The Networked Data Lab

Topic 5: Waiting Lists Final Report

NDL [*Leeds*]

Joshua Elvidge-Murgatroyd, Helen Butters, Anna Palczewska, Frank Wood

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[V0.2]

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1. Introduction

As of December 2024, the hospital treatment waiting list in England exceeded 7.5 million patients, commonly known as the "elective care" or "RTT" (referral to treatment) waiting list (NHS England, 2024). This figure included approximately 6.2 million unique patients, as some individuals were on multiple pathways. Among those waiting, 200,375 patients had been on the list for more than 52 weeks, 15,568 for over 65 weeks, 2,059 for more than 78 weeks, and 155 for over 104 weeks. Only 58.9% of cases met the NHS standard of receiving treatment within 18 weeks, falling short of the 92% target (last year NHS target).

In December 2024 alone, 1,549,314 new RTT pathways were initiated, marking the start of new treatment periods. During the same month, 275,241 pathways were completed through admitted treatment, while 1,059,598 were completed through non-admitted routes. At the end of December, the median waiting time for patients yet to start treatment was 14.2 weeks, while the 92nd percentile waiting time stood at 42.7 weeks.

The NHS Constitution stipulates that patients referred for non-cancer pathway consultant-led treatment should begin treatment within 18 weeks, with the target being that 92% of those on the waiting list should wait less than 18 weeks, and a 'zero tolerance' policy for waits over 52 weeks (NHS England, 2022).

The Labour Party has outlined a comprehensive plan to revitalize the National Health Service (NHS) (Labour Party, 2025) and ensure it meets future healthcare demands. Central to this plan is the reduction of NHS waiting times by introducing 40,000 additional appointments weekly, effectively providing an extra two million operations, scans, and consultations annually. This initiative aims to address the backlog and enhance patient access to timely care. To improve diagnostic capabilities, Labour proposes doubling the number of cancer scanners, facilitating earlier detection and treatment of cancer. Recognizing the critical need for mental health services, the plan includes the recruitment of 8,500 additional mental health professionals, ensuring that support is accessible and comprehensive.

On 30 January 2025, NHS England released its operational planning guidance for 2025/26, outlining key priorities for healthcare improvement. The plan focuses on four main objectives: (1) reducing elective care waiting times, aiming for at least 65% of patients to receive treatment within 18 weeks; (2) enhancing emergency care by improving ambulance response times and ensuring a minimum of 78% of A&E patients are seen within four hours; (3) expanding access to general practice (GP) and urgent dental care, including the provision of 700,000 additional urgent dental appointments; and (4) accelerating patient flow in mental health crisis services and outpatient care pathways to improve overall service efficiency (NHS England, 2025).

Similarly on a local level the Elective Recovery and Planned Care program is working to meet the following objectives: no patient to wait 48 weeks or more by March 25, Reducing the Outpatient RTT waiting list by 10% and focusing on Ear, Nose, Throat (due to large numbers). The local partnership is also working towards meeting the nationally set waiting list target of treating all patients waiting 65 weeks or more by the end of September 2024 (West Yorkshire Accisioation of Acute Trust, 2024)

To address the objectives for Ear, Nose, Throat (ENT) the following action has been taken: developing a directory of GPs with Extended Roles (GPwER) and maximizing their roles in ENT pathways, a newly planned pilot programme with the Tympa platform[1] to increase access and

[1] Tympa Platform - TympaHealth

delivery of ear and hearing care in West Yorkshire, the new ‘super clinic’ at Mid Yorkshire Teaching NHS Trust to see, treat and discharge patients in a session.

Leeds Teaching Hospital Trust currently addresses a challenge to improve the number of cataract cases seen in theatre following GIRFT[2] guidance by planning new cataract pathways by reducing the number of appointments and introducing (One Stop Clinic)[3].

The biggest local challenge is to reduce numbers for outpatients’ appointments, Currently, in local trusts there are 82% of patients on RTT pathways waiting to see a consultant in an outpatient clinic. The goal is to reduce the non-admitted waiting list by 10% overall (21,000 fewer patients this time next year). This will support the objective to ensure no patient waits more than a year for treatment by March 2025. Trusts will continue to work towards reducing the number of unnecessary follow-up appointments, whilst recognising that there is a backlog of follow-up patients who still need to be seen.

Additionally, the Leeds system Priorities included the following KPI to achieve by March 2025 (Leeds Health & Care Partnership, 2024):

- The number of incomplete Referral to Treatment (RTT) pathways (patients yet to start treatment) of 65 weeks or more (especially around Gynaecology, Trauma and Orthopaedics, Paediatrics)
- Reduce the number of cancer patients waiting for over 62 days.
- Meet the cancer faster diagnosis standard by March 2024 so that 75% of patients who have been urgently referred by their GP for suspected cancer are diagnosed or have cancer rules out within 28 days.
- Increase the percentage of patients that receive a diagnostic test within 6 weeks in line with the March 2025 ambition of 95%.

To address the above priorities, a better understanding of patients’ characteristics and their health conditions is required. This will provide support in understanding who is waiting and what additional care is needed while waiting to support patients and to adequately plan strategies to reduce waiting times. The Leeds NDL team will contribute towards this by identifying inequalities and consequences of waiting as the main project aims.

The scoping phase showed that there is limited usability of the national Waiting List Minimum Dataset (WLMDS) dataset. The Leeds Office of Data Analytics (ODA) created a dashboard for monthly RTT reports for the financial year 2023-2024 showing numbers for incomplete pathways. North of England Care System Support (NECS) our commissioning support service with South Yorkshire ICB have developed an enhanced dashboard RAIDR National Elective Waiting List Dashboard Development[4]. The main use of this dashboard is to report the current waiting cohort, determine health inequality, and analyse patients moving through the system on selected pathways.

The RAIDR System uses WLMDS dataset, a weekly data collection. This national dataset has been flowed to West Yorkshire ICB data warehouse, and it is the main data source for this analysis. The pre analysis showed a problem with the flow of patients between different waiting lists as well as data quality issues, which has not been addressed in the RAIDR

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2 Further Faster Programme - Getting It Right First Time - GIRFT
3 Cataract Pathways and One Stop Clinics (youtube.com)
4 RAIDR NEWL

documentation. Thus, quantifying data quality and proposing preprocessing methods will be one of the objectives of this project.

Discussion with local stakeholders has helped to identify the following areas of interest to understanding impact of waiting for: gynaecology diagnostics, gall bladder removal and hip replacement as a procedure that impact patients' quality of life. These characterise with the increased return to health care services for prescription, GP visits and AE and non-elective admission. Also, the areas of orthopaedics related to hip replacement is one of the local interest due to large numbers of waiting patients.

In 2023 HealthWatch interviewed over a thousand patients who have their NHS care cancelled or postponed (HealthWatch, 2023). They found 39% of surveyed patients had their NHS care cancelled or postponed two or more times in that year. This included hospital operations, tests, scans, outpatient appointments, and community health service appointments. 18% of the respondents have had their care cancelled or postponed at the last minute, and 45% experienced a cancellation with between one- and seven days' notice. 66% said cancellations had impacted their lives, reporting ongoing pain, worsening mental health, worsening symptoms, and disrupted sleep, among many other problems. Around 40% of respondents were told or believed their cancellation was due to industrial action in the NHS. Additionally, another 40% of responders said their care was cancelled for another reason; and 20% did not know why. Local stakeholders also suggested analysing missed appointments (did not attend DNA) and cancelations as they have a significant impact on the waiting lists.

The proposed NDL analyses aim to explore elective waiting list by defining elective patients' pathways with the activities on referral to treatment (RTT) periods, together with non-RTT events by linking this data to primary and secondary care data. To achieve this, a set of research questions have been identified and grouped into four general themes. These include:

1. Describing wait lengths of 'referral to treatment' pathways for patients waiting for elective NHS care, and how they vary between specialties, demographic groups and patient health characteristics.

2. Describing the reasons patients are removed from the NHS elective care waiting list, and how they vary between specialties, demographic groups and patient health characteristics.

3. Describing and compare patients' primary and secondary healthcare use before and after waiting for elective treatment, by specialty and by patient demographic and health characteristics.

4. Assessing the causal impact of waiting for longer periods of time on healthcare usage and costs.

The research questions related to each analysis theme are summarised in Tables 1 - 4.

Table 1 Describe wait lengths of 'referral to treatment' pathways for patients waiting for elective NHS care.

Objective 1: Describing wait lengths of 'referral to treatment' pathways for patients waiting for elective NHS care		
Output no.	**Research Questions**	**Analytical Output**

1.1	How many patients are waiting for <=18 weeks, >18 weeks, >36 weeks and >52 weeks for elective NHS care?	Counts and proportions of all patient pathways stratified by wait length
1.2	What specialties have people waiting for <=18 weeks, >18 weeks, >36 weeks and >52 weeks been referred to?	Counts and proportions of all patient pathways stratified by wait length and specialty
1.3	What are the demographic characteristics of patients waiting <=18 weeks, >18 weeks, >36 weeks and >52 weeks?	Counts and proportions of all patient pathways stratified by wait length and demographic variables
1.4	What are the health characteristics of patients waiting <=18 weeks, >18 weeks, >36 weeks and >52 weeks?	Counts and proportions of all patient pathways stratified by wait length and health characteristics
1.5	How does mean and median length of wait differ between specialties, demographic groups and health characteristics?	Mean, median, SD and IQRs of completed patient pathways lengths stratified by specialty and patient demographic and health characteristics

Table 2 Describe the reasons patients are removed from the NHS elective care waiting list

Objective 2: Describing the reasons patients are removed from the NHS elective care waiting list		
Output no.	**Research Questions**	**Analytical Output**
2.1	What are the reasons that people are removed from the NHS elective care waiting list?	Counts and proportions of completed patient pathways stratified by reason for clock stop
2.2	How do the reasons that people are removed from the NHS elective care waiting list vary between specialties?	Counts and proportions of completed patient pathways stratified by reason for clock stop and specialty
2.3	How do the reasons that people are removed from the NHS elective care waiting list vary between demographic groups?	Counts and proportions of completed patient pathways stratified by reason for clock stop and patient demographics
2.4	How do the reasons that people are removed from the NHS elective care waiting list vary by patient health characteristics?	Counts and proportions of completed patient pathways stratified by reason for clock stop and health characteristics

Table 3 Describe and compare patients' primary and secondary healthcare use before and after waiting for elective treatment.

Objective 3: Describing and compare patients' primary and secondary healthcare use before and after waiting for elective treatment		
Output no.	**Research Questions**	**Analytical Output**
3.1	How much healthcare do patients use before, during and after waiting?	Counts of healthcare use by point of delivery in the three months prior to referral,

		over the waiting period, and in the three months after treatment
3.2	Does healthcare use before, during and after waiting vary between specialties?	Counts of healthcare use by point of delivery in the three months prior to referral, over the waiting period, and in the three months after treatment stratified by specialty
3.3	Does healthcare use before, during and after waiting vary between demographic groups?	Counts of healthcare use by point of delivery in the three months prior to referral, over the waiting period, and in the three months after treatment stratified by patient demographics.
3.4	Does healthcare use before, during and after waiting vary by patient health characteristics?	Counts of healthcare use by point of delivery in the three months prior to referral, over the waiting period, and in the three months after treatment stratified by patient health characteristics

Table 4 Assess the causal impact of waiting for longer periods of time on healthcare usage and costs

Objective 4: Assessing the causal impact of waiting for longer periods of time on healthcare usage and costs		
Output no.	**Research Questions**	**Analytical Output**
4.1	What is the effect of waiting for treatment for an additional [x] weeks for [y] procedure on healthcare use for [z] point of delivery?	Difference-in-difference analysis comparing the healthcare use of above-target waiters to target or below target waiters for [y] procedures and [z] points of delivery
4.2	What is the effect of waiting for treatment for an additional [x] weeks for [y] procedure on healthcare cost incurred for [z] point of delivery?	Cost-weighted results of the difference-in-difference analyses performed for output 4.1
4.3	What are the demographic and health characteristics of patients in the cohorts compared in output 4.1?	Descriptive statistics of patient demographic and health characteristics of the cohorts compared in the difference-in-difference analyses performed for output 4.1

2. Methods

2.1 PPIE and stakeholder engagement

Firstly, we put together an insight report to understand the experiences, needs and preferences of patients waiting for care and treatment. The main themes identified were: waiting times are longer and it is harder to access GP services post-COVID-19, staff not listening to issues especially to the elderly, advocacy is so important to help and speak up for patients/carers, people are using other services whilst waiting, for example, physiotherapy, hospital admissions, and social prescribing activities, waiting can have a financial impact on people resulting in being unable to work or funding private treatment, impact on physical health with health deteriorating resulting in poorer outcomes, impact on mental health often resulting in anxiety and depression whilst waiting and unable to undertake daily tasks which could result in social isolation. This information influenced the analysts' areas of interest mainly around health care utilisation.

Next, Healthwatch Leeds was commissioned to facilitate the participation of local Leeds residents in focus groups. Ten patients who had been waiting for more than 52 weeks were recruited. The panel included a balanced mix of male and female participants from British and Indian backgrounds. Panel members shared their personal experiences and helped analysts identify gaps in the data while providing recommendations for improvement.

There were four meetings where patients discussed their experiences with accessing healthcare, waiting times, and the support needed during their wait. The third meeting focused on gathering feedback on preliminary results and facilitating discussions on key local issues that should be addressed through further analysis and patient experiences. And final meeting was based on the results, patient help to formulate the recommendations.

Parallel with engaging with group, we developed a survey to gather wider experience of patients waiting for treatment longer than > 52 weeks.

2.2 Data extraction & processing

The Leeds Data Model is a pseudonymised, personal level linked data set bringing together data from the range of a partner organisation delivering health and care to the people of Leeds. The model provides the ability to identify specific cohorts through our population segments model to which we can compare service utilisation, prioritise service and help to plan existing or new services.

This data is restricted to Leeds GP registered patients who have not opted out of data sharing for secondary use. Data is linkable via anonymised patient id.

These data are hosted by North England Commission Support (NECS) and accessed through secure connection to a virtual data warehousing environment, and the cloud services. Datasets for this study are listed below.

Data sets

- WLMDS - The Waiting List Minimum Dataset (WLMDS) is a weekly data collection relating to demand, activity and waiting lists for elective care. The data started to be flown on January 2024 to the WYIC warehouse and covers data from April 2021 when providers began submitting data to WLMDS on a weekly basis. It contains collections of: RTT open (incomplete) pathways, RTT clock starts (new RTT periods), RTT clock stops (completed pathways) and RTT Diagnostics.

- Secondary Uses Service (SUS), containing inpatient attendances, outpatient appointments, and A&E visits. The extract of the data is available for Leeds NDL team via LDM, including information related to the service provision and where available RTT period.
- LDM Cohort table – Leeds GP registered patients record with the demographic information and long-term condition flags. These were retrieved from Primary Care Systems (TPP/EMIS)
- LDM GP data - including information about patients' appointments.
- LDM GP Events - Read/SNOMED for GP patient's appointments.
- LDM Prescription - BNF codes for GP issued prescriptions.
- Death Records

2.3 Data analysis

The descriptive portions of this study (objectives 1-3) will employ a retrospective cohort design to explore the wait lengths, pathway outcomes, and various health and demographic breakdowns of the elective care waiting list. The causal analysis (objective 4) will use a difference-in-difference study design to assess the effect of waiting for longer than target periods of time on healthcare use and costs.

2.3.1 Study design

This study is intended as a retrospective observation of patient pathways during the study period, aiming to understand which, if any, personal characteristics affect waiting times along with additional analyses into utilisation of healthcare for those who are waiting.

2.3.2 Study period

The patients being referred to a specialty between 1st of April 2022 and 31st of March 2024 will be used to construct the study population. The follow up period will be 6 months after treatment for patients being treated by March 2024. The outcome variables (see **Section 2.3.4**) will be obtained based on primary, secondary, and waiting list data.

2.3.3 Study population

There are three cohorts considered for the descriptive portion of this analysis:

Cohort 1: All new referrals onto the elective waiting list (i.e., unique pathways with a patient pathway ID and clock start) between 1 April 2022 and 31 March 2024. This will include some patients without a clock stop (incomplete pathways). This cohort will be used to create outputs 1.1 - 1.4, as well as being the basis for all further cohorts.

Cohort 2: Of Cohort 1, all pathways with a definitive end within the study period, of any kind. This cohort will be used to create the outputs 1.5 and 2.1 – 2.4, as well as being the basis for cohort 3.

Cohort 3: Of cohort 2, all pathways ending in a definitive treatment (treatment status = 30, to filter out patients on active monitoring) and with patient-level linkage to local electronic health records. This cohort will be used to create outputs 3.1 – 3.4.

For the causal analysis (objective 4), the following cohort is defined:

Cohort 4: Of cohort 3, all pathways for procedures of choice. This cohort will be used to create outputs 4.1 – 4.3.

2.3.4 Definitions of outcomes and exposures

Figure 5 presents the summary of the information retrieved for this study.

Table 5 Definitions of outcomes and exposures

Type of variable (outcome or exposure)	Definition criteria	Dataset(s) from which the variable is derived	Other comments (including external references)
Outcome variable	A&E Visits	SUS	Major A&E attendances as primary outcome; also

			report type 2/1/minor units if available
	OP Visits	SUS	
	Elective Admission	SUS	
	Non-Elective Admission	SUS	
	Death	Death Record	
	GP Visits	GP	Measured as number of contacts (exclude multiple contacts on same day)
	Prescription	GP	Measured as number of unique drugs prescribed
	Pain Prescription	GP	Measured as number of unique drugs prescribed
	Antidepressants	GP	
	Antibiotics	GP	
Exposure variable	Age	LDM Cohort	
	Age Band	LDM Cohort	
	Gender	LDM Cohort	
	Ethnicity	LDM Cohort	
	IMD 2019	LDM Cohort	Area deprivation of patient residence
	PCN	LDM Cohort	Primary Care Networks based on registered GP practice of patient
	Frailty index (eFI)	LDM Cohort	Electronic Frailty Index, a measure of patient frailty, incorporates 36 deficits constructed using 2,171 CTV3 codes
	LTC Count	LDM Cohort	Recorded as “Single LTC”, “Comorbidity”, “Multimorbidity”, and “NA” for no record of LTC
	LTC	LDM Cohort	The presence of a set of long-term conditions flagged in existing LTC table.

2.3.5 Statistical approaches

Objective 1: Describing wait lengths of 'referral to treatment' pathways for patients waiting for elective NHS care, and how they vary between specialties, demographic groups and patient health characteristics

For outputs supporting objective 1, wait lengths are divided into groups based on the nearest whole week (e.g. – someone who received their treatment at 128 days would be assigned to the <=18 weeks group, while someone waiting for 132 days would be assigned to the >18 weeks group). If the day is equidistant from its nearest whole weeks, assign to the lower group (e.g. a 130-day waiter would be assigned to the <=18 weeks group).

For all pathways (Cohort 1), we reported the number and percentage of patient pathways by waiting time category. For completed pathways (Cohort 2), mean, median, standard deviation and inter-quartile ranges were supplied for waiting times in days. In both cases, it was stratified by:

- Specialty
- Sex
- Age band
- Ethnic category (ONS categories)
- IMD quintile (national IMD with all components)
- Number of comorbidities
- Electronic frailty index categories (if available)

Objective 2: Describing the reasons patients are removed from the NHS elective care waiting list, and how they vary between specialties, demographic groups and patient health characteristics

Pathway outcome is defined by the stated reason for clock stop given in the RTT data. If no reason is available due to the clock stop being imputed during processing, the value “Missing – imputed clock stops” is imputed.

For completed pathways (Cohort 2), the number of patient pathways falling into each clock stop category and the percentage they represent of the total cohort were reported and broken down by:

- Specialty
- Sex
- Age band
- Ethnic category (ONS categories)
- IMD quintile (national IMD with all components)
- Number of comorbidities
- Electronic frailty index categories (if available)

Objective 3: Describing and compare patients’ primary and secondary healthcare activity before, during and after waiting for elective treatment

For completed pathways with a definitive treatment (Cohort 3) and patient-level linkage to local electronic health records, we reported healthcare use for each of the outcome variable described in **Section 2.3.4.** Healthcare use was reported across three time periods: the three months prior to referral; across the total waiting period; and the three months following treatment. Patients for whom an insufficient follow-up period is available were excluded. For these time periods, we reported:

- Total healthcare use for each given point of delivery over that period for the whole cohort.
- The size of the cohort (in persons-pathways for the 3 months prior to referral and 3 months following treatment; in person-weeks for whilst waiting)
- Mean, median, SD and IQR of healthcare use for each given point of delivery (over the whole period for the 3 months prior to referral and 3 months following treatment; per week for whilst waiting)

The results were stratified by the following patient pathway characteristics:

- Specialty
- Sex
- Age band
- Ethnic category (ONS categories)
- IMD quintile (national IMD with all components)
- Number of comorbidities
- Electronic frailty index categories (if available)
- Wait length (<=18 weeks, >18 weeks, >36 weeks, >52 weeks).

Objective 4: Causal Analysis

To assess the impact of waiting for long periods of time on health care usage and costs, we proposed a set of difference-in-difference comparisons where a group who waited for 18 weeks or less are compared to groups who waited for longer periods of time. These comparisons would be conducted as difference-in-differences covering the entire period of waiting for each group and a follow up period after waiting, with the period immediately after treatment removed. The follow-up period, where both groups have received their procedures, would be the reference time (time = 0), while the period of waiting would be our intervention period (time = 1). The after-procedure period is likely a better approximation of the "normal" relationship between the healthcare use of these two groups than the period prior. The intervention in this case would be having an "excessive wait time".

To assess for the effects of having to wait for various ranges of time, we proposed dividing the groups of above-target waiters into a few sub-groups based on their time of waiting. Each of these groupings would then be separately compared to the control group (target-time waiters) in a series of difference-in-difference comparisons. From these comparisons, could estimate the effect of having waited for various periods of time beyond a given target on healthcare use and attendant costs.

This analysis was conducted on cohort 4, detailed in **Section 2.3.3**. Demographic and health characteristics of the cohort for each procedure, split by wait time group, primary care use and emergency use.

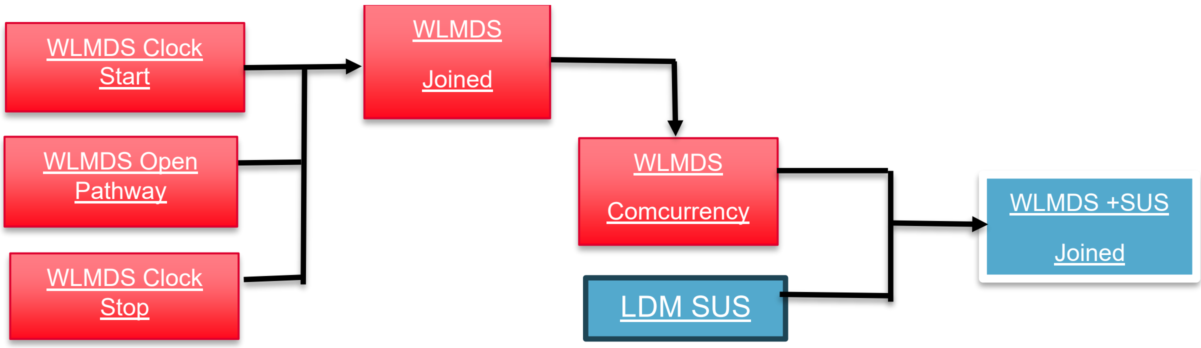
2.3.6 Methods for addressing missing data

Waiting list data was categorized into four lists: Clock Start, Open Pathway, Clock Stop, and Diagnostics. The latter was not used in this study. Data from Clock Start, Open Pathway, and Clock Stop were submitted weekly, resulting in multiple entries for each patient pathway, particularly for open pathways.

The data preprocessing followed the approach proposed by the NHS England team to create the Elective Patient Pathways (EPP) dataset. This dataset integrates relevant Secondary Uses Services (SUS) data and the Waiting List Minimum Dataset (WLMDS) into a unified dataset to analyse Referral to Treatment (RTT) and post-RTT hospital activity. The EPP dataset provides insights into the interactions between different elective services across RTT periods and patient pathways.

The methodology used in developing Version 1 (V1) of the dataset involved linking information from different data tables and grouping records by RTT periods and patient pathways (defined by Patient ID and Treatment Function Code (TFC); see Figure 1). This approach addressed several data quality issues, such as duplicate records, input errors, and missing data, by leveraging:

Figure 1 Data preprocessing



- RTT rules,
- The WLMDS data collection framework,
- Expert knowledge from WLMDS & SUS, and
- Insights gained from reported datasets.

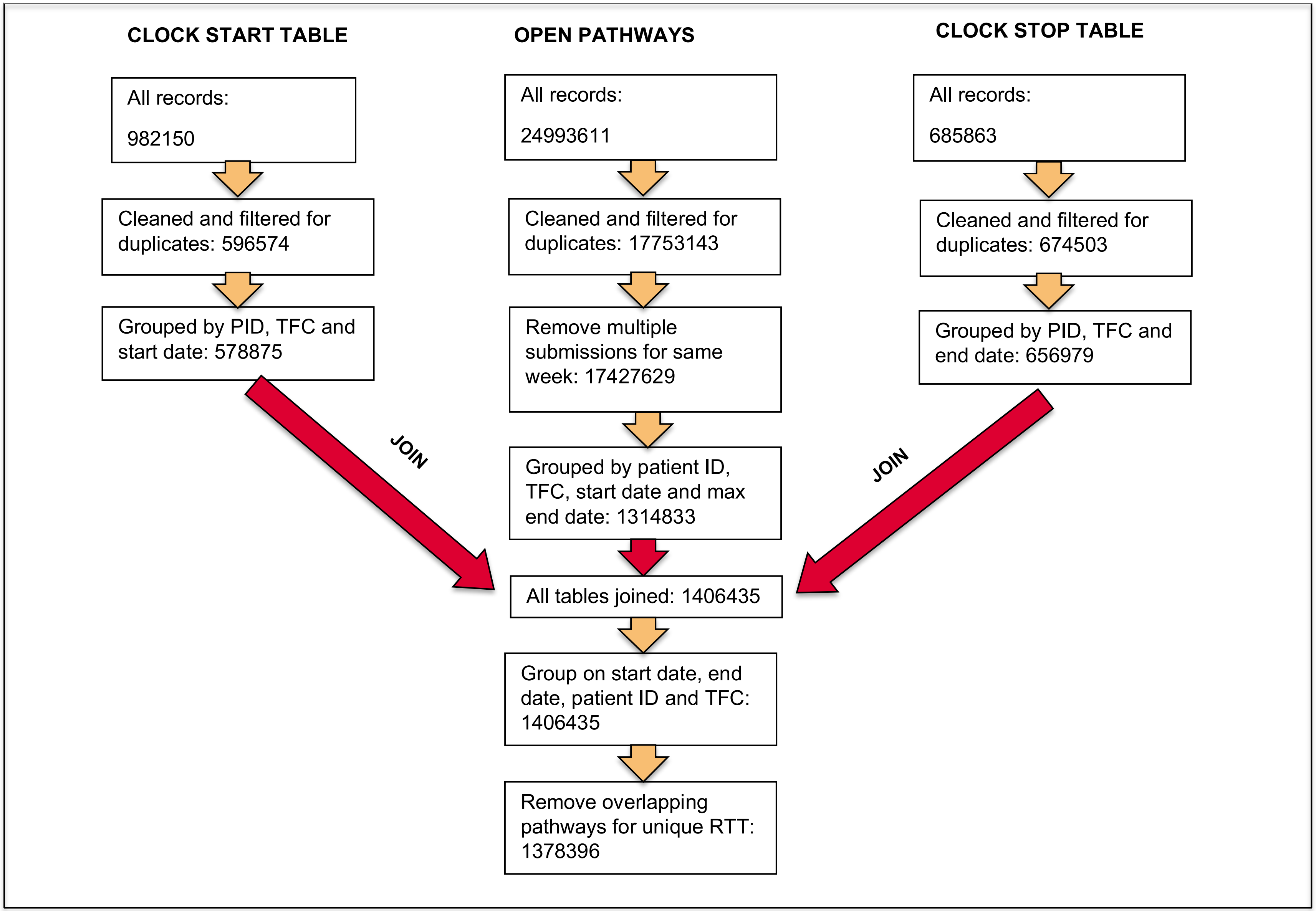
The individual records were processed to consolidate each patient's RTT period into a single record, spanning from the clock start to the clock stop. Figure 2 shows the flow for preprocessing the separate list records with the number of instances left after each step. The number present the number of records available in Leeds warehouse from May 2021 until December 2024

The key variables used for merging records were Patient ID, TFC, and clock start date. Missing information was imputed where possible using available waiting list records. When clock start and stop dates were missing, they were derived using the minimum and maximum week-ending dates. The reported clock start and stop dates were prioritized over derived ones. Additional information, such as TFC, priority status, Did Not Attend (DNA) date, cancellation date, and date-to-admit, was determined by selecting the most recent non-empty reported value for each patient pathway. Records lacking a Patient ID or containing date errors were removed before preprocessing.

Clock start and stop dates were crucial for the analysis and were imputed where necessary. Although these values existed in all data sources, they were however nullable. Since three data sources were integrated before linking to SUS data, these dates were coalesced sequentially based on predefined priority rules. Start dates were assigned by selecting the first non-null value in the order of Clock Start, Open Pathways, and Clock Stop. If no clock start date was found after this process, an imputation was attempted using the submission week of the record, introducing a potential inaccuracy of up to seven days. Similarly, clock stop dates were assigned using the first available non-null value, prioritizing Clock Stop, followed by Open Pathways and Clock Start.

Imputing missing clock start and stop dates and linking records resulted in the creation of multiple RTT periods for the same pathway. To manage overlapping RTT periods, concurrency adjustments were implemented. These adjustments either consolidated multiple overlapping RTT periods into a single longer period or separated them into distinct RTT periods. End dates were noted to be affected by data quality problems and had high occurrences of null values. These were imputed using the submission date for the clock stop in the case that a reported end date was not available. This derivation led to uncertainty in some cases where an end date may not necessarily need to exist but was nonetheless imputed. To counteract this, reported end dates and start dates were trusted where possible. Functionally, this meant that if an imputed end date was before the next start date, the end date was adjusted to be one day before the next start date.

Figure 2 Data preprocessing flow.



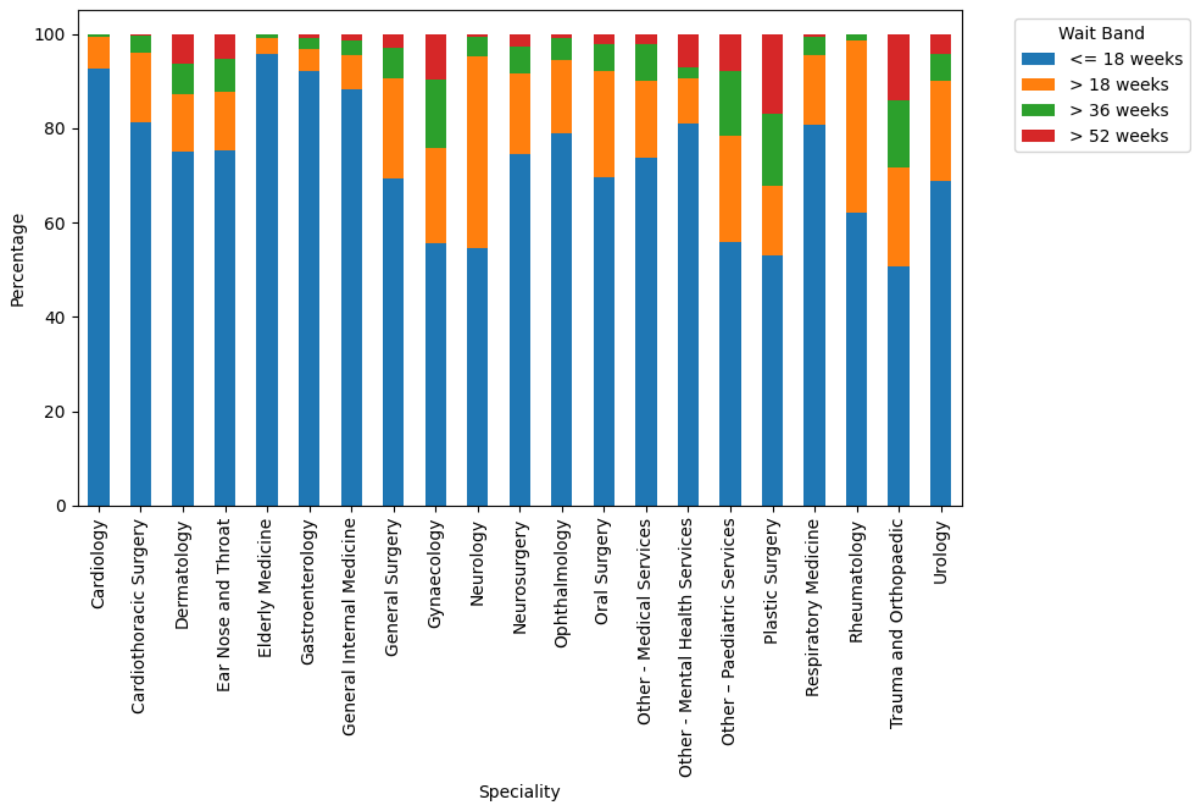
3. Results and Discussion

3.1 Descriptive analysis (Objectives 1-3)

Objective 1: Describe wait lengths of 'referral to treatment' pathways for patients waiting for elective NHS care, and how they vary between specialties, demographic groups and patient health characteristics

The waiting list spells have been used in this objective. After EPP preprocessing there were 488355 patient-pathway RTT periods starting from 1 April 2022, of which 85% were completed by the end of March 2024. Four groups of waiting times were used: “< = 18 weeks”, 19-36 weeks” (> 18 weeks), 37-52 weeks (> 26 weeks) and > 52 weeks. Figure 3 presents the distribution of patient- pathways within the waiting time groups.

Figure 3 Percentage of the waiting patient for each waiting group:



The volume of patients accessing healthcare services (see Figure 4) varies significantly across specialties. "Other - Medical Services" has the highest patient count, indicating a broad category covering diverse medical needs. Similarly, Ophthalmology, Dermatology, Cardiology, and Gastroenterology see high patient volumes, likely reflecting the common and chronic nature of conditions treated in these fields.

Surgical specialties such as General Surgery, Urology, and Trauma & Orthopaedics also show substantial patient numbers, highlighting the demand for elective and emergency surgical interventions. In contrast, Neurosurgery, Cardiothoracic Surgery, and Elderly Medicine serve fewer patients, possibly due to the highly specialized nature of these services. These specialities have also the large number of patients seen withing target time. This could be explained by the low volume of patient accessing the services.

While higher patient volumes are often associated with a larger percentage of wait times over 18 weeks, as seen in Ophthalmology and Dermatology, specialties such as Cardiology and Gastroenterology show a more balanced distribution, with a relatively higher percentage of patients seen within the target time compared to other high-volume areas. The larger number of patients waiting for treatment may indicate service pressures, resource limitations, or growing patient demand and underscores the need for capacity planning and service optimization to ensure timely access to care.

Figure 4 Count of patients under/over 18 week waits by specialty:

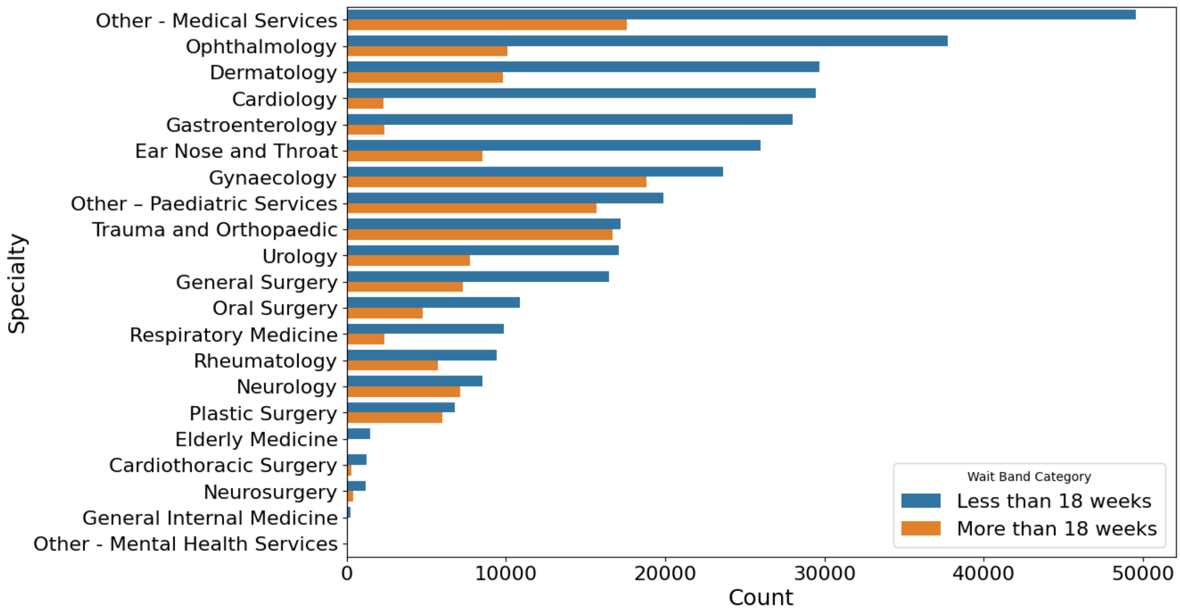


Figure 5 compares waiting times for patients at Leeds Teaching Hospitals Trust (main Leeds provider) and Non-Leeds Teaching Hospitals Trust, categorized by whether they waited less than 18 weeks or more than 18 weeks.

Both providers have a higher proportion of patients receiving treatment within 18 weeks (blue bars) than those waiting longer (orange bars). However, Leeds Teaching Hospitals Trust has a slightly higher proportion of shorter waits compared to Non-Leeds providers. Conversely, the proportion of patients waiting more than 18 weeks is slightly higher in Non-Leeds providers.

This suggests that while both providers experience delays, Leeds Teaching Hospitals Trust may have a marginally better performance in managing waiting times, potentially due to greater capacity, efficiency, or prioritization of urgent cases.

Figure 5 Proportion of patients under/over 18 week waits by provider (left) and provider site (right):

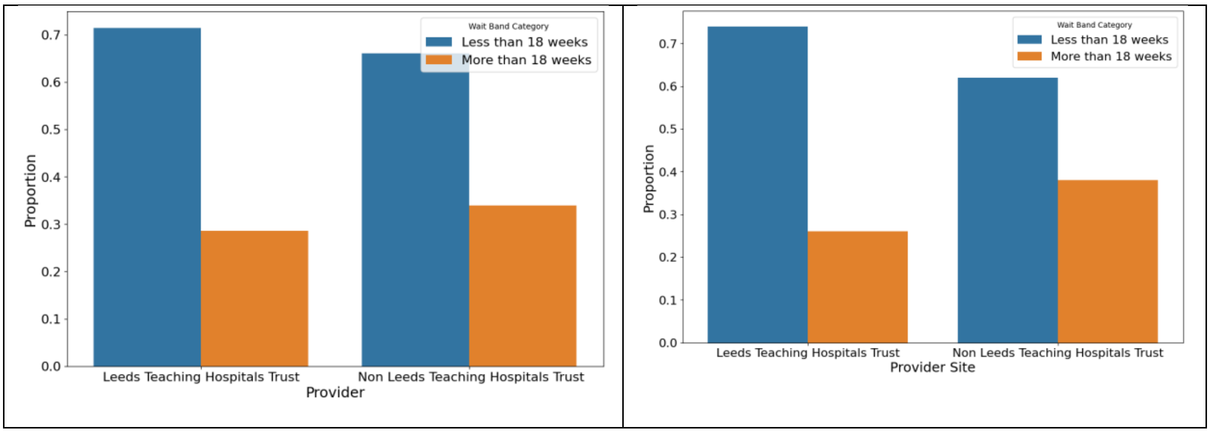


Table 6 shows the waiting time groups across a number of short waiting groups. There was 26 % of patient seen within first 3 weeks and around 40% seen within first 6 weeks. The increase in 52+ weeks group is related to presence of open pathways within Cohort 1.

Table 6 Wating time groups for Cohort 1

Total	**0-3 weeks**		**4-6 weeks**		**7-9 weeks**		**10-12 weeks**		**13-15 weeks**		**16-18 weeks**		**19-21 weeks**		**22-24 weeks**		**25-27 weeks**	
n	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*N*	*%*
488335	128467	26.31	66163	13.55	51760	10.60	40170	8.23	32097	6.57	25847	5.29	21057	4.31	18477	3.78	14700	3.01
	28-30 weeks		**31-33 weeks**		**34-36 weeks**		**37-39 weeks**		**40-42 weeks**		**43-45 weeks**		**46-48 weeks**		**49-51 weeks**		**52+ weeks**	
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*N*	*%*
	11868	2.43	9756	2.00	8917	1.83	8818	1.81	7822	1.60	6585	1.35	6113	1.25	5341	1.09	24377	4.99

The patient-RTT-pathway count per Speciality and main person characteristics such as Age, Gender, Ethnicity, IMD, LTC count, and Frailty were generated and presented in **Table 1.1 (See Supplementary Material)** across four waiting time groups**.**

Across this cohort, approximately 70% of patients were observed to have completed their RTT period within 18 weeks. 12 of 21 specialties achieved a completion rate above this average value. Furthermore, two of these twelve had a 92% pathway completion rate of under 18 weeks meaning that many specialties that are treated under the NHS were unable to meet the NHS provided KPI of 92% of referral to treatment pathways being completed in 18 weeks. The majority of specialties (15) did however have a marginal percentage (under 5%) of pathways that took beyond a year to be completed, and as expected, the specialties with the lowest proportion of sub-18-week completions tended to be the most affected by > 52-week pathways. Neurology and Rheumatology had the highest proportions of patients in the >18-week group, but had low numbers of patients in larger brackets, suggesting that although these specialties struggle to provide treatment within 18 weeks, patients of these specialties are still unlikely to see extreme waiting lengths.

Comparing personal characteristics as shown on Figure 6 we can notice that there is not much difference in terms of disproportion among various groups. The differences are relatively small. From Table 1.1 (HF_Objectives1), patients with severe frailty and multimorbidity are more likely to experience shorter waits, with 78.37% and 75.21%, respectively, waiting ≤18 weeks, compared to 65.76% for those with no long-term conditions (LTCs). Older patients, particularly those aged 84+, also have better access, with 79.73% waiting ≤18 weeks, whereas younger patients, such as those aged ≤10 years, face longer delays (54.32% ≤18 weeks). Males tend to experience shorter waits (72.58% ≤18 weeks) compared to females (68.99%). Ethnicity reveals some disparities, with white-background patients having slightly higher proportions of shorter waits (71.39% ≤18 weeks) compared to Asian-background patients (68.19%). Deprivation also plays a role, as the least deprived quintiles (IMD 4 and 5) report shorter waits (71.37% and 70.62%, respectively), while the most deprived quintile (IMD 1) has a lower proportion (69.89%) waiting ≤18 weeks.

Age of the patient seems to be the personal characteristic with the strongest correlation to the length of the referral to treatment period, with the youngest patients generally having the longest pathways. This will be directly linked to Paediatric services having longer waiting times however the trend remains true across adult healthcare, where generally, older adults tend to experience shorter waiting times than younger ones. This is further reflected by the overall long waits seen across the speciality paediatric services, but this trend is not limited to the youngest patients only, with median pathway treatment lengths steadily decreasing with age (see Figure 7**)**

Figure 6 Patient Characteristics per waiting time

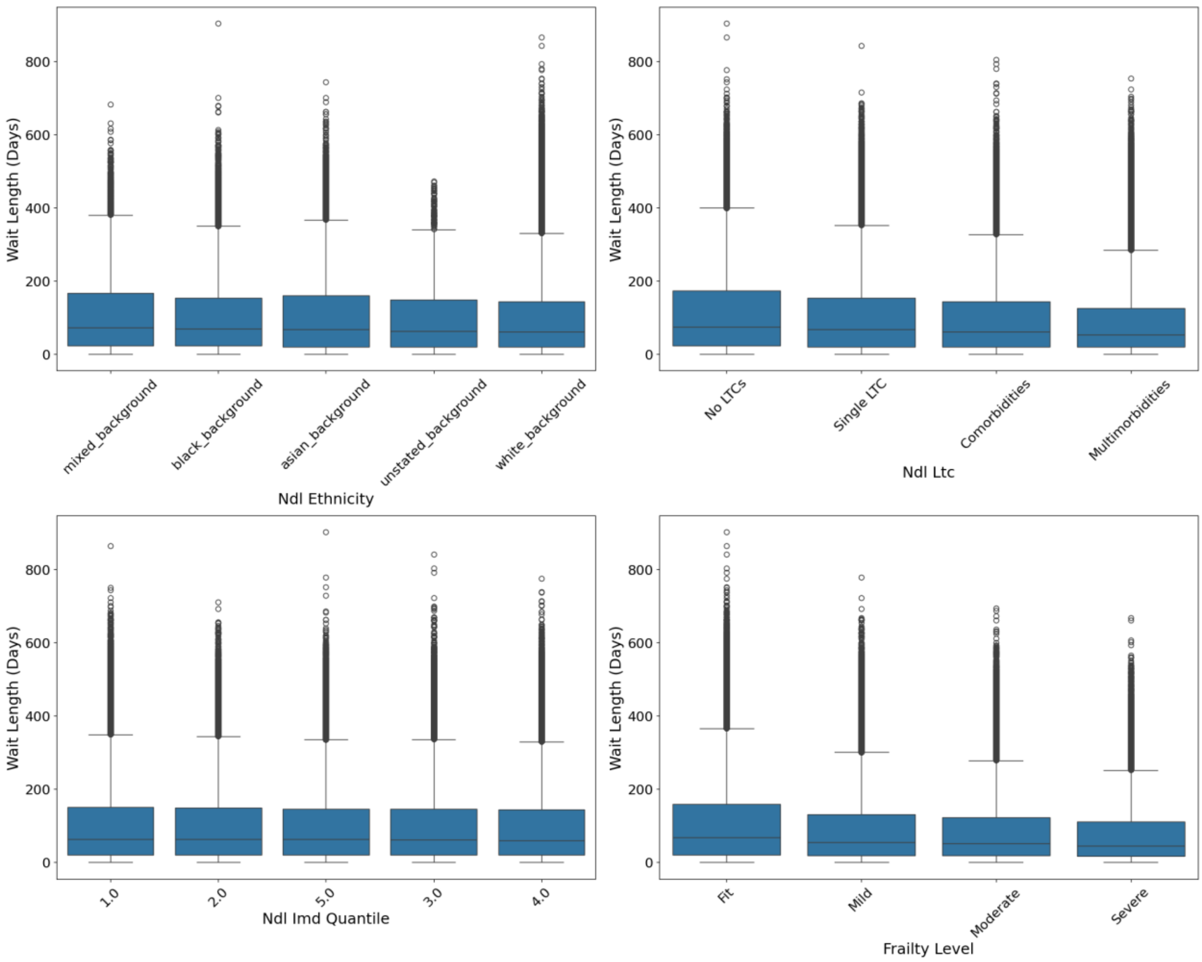
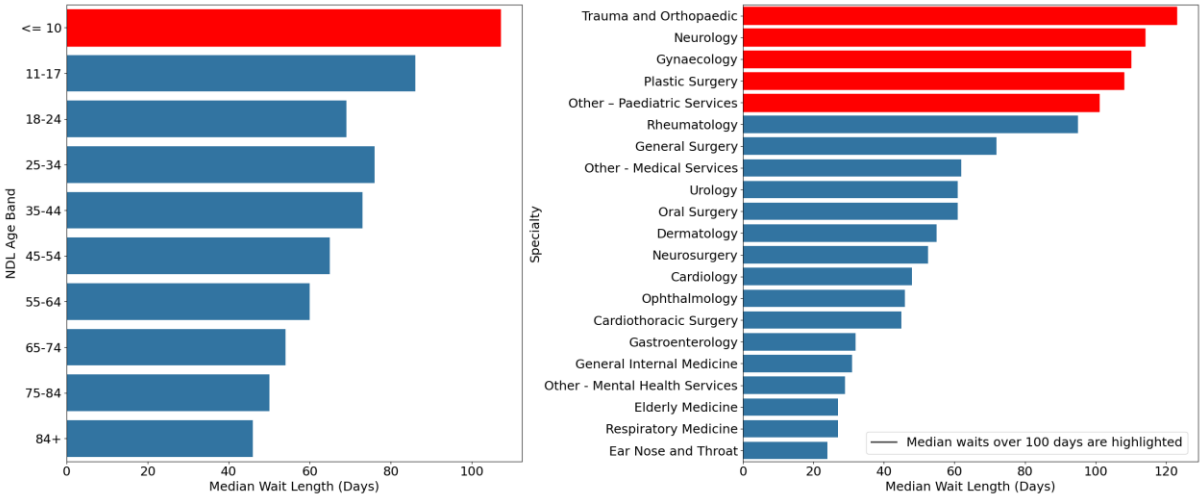
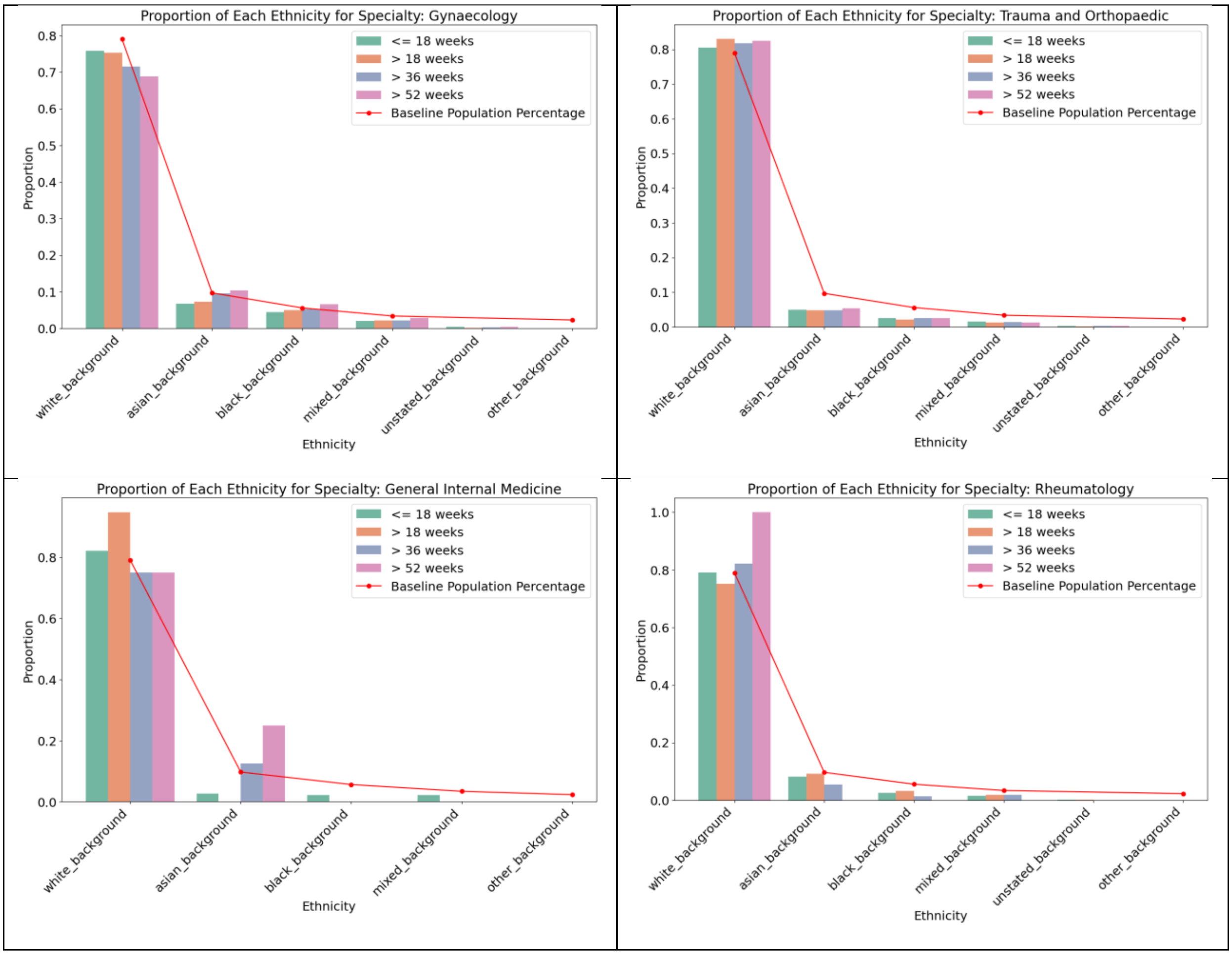


Figure 7 Median wait length vs age band (left) and specialty (right)



For Gynaecology, Trauma and Orthopaedics, Rheumatology and General Medicine we have compared the ethnicity distribution in the waiting group vs Leeds population rate (see Figure 8). For Gynaecology a higher proportion of women from Asian and Black Ethnicity are waiting longer. This supports national findings (RCOG, 2024). For Trauma and Orthopaedic it has been noticed that other ethnic groups are under- represented in the cohort study. General Internal medicine showed a large percentage of Asian background waiting longer than 36 weeks. Rheumatology shows larger number of white waiting longer than >52 weeks.

Figure 8 Cohort distribution vs Leeds population comparison.



Cross tabulations were produced in **Table 1.2 (see Supplementary Material)** to further investigate any underlying trends between personal characteristics and waiting lengths. The data reveals significant variations in waiting times across age groups, genders, and deprivation levels (IMD quantiles). Older age groups, particularly those aged 75–84 and 84+, have the highest proportions of shorter waiting times (≤18 weeks), with more males waiting <18 weeks. For example, 81.34% of males aged 84+ waited ≤18 weeks compared to 78.43% of females, and in the 75–84 age group, 78.7% of males and 75.58% of females waited ≤18 weeks. In contrast, younger age groups, such as those ≤10 years, experience longer delays, with only 54.8% of males and 53.7% of females waiting ≤18 weeks, and the highest percentages of extended waits (>52 weeks) at 8.45% and 8.66%

Deprivation levels further exacerbate disparities, with individuals in more deprived areas (IMD quintile 1) having slightly lower percentages of shorter waiting times compared to those in less deprived areas (quintile 4). For instance, 68.32% of females and 72% of males in quintile 1 waited ≤18 weeks, compared to 69.69% and 73.5% in quintile 4. The proportion of patients waiting >36 or >52 weeks also decreases as deprivation decreases, highlighting socioeconomic inequalities. Overall, waiting times are shorter for older patients, males, and those from less deprived areas, suggesting age-related prioritization and disparities based on both gender and socioeconomic status.

To understand the waiting time and differences between specialities **Table 1.3 (Supplementary Material)** was produced. Trauma and Orthopaedic had the highest mean waiting time (167.49), with an extremely high standard deviation of (147.06), indicating significant variation in waiting times. Plastic Surgery also has a high mean (168.65) and high variation (SD = 159.88). Cardiothoracic Surgery had a relatively lower mean (73.95) but a high standard deviation (73.11), indicating significant variation. General Internal Medicine has a mean waiting time of 59.47, with a large standard deviation (84.92), suggesting diverse waiting times within this specialty.

For Age, the group <=10 years had the highest mean (149.05), followed by 11-17 years (130.52), suggesting younger patients have higher waiting times. 75-84 years had a much lower mean (87.33), indicating older patients tend to wait less compared to the younger age groups. 65-74 years and 55-64 years have mean waiting times of 93.03 and 99.38, respectively, with moderate variation.

Females (F) have a slightly higher median waiting time (66) compared to Males (M) (59). The variation is also higher in females (SD = 115.64 vs. SD = 109.03).

Regarding Long Term Conditions, patients with No LTCs had the highest mean waiting time (117.53), indicating that individuals without long-term conditions may experience longer waits. Severe health status had the lowest mean (83.23), with lower variation (SD = 97.27). Moderate and Mild health status categories have similar means (90.0 and 96.13), with Mild having slightly higher variation (SD = 106.37). Patients with Multimorbidity had a mean of 91.79, suggesting that patients with multiple conditions may experience slightly shorter waiting times than those without long-term conditions.

Patients with a White background had a lower mean waiting time (102.14) compared to Black backgrounds (109.55) and Asian backgrounds (110.16), although the variation is similar across groups. Patients of Mixed backgrounds had the highest mean waiting time (114.17), indicating potential trends related to ethnicity or socio-economic factors.

Cross-frequencies between Age group and Sex and IMD and sex as well Age group and IMD in **Table 1.4 (Supplementary materials)** showed some patterns across age, gender, and IMD quantiles. Younger age groups, especially those aged <=10 and 11-17, exhibit the highest mean waiting times, with females in the <=10 age group showing a mean of 149.74 and males 148.51, accompanied by large variability. Older age groups, particularly those aged 75-84 and 84+, tend to have lower mean waiting times, with females in the 84+ age group showing a mean of 83.44 and males 76.5. Females experience longer waiting times than males, with exceptions in the 75-84 age group where males have slightly lower mean waiting times. Individuals from lower IMD quantiles (1 and 2) also tend to have longer waiting times, with females in quantile 1 showing a mean of 111.06 and males 100.15, while those in higher IMD quantiles (4 and 5) have shorter waiting times, such as females in quantile 5 with a mean of 107.32 and males 98.67. The data also highlights significant variability, particularly in younger age groups and lower IMD quantiles, where standard deviation and interquartile range are larger. Across intersections, the most commonly appearing variable is an age value of 11-17, with 11-17 females experiencing median waiting lengths of 94 days. In fact, 6 of the 10 highest median waits of these cross sections have an age value of 11-17.

From the analysis for Objective 1 we can notice that younger, and more disadvantaged groups tend to experience longer and more variable waiting times, while older and more advantaged groups experience shorter, more consistent waits. There are main trends observed here: older patients tend to be treated more quickly, males often face shorter waiting times, though the difference is relatively small. People from more deprived areas tend to experience longer waits. Patients with no long-term conditions experience longer waits, while those with severe conditions seems to be prioritized.

Inpatient / Outpatient Analysis

The statistics produced for **Table_1.1_op** and **Table_1.1_in** (Supplementary Material) were developed in a manner split by outpatient and inpatient pathways, with an inpatient pathway being defined as when a patient is admitted at any point during their pathway before it ends via any means. Conversely, outpatient pathways were defined as any pathways that did not include any admissions for the patient before the pathway ended. Comparing these tables displayed some stark differences in the waiting lengths of patients. As an example, across most measured personal characteristics (speciality, age, ethnicity, IMD, frailty, LTCs, sex), inpatient pathways had considerably less pathways that concluded within 18 weeks when compared to outpatient ones. This can likely be explained by the nature of an inpatient pathway suggesting the need for additional care such as medical procedures, but the difference is still notable.

Some specialties saw greater percentages of sub-18-week completion rates for inpatient pathways when compared to outpatient ones, such as Rheumatology, Respiratory Medicine, Neurology, Opthamology and General Internal Medicine. Gynaecology and Paediatric services saw the greatest difference in percentages of >52-week pathways, with 23.39% of inpatient paediatric services pathways being above 52 weeks (compared to 16.5% for outpatient) and 20.77% of Gynaecology pathways taking more than 52 weeks (compared to 9.02% for outpatient)

For outpatient pathways, there is some difference in the waiting length for each sex which matches with prior observations. Men have the larger percentage of sub-18-week outpatient pathways and a smaller share of beyond 18-week pathways when compared with women, however, this trend disappears for inpatient pathways where each sex has mostly mirrored proportions for each wait length bracket. Across all ages, outpatient pathways had a larger share of sub-18-week completions compared to inpatient ones. Outpatient pathways had relatively balanced shares of >52-week pathways, ranging from ~1.7% to ~4.5% whilst inpatient pathways saw much more variation. Patients older than 55 had the smallest share of >52-week inpatient pathways, with no age brackets above 55 having above 10%, following trends observed in previous sections, older patients had a smaller percentage of >52-week pathways which steadily increased the younger the patient was. Paedaitric ageshad the highest proportion of >52 week waits (25.49% for <=10 and 20.09 for 11-17) but young adults still had large amounts of pathways above 52 weeks.

People of unstated backgrounds had the highest proportion of >52-week outpatient pathways whilst people of unknown backgrounds (missing data) had the highest for inpatient pathways. For known ethnicities, people of mixed backgrounds had the highest proportion of >52-week outpatient waits (4.39%) whereas this was true for people of black backgrounds when considering inpatient pathways (13.19%). Regarding long term conditions, a positive correlation between number of LTCs and proportion of sub-18-week waits was observed for both inpatient and outpatient pathways; people with no long-term conditions had the smallest share of <18-week pathways. The trend seen for long term conditions appeared in a similar manner for frailty level, where more frail people had larger percentages of pathways being less than 18 weeks.

Overall, inpatient pathways generally saw longer time to completion compared to outpatient ones and most of the prior observed trends regarding personal characteristics and pathway length remain true, with some examples of flattening of groups for inpatient pathways compared to higher variation in outpatient ones.

Objective 2: Describe the reasons patients are removed from the NHS elective care waiting list, and how they vary between specialties, demographic groups and patient health characteristics

From Cohort 1 patient-pathways were selected that were completed before 1st April 2024. There were 419529 patient pathways, of which 45% were completed within 6 weeks and around 75 % were seen within 18 weeks (see Table 7).

Table 7 Waiting time groups for Cohort 2

Total	**0-3 weeks**		**4-6 weeks**		**7-9 weeks**		**10-12 weeks**		**13-15 weeks**		**16-18 weeks**		**19-21 weeks**		**22-24 weeks**		**25-27 weeks**	
N	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
419529	127125	30.30	63333	15.10	47491	11.32	35960	8.57	27972	6.67	22133	5.28	17183	4.10	14515	3.46	11396	2.72
	28-30 weeks		**31-33 weeks**		**34-36 weeks**		**37-39 weeks**		**40-42 weeks**		**43-45 weeks**		**46-48 weeks**		**49-51 weeks**		**52+ weeks**	
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
	8727	2.08	7011	1.67	6204	1.48	5155	1.23	4295	1.02	3448	0.82	3146	0.75	2738	0.65	11697	2.79

From Cohort 2 the waiting list status (reason) has been analysed. The status describes why the RTT period has been ended. Following the RTT guidance (NHS England RTT, 2024) there are the following codes for stopping the clock (see Table 8)

Table 8 RTT status code for Clock Stop

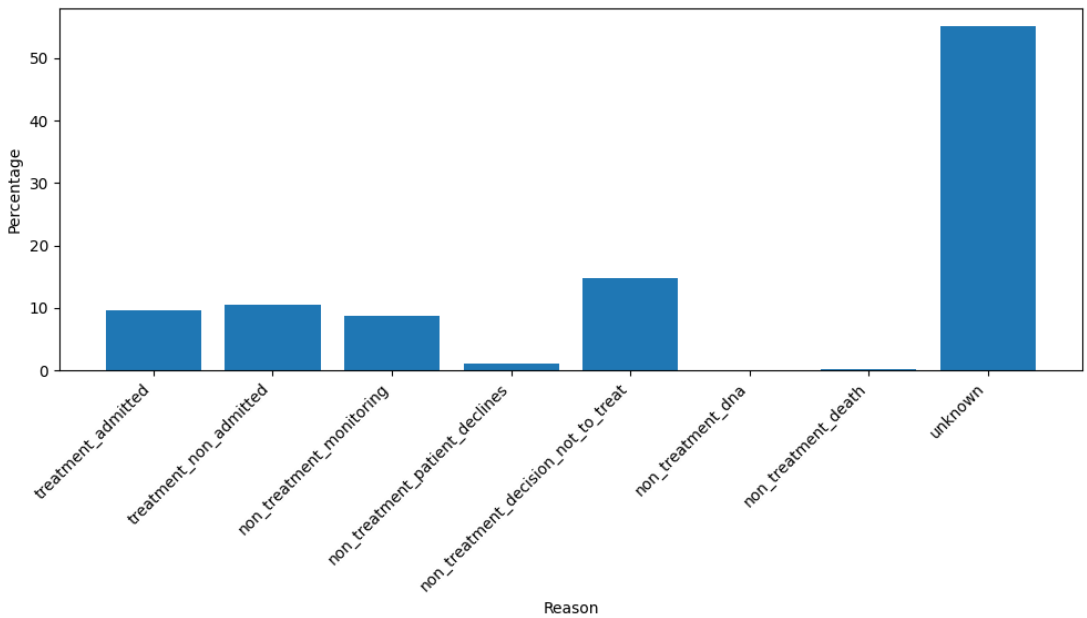
Code	Description
30	End of the **REFERRAL TO TREATMENT PERIOD**: Start of **First Definitive Treatment**
31	End of the **REFERRAL TO TREATMENT PERIOD**: Start of **Active Monitoring** initiated by the **PATIENT**
32	End of the **REFERRAL TO TREATMENT PERIOD**: Start of **Active Monitoring** initiated by the **CARE PROFESSIONAL**
33	End of the **REFERRAL TO TREATMENT PERIOD**: Did not attend - the **PATIENT** did not attend the first **CARE ACTIVITY** after the referral

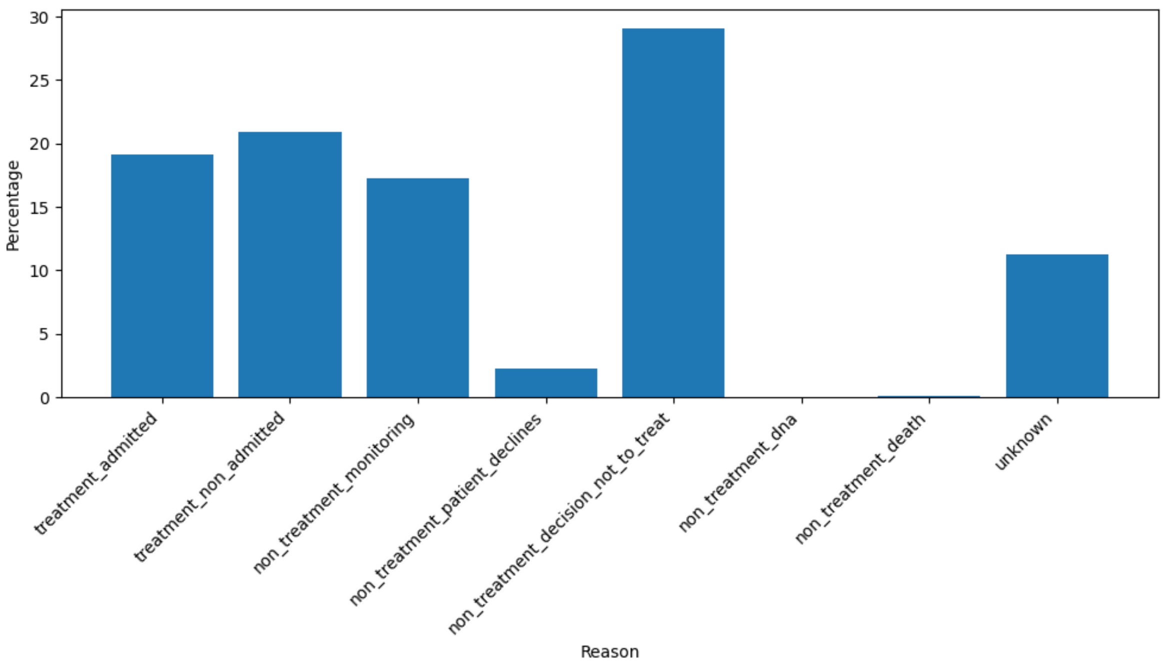
34	End of the **REFERRAL TO TREATMENT PERIOD**: Decision not to treat - decision not to treat made or no further contact required
35	End of the **REFERRAL TO TREATMENT PERIOD**: **PATIENT** declined offered treatment
36	End of the **REFERRAL TO TREATMENT PERIOD**: **PATIENT** died before treatment
99	not yet known

A reported end date was present in 50% of the records in our study. The remaining end dates were derived based on the maximum week-ending date from the Open Pathways list due to the absence of corresponding records in the Clock Stop list. In such cases, the status (reason) was imputed from the latest non-empty entry. In some cases, pathways with a recorded clock stop had no information regarding status, and this logic led to the status being taken from the Open pathways data; it was surmised that the status from this data source would not accurately reflect the position of a completed pathway and as such they were converted to 99 (unknown).

Figure 9 (top) shows distribution of the status/ reason among all completed pathways. . Almost all derived Clock Stop entries (99% of patient RTT pathways) were assigned the status “unknown. Over 20% of pathways were provided treatment and 15% were decided to not treat, which is the largest percentage among the group with reported clock stop (see middle plot). The shortest median of waiting time is for patients that decision was not to treat, compared with the longest median waiting time for a patient that declined.

Figure 9 Reason for stopping RTT clock: all data (top) vs reported clock stop (middle) vs median wait length for reported clock stop (bottom)





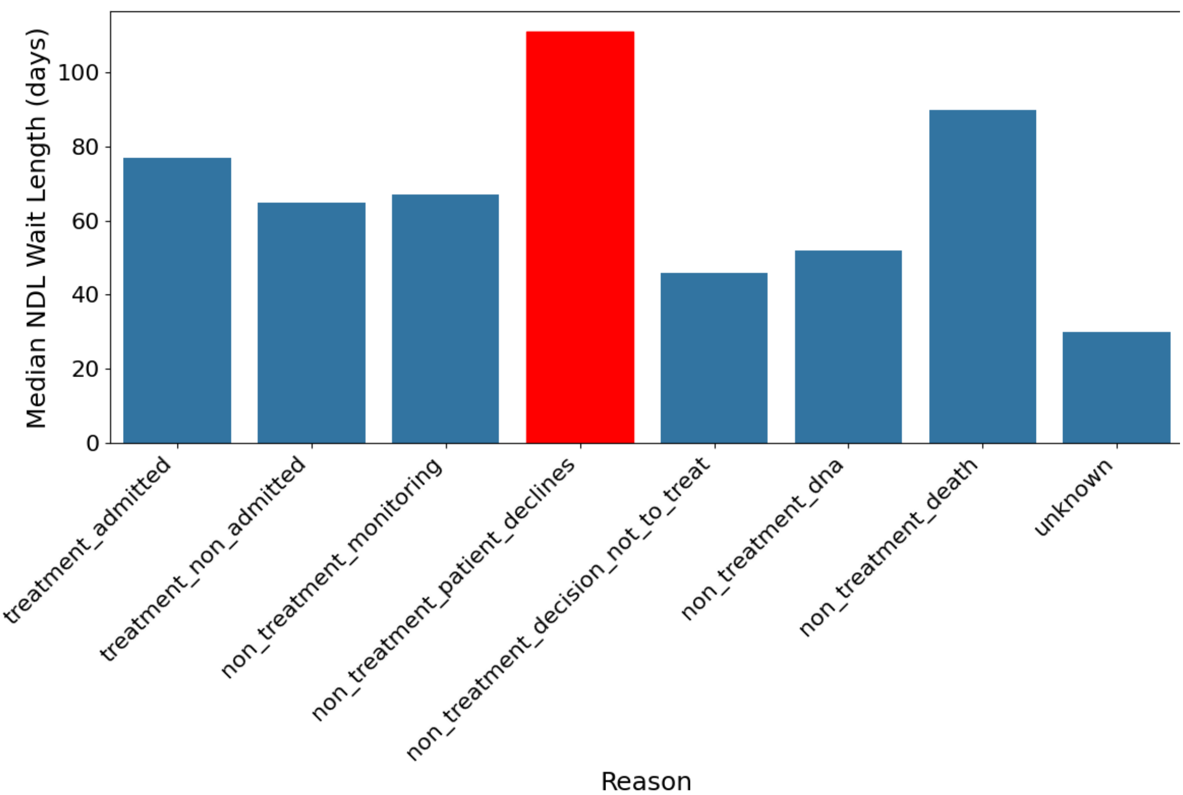


Table 2.1 (Supplementary Material) shows summary of the distributions for the personal characteristics and speciality. The dataset reveals key patterns in RTT clock stop statuses across different demographics and clinical characteristics. The majority of cases are either treatment-admitted or result in a decision not to treat, with visible variations across specialties. Cardiothoracic Surgery (30.88%) and Plastic Surgery (34.1%) have the highest proportions of treatment-admitted cases, whereas Dermatology (28.33%) and Gastroenterology (14.96%) exhibit higher rates of non-treatment decisions. Age-wise, treatment-admitted cases peak in

older adults (75–84 years: 13.75%), whilst younger adults and the elderly appear the most likely to decline treatment (1.43% for 84+ and 1.47% for 18-24). Socioeconomic factors also influence outcomes; patients from the most deprived areas (IMD 1) are more likely to decline treatment (0.93%) or have a non-treatment decision (14.05%) compared to less deprived groups. Frailty is another key factor, with severely frail patients experiencing higher rates of non-treatment decisions (13.81%) than fitter individuals (15.19%). Additionally, multimorbidity plays a role, as patients with long-term conditions (LTCs) have a slightly higher treatment-admitted rate (10.74%) compared to those without LTCs (8.01%).

Overlapping Pathways Analysis

In completed pathways there were over 250 thousand patients waiting for treatment, 15 percent of those had overlapping pathways for various treatments and specialties.

Patients in non-overlapping pathways generally experience shorter waiting times, with 74-80% being seen within 18 weeks and less than 3% waiting over a year. In contrast, those in overlapping pathways face significantly longer waits, with only 54-62% treated within 18 weeks and 5-9% waiting over 52 weeks. This suggests that overlapping pathways can create bottlenecks that delay patient care.

Age disparities are evident, with younger (11-24) and middle-aged (45-64) patients seeing the largest increase in waiting times under overlapping pathways. Older adults (65+) continue to receive relatively faster treatment, though they also experience a decline in short-wait percentages. Deprivation further exacerbates delays, as patients from the most deprived backgrounds have a slightly higher likelihood of long waits compared to those from wealthier areas.

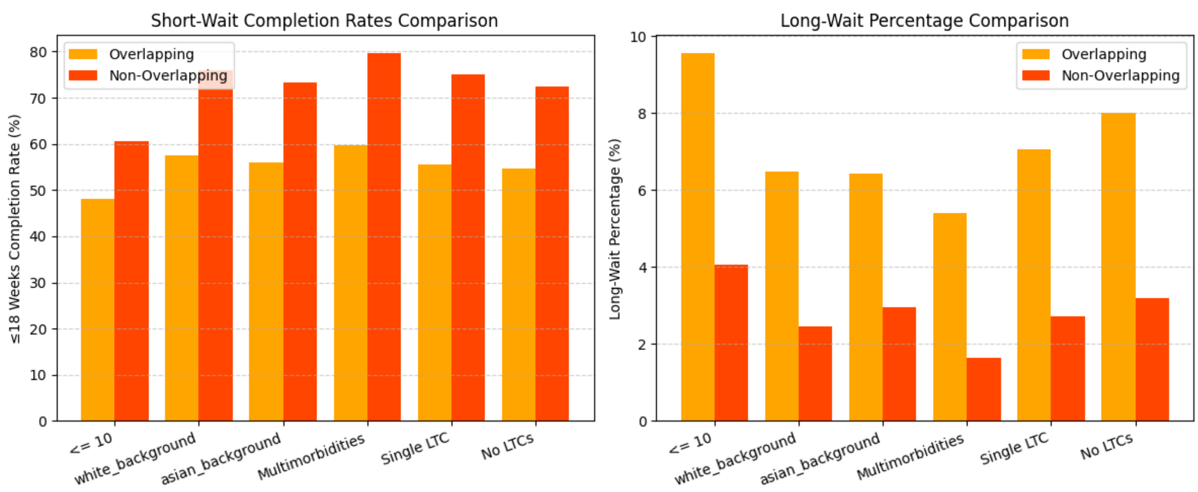
Ethnic disparities widen under overlapping pathways. While White patients, on average, experience shorter waits in both datasets, Black and Asian patients see a more significant drop in short-wait percentages and an increase in long-wait cases. Patients without long-term conditions are disproportionately affected, with their long-wait percentage increasing from 3% in non-overlapping pathways to over 8% in overlapping ones. Meanwhile, multimorbid patients still receive priority treatment, though their short-wait rate declines from 80% to 59%.

Frailty levels do not drastically change waiting times, but severely frail patients are still treated faster in both datasets. A small gender gap persists, with males experiencing slightly shorter waits than females. Overall, the data highlights how overlapping pathways significantly extend waiting times across all groups, with particularly adverse effects on younger patients, deprived populations, ethnic minorities, and those without pre-existing conditions, this was consistent with our finding from PPIE group of long waiting patients.

The data suggests (see Figure 10) that having overlapping treatments impacts waiting times significantly. Patients in overlapping pathways experience fewer occurrences of short waits (≤18 weeks) and higher long-wait percentages (>52 weeks) compared to those in non-overlapping pathways. This trend is evident across all patient groups, with overlapping patients consistently facing delays in receiving timely care. The impact is particularly noticeable for younger patients (≤10), those without long-term conditions, and ethnic minority groups, who show a greater likelihood of extended waiting times.

These findings indicate that overlapping treatments create bottlenecks in the healthcare system, leading to prolonged waits and reduced efficiency in patient care delivery

Figure 10 Comparison of selected characteristics of short vs long waiters among overlapping and non-overlapping group patients.



Objective 3: Describe and compare patients' primary and secondary healthcare activity before, during and after waiting for elective treatment

From Cohort 2 the RTT patient-pathways with a First Definite Treatment outcome were selected resulting in 84700 RTT periods. As illustrated in the previous section, this was 40% of the initial Cohort 2.

Table 9 presents the waiting time distribution. Around 45% of patient pathways were completed within six weeks, over 70% were treated within 18 weeks, and nearly 5% waited more than 52 weeks for treatment.

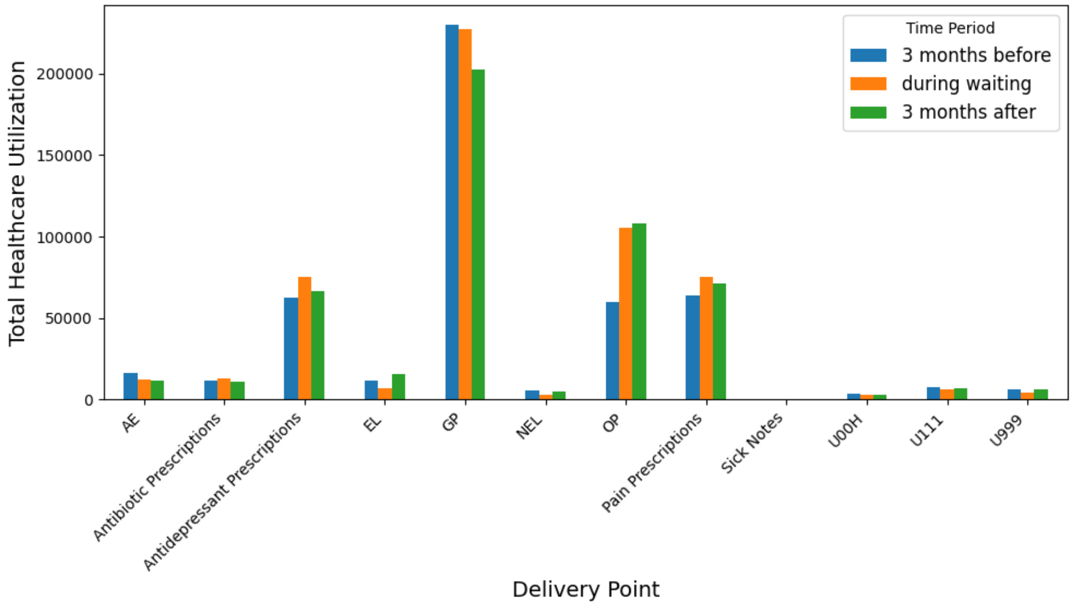
Table 9 Waiting time groups for Cohort 3

Total	0-3 weeks		4-6 weeks		7-9 weeks		10-12 weeks		13-15 weeks		16-18 weeks		19-21 weeks		22-24 weeks		25-27 weeks	
N	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*N*	*%*
84700	17545	20.71	12622	14.90	9766	11.53	7784	9.19	5943	7.02	4910	5.80	3980	4.70	3550	4.19	3053	3.60
	28-30 weeks		**31-33 weeks**		**34-36 weeks**		**37-39 weeks**		**40-42 weeks**		**43-45 weeks**		**46-48 weeks**		**49-51 weeks**		**52+ weeks**	
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*N*	*%*
	2359	2.79	1860	2.20	1809	2.14	1478	1.74	1339	1.58	1018	1.20	946	1.12	817	0.96	3921	4.63

Figure 11 shows total contact for the delivery points discussed in Table 5 including GP, AE, NEL, EL, OP, U111, U999, U00H. It shows GP and AE contacts in the three months leading up to the waiting period show frequent interactions, which could indicate hidden waiting times. This suggests that individuals may be repeatedly reaching out to healthcare services for consultations with specialists while awaiting a referral. Additionally, prescriptions are used more during the waiting period than before or after, highlighting a trend of increased utilisation.

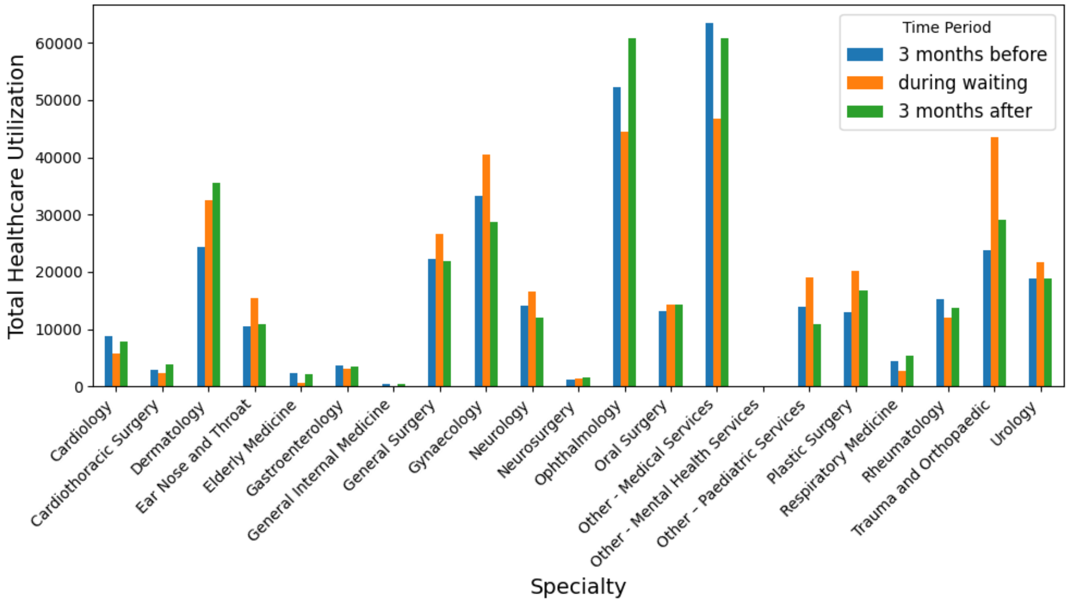
Outpatient appointments also reveal an interesting pattern, with higher healthcare use during the waiting period compared to before it. There is a marked increase in appointments following treatment, potentially indicating follow-up care such as monitoring or post-treatment check-ups.

Figure 11 Health care utilisation per delivery point: 3 months before start waiting, during waiting and after treatment



In the next step, total health care utilisation for all delivery points was compared across specialities (see Figure 12); Ophthalmology leads with the highest total contact volume (170,945), followed by Other - Medical Services (179,577), Gynaecology (110,258), and Trauma and Orthopaedics (102,801), highlighting their significant patient demand. Conversely, Other - Mental Health Services (89) and General Internal Medicine (1,034) exhibit much lower contact totals, likely reflecting more targeted or specialised care pathways. Specialties like Neurosurgery (4,547) and Elderly Medicine (5,389) also demonstrate relatively low activity, indicative of their specialized focus. The data underscores the diverse levels of service utilisation across specialties, with certain areas like ophthalmology and medical services showing consistently high patient engagement across all care settings.

Figure 12 Total health care utilisation vs specialities



The data summarises medication utilisation across various specialties over three periods: 3 months before, during waiting, and 3 months after treatment Figure 13. Ophthalmology consistently exhibits the highest medication usage, peaking at 229,778 uses in the post-treatment period, followed by Other - Medical Services (216,586 post-treatment) and Gynaecology (101,365 during waiting). Increase in utilisation during waiting periods are observed in Trauma and Orthopaedics (from 63,091 to 132,572) and Plastic Surgery (from 35,822 to 63,903), highlighting greater demand in these phases. In contrast, Elderly Medicine and Neurology show sharp declines during waiting, with utilisation rising again post-treatment. Other - Mental Health Services and General Internal Medicine demonstrate the lowest overall usage. This data highlights how medication demand varies significantly across specialties and time periods, with most specialties showing increased usage during or after waiting periods.

Figure 13 Total medication utilisation vs specialities

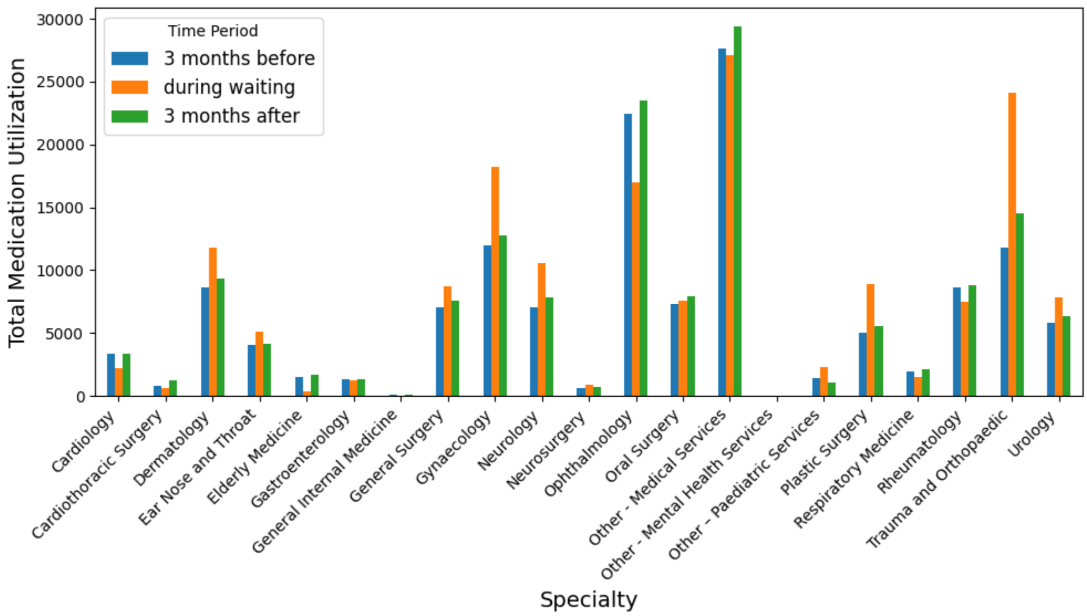


Table 3.1 (Supplementary Material) summarises use of GP and AE. For GP contacts, healthcare utilisation tends to peak during waiting times, indicating increased need for GP care while waiting for treatment. For most patients, GP usage drops post-treatment,

suggesting that the intervention addresses their health concerns. Specialties with ongoing conditions (e.g., Rheumatology, Elderly Medicine) show sustained post-treatment GP engagement. Younger age groups and mental health services see a marked decline post-waiting, possibly due to alternative care pathways.

For A&E, usage tends to be low across all groups, with median values consistently at zero. However, some specialties, such as neurosurgery, general internal medicine, and mental health services, show higher mean A&E usage compared to others. A&E usage appears to decrease during the waiting period across most specialties and then slightly increases post-treatment, though not always returning to pre-waiting levels. Among age bands, younger patients (≤10 and 18-24) tend to have higher A&E usage, while older age groups (65+) show lower rates. The highest mean usage is seen in the "unknown" category, which may indicate data inconsistencies or complex cases. The overall trend suggests that while A&E use is common before treatment, it tends to decline slightly during waiting and remains relatively stable afterward for most groups.

Across specialties, prescription trends varied significantly before, during, and after the waiting period. Elderly Medicine consistently showed the highest prescription rates across all periods, while Paediatric Services and younger age groups had the lowest. Trauma and Orthopaedics, Ophthalmology, and Rheumatology had relatively high prescription use before the waiting period, with some fluctuation during and after. Notably, during the waiting period, Trauma and Orthopaedics, Neurosurgery, and Plastic Surgery saw substantial increases in prescription usage, suggesting higher treatment needs. Cardiothoracic Surgery, Neurology, and Cardiology exhibited post-waiting increases in prescription use, possibly indicating ongoing management post-procedure. Age-wise, older patients (65+) had consistently higher prescription rates, with the highest among those aged 75-84 and 85+. This trend was also visible for younger patients, with children under 10 and paediatric services having some of the largest mean antibiotic use, alongside those with severe frailty.

Investigating frailty further, it was observed that severe frailty had the strongest link to antidepressant use when considering all personal characteristics, with the three highest mean values being after waiting, before waiting, and whilst waiting (2.37, 2.27, 2.15 respectively) with moderate frailty not far behind. This remains true for painkiller prescriptions suggesting that overall, level of frailty may be the largest indicator of prescription use, regardless of type. Conversely, patients with a frailty classification of “fit” were consistently some of the lowest users of prescriptions. Furthermore, some of the highest mean values of both 111 and 999 calls were from patients with severe frailty (111: mean of 0.22 before waiting, 999: mean of 0.35 after waiting), although unlike with prescription use, this type of utilisation was less common from patients with moderate or lower frailty.

Ethnicity analysis showed white-background patients having the highest prescription usage levels, followed by unknown and Black-background groups. Prescription use was highest whilst waiting for patients of black, mixed, and white backgrounds. Overall, waiting periods were associated with varying degrees of increased prescription usage, ~60% of which had the highest prescription use whilst waiting.

Table 3.2 (Supplementary Material) summarises the comparison of healthcare use in the waiting time groups. During waiting time, GP healthcare use is significantly higher for patients with longer waits. The >52 weeks group sees the highest GP use (9.35), 18 weeks group has the lowest (1.43). Before and after waiting, GP use is relatively stable across groups, around 2.5 on average. The longer the wait, the greater the increase in GP use during waiting. Similarly, A&E visits are highest during the waiting period for longer waits: >52 weeks group has the highest A&E use during waiting (0.46). <18 weeks group has the lowest (0.09). Before and after waiting, A&E use is relatively low and stable across groups (~0.12-0.22).

Regarding waiting lengths – Patients waiting longer than 52 weeks consistently saw the most use of antibiotics, antidepressants, and painkillers, with stark differences for the latter two. Patients that were currently waiting on pathways >52 weeks and >36 weeks had the highest mean antidepressant (3.43, 2.29) and painkiller (3.07, 2.23) usage respectively, before an approximate 50% decrease in mean usage for the next highest example in both cases. Similarly, 111 and 999 calls were most frequently seen in longer pathways (>52 weeks, >36 weeks) whilst waiting.

Sick notes, although tracked across personal characteristics and waiting lengths did not see enough usage to ascertain any prevalent trends. This may be due to the level of granularity being small, and the likelihood of patients requiring more than one (if any) sick notes during a given pathway is likely small.

Pathway Rate Analysis

Alongside absolute values for healthcare utilisation, utilisation rates were also calculated defined as the overall usage for each characteristic and time period (before, during, after) divided by their respective number of pathway weeks. Because the number of pathway weeks is constant for the before and after periods (which are a fixed 3 months), the variable usage numbers alongside the number of pathway weeks included in the waiting period can highlight additional trends respective to the scaled size of usage. For specialties, notable trends were identified where the absolute usage values were significantly lower than their rates. Elderly Medicine had some of the highest GP use rates (0.42 before, 0.41 during, 0.35 after) despite their absolute values being low. Of note, Elderly Medicine had a low mean of 1.23 whilst waiting despite this high rate. General internal medicine also had high GP usage whilst waiting and after waiting (0.36 and 0.35 respectively) despite having a low footprint on overall values.

When considering GP usage rates against the mean absolute usage rates, notable outliers include Plastic Surgery, with a mean GP usage of 3.41 despite a low rate of 0.17. Ear Nose and Throat GP usage similarly had a high mean usage of 3.12 whilst waitng but had a low rate of 0.14. Severe frailty had high pathway week usage rates to match their high absolute usages for GP contacts with 0.40 before, 0.39 whilst waiting, and 0.38 after, with moderate frailty showing a similar trend with lower, but still high rates (0.33 before, 0.31 both whilst waiting and after).

For outpatient utilisation, Cardiothoracic Surgery appeared to be the specialty with the strongest correlation with a pathway week rate of 0.28 whilst waiting, 0.19 after waiting, and 0.16 before waiting. Of the ten largest pathway week rates calculated for outpatient usage, eight were related to a specialty (Cardiothoracic Surgery, Respiratory Medicine, Dermatology, Plastic Surgery, Opthamology). Five of these eight specialty related outpatient usages were during the after waiting period, suggesting that these specialties in particular lead to additional outpatient appointments once treatment has been given.

Regarding prescription usage, severe frailty had the three highest values of pathway week rates (0.20 while waiting, 0.18 after waiting, 0.17 before waiting), with all time periods of moderate frailty not being far behind. Elderly medicine was the specialty with the strongest link to antidepressant usage when considering rates with values of 0.16 after waiting, 0.15 before waiting and 0.14 whilst waiting). These trends remained true for painkiller prescription usage, with the three largest pathway week rate values stemming from severe frailty (with values of 0.24 after waiting and 0.23 both whilst waiting and before waiting). A specialty of Elderly Medicine or a frailty level of moderate were also strong indicators of painkiller prescription usage, similar to antidepressants. Beyond this, having multimorbidity or an age of 84+ also had strong links to painkiller usage for the whilst waiting and after waiting groups.

For A&E usage, the specialty Other – Mental Health Services had an extreme value for pathway week rate whilst waiting but the low pathway count for this condition suggests that the rate may not reflect true values. Disregarding Other – Mental Health Services, General Internal Medicine was the specialty with the next highest rates of A&E usage, with values of 0.05 before waiting and whilst waiting, and 0.04 after waiting.

3.2 Causal Analysis (Objective 4)

For the causal analysis, new cohorts were created for each of the selected procedures: Cholecystectomy, Hip Replacement, and Hysteroscopy. The full EPP dataset was utilized for this analysis, with inpatient activity data used for Cholecystectomy and Hip Replacement. For Hysteroscopy, both outpatient and inpatient activities were included in order to identify the first occurrence within the pathway sequence corresponding to each event.

The Difference-in-Differences (DiD) model was applied to assess the effect of longer waiting times on healthcare use. The reference period corresponds to the post-treatment phase, where the length of follow-up matches the patient's waiting time. Total costs were calculated. The key measure of interest, Excess Healthcare Use (DiD Estimator), describes how much healthcare a patient used during the intervention period compared to a reference period, relative to the control group. Positive values indicate increased use in the intervention (waiting longer) group and negative values indicate reduced use. The table also includes healthcare point of delivery or treatment categories (e.g., GP, GP Cost, AE, OP) and summarises total healthcare use during both the intervention period and the reference period for each group. Additionally, it reports the total number of person-weeks observed, representing the time that patients spent in the study, along with the standard error (SE) of the DiD estimator, which quantifies uncertainty in the estimate. The total excess measure captures the overall difference in healthcare use between the intervention and control groups for each waiting period, while the number of unique pathways provides insight into group sizes. Finally, the p-value of the DiD estimator determines statistical significance, with $p < 0.05$ indicating a significant effect).

3.2.1 Cholecystectomy – Gallbladder removal

In the Secondary Care (SUS) dataset, 2,107 gallbladder-related procedures were identified, defined by a primary OPCS code starting with “J18”, occurring during the study period April 2022 – March 2024. Of these, only 1,506 had recorded corresponding waiting times.

Table 4.3gb_all_group (Supplementary Materials) presents the characteristics of patients waiting for 5 waiting groups (<=6 weeks, <=18 weeks, 19-30 weeks, 31-42 weeks and > 42 weeks). Analysis of waiting times reveals some variation across patient demographics. Younger patients, particularly those aged 18-24, tend to experience shorter waiting times (<= 6 weeks) compared to other age groups. There is also a trend for Black patients to have a higher proportion of shorter waiting times. Additionally, patients with unknown frailty levels and fit patients present with shorter waiting times. Males exhibit slightly shorter waiting times than females. However, it is important to note that some categories, such as those with unknown deprivation quantile and unknown frailty level, have small sample sizes, which may limit the generalizability of these findings.

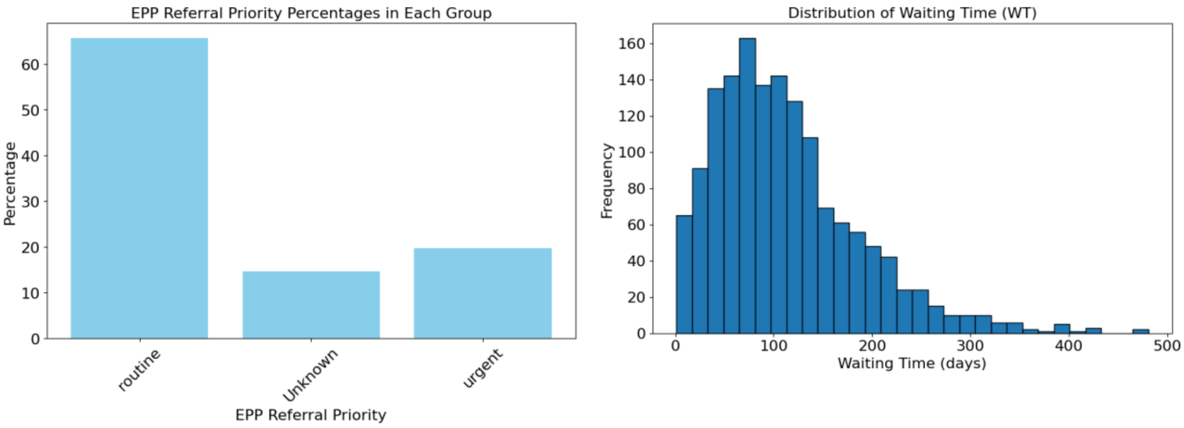
The distribution of waiting times is presented in Table 10 and Figure 14, showing that 65% of patients were treated within the target timeframe of 18 weeks. Approximately 20% of cases were classified as urgent, with 50% of these occurring within 6 weeks and 75% within 18 weeks. The remaining 25% of urgent cases were seen within 36 weeks.

Table 10 Distribution of wait lengths for cholecystectomy

Total	**0-3 weeks**		**4-6 weeks**		**7-9 weeks**		**10-12 weeks**		**13-15 weeks**		**16-18 weeks**		**19-21 weeks**		**22-24 weeks**		**25-27 weeks**	
N	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
1506	83	5.51	165	10.96	*175*	*11.62*	213	*14.14*	*179*	*11.15*	*174*	*11.55*	*136*	*9.03*	*87*	*5.73*	74	4.91
	28-30 weeks		**31-33 weeks**		**34-36 weeks**		**37-39 weeks**		**40-42 weeks**		**43-45 weeks**		**46-48 weeks**		**49-51 weeks**		**52+ weeks**	

	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
	63	4.18	49	3.25	30	1.99	22	1.46	14	0.93	15	1	7	0.48	6	0.4	14	0.93

Figure 14 Priority for Treatment (left) and Waiting time distribution (right)



For further analysis, four main waiting groups were considered <=18 weeks, 19-30 weeks, 31-42 weeks and >42 weeks. Short waiters (≤6 weeks, 34%) were excluded from the dataset for analysis, and three patients were removed due to death during follow-up, including one from the 18-week group and two from the 19–30 weeks group. Patients whose follow up period was shorter than their waiting time were also removed, resulting with final 972 patient pathways for analysis.

Table_4.3gb_not_in_did, Supporting Materials) shows characteristics of the patients removed for DID analysis due to insufficient follow up period**.** Younger age groups (25-34 years), older adults (65-74 years), multimorbid patients, frail individuals, and ethnic minorities (black and Asian backgrounds). Additionally, a significant proportion of patients from higher deprivation quintiles (IMD 5) and female patients experienced incomplete follow-up.

Patient Characteristics

Table 4.3_gb (Supplementary Material) presents a description of the cohort used in the difference-in-differences analysis, highlighting variations in waiting list statistics across different demographic and clinical groups. The analysis reveals that waiting times are fairly similar between males and females. Among males, 49.22% receive care within 18 weeks, while for females, this figure is slightly lower at 48.04%. However, a slightly higher proportion of females (37.54%) compared to males (34.88%) fall into the 19-30 week waiting category. Both genders show comparable distributions for longer waits (31-42 weeks and 43+ weeks), indicating that gender does not play a significant role in determining waiting time outcomes.

A clear pattern emerges when examining waiting times across different age groups. Young adults aged 18-24 years have the highest proportion of short waits, with 65.63% of patients receiving care within 18 weeks. This suggests that younger patients are either prioritized or require less complex treatment, leading to faster service. However, waiting times become longer for middle-aged adults, particularly those aged 25-54, where the proportion of long waiters (31-42 weeks) increases.

Older adults aged 75-84 years have a relatively high proportion of short waits (67.69% within 18 weeks), suggesting that they may receive priority care due to increased healthcare needs. However, a small proportion of these patients also experience extreme delays, with some waiting over 43 weeks, highlighting the variability in prioritization among elderly patients.

When examining waiting times by IMD quintiles, trends show that patients in the most deprived quintile (IMD 1) have a high proportion of short waits (48.95% within 18 weeks). This might indicate equitable or prioritized access to services or exclusion of patients with long waits due to insufficient follow-up time. In contrast, patients in IMD 4 face longer delays, with 14.46% waiting between 31-42 weeks, one of the highest among all groups.

This finding suggests that while the most deprived patients are not necessarily disadvantaged in waiting times, those from mid-range deprivation groups (IMD 3 and 4) may be at a higher risk of prolonged delays. Further investigation is needed to determine whether this is due to resource allocation, service availability, or differences in health-seeking behaviour.

Differences in waiting times across ethnic backgrounds indicate potential disparities in healthcare access. Patients from a white background have a short-wait proportion of 47.96%, which is slightly lower than the 50% for Black background patients and 48.44% for Asian background patients. However, Asian background patients show the highest proportion of 31-42 week waiters (15.63%), suggesting that they are at greater risk of experiencing delays in receiving care.

Although the data does not indicate substantial differences between ethnic groups for shorter waits, the higher proportion of long waiters among Asian background patients may suggest potential barriers in access, referral pathways, or prioritization within the healthcare system. This trend warrants further exploration to ensure that waiting times are equitable across all ethnic groups.

Frailty level and long-term conditions (LTCs) appear to significantly impact waiting times. Fitter patients tend to wait longer, with 38.29% in the 19-30 week category, suggesting that prioritization may favour those with higher healthcare needs. Interestingly, patients with mild frailty have the highest proportion of 31-42 week waiters (13.73%) and 43+ week waiters (5.88%), indicating that they may not receive the same level of prioritization as those with severe frailty.

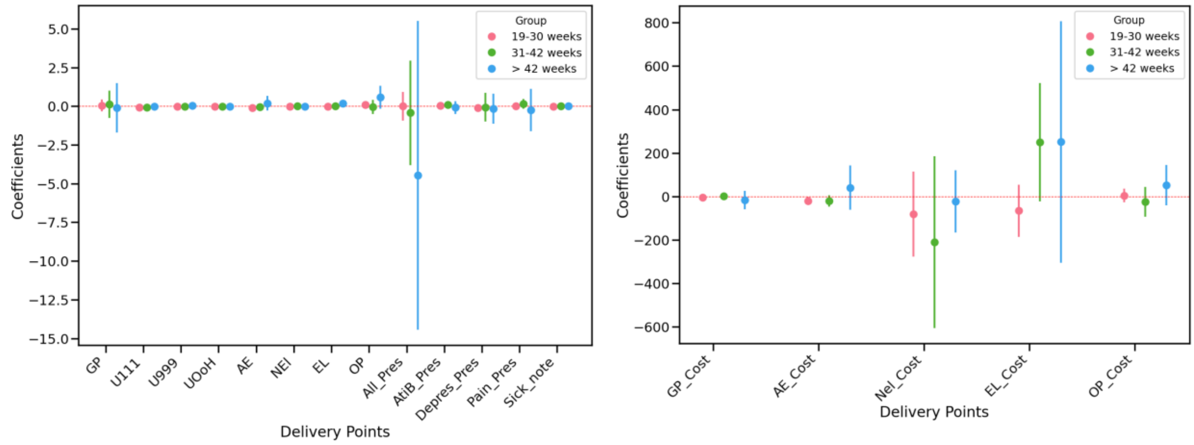
When analysing long-term conditions, patients with multimorbidities show the highest percentage of extreme long waits (5.86% waiting 43+ weeks). Additionally, patients with comorbidities and multimorbidities have a higher proportion of 31-42 week waiters compared to those without LTCs. This suggests that those with complex health conditions may experience treatment delays, which could negatively impact their health outcomes.

Overall, the analysis indicates that younger and older patients receive faster access to care, while middle-aged adults, those from mid-range deprivation groups, and patients with multimorbidities experience longer waits. Additionally, mildly frail individuals and patients from Asian backgrounds appear to be at a higher risk of long delays, suggesting potential disparities in healthcare access and prioritization. Further research is needed to explore the underlying reasons for these trends and to ensure that healthcare services are equitably distributed across different patient group.

Difference-in-differences

The results in **Table4.1_Table4.2_gb (Supplementary Material)** of the Difference-in-Differences (DiD) analysis suggest that waiting times have minimal impact on excess healthcare use. There is no strong evidence of increased GP visits across waiting time groups, as the estimated excess usage is small and statistically insignificant ($p > 0.7$). A&E visits show a significant reduction for the 19–30-week group (-0.11, $p = 0.02$), leading to cost savings (-£10,175), though this effect diminishes for longer waits. Prescription use, including painkillers and antidepressants, remains stable, with no meaningful changes. Emergency admissions also show small, non-significant reductions. Overall, while moderate waiting times may reduce A&E visits and costs, healthcare utilisation patterns appear largely unchanged, suggesting that patients do not significantly increase their use of GP or emergency services while waiting. Figure 15 shows the estimates and the confidence intervals CI for Difference in Difference model. One can notice large variability (SE) for antibiotics and hospital admission costs.

Figure 15 Coefficients of Features w/ 95% Confidence Intervals for cholecystectomy

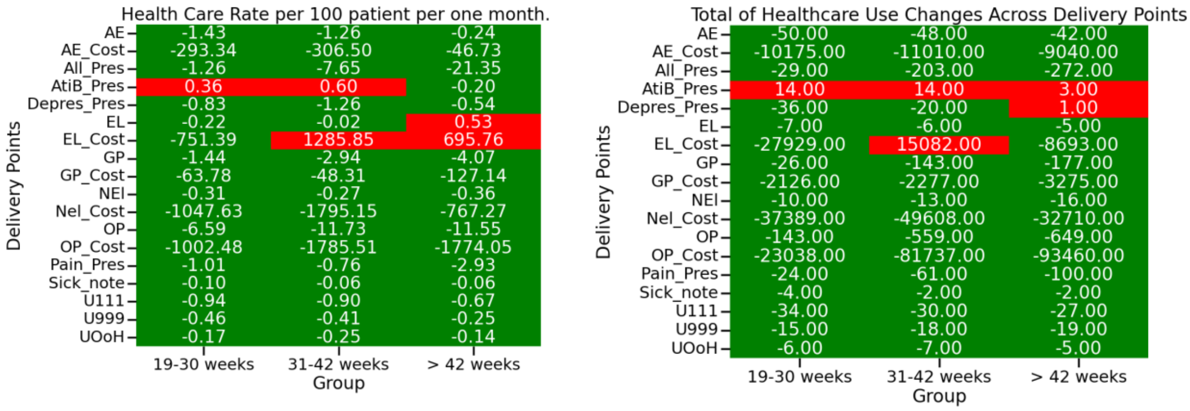


Data in **Table4.1_Table4.2_gb (Supplementary Material)** primarily show negative total excess healthcare use, indicating that patients with longer waiting times generally required fewer healthcare services. However, positive excess can be observed for antibiotics (AntiB_Pres) for all waiting groups, depressant prescriptions in the >42-week waiting group, and elective admission costs. This may suggest that the longer-waiting cohort is healthier overall and requires less frequent healthcare contact, or that some patients experience medical conditions preventing them from receiving earlier treatment, or simply due to the size of the group. The occurrence of elective admissions during the waiting period may indicate that patients were awaiting treatment for other conditions that required intervention before their planned procedure. Figure 16 (right) presents total excess healthcare use, highlighting a positive difference in utilisation between the comparison groups compared to <= 18 weeks group.

To further understand differences in healthcare utilisation, the healthcare rate per 100 patients per month was calculated (Figure 16, left). The results indicate that longer waiting times are associated with reduced healthcare utilisation across multiple settings. Patients waiting 19-30 weeks, 31-42 weeks, and >42 weeks had fewer AE visits (-1.43, -1.26, and -0.24 per month per 100 patients, respectively) and lower AE costs, suggesting a decline in emergency care use over time. GP contacts also decreased significantly (-1.44, -2.94, and -4.07), along with a reduction in GP-related costs, indicating lower primary care engagement among those with extended waits.

Outpatient visits saw the largest decline, particularly for those waiting beyond 31 weeks (-11.73 and -11.55), accompanied by substantial cost reductions. Prescriptions also decreased sharply, with an overall decline of -21.35 for patients waiting >42 weeks, particularly in pain-related medications. Meanwhile, elective admissions (EL) slightly increased after 42 weeks, with a corresponding rise in costs, suggesting that some interventions were delayed but eventually required. Non-elective hospital admissions (NEL) and urgent care use (111, out-of-hours) also trended downward, reflecting lower acute care utilisation among longer-waiting patients.

Figure 16 Excess of the healthcare use(left) per 100 patients per month, (right) total excess for cholecystectomy



The findings suggest that patients with higher healthcare utilisation may be prioritized for earlier treatment, resulting in minimal differences in excess healthcare use between waiting time groups. If individuals with greater healthcare needs are seen more quickly, those who experience longer waits may represent a cohort with lower baseline utilisation, potentially explaining the observed trends. The reduction in A&E visits for patients waiting 19–30 weeks may indicate improved self-management or alternative care-seeking behaviors during moderate waiting periods. However, the diminishing effect for longer waits suggests that prioritization mechanisms may not extend indefinitely or that other factors, such as condition severity and coping strategies, influence healthcare utilisation during prolonged waits.

The data shows patterns in GP utilisation **(Table_4.4_gb, Supplementary Material)**, with certain groups more likely to be in the top 10% of users. Age, long-term conditions (LTCs), and deprivation levels show statistically significant differences, with p-values below 0.05. Age bands such as 55-64, 25-34, 45-54, 65-74, 35-44, 75-84, and 18-24 all exhibit significant differences ($p = 0.0095$). Similarly, LTC categories, including Single LTC, No LTCs, Multimorbidities, and Comorbidities, also show significant variation ($p < 0.001$) Deprivation levels (IMD quantiles 1, 2, 3, 4, and 5) display marked differences ($p < 0.05$). In contrast, ethnicity (White, Black, Asian, Mixed, and Unknown) and sex (Male and Female) do not show significant differences, with p-values above 0.05. These findings suggest that age, deprivation, and long-term conditions are key drivers of high GP utilisation, while ethnicity and sex do not appear to significantly influence usage patterns.

The analysis of AE usage **(Table_4.5_gb, Supplementary Material)** shows the distribution of various factors across the bottom 90% and top 10% of utilisation, with some significant patterns emerging. For example, in terms of age, the categories "25-34", "45-54", and "55-64" show a significantly higher proportion of individuals in the bottom 90% compared to the top 10%, with p-values < 0.05, indicating statistical significance. Similarly, individuals with a "Single LTC" (Long-Term Condition) or "Multimorbidities" appear more frequently in the bottom 90% of utilisation, though the p-values for these categories suggest less statistical significance (above 0.5). Ethnicity categories like "mixed_background", "asian_background", "white_background", and "black_background" also show a clear majority in the bottom 90%, with p-values greater than 0.2, implying no significant difference between the groups in terms of utilisation distribution. Notably, age bands such as "65-74", "75-84", and "84+" show a higher concentration in the bottom 90%, but again with p-values indicating that these differences may not be significant. Overall, factors like age band and the presence of comorbidities or long-term conditions appear to have a more pronounced effect on utilisation, although the statistical significance of these findings varies across the dataset.

3.2.2 Hip Replacement

The hip replacement procedures were identified based on OPCS primary code (See Appendix Codes) in secondary health care data. There were 2466 procedures reported in the study period, of which 1264 were identified with corresponding waiting time. **Table 4.3hip_all_group (Supplementary Materials)** presents the characteristics of patients waiting for 5 waiting groups (<=6 weeks, <=18 weeks, 19-30 weeks, 31-42 weeks and > 42 weeks). Characteristics for long waiters: Older adults (84+) consistently show the highest values in the wait time metrics. This may suggest that older patients experience significantly longer waits. Patients with comorbidities tend to have elevated values across the wait time metrics, indicating longer waiting times. Patients with severe frailty exhibit the highest values in the wait time metrics, even though they represent a smaller patient population. Patients with moderate frailty also show higher wait time metric values compared to those with mild or no frailty. While White background has a high volume, other groups show higher wait times. Mixed background patients, despite being a smaller group, appear to have higher values in some wait time metrics. Females, while representing a larger patient volume, also show higher wait time metric values compared to males. Short waiters tend to be younger, non-comorbid, fitter or less frail, compared to longer waiting group, also male patients tend to experience shorter waiting times. Figure 17 shows the distribution waiting times for hip replacement patients and Table 12 shows the weekly break down between waiting groups. Less than 50% of patients were seen within target time 18 weeks. Around 10% were urgent cases, of which 70% occurred within 6 weeks.

Figure 17 Priority for Treatment (right) and Waiting time distribution (left) for hip replacement

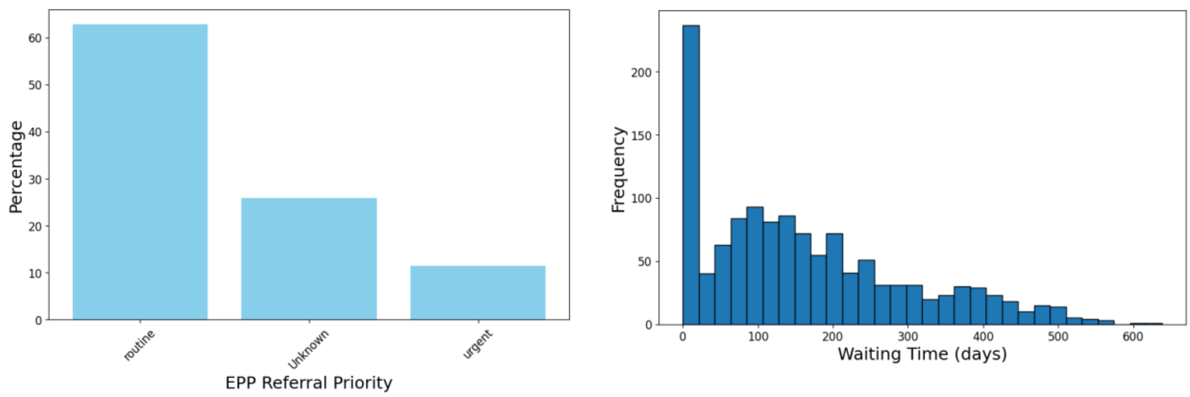


Table 11 Distribution of wait lengths for hip replacement

Total	0-3 weeks		4-6 weeks		7-9 weeks		10-12 weeks		13-15 weeks		16-18 weeks		19-21 weeks		22-24 weeks		25-27 weeks	
n	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
1264	237	*18.8*	40	< 5	*63*	< 5	82	*6.5*	*94*	*7.4*	*79*	*6.3*	*85*	*5.72*	*69*	*5.46*	58	<5
	28-30 weeks		**31-33 weeks**		**34-36 weeks**		**37-39 weeks**		**40-42 weeks**		**43-45 weeks**		**46-48 weeks**		**49-51 weeks**		**52+ weeks**	
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
	71	5.6	43	<5	44	<5	35	<5	30	<5	33	<5	20	<5	23	<5	158	12.5

Next, the short (6 weeks) waiters (18%) were removed from the data. Additional patients were removed from the dataset due to the death in reference (post- treatment) time. One patient in

<=18 weeks, one in 19-30 weeks, two in 31-42 weeks and one in <42 weeks. Patients with too short of a follow up also were removed resulting in a total number of 772 patient-pathways.

There were 460 patients with not long enough follow up period that were removed from the cohort for DID modelling (see **Table_4.3_hip_not_in_did, Supporting Materials).** Patients in the younger age bands (11-17, 25-44), unknown and less deprived IMD quintiles, black and Asian backgrounds, females, and those with moderate to severe frailty **levels** were excluded from DiD analysis due t**o** short follow-up times**.**

Patient Characteristics

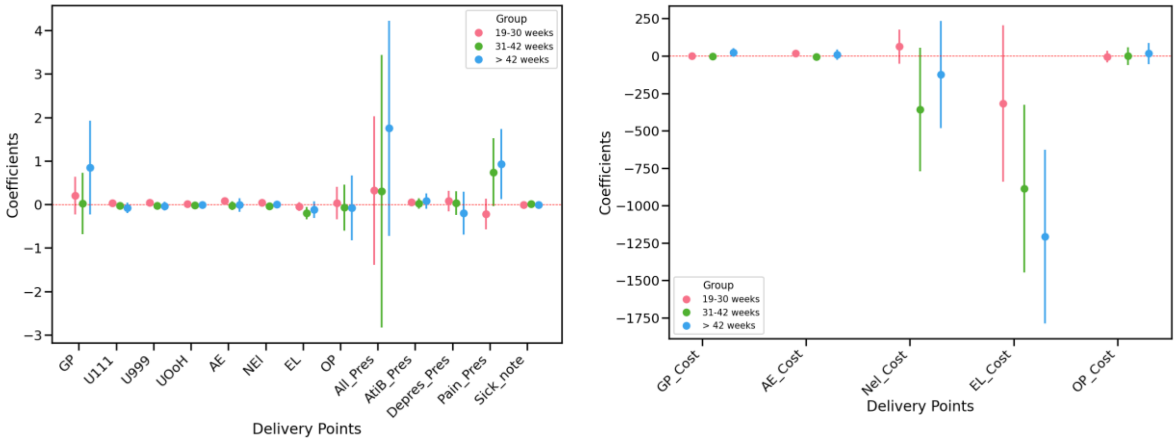
Table4.3hip (see Supplementary Material) highlights several key trends in waiting times across different demographics and clinical groups. Older patients, particularly those aged 65-74 and 75-84, are more likely to experience long waits, with over 20% waiting more than 42 weeks, while younger patients, especially those aged 18-24, have the shortest waits, with 66.67% treated within 18 weeks. Socioeconomic deprivation also plays a role, as patients from the most deprived areas (IMD 1) are more likely to wait over 42 weeks (22.64%), whereas those from the least deprived areas (IMD 5) have the highest proportion treated within 18 weeks (32.26%). Ethnicity patterns show that white-background patients make up the majority, with wait distributions reflecting the overall trend, while black-background patients have a slightly higher proportion waiting 31-42 weeks and Asian-background patients have the highest proportion treated within 18 weeks (33.33%), with none waiting beyond 42 weeks. Patients with no long-term conditions (LTCs) experience the shortest waits, with only 5.38% waiting more than 42 weeks, whereas those with multimorbidity are more likely to face longer delays. Women tend to wait longer than men, with 16.85% waiting over 42 weeks compared to 14.24% for men, though men have a slightly higher proportion in the 31–42-week category. Frailty levels also influence waiting times, with severely frail patients experiencing the longest delays, as 66.67% wait 19-30 weeks, and only 11.11% receive treatment within 18 weeks, while fit patients are more likely to be treated earlier.

Overall, the data suggests that older, multimorbid, deprived, and severely frail patients face the longest waits, while younger, healthier, and less deprived groups are more likely to be treated within 18 weeks.

Difference-in-Differences

Similarly to gall cholecystectomy, the difference in differences model results were collected and presented in **Table 4.1_Table 4.2hip (See Supporting Material).** The results suggest that GP utilisation and associated costs do not show significant differences across waiting time groups, with no convincing evidence of excess GP visits or increased costs at any waiting duration. However, A&E visits and costs are significantly higher for patients waiting 19–30 weeks, indicating increased emergency care usage during this period, though this trend is not observed for longer waits. Pain prescriptions show an increase for those waiting over 42 weeks, highlighting the potential worsening of patient conditions due to prolonged delays. Additionally, elective procedures significantly decrease for patients waiting more than 42 weeks, likely due to cancellations or delays in treatment. While some trends suggest increased healthcare utilisation with longer waits, statistical significance is limited, except for the observed rise in A&E visits and costs in the 19–30-week group and the increase in pain prescriptions for those with the longest waits. Figure 18 shows statistical significance of the health care utilisation for all delivery points, Large vertical bars represent standard errors (SE)-indicating uncertainty around estimates.

Figure 18 Coefficients of Features w/ 95% Confidence Intervals for hip replacement

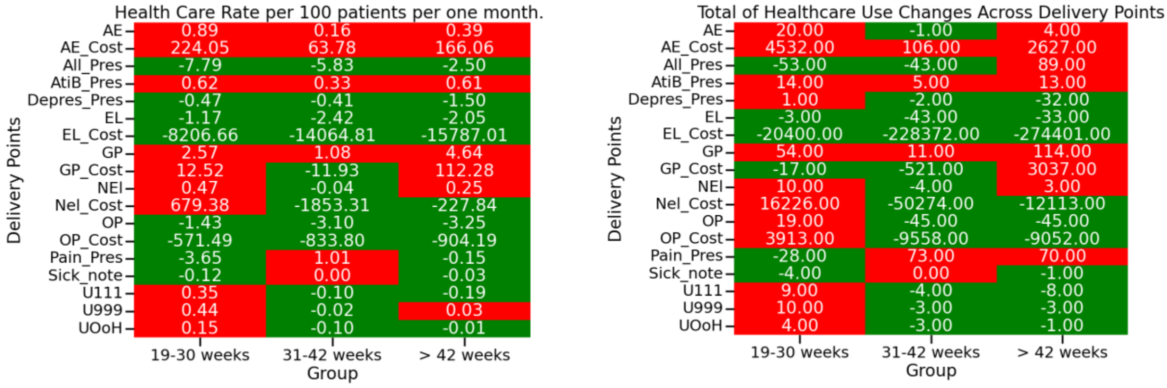


When considering total excess healthcare utilisation, A&E visits and costs contribute the most to positive excess in the 19–30 week waiting period, while pain prescriptions significantly contribute to excess for patients waiting over 42 weeks. In contrast, elective procedures show a negative excess, particularly for those with the longest waits, suggesting reduced access to planned treatments. These findings suggest that whilst extended waiting times may lead to increased healthcare needs, the impact varies depending on the type of service and the duration of the wait, with some patients experiencing worsened conditions leading to excess utilisation, while others face barriers to accessing necessary procedures.

Total excess may indicate certain trends; however, it does not account for differences in group sizes or the significant imbalance in cardinality between the compared cohorts. **Error! Reference source not found.** contrasts the total excess with the monthly healthcare utilisation rate per 100 patients, offering a more standardized perspective. The analysis reveals distinct patterns linked to increasing waiting times. In general, patients with longer waits show a decline in Accident & Emergency (AE) attendance, with a slight increase observed in the >42 weeks group. Correspondingly, AE-related costs are lower for the 31-42 weeks group but rise again for those waiting more than 42 weeks. Elective (EL) care and associated costs decrease significantly as waiting times increase, indicating deferred planned treatments. Similarly, non-elective (NEL) admissions and costs peak at 19-30 weeks before declining substantially for longer waits, suggesting either postponed urgent care needs or shifts in healthcare-seeking behaviour. GP visits and costs vary, reaching their lowest point in the 31-42 weeks group before increasing again in the >42 weeks group, possibly reflecting worsening health conditions that require primary care intervention. Prescriptions for antibiotics and depression-related medications remain relatively stable but show a slight decline with longer waiting times. Outpatient (OP) visits and costs follow a downward trend, consistent with the reduction in elective care. Pain-related prescriptions exhibit minimal variation across waiting groups, indicating stable chronic pain management despite delays in care. Interestingly, urgent care service utilisation—including NHS 111, emergency ambulance (U999), and out-of-hours (UOOH) services—remains largely unchanged across waiting groups. This suggests that patients awaiting treatment do not utilisation but may also lead to greater reliance on primary care in later stages, while urgent care usage remains stable.significantly adjust their use of immediate healthcare services. These findings indicate that extended waiting times are primarily associated with reduced elective and outpatient care

Utilisation of the AE **(Table 4.5_hip, Supplementary Material)** reveals some key differences in utilisation across categories, with certain age bands showing significant variations. Age bands like "55-64", "45-54", and "65-74" have a higher concentration in the bottom 90%, with p-values <0.05 indicating statistically significant differences. Utilisation of the AE **(Table 4.5_hip, Supplementary Material)** reveals some key differences in utilisation across

Figure 19 Excess of the healthcare use(left) per 100 patients per month, (right) total excess



categories, with certain age bands showing significant variations. Age bands like "55-64", "45-54", and "65-74" have a higher concentration in the bottom 90%, with p-values <0.05 indicating statistically significant differences.

Utilisation of the AE **(Table 4.5_hip, Supplementary Material)** reveals some key differences in utilisation across categories, with certain age bands showing significant variations. Age bands like "55-64", "45-54", and "65-74" have a higher concentration in the bottom 90%, with p-values <0.05 indicating statistically significant differences. The dataset for GP utilisation **(Table_4.4_hip, Supplementary Material)** reveals several significant differences across different categories, particularly in terms of age, long-term conditions (LTC), and ethnicity. Age bands such as "55-64", "45-54", "65-74", "75-84", and "84+" show significant differences in the distribution of utilisation, with p-values below 0.05, indicating that these age groups tend to have a higher proportion in the bottom 90% compared to the top 10%. Specifically, the "55-64", "45-54", and "65-74" age bands show differences with p-values < 0.05.

Long-term conditions also play a role, with "Single LTC", "No LTCs", "Multimorbidities", and "Comorbidities" categories showing significant differences (p-values < 0.05), highlighting that individuals with these conditions are more likely to be in the bottom 90%. Ethnicity categories, such as "asian_background", "white_background", and "black_background", also show significant differences, with p-values below 0.05, though these categories have a relatively small sample size, particularly "asian_background" and "black_background", which may limit the generalizability of these findings.

Other factors like IMD quantiles and sex exhibit little to no significant differences, with p-values above 0.05 in most cases, suggesting these factors may not be as influential in determining GP utilisation. Overall, the most significant trends in GP utilisation appear to be driven by age bands and the presence of long-term or comorbid conditions, with ethnicity also playing a role in certain cases.

3.2.3. Hysteroscopy – Diagnostics in Gynaecology

There were 2,928 hysteroscopy procedures identified during the study period, of which 2,536 had associated waiting times (see Table 12). **Table 4.3_hyster_all_group (Supplementary Materials)** presents the characteristics of patients waiting for 5 waiting groups (<=6 weeks, <=18 weeks, 19-30 weeks, 31-42 weeks and > 42 weeks). Patients in the shorter waiting groups (≤6 weeks and ≤18 weeks) exhibit distinct demographic and clinical characteristics compared to those experiencing longer waits (>18 weeks). Short waiters tend to be younger, predominantly from the 11-17 and 18-24 age groups, with minimal representation of older adults (≥65 years). They are more likely to be healthier, with a higher prevalence of individuals having no long-term conditions (LTCs) or only a single LTC. Additionally, patients classified as fit or with mild frailty are overrepresented in these shorter wait groups.

In contrast, longer waiters are disproportionately older, with the 75-84 and 84+ age groups showing the highest values in wait time metrics. These groups also include a higher proportion of patients with multiple comorbidities and multimorbidities, indicating a strong association between complex health needs and extended wait times. Frailty is another critical determinant, as individuals with moderate and severe frailty consistently exhibit longer wait times, with a notable accumulation in the >42-week group.

Ethnic disparities are also evident, with white background patients constituting the majority across all groups. However, patients from mixed, black, and Asian backgrounds tend to experience higher wait times despite representing smaller proportions of the overall cohort. Furthermore, gender differences emerge, where males are more likely to experience shorter waiting times, while females, despite constituting a larger patient volume, exhibit higher wait time metrics and are overrepresented in longer wait categories.

Socioeconomic deprivation, as measured by the Index of Multiple Deprivation (IMD), further differentiates waiting time patterns. Patients from higher socioeconomic backgrounds (lower IMD quintiles) are more likely to be seen within 6 and 18 weeks, whereas those from more deprived areas (IMD 1 and IMD 2) are disproportionately represented in longer wait categories. This gradient suggests that socioeconomic disadvantage contributes to extended waiting times and potential disparities in

The value of 43 % of the cancer-related pathways were removed from the dataset, resulting in a final 1,412 cases waiting for hysteroscopy diagnostics. The characteristics of Cancer patients are presented in **Table_3.4_hyster_cancer_non_in_did (**Supporting Materials). Cancer patients with higher frailty levels, comorbidities, and those from deprived or ethnically diverse backgrounds experience longer waiting times, potentially reflecting disparities in timely access to care. Although the majority of cancer patients are seen within ≤6 weeks, vulnerable subgroups, including frail, multimorbid, and ethnically diverse populations, exhibit longer wait times, highlighting areas where prioritization and resource allocation may need refinement.

Among the remaining cases, half were treated as urgent cases (≤ 6 weeks), while 43% of patients were seen within six weeks. The group of patients waiting longer than 42 weeks accounted for 17%, the largest proportion among all waiting time categories (<18 weeks, 19–30 weeks, 31–42 weeks, and >42 weeks) (see Figure 20).

The urgent cases were removed from dataset, there were 2 deaths during the waiting time, one in group <- 18 weeks and second on 31-42 weeks. Next, the pathways with no follow up period, were filter out, resulting with remaining final 569 pathways.

1458 patients were excluded from DID analysis due to insufficient follow – up period beyond 42 weeks. **Table_3.4_hyster_non_in_did (**Supporting Materials) contains patient characteristics. The majority of exclusions occurred in younger (11-24 years) and older (75+ years) age groups, as well as among patients with moderate and severe frailty, multimorbidities, and single LTCs. Additionally, individuals from more deprived IMD quintiles, mixed and Asian backgrounds, and unknown ethnicity had a high exclusion rate.

Table 12 Distribution of wait lengths for Hysteroscopy

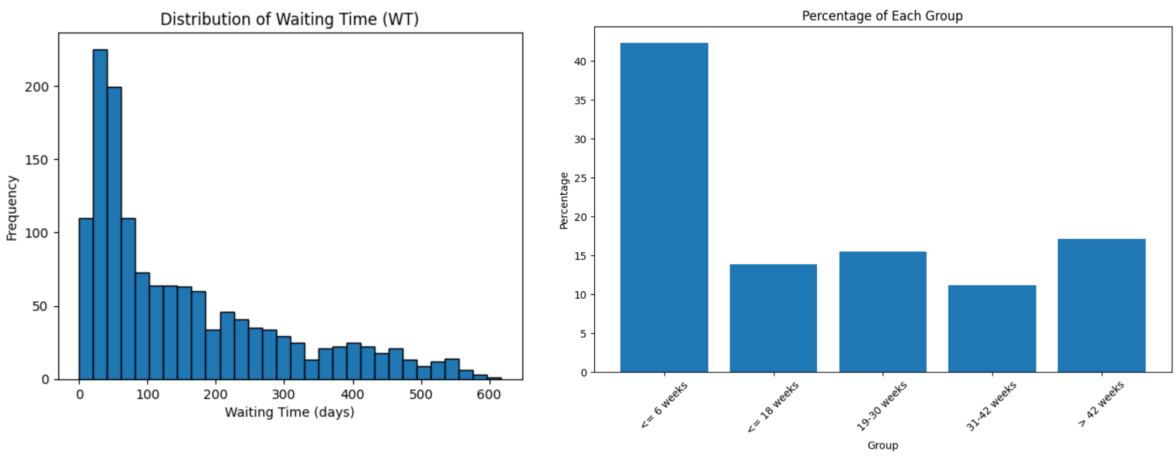
Total	**0-3 weeks**		**4-6 weeks**		**7-9 weeks**		**10-12 weeks**		**13-15 weeks**		**16-18 weeks**		**19-21 weeks**		**22-24 weeks**		**25-27 weeks**	
n	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*

2536	380	*14.98*	629	24.8	*419*	*16.52*	179	*7.06*	*111*	*4.38*	*102*	*4.02*	*88*	*3.47*	*70*	*3.47*	71	2.8
	28-30 weeks		**31-33 weeks**		**34-36 weeks**		**37-39 weeks**		**40-42 weeks**		**43-45 weeks**		**46-48 weeks**		**49-51 weeks**		**52+ weeks**	
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
	41	1.62	51	2.01	44	1.74	39	1.54	43	1.7	25	0.99	30	1.18	17	0.67	197	7.77

Patient Characteristics

Table **4.3_hysteroscopy (Supplementary Material)** shows disparities across different demographic and clinical groups. Older age groups, particularly those aged 75-84 and 65-74, had a higher proportion of patients waiting more than 18 weeks, with 46.15% and 32.14%, respectively, experiencing delays. In contrast, younger age groups, such as 18-24 years, had a lower overall volume of cases but a considerable proportion (64.29%) waited between 19-30 weeks.

Figure 20 Distribution of the waiting time and pathway percentage in each of waiting group for hysteroscopy.



Ethnicity also appeared to influence waiting times. 38% of patients from an Asian background waited more than 18 weeks, whereas 35.5% of those from a white background exceeded the 18-week threshold. Individuals from a black background had the highest percentage of patients waiting more than 42 weeks (16%) compared to other ethnic groups.

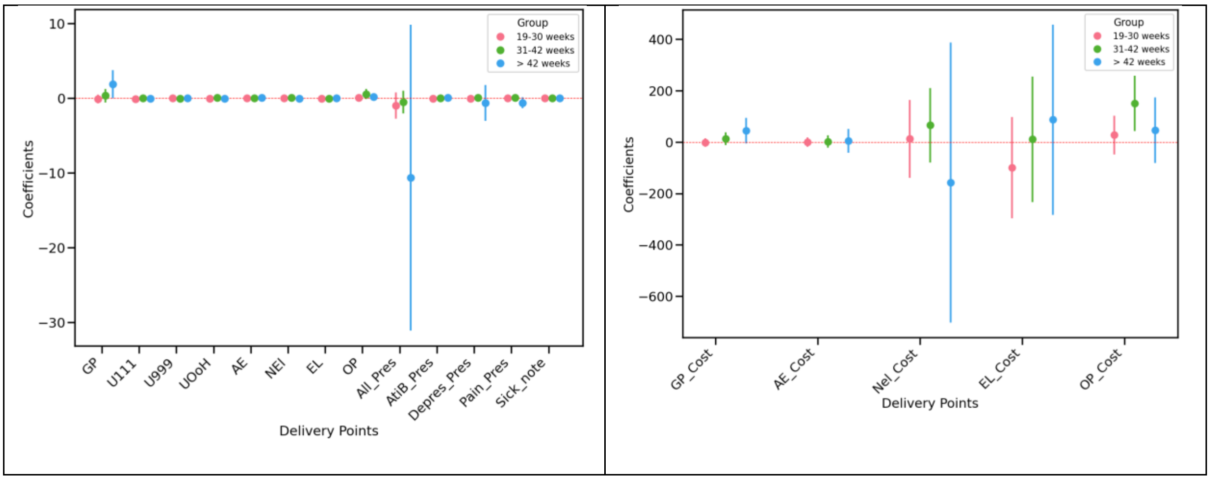
Patients with multiple long-term conditions (LTCs) experienced longer waits, with 40.66% of multimorbid patients waiting less than 18 weeks, while comorbid patients had a slightly higher percentage waiting longer (40.86% beyond 18 weeks). Similarly, frail individuals, particularly those with severe frailty, showed the highest proportion of patients waiting over 42 weeks (50%), suggesting that more vulnerable patients might be disproportionately affected by extended delays in care.

Overall, the findings indicate that older adults, patients with comorbidities, and individuals from certain ethnic backgrounds are more likely to experience prolonged waiting times. These trends highlight potential inequalities in access to timely care and may inform targeted interventions to improve wait-time management for high-risk groups.

Difference-in Differences

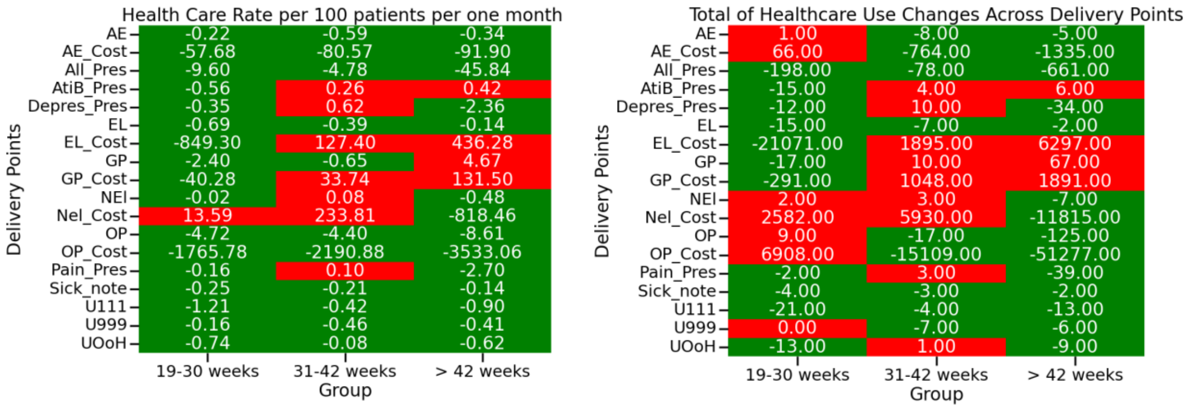
The analysis of healthcare utilisation (see **Table_4.1_Table_4.2_hyster, Supplementary Materials**) over different time periods reveals significant variations in service demand, particularly in general practitioner (GP) visits and outpatient care costs. In the period exceeding 42 weeks, there was an increase in GP visits, with a total excess of 67 additional visits and a statistically significant difference-in-differences (DiD) estimator of 1.88 ($p = 0.0499$), indicating increased reliance on primary care. GP-related costs also rose substantially in this period, with an excess cost of £1891, though statistical significance was not achieved. Outpatient costs demonstrated a significant increase during the 31–42-week period (DiD = 149.55, $p < 0.05$), suggesting a potential shift towards secondary care utilisation. Conversely, the use of urgent care services, including NHS 111 calls and out-of-hours (UOoH) visits, showed a decline, which may reflect a shift in healthcare-seeking behavior towards scheduled GP consultations. Emergency department (AE) visits and non-elective (NEL) admissions fluctuated over time but did not exhibit statistically significant differences. Additionally, prescribing patterns for pain relief and antidepressants remained relatively stable, with minor variations that did not reach statistical significance. These findings highlight the impact of prolonged waiting times on healthcare utilisation, particularly the increased burden on GP services, and suggest a possible shift in additional healthcare demand from urgent to planned care as waiting time increases. Figure 21 shows the DID estimates with the standard errors.

Figure 21 Coefficients of Features w/ 95% Confidence Intervals for hysteroscopy



The analysis of healthcare utilisation (see Figure 22) across different delivery points over three waiting periods (19-30 weeks, 31-42 weeks, and >42 weeks) reveals distinct trends in service demand and cost allocation. The first heatmap, representing healthcare rates per 100 patients per month, indicates a progressive increase in general practitioner (GP) consultations and associated costs, particularly in the >42 weeks group. Concurrently, accident and emergency (AE) visits and AE-related costs exhibit a decline, suggesting a shift from acute to primary care management. Urgent care services, including U111 and U999, remain relatively stable or show minor reductions across all periods. Notably, elective care (EL) and outpatient services (OP) present diverging trends, with EL-related costs experiencing a sharp increase in the >42 weeks group, whereas outpatient costs initially rise at 31-42 weeks before a subsequent decline. The second heatmap, which illustrates total healthcare use changes, reinforces these findings by highlighting significant cost fluctuations, particularly in elective and outpatient services. Prescription trends remain relatively stable, with minor variations in antibiotic prescriptions and deprescribing initiatives. These findings suggest a shift in resource utilisation, with a greater emphasis on planned and primary care interventions as gestation progresses, potentially reducing emergency service dependency while increasing expenditures in elective and outpatient care.

Figure 22 Excess of the healthcare use(left) per 100 patients per month, (right) total excess for hysteroscopy



There are several significant differences in GP utilisation (see **Table_4.4_hyster, Suplementary Material**) based on long-term conditions (LTC) and some age bands, but less so for other factors like ethnicity or IMD quantile. The "Single LTC", "No LTCs", "Multimorbidities", "Comorbidities", and "unknown LTC" categories all show highly significant differences in utilisation, with p-values < 0.001, indicating strong distinctions between the bottom 90% and top 10% of utilisation in these groups. For instance, individuals with multiple morbidities and comorbidities tend to have a higher proportion in the top 10% of utilisation. Age bands also show some differences, particularly with those aged 55-64 and 45-54, although the p-values are relatively high (around 0.77), suggesting that age alone may not be a strong factor in determining utilisation. Ethnicity, on the other hand, does not show any significant differences, with p-values near 0.98 for all ethnic categories, indicating no substantial impact on GP utilisation in this dataset. Similarly, IMD quantiles show no clear distinction in utilisation, as evidenced by the p-values above 0.49. Sex also shows minor differences, with females comprising a slightly higher proportion of the top 10% of users

In the AE utilisation data (see **Table_4.5_hyster**), significant differences are observed mainly in ethnicity, with the "mixed_background," "asian_background," "unknown," "white_background," and "black_background" categories showing variations in the distribution between the bottom 90% and top 10% of users. The p-values for these categories are all below 0.05, indicating a statistically significant impact on AE utilisation. For instance, individuals with a "mixed_background" ethnicity and "asian_background" ethnicity have relatively small percentages in the top 10%, while those from a "white_background" or "black_background" ethnicity show even more pronounced differences, with small top 10% percentages. Age bands, LTC status, and IMD quantiles show minimal significant differences in AE utilisation. For example, the p-values for "age_band" categories (like 55-64, 25-34, 45-54, etc.) range from 0.858 to 0.858, suggesting no significant impact of age on AE utilisation. Similarly, LTC status (e.g., "Single LTC," "No LTCs," "Multimorbidities") has relatively high p-values (above 0.5), indicating that having long-term conditions does not have a strong effect on AE usage in this dataset. Notably, "IMD quantile" categories also show little to no impact, with all p-values above 0.28, further reinforcing that deprivation levels, as measured by IMD, do not significantly affect AE utilisation. Overall, ethnicity stands out as the most significant factor influencing AE utilisation, while age, LTC, and IMD quantile have relatively minor effects.

3.2.4 Comparison of short waiters vs long waiters

This analysis examines General Practitioner (GP) and Accident & Emergency (AE) contacts, as well as medication intake, in relation to waiting times for selected medical procedures. A significant proportion of patients were seen within the target time (≤18 weeks), while long waiters, especially those waiting more than 32 weeks, were relatively infrequent for the selected procedures. To further understand this issue, short waiters were compared to long waiters.

Table 13 Total excess for health care utilisation.

Delivery Point	Gallbladder	Hip Replacement	Hysteroscopy
AE	-36	3	8
AE_Cost	-£7745	£1,143	£2315
Non-Electives Admission (NEL)	-5	-3	6
GP	28	113	186
GP Cost	-£1846	£1,611	£4748
UOOH	-8	-2	-14
Elective Admission (EL)	6	-5	-20
Out-Patient (OP)	91	65	251
U111	-35	-9	-7
U999	-8	-6	-1
Antibiotics	19	18	-11
Anti-Depresants	-69	1	-48
Pain Prescription	13	307	-32
Sick Note	-4	-5	-3

Table 14 shows the trend measured in total excess and the following patterns were observed: The total excess healthcare use for Gallbladder, Hip Replacement, and Hysteroscopy procedures reveals distinct patterns across various delivery points. Gallbladder procedures show a decrease in AE visits, AE costs, and non-elective admissions, while GP visits and outpatient appointments increase. Hip Replacement procedures exhibit a significant rise in GP visits, outpatient care, and pain prescriptions, along with a slight increase in GP-related costs and a decrease in AE visits, AE costs, and elective admissions. Hysteroscopy procedures indicate an increase in GP visits and outpatient care, with a decrease in the use of antibiotics, pain prescriptions, and sick notes, alongside higher GP-related costs. These trends suggest that Hip Replacement and Hysteroscopy patients are more likely to use outpatient services and require pain management, whereas Gallbladder patients rely less on urgent care services.

Gallbladder

The analysis reveals trends in healthcare utilisation for patients waiting more than 18 weeks. GP and outpatient visits increased during the intervention period, with GP contacts rising from 856 to 1519 in the reference period and from 1043 to 1734 in the intervention period, while outpatient visits saw a similar upward trend. However, the Difference-in-Difference (DiD) analysis indicates that these increases were not statistically significant. Emergency and urgent care usage declined, with AE visits showing a reduction of 36 cases (DiD = -0.07, p = 0.10) and U111 visits decreasing significantly by 35 cases (DiD = -0.07, p = 0.01). AE costs also dropped by £7745, though this change lacked strong statistical significance. Elective admissions increased slightly, but elective costs rose significantly by £15,616 (DiD = 23.12, p = 0.71), suggesting higher resource utilisation. Prescription trends remained relatively stable, with a slight increase in antibiotic prescriptions (+19, DiD = 0.04, p = 0.27), a minor decrease in antidepressant prescriptions (-69, DiD = -0.08, p = 0.57), and no significant change in pain prescriptions. Non-elective admissions showed scant variation, but non-elective care costs declined significantly by £50,915 (DiD = -105.87, p = 0.25). Overall, these findings suggest a shift towards increased reliance on primary care and outpatient services, with reduced use of emergency and non-elective care, although cost implications remain complex and warrant further investigation.

Hip Replacement

Difference-in-Differences (DiD) analysis reveal trends in healthcare utilisation and costs for patients waiting more than 18 weeks. GP visits and associated costs show a positive excess, with GP visits increasing by 0.31 and costs by 4.36, though neither result is statistically significant. Urgent care visits (U111, U999, UOoH) show negative or near-zero effects, suggesting fewer urgent care contacts in the intervention group, but again, none of these results are significant. Emergency admissions (AE) and their costs show minor increases (0.05 and 10.82, respectively), but remain statistically insignificant. Non-elective admissions (NEL) exhibit minimal differences, while elective admissions (EL) show a decline (-0.1, p = 0.04), with a significant reduction in elective costs (-635.76, p = 0.00). Outpatient (OP) visits and costs also show negative trends but lack statistical significance. Prescription usage increases slightly, with all prescriptions showing a DiD estimator of 0.9, while pain prescriptions (0.28) and antidepressants (0.03) show smaller effects, none reaching significance. Overall, while GP utilisation rises with longer waits, elective admissions decrease significantly, and cost variations are observed but rarely reach statistical significance. Patients waiting longer than 18 weeks tend to be older, with the highest proportions in the 45-54 (75.24%), 55-64 (70.05%), 75-84 (72.09%), and 84+ (72.00%) age groups. Socioeconomic deprivation appears to play a role, as those in IMD quantile 1 (most deprived) have the highest percentage of long waiters (75.8%). Ethnicity-wise, white-background patients (71.24%) and black-background patients (75.0%) have higher long-wait proportions. Health status also influences waiting times, with patients having multimorbidity (73.83%) and single long-term conditions (72.46%) waiting longer. Frailty is a significant factor, with 88.89% of severely frail individuals waiting over 18 weeks. Gender differences are minimal, with males (71.1%) and females (70.56%) having similar long-wait percentages.

Hysteroscopy:

For hysteroscopy patients waiting longer than 18 weeks, GP usage and costs increased, with an excess of 0.33 GP contacts per person-week and additional GP-related costs of £9.67 per person-week (£4,748 total excess), though not statistically significant. Outpatient visits also rose, with an excess of 0.21 per person-week and a significant cost increase of £68.36 per person-week (£95,356 total excess, p=0.06). In contrast, emergency and out-of-hours contacts showed no meaningful increase, and elective admissions slightly declined, leading to a reduction in associated costs. Non-elective admissions had a small excess but were not statistically significant. Prescription use, including pain medication and antidepressants, showed slight decreases rather than increases. Overall, the findings suggest that longer waits for hysteroscopy may drive higher GP and outpatient usage without a corresponding rise in emergency care or medication prescriptions. Patients aged 35-44 and 25-34 have the highest proportions waiting longer than 18 weeks (69.14% and 70.0%, respectively), while those aged 65-74 have the lowest (44.44%). Ethnically, individuals from an Asian background (75.81%) and Black background (76.0%) experience longer waits more frequently than White patients

(64.6%). Socioeconomic disparities are evident, as those in the most deprived IMD quantile (IMD 1) face longer waits (68.37%) compared to the least deprived (IMD 3 at 57.61%). Patients with no long-term conditions (LTCs) wait longer (69.71%) compared to those with multimorbidities (59.34%). Regarding frailty, those classified as "Severe" (100%) and "Fit" (67.19%) have longer waits, while those with moderate frailty have shorter waits (56.0%). Overall, younger patients, ethnic minorities, deprived groups, and those without comorbidities are disproportionately affected by extended waiting times.

4 Discussion

The analysis of RTT waiting times in Leeds between April 2022 and March 2024 highlights several critical trends and disparities, many of which align with national patterns observed in NHS waiting lists. The findings suggest that while a majority (70%) of patients complete their pathways within 18 weeks, this is well below the NHS operational standard, which aims for 92% completion within this timeframe. National 2025/26 NHS Planning Guidance acknowledge this disparity with revised waiting list targets (NHS England, 2025) . This reinforces concerns about increasing backlogs and waiting times post-pandemic, as documented by the King’s Fund (The King's Fund, 2024) and Nuffield Trust (Nuffield Trust, 2024).

The variation in waiting times across specialties is particularly observed. Specialties such as Trauma and Orthopaedics and Plastic Surgery show the longest average waiting times (167-169 days), while General Internal Medicine and Cardiothoracic Surgery have shorter mean waits. This is consistent with national NHS England data, which frequently identifies orthopaedics as one of the most delayed specialities due to high demand, reliance on surgical capacity, and limited theatre space (British Orthopaedic Association, 2023) (Royal College of Surgeons of England, 2023).

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4.2 Demographic Disparities in Waiting Times

Age is the strongest personal characteristic predictor of waiting time disparities. Older patients (aged 75+) were more likely to receive treatment within 18 weeks, while younger patients, particularly those aged ≤10, faced the longest delays (mean: 149 days). This pattern aligns with findings from recent NHS Digital reports, which suggest that paediatric specialties, especially elective surgical services, experience longer waits due to capacity constraints and prioritization of adult services (large number of children waiting over 18 weeks for treatment, particularly for "other paediatrics" categories, where only around 59.8% of patients are seen within the 18-week target)

These age-related disparities may also reflect prioritisation strategies where older patients with complex comorbidities receive expedited treatment. The Leeds data supports this, showing that patients with multimorbidity’s or severe frailty have significantly shorter waits than those without long-term conditions (67.72% vs. 61.87% completing RTT ≤18 weeks). This is consistent with studies suggesting that frail patients are fast-tracked due to the higher risk of deterioration (Fried, 2001). It mentions that frail patients are often fast-tracked due to the potential for rapid deterioration, particularly in settings like hospitals where delayed interventions can result in significant harm. From the analysis, frailty was also observed to be a factor related with longer waits especially around emergency admission and specific treatments (Knight, 2023)

4.3 Socioeconomic and Ethnic Inequalities

The findings also indicate a small but notable association between deprivation and waiting times. Patients from the most deprived quintile (IMD 1) have longer waits than those from the least deprived quintile (IMD 5), a trend observed in other NHS studies. Recent analyses from the (Nuffield Trust, 2024) show that socioeconomic status impacts access to care, with more deprived patients often waiting longer due to systemic factors such as higher demand in under-resourced areas, greater likelihood of missed appointments, and logistical barriers to accessing secondary care.

Ethnicity also plays a role, with patients from Asian backgrounds having longer waits compared to White patients (62.30% vs. 64.88% completing RTT ≤18 weeks). This echoes prior research showing that ethnic minority patients often face longer waits due to factors such as communication barriers, referral pathways, and healthcare-seeking behaviour differences (Public Health England, 2022). The observed disparities in Gynaecology, where Asian and Black women were overrepresented among long waiters, align with evidence of racial and ethnic disparities in women's health services, as highlighted by the Royal College of Obstetricians and Gynaecologists (RCOG, 2024)

4.4 Healthcare Use

According to the national NHS RTT Waiting Times statistics (NHS England RTT, 2024)the overall national trends show a steady increase in waiting times, particularly for patients waiting longer than 52 weeks. This aligns with your findings where patients in the longer waiting periods (>52 weeks) show greater healthcare usage, particularly in GP contacts and A&E visits.

National studies confirm that healthcare utilisation, particularly GP visits and prescriptions, peaks during the waiting period and often stabilizes or declines post-treatment. This matches the findings in Leeds, where the waiting period showed a marked increase in healthcare use (e.g., GP visits, prescriptions). For example, Trauma and Orthopaedics showed a significant increase in prescription use during waiting, which aligns with national trends that longer waits often exacerbate health issues, leading to increased medication use)

The comparison of waiting times between people on single and overlapping pathways shows the interdependency and co-ordination of treatment for more than one health issue exacerbates waiting times. There may be a requirement for additional resource and monitoring to track these patients and co-ordinate their care.

4.5 Selected procedures

There is a common trend among selected procedures where older patients tend to experience longer waits. Those in the age groups 65-84 show higher proportions of long waits (>42 weeks) compared to younger patients, especially those aged 18-24, who have the shortest waits. Patients from more deprived areas (lower IMD quintiles) are more likely to face long waits, with those in the most deprived areas (IMD 1) showing a higher proportion waiting over 42 weeks. Conversely, patients from less deprived areas (higher IMD quintiles) tend to experience shorter waits. This trend is also reflected in the higher proportion of patients from the most deprived areas (IMD 1) waiting over 42 weeks, while those from the least deprived (IMD 5) have the highest proportion treated within 18 weeks. White-background patients tend to follow the overall trend, with the highest proportion treated within 18 weeks.

Frailty and Multimorbidity are two of the main characteristics that contradict general findings, for overall statistics it seems that people with health conditions were prioritised to receive their diagnostics and treatment. For these selected procedures however, these are factors related to longer waits which is consistent with literature showing that for specific treatments these conditions are associated with longer waits.

Ethnic differences in waiting times have been explored in several studies. Black and Asian populations especially might experience different wait times.

4.6 Policy and Systemic Implications

The findings raise important policy considerations for managing waiting times in Leeds and across the NHS:

- **Specialty-Specific Targeting**: Trauma & Orthopaedics and Plastic Surgery require urgent attention due to their long wait times and high variation in waiting periods. Expanding surgical capacity and optimising referral pathways in these areas could help reduce extreme delays.
- **Addressing Paediatric Waiting Times**: Given the disproportionately long waits for younger patients, strategies such as expanding paediatric elective surgery capacity and introducing dedicated paediatric treatment pathways could help mitigate delays.
- **Reducing Socioeconomic and Ethnic Disparities**: Targeted interventions in deprived areas, such as community-based triage services and improved appointment scheduling systems, could reduce barriers to timely treatment for disadvantaged groups.

5 Limitations

The Weekly Waiting List Minimum Dataset (WLMDS) is crucial for tracking patient waiting times, but it has several limitations and challenges that can affect its reliability and usefulness. The main issues include:

Category	Issue	Details
Data Completeness & Accuracy	Missing Data	Incomplete fields, especially around treatment function group, clock start and stop, patient id, pathways id.
Data Entry Errors	Manual entry and inconsistent reporting across different healthcare providers introduce inaccuracies.	Wrong date format or provider codes
Variability in Data Definitions & Collection	Differences in Data Collection	Hospitals may apply different criteria for calculating waiting times, causing inconsistencies.
Data Timeliness & Frequency	Reporting Delays	Weekly updates do not capture real-time demand fluctuations, particularly during seasonal pressures. Lack of flow between lists
Challenges in Linking to Outcomes	No Clinical Outcome Data	The proposed TFC not always match events In SUS. Only 65% of waiting list spells were matched to corresponding SUS activities, additionally proposed procedures, do not match reported in SUS.

Healthcare Utilisation Granularity	Utilisation Tracked to Pathway Level Before Aggregation	For objective 3, utilisation was tracked at the patient pathway level, leading to minute figures for some aggregated measures. In certain cases, pattern recognition became infeasible.

The proposed DID model has several limitations due to the way it handles time periods and cohort selection. The model does not match cohorts but instead runs on the entire dataset. This approach can introduce confounding, as patients in the intervention period may systematically differ from those in the reference period in terms of demographics, clinical characteristics, or healthcare needs.

Another concern is the potential shift in patient characteristics over time. If case mix changes—such as differences in severity, comorbidities, or socioeconomic status—the observed effects may be driven by these changes rather than by differences in waiting times. Moreover, the model does not adjust for temporal trends, which means that external influences, such as increasing GP workload or evolving healthcare policies, could impact outcomes across the dataset, making it difficult to isolate the true effect of waiting times.

Furthermore, regression to the mean could distort findings, especially if high healthcare usage led to a patient being classified in the intervention group. Natural fluctuations in healthcare usage over time could then create an illusion of improvement or deterioration. Finally, the lack of control for unmeasured confounders, such as deprivation levels, hospital-specific practices, and variations in access to primary care, poses a risk of bias in the analysis.

To improve the robustness of the model, it would recommend using equal timeframes between cohorts for comparison and apply cohort matching techniques like propensity score matching.

6 Impact and dissemination

The analytical report was translated into plain English and shared with the patient/carer waiting list panel. Leeds analysts met with the waiting list Patients and Carers' Panel on the 7 February to talk through the findings, and together, recommendations from the study were agreed. We asked the panel to discuss the following questions:

1. What matters most from the findings?
2. Were there any surprises in the results?
3. What is one change that should be prioritised?

Main themes important to the group:

- Importance of Meeting NHS Targets (18-Week Referral-to-Treatment Standard) - Hold NHS services accountable for meeting targets. Address barriers causing delays, particularly for marginalised groups.

- Communication and Transparency Issues - Ensure clarity in NHS messaging, especially for those who are digitally excluded.
  Strengthen communication between GPs and hospitals to reduce referral delays.

- Disparities in Waiting Times and Equity Concerns - Investigate racial and socioeconomic disparities in access to treatment. Explore solutions to ensure fairer access across different patient demographics.

- Enhance Public Awareness of Patient Rights - Increase efforts to inform people about their rights and options while waiting for treatment. Improve visibility of the ICB's role and responsibilities

The findings and recommendations will be discussed with local decision makers over the next few months with actions which we will monitor. We have engaged with the relevant commissioners in this area at the Leeds ICB throughout the project. An external and internal media release will be drafted to publicise the findings.

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Appendix

Hip Replacement OPCS codes

'W371', 'W378', 'W379', 'W381', 'W388', 'W389', 'W391', 'W398', 'W399',

'W931', 'W938', 'W939', 'W941', 'W948', 'W949', 'W951', 'W958', 'W959',

'W461', 'W468', 'W469', 'W471', 'W478', 'W479', 'W481', 'W488', 'W489',

'W191', 'W192', 'W193', 'W194', 'W195', 'W196', 'W198', 'W199', 'W241',

'W242', 'W243', 'W244', 'W245', 'W246', 'W247', 'W248', 'W249'

Hysteroscopy OPCS Codes: Q181m Q188, Q189

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