

Waiting List Issues for Northern Ireland Hospitals

Data Science project by Kevin Breslin

A Proof of Concept Analysis

19 April 2020

1. Introduction

1.1 Background – Hospital Care in Northern Ireland

Northern Ireland healthcare is provided through the National Health Service (NHS) and most NHS care is free. While a private health care sector exists, the public health service is used by the majority of people. Northern Ireland healthcare is administered by 5 Health and Social Care (HSC) Trusts which provide health and social services across Northern Ireland. While the Board commissions services, it's the Trusts that provide them 'on the ground'. Each Trust manages their own staff and services and controls its own budget. They are the Western Trust, The Northern Trust, The Belfast Trust, The South Eastern Trust and The Southern Trust. There is also a Six Trust dealing with ambulances called the Northern Ireland Ambulance Service Health and Social Care Trust but is not looked at in this report.

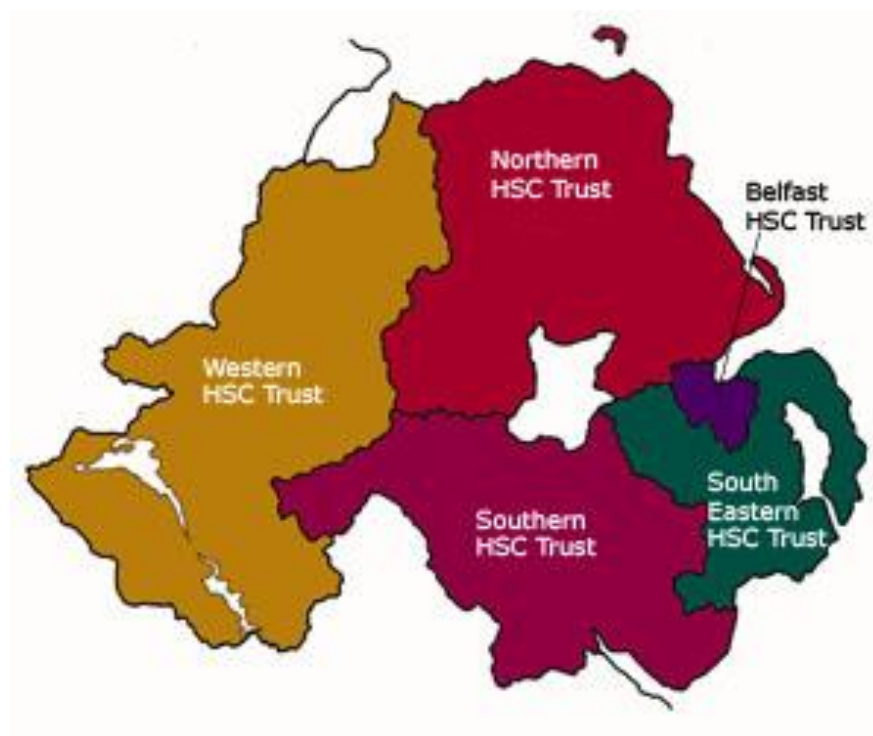


Figure 1 Health and Social Care Trusts in Northern Ireland

Hospitals in Northern Ireland are under the management of the five regional Health and Social Care Trusts. A List of Hospitals is given below:

Belfast	Royal Victoria Hospital, Belfast City Hospital, Mater Hospital, Musgrave Park Hospital, Children's Hospital, Royal Maternity, Forster Green Hospital, Knockbracken
Western	Altnagelvin Area Hospital, Grangewood Hospital, Lakeview Hospital. South West Acute (Enniskillen), Omagh Hospital and Primary Care Complex, Waterside Hospital (Gransha)
Northern	Antrim Area Hospital, Braid Valley Hospital, Causeway Hospital, Dalriada Hospital, Holywell Hospital, Mid-Ulster Hospital, Moyle Hospital, Robinson Hospital, Whiteabbey Hospital
South Eastern	Ards Community Hospital, Bangor Community Hospital, Downe Hospital, Lagan Valley Hospital, Ulster Hospital
Southern	Armagh Community Hospital, Craigavon Area Hospital, Daisy Hill Hospital, Lurgan Hospital, South Tyrone Hospital, St Luke's Hospital

1.2 Problem Definition – The scale of the waiting list approach

This project looks at examining trends and behaviours across the wide range of hospitals in Northern Ireland. Healthcare waiting lists, like all aspects of national public sector healthcare policy are a deeply sensitive issue, concerns about the life and death of loved ones is put at odds with issues around capacity issues such as the supply of finance, labour, medicine, equipment and facilities.

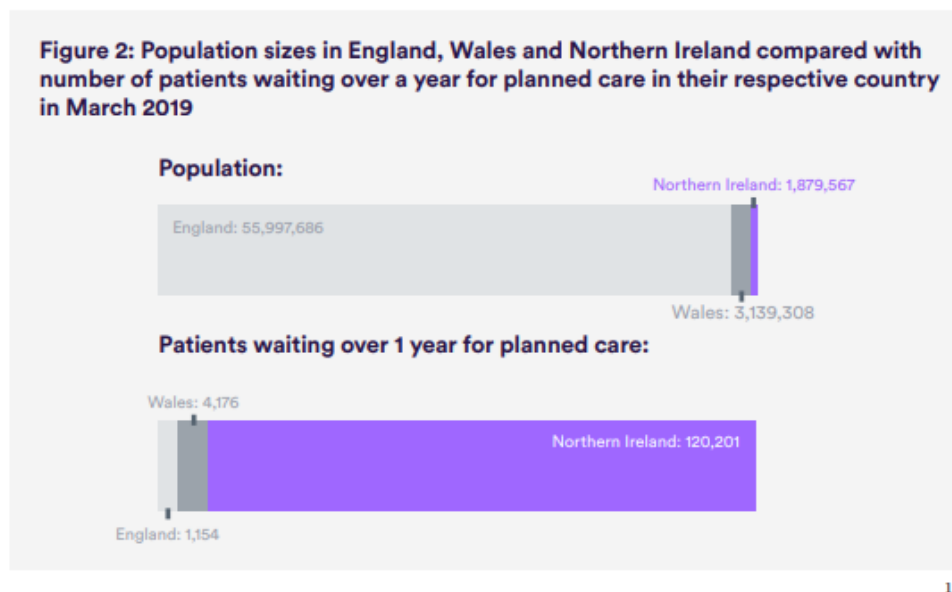
The problem of Northern Ireland's waiting lists is difficult, and there are no easy or obvious answers.

According to Professor Deirdre Heenan, when compared to the Merseyside and Wirral region 227.48 km across the Irish Sea as the crow flies, Northern Ireland's statistics on long term waiting lists are poor.

"Merseyside and Wirral has a population of two million and has 10 people on its waiting lists for more than a year," she said. "The equivalent here - where there is a population of 1.8m - is 120,000."
(Halliday, 2019)

While it is true that Northern Ireland (14,130 km²) contains twice as much area as the Liverpool City Region (723.97 km²) (LCRA 2019) , higher deprivation and higher disability

the scale of the problem is quite startling. The scale of the problem compared to England and Wales is given below:



Note: Data for Scotland were not available. Northern Irish waiting lists may be relatively somewhat understated, as for waits in some areas the ‘clock’ starts later in the patient journey than in Wales or England (Northern Ireland counts from the point of the decision to admit, rather than referral).

Northern Ireland’s healthcare issues has also been aggravated by the recent collapse in power sharing institutions, limiting decision making critical decision making capacity and is set to be further aggravated by the global COVID-19 corona virus pandemic increasing demand upon the local health service. In this statement Prof. Hennan identifies historical failings in workforce planning for the health service in Northern Ireland, a shortage of important staff groups and a costly reliance on temporary workers. In response to this challenge, Professor Heenan, co-wrote a report with Mark Dayan, a Nuffield Trust policy analyst, called the “Change or Collapse: Lessons from the drive to reform health and social care in Northern Ireland” (Nuffield Trust, 2019)

One of the main methods of addressing the crisis looks at community care and centralisation, highlighted in the opening section.

“The health and social care system in Northern Ireland has seen seven fundamental reviews setting out major changes of direction in the last 20 years. Each has delivered a similar verdict: the country needs to reduce its reliance on hospitals, centralise some services for a

critical mass at a smaller number of sites, and focus more on prevention and keeping people healthy.”

The report looks at what is helping and hindering the system from delivering four broad goals indicated in the Bengoa review and set out in detail in “Delivering together” a Northern Ireland Executive paper that focuses on Health reform. It suggests four areas of Healthcare reform:

- Shifting care out of hospitals, so that greater use is made of services that treat people in their neighbourhoods or their own home.
- Greater focus on prevention rather than curative services, and a focus on the health of the population as the essential task of health and social care.
- Increasing public trust in the system by **reducing waiting times** to an acceptable level
- The **centralisation of hospital services** where this improves quality or safety by concentrating key staff.

The report itself is largely qualitative seeking to understand different helpful or unhelpful factors. There was some quantitative analysis around finance, workforce and waiting times was also carried out. These methods have focused on CCG-based funding model which addresses the factors which might determine whether Northern Ireland has higher or lower funding needs than other parts of the UK.

1.3 A Data Science Paradigm for the Report

What isn’t explored in the mentioned report, and what I believe is a good challenge for a data scientist, is the **relationship between waiting times and the positioning of hospitals**, independent of finance, the performance of the workforce, or the regional health care demand. Data on the waiting lists from Open NI, and vocational data for the hospitals involved can offer new insights into the scale of this issue.

It is my belief that clustering tools looking at waiting times in the context of regional performance can provide a useful metric in identifying where the scale of the problem exists in terms of either a trust.

Looking at the positioning of these clusters might also address where community care from outside a hospital, preventative measures to bad health may need to be introduced, and even lay the foundation to examine the scope for cross border co-operation along trusts in the border regions Western Trust (bordering Donegal, Leitrim, Cavan and Monaghan) and Southern Trusts (bordering Monaghan and Louth)

To judge performance, metrics of relative “waiting list improvement” score will need to be developed showing the average improvement in a hospital’s improvement by regression analysis of historical data.

Finally, classification tests between different hospital types and different types of waiting lists (inpatient, outpatient, diagnostic, cancer and emergency room) can highlight which performance areas

1.4 Targeted interest groups

In summary, the goal of this project is to develop statistical metrics to identify which hospitals, trusts or areas have had the best and worst regional performance in terms of simplified metric. Its main goal is to provide a “proof of concept” for such highly generalised statistical measurements which may need to be examined by decision makers and relevant experts in the field. Scope for improvement and advancement of the model. The drive to better efficiency and resourcefulness must take account of the sensitivity of key stakeholders such as medical and ancillary healthcare staff, patients and their loved ones, and those in administration, as well as the taxpayers who rely on the system. The develop of statistical measurements of the geographical spread of results will be of primary use for social policy researchers, rather than for application at the front end of policy making decisions. It will be for these researchers to refine the highly generalised data science findings of these reports to develop applications

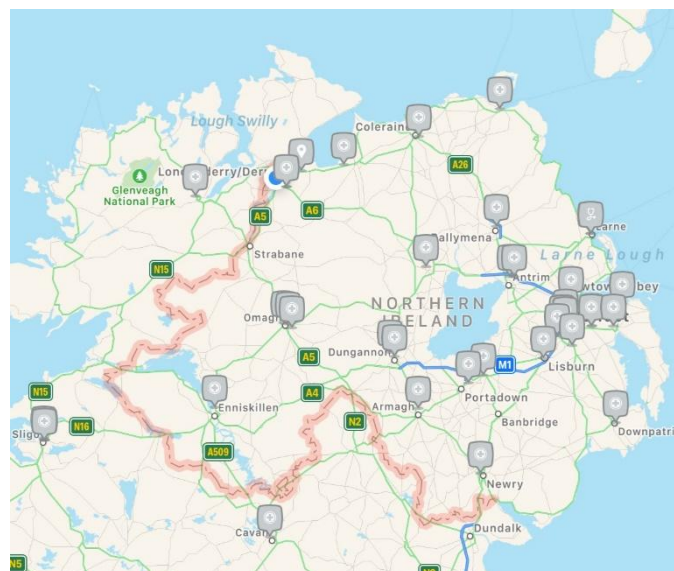
2. Data Acquisition and Data cleaning

2.1 Data Sources

Information on Waiting Lists will be acquired from Open Data NI (Open Data NI, 2017), it provides data on 5 key medical waiting lists; diagnostic, accident and emergency, cancer, in patient, and outpatient.

Another possible source Department for Health of Northern Ireland (DoH, 2020). Waiting times information is available for (i) a first outpatient appointment, (ii) a diagnostic service, (iii) admission for inpatient treatment and (iv) cancer services and is reported on a quarterly basis within the ‘Northern Ireland waiting list bulletins’ and ‘Northern Ireland cancer waiting times bulletin’. Emergency care waiting times information is available on a monthly basis and published quarterly. (DoH, 2020)

The final source of data is location data from the Foursquare TM database, a Foursquare search for hospitals show this is possible. A general Foursquare search for hospitals in Northern Ireland provides a broad spread of co-ordinates



2.2. Data Cleaning

The CSVs from Open Data have three main types, we are going to focus on the type 1 trusts because they are the biggest hospital types and as such will have the longest waiting lists.

Some hospitals in the 2 and 3 are specialist hospitals like mental hospitals and will not necessarily provide services like cancer or accident and emergency care.

Locational data from Foursquare would have to be cleaned to remove ... private sector hospitals clinics, hospitals in the wrong place, public sector and university hospitals in the Republic of Ireland, Isle of Man and Britain, type 2 & type 3 trusts of the HSE, hospital wards in the hospital, veterinary centres, medical schools.

“Royal Victoria and Royal Victoria ENT & RAES” is a bit too long and will have to be replaced by Royal Victoria.

2.3 Feature Selection

The key features will be the numbers of patients in the highest bracket of the relevant waiting list, the total numbers of patients, the hospital names and the hospital year. Some waiting lists require more urgency than others (e.g. accident and emergency). We will also have to aggregate the monthly data to form an annual data set for each year. The use of an annual data set will adjust for aspects like seasonal influenza.

Spatial (Locational) – Co-ordinates of Hospital, for a Trust I can use the centroid point of the hospitals in an area as a location

Temporal – Hospital Years measures will be matched up between the waiting lists.

Performance – The Performance in a year will be those in the number in the highest bracket divided by the total number of patients.

3. Results -

3.1 Emergency Waiting Times

Co-ordinates provided by Foursquare were used along with Emergency Waiting Times List to give a Bubble map of Northern Ireland hospitals based on how many Emergency Waits went over the Four Week/Day response shown in Figure 2.

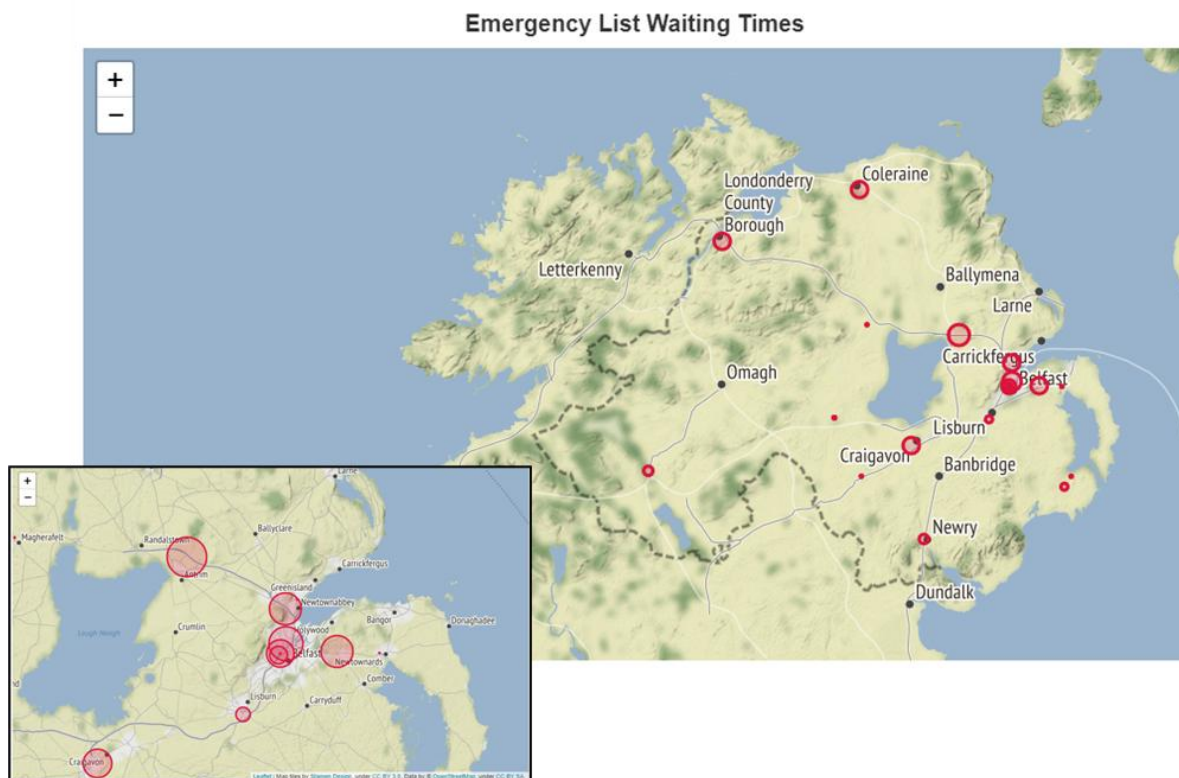


Figure 2: Emergency Waiting Times Map

How the Emergency Waiting times compare across trusts, categories and times are given in Figures 3 and 4.

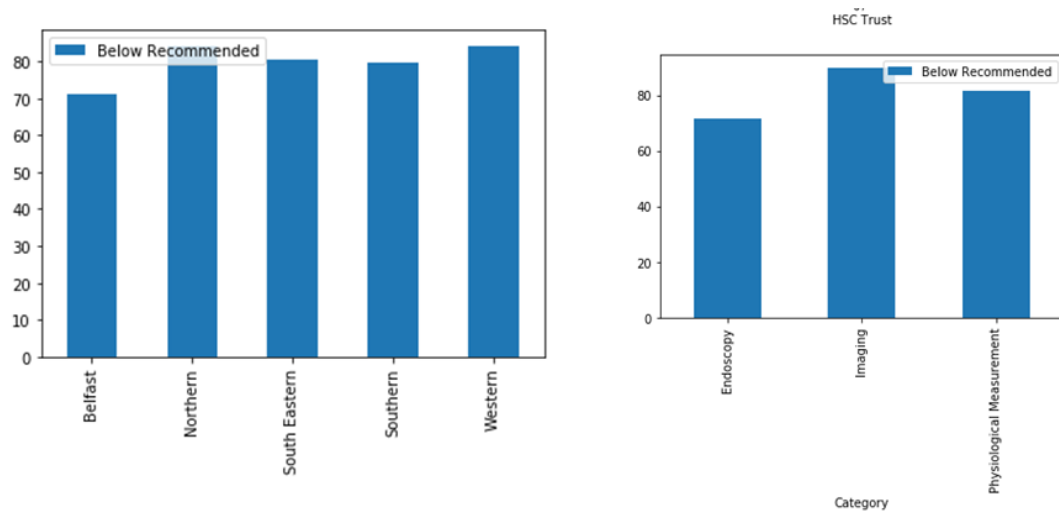


Figure 3: Emergency Time Results by Trust and by Category

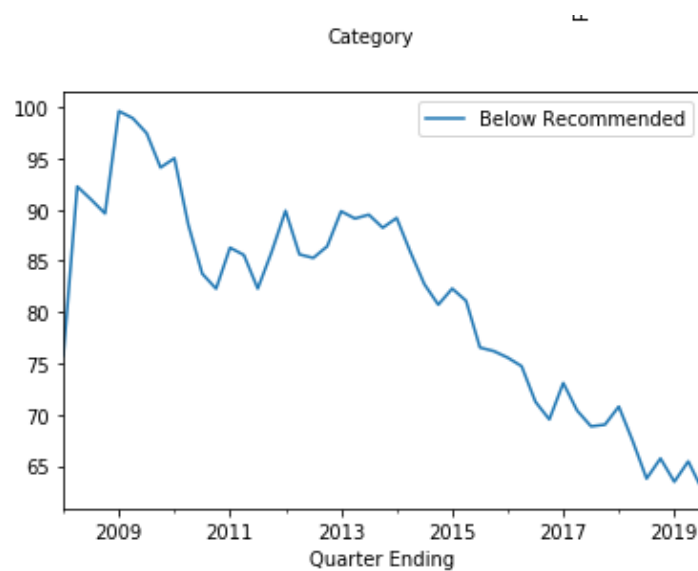
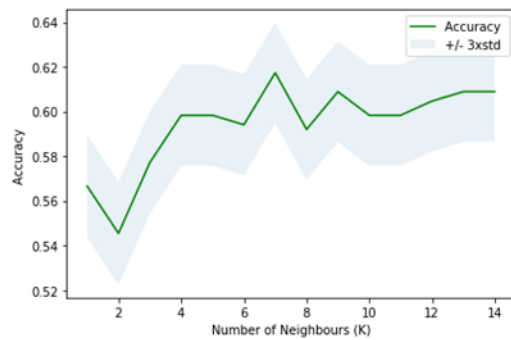


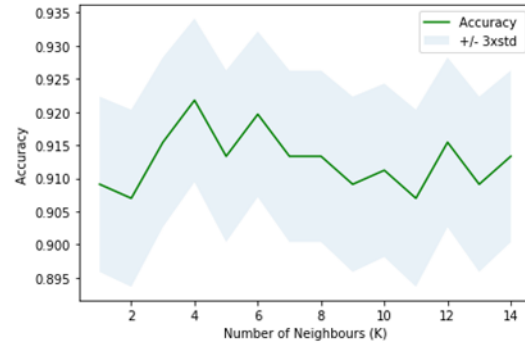
Figure 4: Emergency Waiting Time Results by Quarter

3.2. Emergency Waiting Times K-means (k=15) Predictive Analysis.

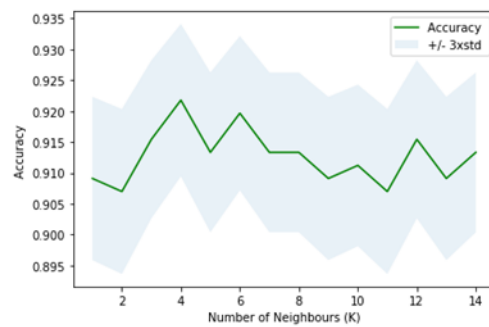
As a test I used K-means clustering to see if hospitals, trusts or grade of hospital could be predicted from the extent of their waiting time. In these K-means tests, the training and test sets were fit to a classifier with a k of 40, then the accuracy and the best $k > 15$ were found from an accuracy test within the range of 3 standard deviations.



The best accuracy was with 0.6173361522198731 with k= 7



The best accuracy was with 0.9217758985200846 with k= 4



The best accuracy was with 0.9217758985200846 with k= 4

Figure 5: Clustering Analysis (Emergency Waiting Times) based on Trust, Grade, Hospital

Hospitals and Hospital Grades exhibit unique separable statistical behaviours compared with Trusts. Based on these results it is easier to confuse Trusts than Hospitals.

3.3 Diagnostic Waiting Time Analysis.

Diagnostic Waiting Times were taken from the waiting time and the diagnostic reporting turnaround datasets. Diagnostic services have either a threshold of 9 weeks or 13 weeks depending on the service. In these tests, whether a service was below or above this threshold was considered. There were a lot of diagnostic services so only the top 15 are displayed in Figure 6. Information on the extent of the Diagnostic reporting turnaround is given in Figure 7

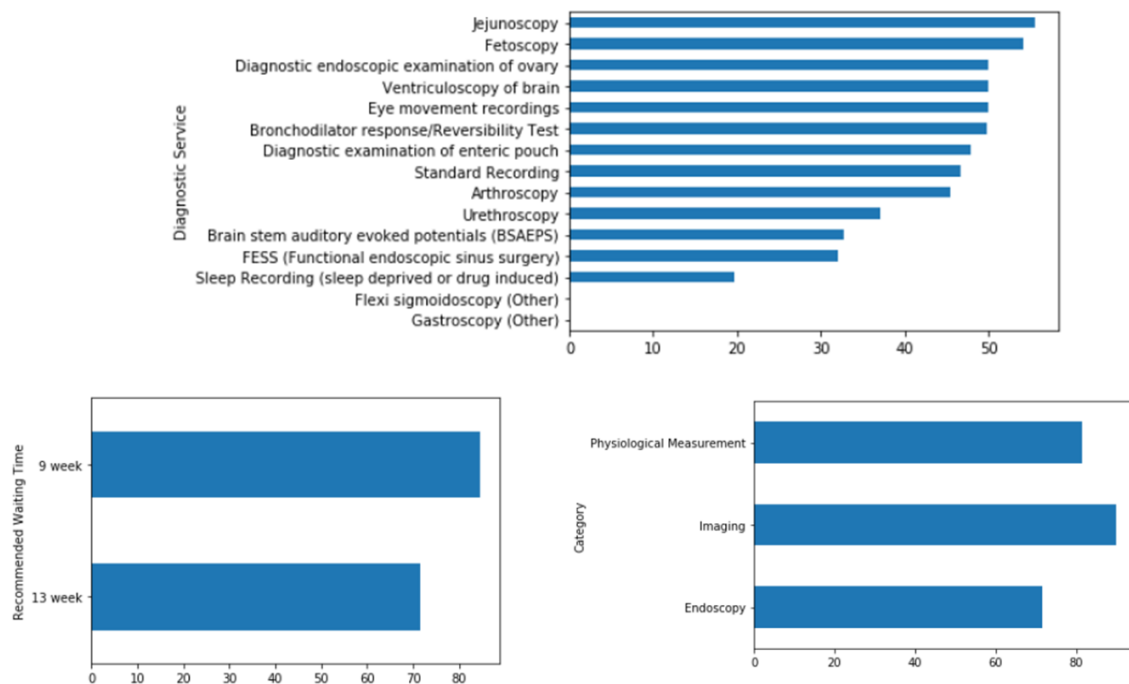


Figure 6: Diagnostic Waiting Time ...Diagnostic Services (highest waits), Recommended Waiting Time ,Category

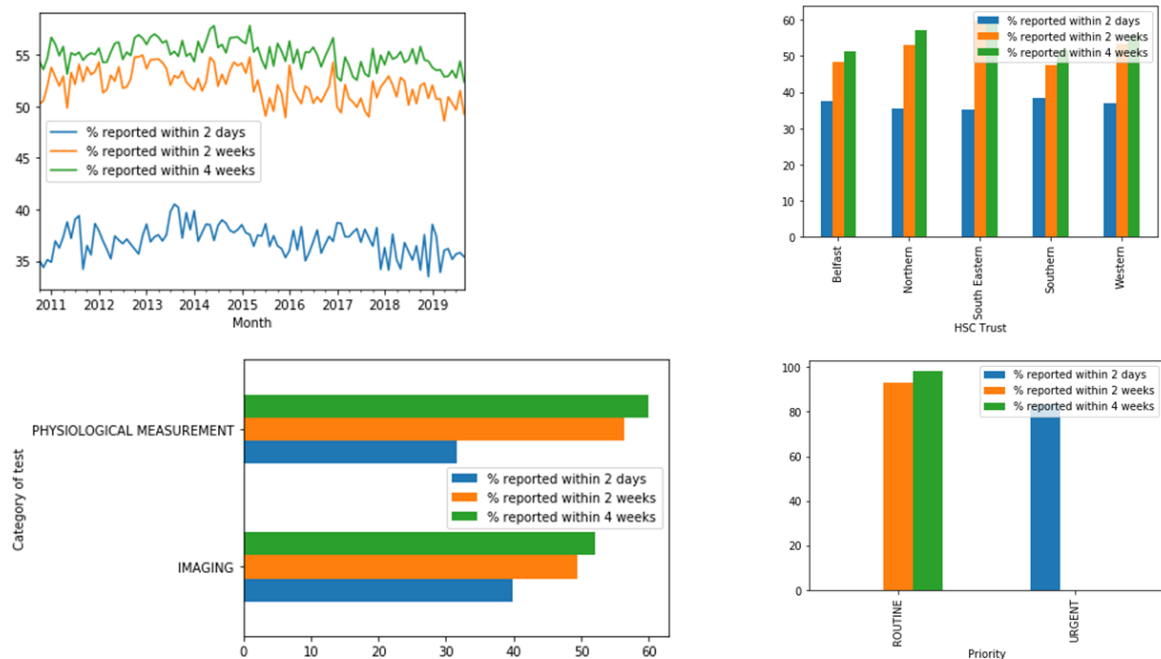


Figure 7:Diagnostic Reporting Turnaround

3.4 Inpatient and Outpatient Waiting Time Analysis.

The ICATs, Day Case, Admissions (labelled as Admin) and Total percentage of patients that were above 26 weeks were compared. Admission numbers and Day case numbers were found to be similar (see Figure 8) while Inpatient and Total numbers were mostly in range of one another, indicating that most of the number of inpatients on long waiting times are ICATS (see Figure 9).

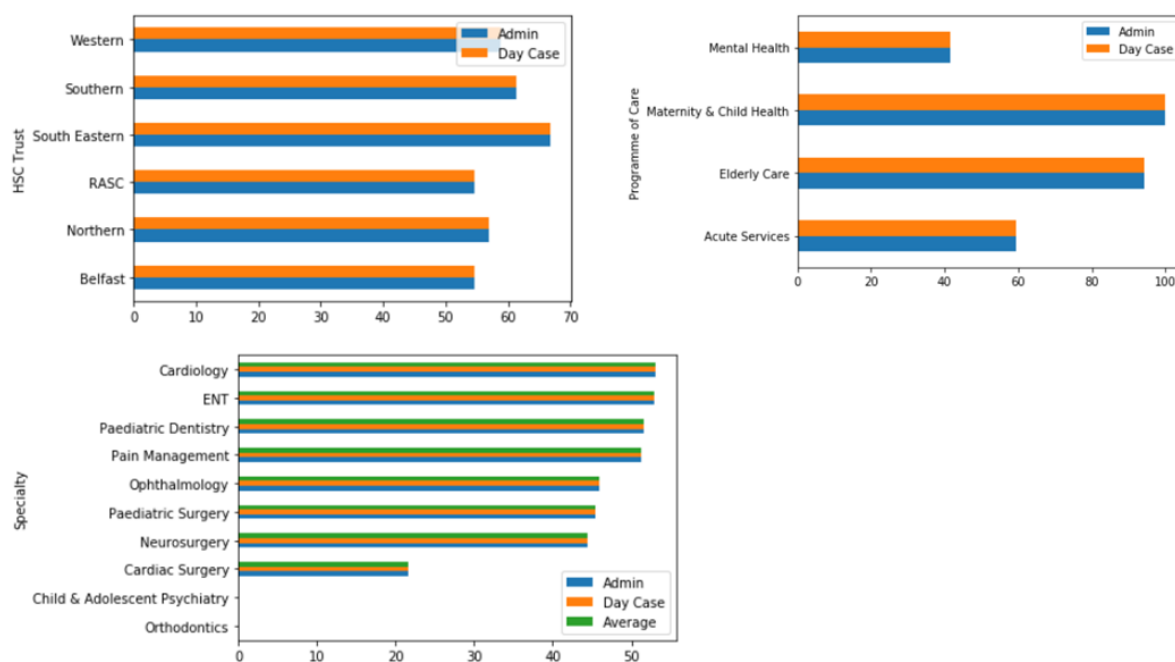


Figure 8: Inpatient Comparison Admin vs. Day Case

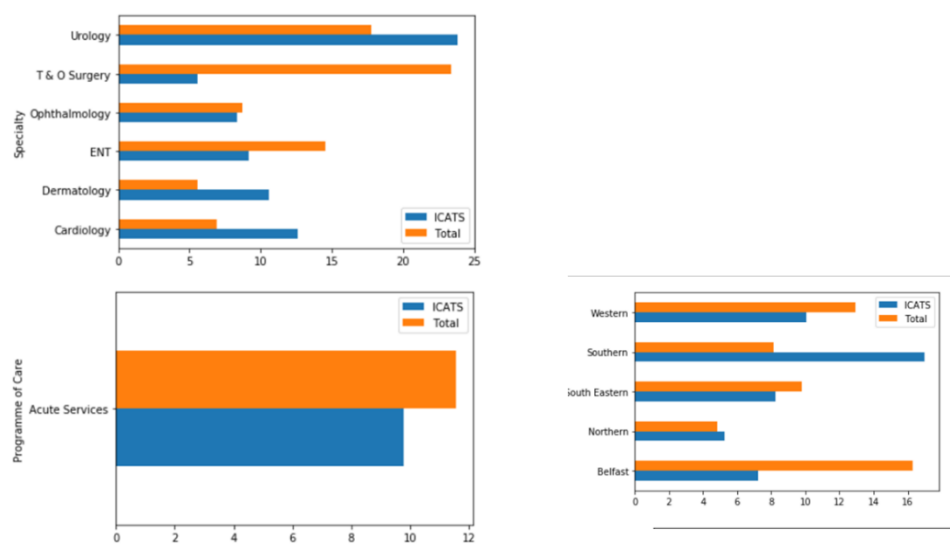


Figure 9: Inpatient Comparison ICATS vs. Total

Outpatient data that was above 18 weeks were accessed separately because only 3 Trusts have provided data

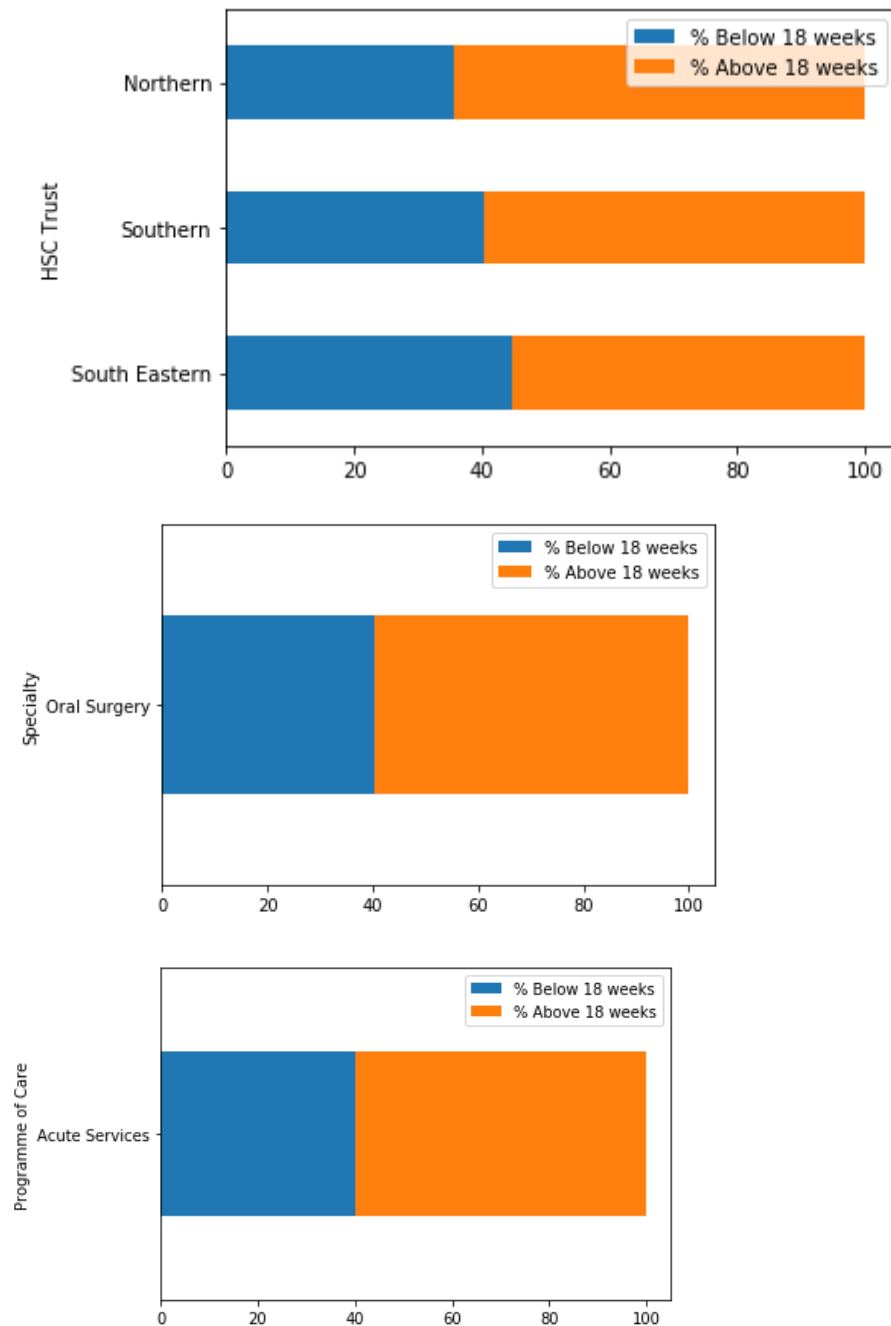
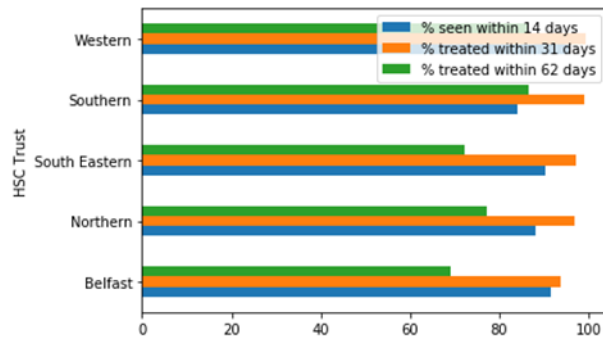


Figure 10: Outpatient Data

Cancer Waiting Time Analysis.

Cancer Waiting Times looked at were based on looking at the 62 Day, 31 day and 14 day Cancer waiting times by trust. The percentage of cancer patients that were seen on time were compared across these 3 values. 14 day cancer patient times seemed to not been recorded beyond 2013.

Graphs of the Cancer waiting times by Trust



Graphs of the Cancer waiting times by Treatment Time

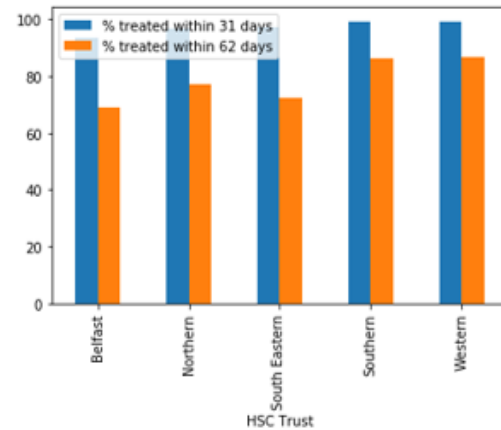
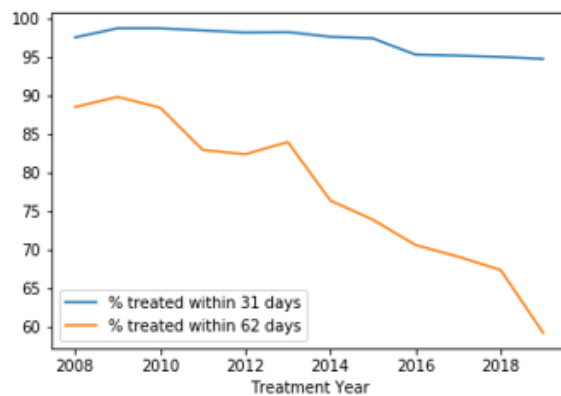
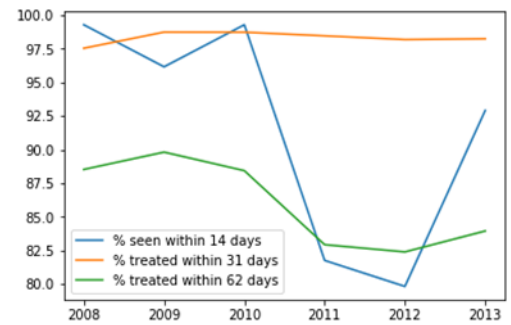


Figure 11: Cancer Waiting Times Comparison

Cancer Waiting Time (KNN k=3) Clustering Analysis.

K-Nearest Neighbour analysis was used to test how successful waiting list performance matched between these three categories. The k used was 3. Looking at the relationship across trusts for these 3 groups of waiting times indicates a degree of clustering patterns between waiting time performance for 62 days and waiting time performance for 31 days. It also shows a degree of clustering patterns between waiting time performance for 31 days and waiting time performance for 14 days. Using K means at k=3 did not indicate any obvious cluster pattern between waiting time performances for 62 days and waiting time performances for 14 days

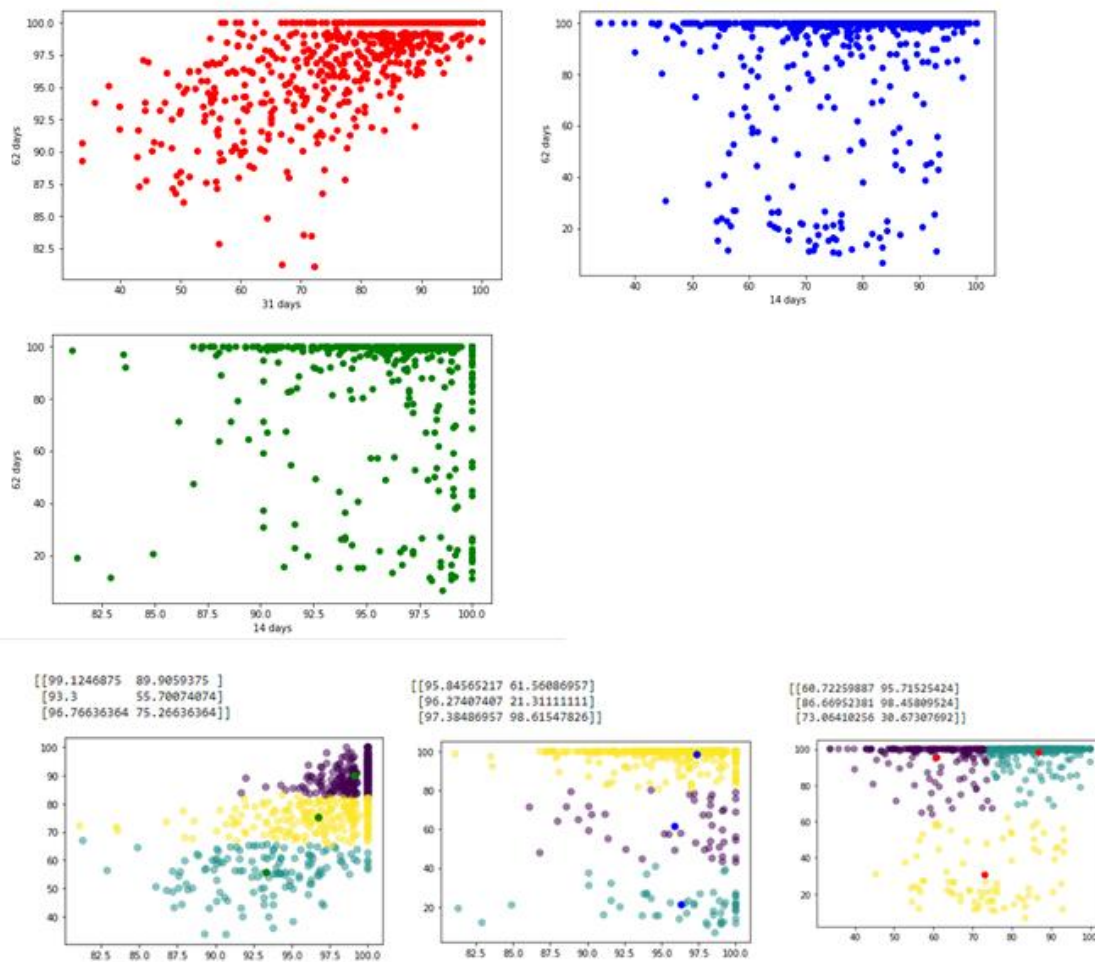


Figure 12: Scattergraphs and K-means analysis for Waiting Times

4. Discussion

The goal of this project was to develop statistical metrics to identify which hospitals, trusts or areas have had the best and worst regional performance in terms of simplified metric. Its main goal is to provide a “proof of concept” for such highly generalised statistical measurements which may need to be examined by decision makers and relevant experts in the field. Scope for improvement and advancement of the model. In that regard this project has had some limited success. What the report highlights is that Performance metrics for waiting times are derivable from readily available data from OpenDataNI. However comparative measures are needed to weigh up how a combined score for diagnostic, emergency, inpatient, outpatient and cancer results. Much of the numerical and temporal data from the raw sources are alphanumeric instead of pure numeric and datetime, so data-cleaning is necessary. A lot of the data had to be cleaned to create the metrics too, and this can be found in the attached notebook.

The develop of statistical measurements of the geographical spread of results will be of primary use for social policy researchers, rather than for application at the front end of policy making decisions. It will be for these researchers to refine the highly generalised data science findings of these reports to develop applications. Unfortunately, not a lot of geospatial information was provided in this report. Much of these waiting lists bar the Emergency Waiting Lists were based on Trusts not on individual hospitals. Expanded geospatial analysis involving Foursquare could take account of ancillary services to Hospitals that could aid with rehabilitation, healthy diet, and exercise.

5. Conclusion

- This investigation was a time limited proof of concept look at trying to apply a data science methodology onto the Hospital waiting times of Northern Ireland.
- Aspects such as performance metrics can be brought to light with sound application of these techniques.
- A thorough analysis of this problem however will require a more holistic approach taking account the constraints placed on trusts in terms of both human and material resources, as well as the geographic change in demand.

Appendix 1- Data definitions

Inpatient and Day Case Activity

Inpatient Admission

Inpatient admissions include both (a) patients admitted electively with the expectation that they will remain in hospital for at least one night, and (b) non-elective admissions (e.g. emergency admissions). A patient who is admitted with this intention but who leaves hospital for any reason without staying overnight is still counted as an inpatient. Day cases and regular attenders are not included.

Day Case

A patient admitted electively during the course of a day with the intention of receiving care who does not require the use of a hospital bed overnight and who returns home as scheduled. If this original intention is not fulfilled and the patient stays overnight, such a patient should be counted as an inpatient. Regular attenders have been included in day case figures with the exception of the acute programme of care.

Average Available/Occupied Beds

The average number of available and occupied beds during the year in wards that are open overnight, measured at midnight. Hospitals may also have a number of beds in wards that are only open during the day. Beds reserved for day care admission or regular day admission are not included.

Outpatient Activity

Outpatient

A patient who attends a clinic to see a consultant, a member of their team, or a locum for such a member.

Outpatient Did Not Attend – DNA

DNA refers to the number of patients with an appointment who did not attend and failed to give advance warning to the hospital. This includes patients who cancelled their outpatient appointment on the same day on which the appointment was scheduled. The DNA rate is calculated by taking the number of missed appointments (DNAs) as a rate of the sum of the total number of attendances and missed appointments.

Appointment cancelled by patient – CNA

A patient cancellation refers to an appointment that was intended to be held but was cancelled by the patient, with the patient contacting the hospital no later than the day before the appointment is scheduled and informing the hospital that they are unable to attend the scheduled appointment. The CNA rate is calculated by taking the number of patient cancellations (CNAs) as a rate of the sum of the total number of attendances and patient cancellations.

Appointment cancelled by the hospital

An appointment that was intended to be held, but which did not occur, due to circumstances within the hospital. Appointments may be cancelled by the hospital for a variety of reasons. These include, in order to reschedule the appointment to an alternative date and due to the unavailability of the consultant. The hospital cancellation rate is calculated by taking the number of appointments cancelled by hospitals as a rate of the sum of the total number of attendances and appointments cancelled by hospitals.

Note: The number of attendances does not equate to the number of individual patients seen, as it is possible for the same person to attend a consultant led outpatient service more than once during the year. This is the same when looking at missed and cancelled appointments, as it is possible for the same person to miss or cancel their appointment or have their appointment cancelled by the hospital more than once during the year.

Regional Assessment and Surgical Centres (RASC)

In October 2016 the then Health Minister launched 'Health and Wellbeing 2026: Delivering Together,' a strategy which underpins the Northern Ireland Executive's draft Programme for Government ambition to support people to lead long, healthy and active lives. As part of this strategy, the Elective Care Plan was published in February 2017, which stated that 'Regional Elective Care Assessment and Treatment Centres will be established to deliver large volumes of assessments and non-complex routine surgery across a broad range of specialties.' In February 2019, prototype 'Regional Assessment and Surgical Centres' became operational for the surgical treatment of Cataracts. Patients waiting for these procedures can now be referred to a RASC for treatment rather than attend the hospital site they may have been referred to previously.

Integrated Clinical Assessment and Treatment Services (ICATS)

ICATS is the term used for a range of outpatient services for patients, which are provided by integrated multi-disciplinary teams of health service professionals, including GPs with a special interest, specialist nurses and allied health professionals. They are provided in a variety of primary, community and secondary care settings and they include assessment, treatment, diagnostic and advisory services.

ICATS Appointment

An ICATS Tier 2 appointment is a non consultant outpatient appointment. Following ICATS Triage, patients who have not been given either a discharge, advice only or referral incomplete outcome will proceed for either a (i) first outpatient appointment, (ii) a diagnostic test or (iii) an ICATS Tier 2 appointment. Following a first Tier 2 ICATS appointment there are a number of outcomes, including a review Tier 2 ICATS appointment or a referral for a first consultant led outpatient appointment.

ICATS Tier 2 appointments attended, those missed by patients (DNA), cancelled by patients (CNA) or cancelled by the hospital (Hospital Cancellations) are defined similarly to those for consultant led outpatient services. Reasons for cancellation of ICATS Tier 2 appointments are not currently collected by the Department.

Virtual Activity

A virtual outpatient appointment is a planned contact by a healthcare professional responsible for the care of a patient for the purposes of clinical consultation, advice and treatment planning. Virtual appointments may take the form of a telephone contact, video-link intervention, an email or a letter.

This information was collated by Hospital Information Branch, DoH.

Further information is available from:

Hospital Information Branch

Department of Health

Annex 2, Castle Buildings

Stormont, BT4 3SQ

Telephone: 028 90 522800

E-mail: statistics@health-ni.gov.uk

1. For media enquiries please contact the DoH Press Office 028 9052 0575 or email pressoffice@health-ni.gov.uk. Out-of-hours please contact the Duty Press Officer on 028 9037 8110.

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