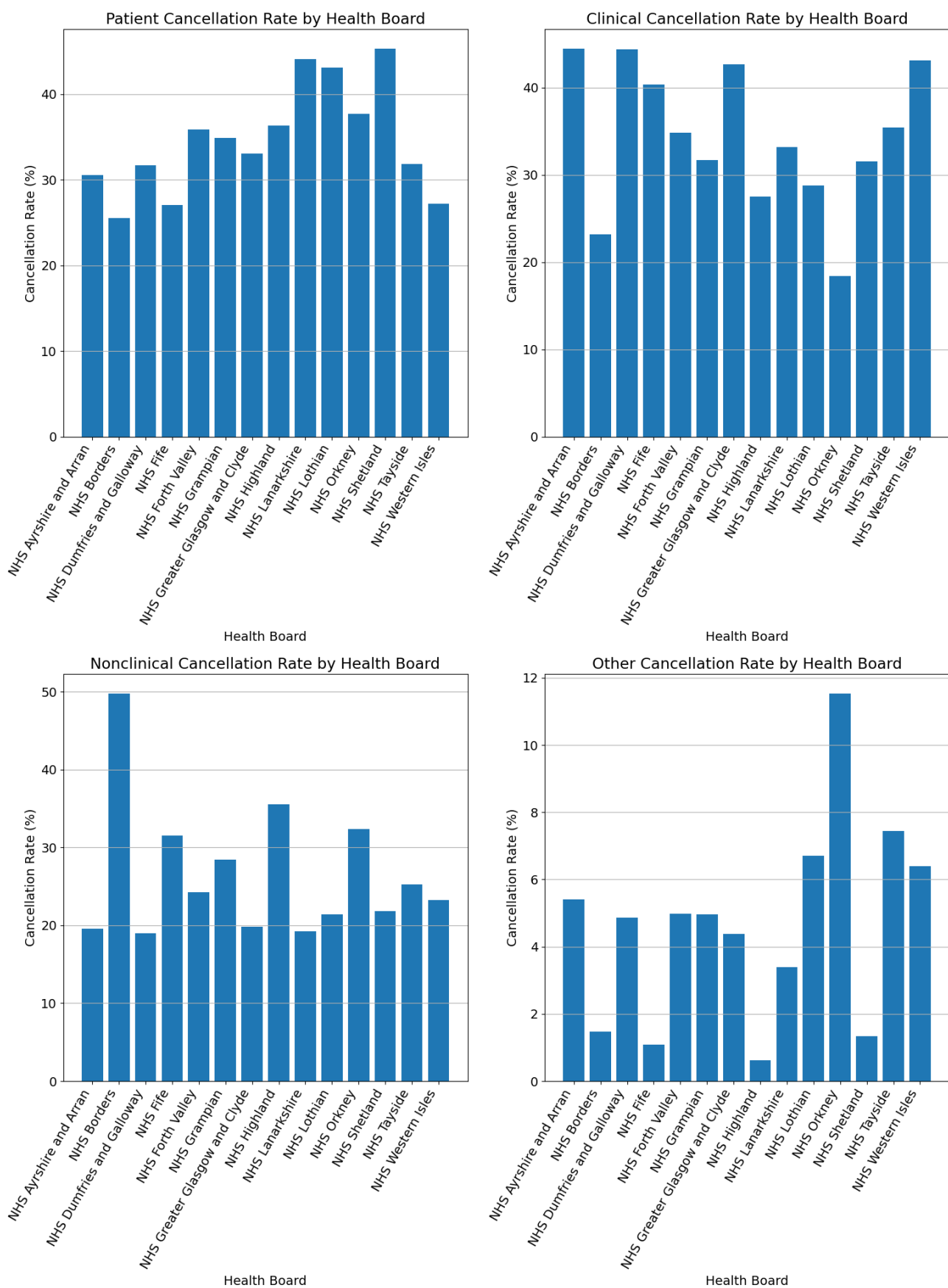Figure 2 shows us cancellation rates for each cancellation reason by health board.

Figure 2: Cancellation rates for each reason by NHS Board. Note the y-axis scales vary for each subplot.

Looking at patient cancellation rates by health board shows no particularly interesting patterns, with NHS Shetland, NHS Lothian and NHS Lanarkshire being the most at risk.

From the clinical cancellation rates graph we can infer that NHS Ayrshire and Arran, NHS Dumfries and Galloway and NHS Western Isles suffer the most from clinical related operation cancellations.

The board with the highest rate of nonclinical cancellations is NHS Borders, accounting for just under 50% of cancellations in that region. An article by the BBC discussed the high number of "bed-blockers" (patients who are well enough to go home but stay in the hospital) in the NHS Borders health board [2]. The article states that they took up just under one in three beds at the Borders General Hospital. This could potentially be the reason behind the high rate of of nonclinical cancellations, which include cancellations due to lack of bed capacity.

NHS Orkney is most at risk of cancellations for reasons under the Other category. This includes cancellations due to patient/staff travel issues, so one potential cause of this pattern is due to the fact that Orkney is a group of islands, making travel to and from it tedious. For example, a surgeon travelling from another hospital would have to fly in or take a boat, which could be delayed by bad weather.
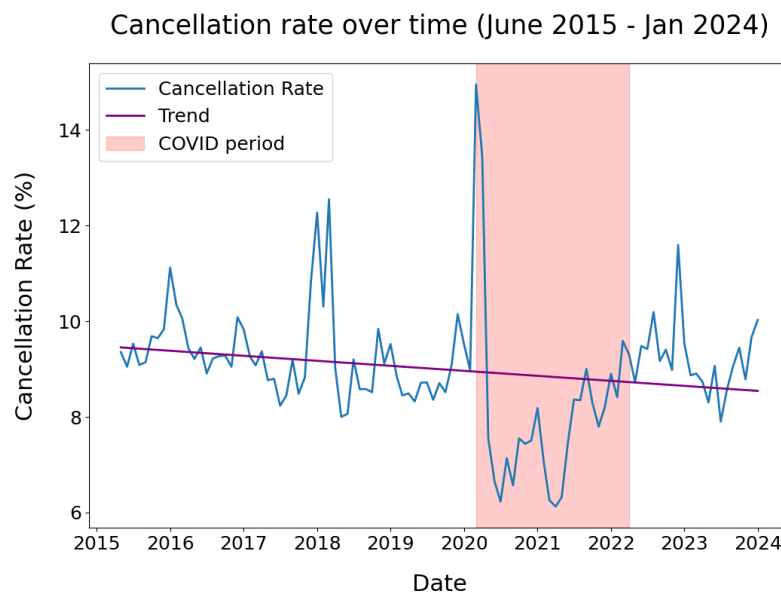

Figure 3: Operation cancellation rates across Scotland by month

Figure 3 shows notable fluctuations in the cancellation rate. Most glaringly, it exhibits a sharp increase to an all-time high of 15% at the onset of the COVID-19 pandemic, succeeded by a rapid decline to 6%. OLS Linear Regression was employed to examine if there is any trend in the data.

Table 2: OLS Linear Regression Results

Slope	Intercept	R-squared	P-value	Standard error
-0.008738	9.452531	0.040374	0.039849	0.004197

Table 2 shows the results of our OLS Linear Regression. The coefficient of determination (R^2) is 0.040374, indicating that the regression accounts for only a small portion of the variability in the cancellation rates. We conclude that the cancellation rate across Scotland is relatively stable, with a minor downward trend.

We can perform a two-sample t-test, a statistical method used to determine if there is a significant difference between the means of two independent groups to compare the mean cancellation rate before

and after the COVID-19 period.

Let μ_x and μ_y denote the means of the pre-COVID-19 and post-COVID-19 cancellation rates respectively. Since we wish to investigate if there is any difference (i.e. no direction), we propose to investigate the following hypotheses:

$$H_0 : \mu_x = \mu_y \text{ versus } H_1 : \mu_x \neq \mu_y$$

We compute the observed test statistic $t = 0.23$. At the 5% significance level, the critical region is $C = \{t : |t| \geq 1.99\}$, where the critical value is $t_{77;0.025} = 1.99$ (to 2 d.p.).

We observe that $t \in C$, so we can conclude by failing to reject the null hypothesis of equal population means at the 5% significance level.

5 Discussion and conclusions

Summary of findings Overall, our analysis of cancelled operations in the Scottish NHS has provided several key insights. We found that patient-initiated cancellations and clinical reasons were the predominant causes of cancelled operations, collectively accounting for over 70% of all cancellations. NHS Borders emerged as the health board most affected by nonclinical capacity related cancellations, with a potential link to bed availability. The linear regression we conducted revealed a slight downward trend in the cancellation rate across Scotland, although it appears to be influenced by other unknown factors. Additionally, our two-sample t-test found no significant difference in the means of the cancellation rates in the pre-COVID-19 and post-COVID-19 periods, suggesting that the pandemic has not had much of a long term effect on cancellation rates.

Evaluation of own work: strengths and limitations The main strengths of this study are the interesting patterns it found in the data, more specifically, the effect of COVID-19 on cancellations and the potential connection between cancelled operations and the lack of bed availability in the NHS Borders health board. The main weakness of this study is that there are possibly unaccounted external factors at play. This is due to the high variance of the graphs plotting cancellation rates over time. This, as well as the sharp spike caused by COVID-19 skews our linear regression, making it a less reliable model for predicting cancellation rates in the future.

Comparison with any other related work Public Health Scotland published an Official Statistics publication analysing the same cancellation datasets as this study [5]. This short article only looks at November 2019 to November 2021 period. It compares the percentage of planned operations at various months individually, something we did not examine.

Cima and Almeida (2022) [3] examines the impact of cancellations on waiting time analysis. The study concludes that not taking cancellations into account when examining wait times can produce biased results, missing patterns such as age bias. This emphasises how important it is to examine cancellation statistics.

Improvements and extensions One extension could involve analyzing clinical cancellation rates according to seasonal variations. Given that the winter months typically witness a rise in flu cases and other seasonal illnesses, it makes sense to hypothesise that there will be an increase in cancellation rates due to patients being sick. Another possible extension is to investigate cancellation reason statistics by hospital. It would be interesting to see if there are any particular hospitals which suffer from one type of cancellation specifically, and if that has any relation to the NHS board in which the hospital is located.

References

[1] BBC. *Covid in Scotland: Planned NHS operations drop 35% in December*. URL: `https://www.bbc.co.uk/news/uk-scotland-55901799`.

[2] BBC News. *Public plea as NHS Borders bed-blocking hits record higher*. 2023. URL: `https://www.bbc.co.uk/news/uk-scotland-south-scotland-67403488`.

[3] Joana Cima and Álvaro Almeida. "The impact of cancellations in waiting times analysis: evidence from scheduled surgeries in the Portuguese NHS". In: *The European Journal of Health Economics* 23 (2022). URL: `https://doi.org/10.1007/s10198-021-01354-5`.

[4] Wikipedia contributors. *Timeline of the COVID-19 pandemic in Scotland (2020) – Wikipedia, The Free Encyclopedia*. URL: `https://en.wikipedia.org/wiki/Timeline_of_the_COVID-19_pandemic_in_Scotland_(2020)`.

[5] Public Health Scotland. *Cancelled planned operations*. URL: `https://publichealthscotland.scot/publications/cancelled-planned-operations/cancelled-planned-operations-month-ending-30-november-2021/`.

[6] Public Health Scotland. *Cancelled Planned Operations Dataset*. URL: `https://www.opendata.nhs.scot/dataset/cancelled-planned-operations`.

[7] Royal College of Surgeons of England. *Operations cancelled at last minute*. URL: `https://www.rcseng.ac.uk/news-and-events/media-centre/press-releases/cancelled-operations-june-2023/`.

[8] The National Archives. *Open Government Licence version 3*. URL: `https://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/`.