How Is Growth in

Diagnostic Testing

Affecting the Hospital System?

A report highlighting the unintended consequences of diagnostic service expansion.

Produced for the Midlands Decision Support Network

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Spring 2023

Document control

Document Title	How is growth in diagnostic testing affecting the hospital system?
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Date	April 2023

Acknowledgements

The authors would like to thank Dr Donald Richardson, CCIO, York Teaching Hospital; Professor Kiran Patel, Consultant Cardiologist and Chief Medical Officer, UHCW; and members of the West Midlands Imaging Network, particularly Tim Cooper (Chair) and Dr James Heron (Network Clinical Director), for their helpful feedback on early drafts of this report.

We also wish to thank colleagues from the Strategy Unit and the wider NHS for their comments and support over the course of this project.

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Foreword

We live in a connected world. In recent years, there has been a growing realisation that we need to think about, manage and shape health and care services recognizing the system dynamics that are at play.

As we bake the notion of systems into our new organisational architecture, it is important that we don't think of 'systems' only in terms of the social dynamics of partnership or the challenges of joined-up care for individuals - critical as they are. We also must take seriously the interactions within the complex adaptive system that we oversee. And taking these interactions seriously requires that we try to understand them. We know for sure - because common sense tells us - that changing something (such as the availability of diagnostic capacity) in a complex system like the NHS will have knock-on effects. When we make high quality decisions about changing things with a systems perspective, we should therefore be trying to understand the broad effects, and of course the uncertainties around those. We should then be using that to inform our assessment of the merits of the case, our implementation approach (if that's what we do), and, critically, the feedback loops we put in place (so we can adjust as we go). It is this recognition of the value in adopting a systems perspective that led the Integrated Care Boards (ICBs) in the Midlands to commission this report on diagnostic services.

Diagnostic services, such as medical imaging, endoscopy, and pathology, have grown substantially in recent years, and at a faster rate than most other healthcare services. Midlands ICBs wanted to understand the impact of that growth on hospital services and, in particular, on the flow of patients through hospitals.

This report is underpinned by detailed analyses of large health service datasets, over many years and across several service areas. The results suggest that while rapid increases in the use of diagnostic tests have brought benefits to patients, these have come at a cost: delays for patients in emergency departments, inpatient wards, and for patients waiting for elective care.

It may be tempting to think that these issues will be resolved if the NHS succeeds in its efforts to further increase diagnostic capacity and efficiency. But the issues we highlight in this report are *not only* caused by a lack of diagnostic capacity, but also by a lack of capacity in those services that rely on diagnostic testing. In A&E, for example, it takes time for a clinician to order a test, to review the results, and to incorporate this knowledge into a care plan. Increasing the availability of tests will also increase the number of clinical and administrative tasks that will need to be performed. This will add to the pressure on services and increase waiting times for patients.

If we are to secure the benefits of increased diagnostic testing without creating further delays in care pathways, then we must recognise the impact on aligned services. This might involve redirecting resources earmarked to increase diagnostic capacity to those services that routinely order and use tests. In the short term, reducing the number of unnecessary tests and strictly prioritising those tests that are ordered may help ameliorate the impacts of care delays.

This is an exploratory analysis of a complex problem. Further work is needed to test our conclusions, quantify the effects we highlight, and to design and evaluate interventions to address the problem. This will require analytical techniques that are suited to modelling complex, adaptive systems. These methods will feature heavily in the Midlands Decision Support Network training prospectus for 2023/24.

We hope that this work stimulates other contributions and perspectives on diagnostic service expansion. We also hope the work triggers a greater appetite for analysing system effects and for using the insight from that to drive high-quality decision making.

Peter Spilsbury

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Executive summary

The growth of diagnostic activity in recent years has been rapid:

- For those seen in A&E and discharged home, the number of tests per attendance has doubled in the last 8 years. [1]
- The number of "key" diagnostic tests requested for elective patients doubled between 2008 and 2020.
- In 2011/12, around 1 in 5 admitted-patient spells involved a "key" diagnostic test. By 2021/22 this had risen to almost 1 in 3.

Whilst increased diagnostic testing brings benefits to patients, rapid growth of one service area within a complex, adaptive system such as the NHS is likely to have wider consequences. This report, commissioned by the 11 Integrated Care Boards (ICBs) that make up the Midlands Decision Support Network, explores some of these secondary effects.

Key Findings

Our systems analysis suggests that, *alongside benefits*, the recent growth in diagnostic testing has had a substantial and adverse effect on the flow of patients through hospitals and on the timeliness of care that patients receive.

We find that growth in diagnostic testing has led to:

1. **Longer waits and overcrowding in emergency departments.**

   - In many cases, additional tests will slow a patient's passage through A&E. A patient given one or more CT scans stayed, on average, 60 minutes longer in A&E than a similar patient who was not sent for one of these procedures.

[1] Approximately 70% of all Type 1 A&E attendances end with the patient being discharged home.

- We estimate that over 300 thousand patients breached the 4-hour target in 2018/19 due to increases in test rates since 2012/13. Longer waits and overcrowding in A&E are strongly associated with increased mortality rates; increased patient harm; staff burnout; and poor levels of patient and staff satisfaction.
- If an individual receives additional tests, it will divert a share of attention and resources away from other patients in the department. The result is longer waits in A&E for all.

2. A longer waiting list (and longer waits) for elective treatment.

- We estimate that increased testing over the last decade has, on average, added between one and two days to elective pathways.
- With tens of millions of pathways completed each year, the cumulative impact of these small delays is startling: Our analysis suggests that if the NHS had, for example, maintained the 2012 rate of testing until 2020, then it might have entered the pandemic with a comparably modest waiting list (1.5 million). Instead, the waiting list was at an all-time high (4.4 million).

3. Longer stays in hospital and decreases in bed availability.

- We estimate that approximately 1,500 hospital beds (of 100 thousand total) are occupied today as a result of the growth of just three key tests since 2011/12 (CT scans, MR scans, and echocardiograms). These 1,500 beds might otherwise have been used to manage the flow of patients from emergency departments without the need for corridor and trolley waits.

Implications

Diagnostic activity in the NHS has increased substantially over the past two decades. Recent reports make the case for a further, rapid expansion of diagnostic capacity. It is argued that increased capacity will improve early diagnosis rates, reduce unnecessary treatments, and allow clinical regimens to be better tailored to patients' needs. These reports tend to highlight the benefits to the individual and examine diagnostic services in isolation.

Yet diagnostic services are one part - albeit a key part - of our health system. Health systems are complex: they defy simple, linear cause and effect explanations. It is inevitable that the consequences of rapidly increasing diagnostic capacity will be profound and felt by many connected services. Therefore, when judging the merits of such a service expansion, the NHS should consider the impact on the entire health system and the population it serves.

Our analysis suggests that, alongside the undoubted benefits, recent growth in diagnostic testing has had an adverse effect on the flow of patients through hospitals and on the timeliness of care that patients receive. These effects are sizeable; they are felt in both elective and emergency pathways; and, unaddressed, they will undermine patient safety.

The key message of this report is that trade-offs are inevitable in our health system. All else being equal, an NHS that increases testing as fast as capacity allows will be more perceptive but less responsive than one offering minimal testing. The question is, what is the correct balance? What rate of diagnostic growth will secure the best overall outcomes for the population? The NHS appears to have arrived at an answer to this question. But has this answer come having considered, and quantified, the wider system effects?

For every test that is carried out, a request must be made, and a result must be reviewed and incorporated into treatment plans.

Findings, whether expected or not, must be acted on. We suggest that, in the absence of research into the optimal growth rate, the pace of diagnostic service growth should be constrained by the ability of aligned services (such as A&E) to expand so as to absorb the additional clinical and administrative tasks without further destabilisation. This may require the NHS to redirect some of the resources that are earmarked for increasing diagnostic capacity, towards those services that order and use diagnostic tests.

Moreover, we believe there are two policies that the NHS should consider above and before increasing diagnostic efficiency and capacity. A crucial step is to reduce the 10% (or more) of tests that are ordered but that add no clinical value. A second step is to ensure that clinicians take full advantage of risk stratification tools, so that patients who have the greatest potential to benefit from a test are prioritised.

These ideas may mean that diagnostic services grow more slowly than the NHS might wish. But this growth will be sustainable and will better balance risks and benefits across the healthcare system.

0. Introduction

0.1 What do we mean by “diagnostic” services?

NHS diagnostic services primarily provide medical tests and procedures designed to assess an individual's state of health. Care professionals may use the results of these tests to monitor or rule out a condition or, commonly, to arrive at a medical diagnosis.

The *Richards’ review* categorises current diagnostic services into five distinct groups or “pillars”, which we outline in Table 1. [2, 3]

Traditionally, these services – whether offered to urgent or elective care patients - have been delivered by provider trusts in acute hospital settings. However, with the recent introduction of Community Diagnostic Centres (CDCs), this model is changing. Through CDCs, the NHS aims to separate elective and urgent diagnostics. This may improve throughput in both cases. [4]

Diagnostic Pillar	Example Procedures
Endoscopy	Colonoscopy
Genomics	Whole genome sequencing
Imaging	CT; Ultrasound; X-ray plain film
Pathology	Blood film examination
Physiological Measurement	Spirometry; Electrocardiogram

Table 1: The five diagnostic “pillars”

[2] Richards, M. (2020). Diagnostics: recovery and renewal–report of the independent review of diagnostic services for NHS England. NHS England.
[3] Richards, M., Maskell, G., Halliday, K., & Allen, M. (2022). Diagnostics: a major priority for the NHS. *Future Healthcare Journal*, *9*(2), 133.
[4] ibid

0.2 Why examine diagnostic services?

Diagnostic services are key to improving outcomes across the NHS, including those for priorities such as like cancer, and cardiovascular and respiratory diseases. Thus, diagnostic referrals and diagnostic activity have grown rapidly in the last two decades and there is no sign that demand will diminish.

The increasing importance of diagnostic services has given rise to several key reports on the subject. These reports tend to focus on the benefits that increased testing brings to the individual and the challenge of securing additional capacity.

Yet, given that diagnostic services interact with many other services, the impact of increased diagnostic activity on population health, and on the system as a whole, also warrants attention. To this end, ICBs of the Midlands asked the Strategy Unit to take a system view on the growth of diagnostic services. These ICBs understand the benefits of increased diagnostic testing, and the challenges that the diagnostic community will inevitably face. What, in addition, are the consequences for our wider health system?

0.3 Services, systems, and change

NHS diagnostics are just one group – albeit a key group - of a vast range of services that act together to support the broad health needs of the population. This unified whole is our health system.

As the world around the health system changes, it must continually respond to new opportunities and challenges. Policy makers aim to re-shape services within the system in such a way that the population receives best health care possible. However, since services in a health system are inter-dependent, understanding the optimal configuration is no easy task. For example, changes to service A might improve outcomes for service B, but may also have consequences for service C, service

D, and others. Some of these consequences might have been unforeseen and unintended at the outset. In contrast to a service-focussed lens, a whole-systems lens helps us to see, understand, and optimise the whole (not just the parts).

0.4 Scope of this paper

The health service's increasing reliance on diagnostic services over the last decade will have affected countless processes across primary, secondary, and tertiary care. We therefore had to select a focus for the report, and we chose to determine the effects of the growth in diagnostic testing on selected hospital processes. For an overview of the impacts on primary care, we recommend, *Temporal trends in use of tests in UK primary care, 2000-1*5. [5]

Our report covers four of the five diagnostic pillars to differing extents. We do not cover Genomics, as routine data collections have not long been established in this field. We also recognise that our coverage favours imaging procedures. This is due more to the availability of data for this pillar than to a judgement of its relative importance.

Finally, many will know that diagnostic services face sizeable challenges at the present time. The biggest of these may be the shortages in the workforce. Such challenges intertwine with the issues covered in this paper but, as these challenges have been covered in some detail in other papers, we will only touch on them here. [6, 7, 8, 9]

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[5] O'Sullivan, J. W., Stevens, S., Hobbs, F. R., Salisbury, C., Little, P., Goldacre, B., ... & Heneghan, C. (2018). Temporal trends in use of tests in UK primary care, 2000-15: retrospective analysis of 250 million tests. *bmj*, *363*.

[6] Richards, M. (2020). Diagnostics: recovery and renewal–report of the independent review of diagnostic services for NHS England. NHS England.

[7] Richards, M., Maskell, G., Halliday, K., & Allen, M. (2022). Diagnostics: a major priority for the NHS. *Future Healthcare Journal*, *9*(2), 133.

[8] Halliday, K., Maskell, G., Beeley, L., Quick, E., & Advisors, R. (2020). Radiology GIRFT programme national specialty report. NHS.

[9] Wickens, C. (2022) Why do diagnostics matter? Maximising the potential of diagnostics services. The King's Fund.

0.5 Our definition of terms: Capacity, supply, activity, and tests.

We will define diagnostic **capacity** as the potential of diagnostic services to supply tests. Diagnostic service capacity depends on factors such as the size of the diagnostic workforce and the availability of equipment and facilities.

The number of tests performed by NHS diagnostic services in a given period might be called the supply of diagnostic services or diagnostic activity. For our purposes, these terms will be equivalent. [10] We will use **supply** when making a comparison with demand, and **activity** in all other cases.

For the sake of readability, we will generally call a unit of diagnostic activity a **test** (rather than a "procedure", or an "investigation"). We acknowledge that some of these "tests" might also be therapeutic procedures.

[10] To express the relationship between**, supply, demand,** and **activity** we use the Real Centre's explanation (from, "The Bigger Picture"):

*"When **supply** for health care meets a **demand** for health care, we see this as health care **activity**."*

In this sense, **supply** is equivalent to, and can be measured by, the observed **activity.**

1. Background: The growth of diagnostic services

The core of this paper (Section 2) looks at how a rise in diagnostic supply (activity) has affected hospital processes over the last decade. To put this growth in context (and later think about possible solutions to the challenges that arise), we will begin by looking at demand for diagnostic services, and the main factors behind its growth.

1.1 What is driving demand for diagnostic services?

Demand for diagnostic services is influenced by an array of factors that interact with each other in complex ways. The main factors driving demand for diagnostic services in the last decade are highlighted here:

a. The population of England is increasing, growing older, and living longer.

All else being equal, a larger population means that more people will be in ill health at any one time. An older population will have greater levels of morbidity. And a population that lives longer will likely spend more time in ill health.

Furthermore, as treatments become more effective, there is a growing cohort of chronically ill individuals who would not have survived in the past. This cohort requires more complex treatment than the rest of the population. All of these factors lead to greater demand for health care and, as a consequence, greater demand for diagnostic services.

b. Medical knowledge and technology are advancing apace.

New medical technologies have come to the fore in the last decade (e.g., CT, MRI, genomic testing). Such technologies permit new modes of investigation and new opportunities for health care. Advances in technology also improve existing diagnostic procedures, making them easier to administer, faster, and/or more accurate.

c. **Diagnostic testing has become central to healthcare policy and practice.**

Early, accurate, diagnosis and treatment both improves disease outcomes and reduces the burden on the health system in the long term. [11,12] In recognition of the importance of diagnostic services to population health, we have seen, for example, a reduction in test thresholds and the introduction of initiatives allowing GPs "direct access" to diagnostic services.

In addition to the benefits of early diagnosis, increased testing may:

- reduce unnecessary emergency admissions; [13]
- reduce instances of missed or incorrect diagnosis;
- reduce length of stay and risk of mortality for patients admitted in an emergency; [14]
- reassure both patients and clinicians; and
- facilitate hospital discharges.

It is therefore no surprise that diagnostic services have become a focus of healthcare policy.

d. **Increased capacity leads to increased demand.**

While healthcare policy has underscored the importance of diagnostics, the cost of technology has also fallen. Hospitals have been able to purchase more equipment (e.g., CT, MR scanners) and expand facilities. As health professionals become aware of

[11] Neal, R. D., Tharmanathan, P., France, B., Din, N. U., Cotton, S., Fallon-Ferguson, J., ... & Emery, J. (2015). Is increased time to diagnosis and treatment in symptomatic cancer associated with poorer outcomes? Systematic review. *British journal of cancer*, *112*(1), S92-S107.

[12] Hawkes, N. (2019). Cancer survival data emphasise importance of early diagnosis.

[13] Wyatt, S. (2019). Waiting Times and Attendance Durations at English Accident and Emergency Departments.

[14] Halliday, K., Maskell, G., Beeley, L., Quick, E., & Advisors, R. (2020). Radiology GIRFT programme national specialty report. NHS.

increases in capacity, they are less likely to see a need to limit access to such resources and may be more willing to refer to diagnostic services.

e. **Medicine likely has a decreasing tolerance of uncertainty.**

New medical technology offers a greater understanding of organs and processes inside the body. Thus, when faced with a difficult decision, clinicians may rely on diagnostic technology to reduce their uncertainty (and there is no disincentive to test). Clinicians may also use diagnostic tests as a mechanism for shared or transferred responsibility.

In addition, clinicians will be increasingly aware of the potential for litigation following an error. All of these factors may influence medical practice.

f. **Medical norms and clinical standards have changed.**

The more diagnostic tests performed by clinicians and their peers, the more testing is normalised, and the less a healthcare professional will question the value of a particular test. In some cases, these norms have been formalised as clinical standards.

g. **Incidental findings have increased.**

Extensive diagnostic testing and large-scale screening programmes may identify disease that is unrelated to the original purpose of the investigation. This gives rise to more healthcare and more diagnostic activity.

h. **Societal norms and expectations of care and of diagnostics have changed.**

As the internet expands, people are increasingly aware of medical technology and possibilities, and of others' health care experiences. Patients may therefore urge their health professional to refer them for diagnostic tests.

i. **Increased diagnostic testing is likely to identify more disease which will, in turn, lead to greater demand for diagnostic services.** [15, 16]

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Some of these factors influence the number of people seeking the attention of health (and allied health) professionals, whilst other factors influence healthcare professionals' tendency to refer to diagnostic services. Some of these factors influence both, as we see in Table 2. If the NHS wishes to understand the challenges posed by diagnostic activity growth (the subject of Section 3 of this report), then the factors that influence health professionals' tendency to refer deserve particular attention.

Factor influencing demand	Affects: Number of people seeking care	Affects: Clinicians' tendency to refer
a. Population growth/age/morbidity	✓	
b. Advances in medical knowledge + tech		✓
c. Healthcare policy	✓	✓
d. Capacity-induced demand		✓
e. Lower tolerance of uncertainty		✓
f. Medical norms and guidelines		✓
g. Societal norms and expectations	✓	✓
h. Incidental findings	✓	
i. More testing leads to yet more testing	✓	

Table 2. Factors influencing demand for diagnostic services.

[15] Richards, M. (2020). Diagnostics: recovery and renewal–report of the independent review of diagnostic services for NHS England. NHS England.

[16] Halliday, K., Maskell, G., Beeley, L., Quick, E., & Advisors, R. (2020). Radiology GIRFT programme national specialty report. NHS.

1.2 How have changes to demand influenced the supply of diagnostic services?

In the NHS, health care is free at the point of access. As price does not act to balance demand and supply, we should expect the population's demand for health care to exceed supply. [17] A gap between demand and supply is, therefore, almost inevitable. Our interest should thus be in the size of the gap; in whether the gap is growing or shrinking; and, importantly, in whether there is value in closing the gap.

Now, whilst demand for diagnostic services has increased over the last decade - driven by the factors highlighted above - the supply of diagnostic services has also risen considerably. Indeed, the supply of diagnostic services has grown more quickly than supply of most other NHS services.[18] Figure 1 illustrates the supply/activity trends (shown by the green lines) for a few key diagnostic procedures.

However, we also see that, for the four cases shown in Figure 1, the gap between demand (the black lines) and supply has widened. [19] The same is true for many diagnostic services.

Some diagnostic modalities have fared better than others in recent years. The supply of CT scans grew by 8% annually and tracked demand closely (relative to other diagnostic modalities). CT is often used to assess patients with acute conditions. As this capability is always required, the supply of CT did not fall away during the pandemic in the same way it did for modalities that

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[17] Tallack C, Charlesworth A, Kelly E, McConkey R, Rocks S. (2020). The Bigger Picture. The Real Centre.

[18] Richards, M. (2020). Diagnostics: recovery and renewal–report of the independent review of diagnostic services for NHS England. NHS England.

[19] We will define **demand** for diagnostic services in a given period as:

Total number of diagnostic procedures completed in the period (emergency and elective)
+
Total number of elective patients waiting for diagnostic procedures at the end of the period

are typically used in elective care. In general, though, the suspension of elective care, and other necessary measures taken during the pandemic, widened demand-supply gaps that were already considerable.

We will look at the implications of a growing demand-supply gap later in the report. However, the focus of this report - the next section - examines the largely unreported consequences of the increased **supply** of diagnostic services in recent years. For the complex imaging modalities, growth in supply has been rapid. But, as we will see, even moderate supply growth has had an impact on hospital processes.

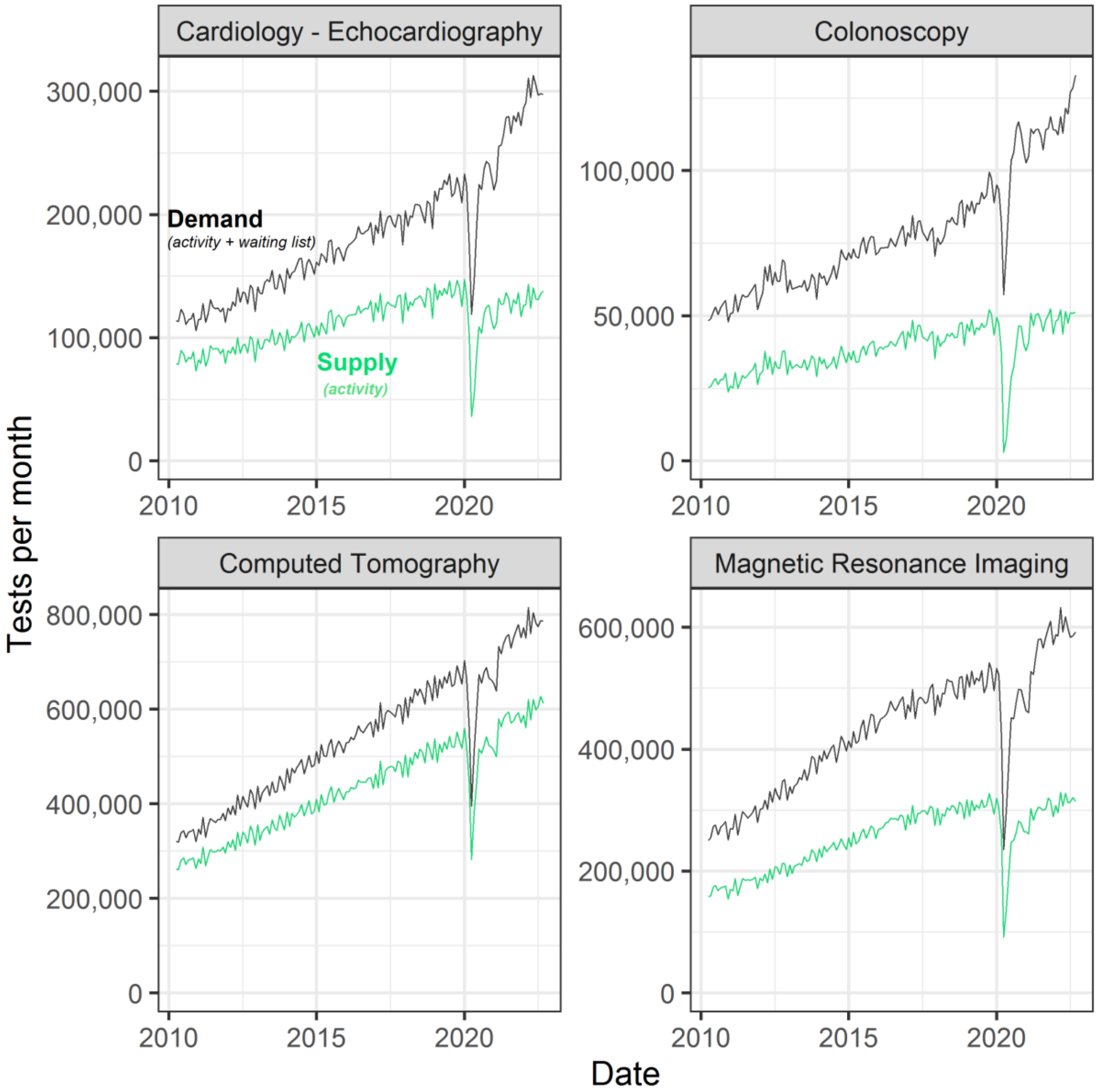

Figure 1. Trends in diagnostic procedures April 2010 to September 2022. [20]

[20] NHSE (2023). Monthly Diagnostics Waiting Times and Activity Data.

2. Focus: The unintended consequences of increased diagnostic testing

A rapid rise in diagnostic testing is likely to have affected processes and practice across the NHS. In this section we explore the unintended impact of increased diagnostic testing on A&E, admitted patient, and outpatient services.

We use statistics and models to examine and understand these effects. Models are simplifications and abstractions of real-world processes. They allow us to see features and relationships that are often obscured by detail. We believe these models are sufficiently robust to support our conclusions, but we set out our methods and assumptions so that others can reach their own view. We hope that these models prompt further work to confirm and quantify the effects we describe. Full details of the models we used are available on request.

With these thoughts in mind, let us begin with A&E care.

2.1 How has increased diagnostic testing affected A&E waiting times?

In simple terms, diagnostic activity may increase due to a rise in the number and/or the morbidity of people seeking health care, or to an increase in the tendency of clinicians to request tests. In the A&E setting, as in other settings examined in this report, all of these factors are at work: the number of people visiting A&E is typically rising by 1-3% each year, these people have growing levels of morbidity and, as we shall shortly see, clinicians are increasingly likely to request diagnostic tests. [21, 22, 23]

[21] Richards, M. (2020). Diagnostics: recovery and renewal–report of the independent review of diagnostic services for NHS England. NHS England.

[22] Nuffield Trust. A&E waiting times. Available at: https://www.nuffieldtrust.org.uk/resource/a-e-waiting-times (accessed on 14th Feb. 2023).

[23] Wyatt, S. (2019). Waiting Times and Attendance Durations at English Accident and Emergency Departments.

Thanks to the Secondary Uses Service (SUS), which has held data on A&E attendances for over a decade, we have information on more than 20 types of test carried out in A&E departments. We have displayed and categorised these tests in Figure 2.

In addition to our analysis of these quantitative data, we shall illustrate our ideas by looking at the experiences of a patient – we'll call her Meera – as she moves through the A&E department. Let's introduce her briefly now (before we return to her later).

Meera came to A&E with chest pain and waited to see an A&E consultant. The consultant examining Meera suggests that they begin with a few tests. [24]

Diagnostic Pillar	Tests recorded in SUS A&E	
Imaging	• X-ray plain film • MRI scan • CT scan	• Ultrasound • GU contrast/tomography • Dental investigation
Pathology	• Biochemistry • Haematology • Cross match • Blood culture • Serology • Immunology	• Toxicology • Histology • Cardiac enzymes • Clotting studies • Urinalysis • Bacteriology • Arterial/capillary bld. gas
Physiological M'ment	• Orthoptic tests	• Electrocardiogram

Figure 2. Categorisation of tests recorded by the SUS A&E datasets.

[24] This is not an unusual situation: in 2019/20, around 70% of patients attending (Type 1) A&E departments received at least one test.

2.1.1 Finding 1: Clinicians are more likely to order tests now than they were in the past

At present, over 70% of people treated in A&E will be discharged home. In this majority group, the average number of tests per attendance has almost doubled in the last 8 years (Figure 3, left). For those admitted, the test rate has increased more slowly (Figure 3, right).

Evidence suggests that people seeking medical attention at A&E today are sicker than those arriving in past years. [25] But this change in case-mix only partially accounts for the growth in test rates in the "discharged home" group.

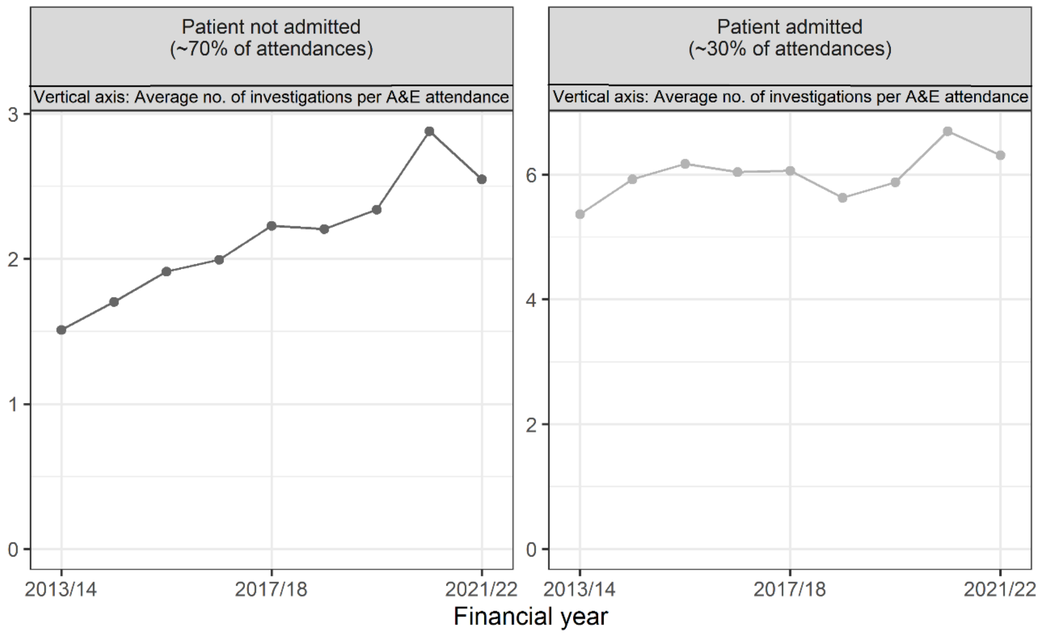

Figure 3. The average number of investigations per A&E attendance - the investigation rate – between 2013/14 and 2021/22. We show the investigation rate for A&E patients who are not subsequently admitted to hospital (left) and for A&E patients who are admitted (right).

[25] Wyatt, S. (2019). Waiting Times and Attendance Durations at English Accident and Emergency Departments.

As part of this analysis, we examined whether the odds of a patient receiving a test has changed over time. We also looked at how changes to the case-mix have affected these odds. We found that, in most cases, patients were several times more likely to receive tests in 2019/20 than they were just 7 years previously (as shown in Table 3). Importantly, these changes remained (and often increased) after we adjusted for changes to the case-mix.

For example, we see that a patient who attended A&E in 2019/20 was almost 5 times more likely to receive an MRI procedure and over 3 times more likely to receive a CT than an individual with similar characteristics attending A&E in 2012/13. [26] This may be partly explained by the fact that hospitals have acquired more MR and CT scanners in the last decade and, as a consequence, clinicians are less concerned about restricting access to scarce resources. But our findings do not only apply to newer technologies: the odds that a patient would receive established investigations such as an ECG, a haematology test, or a biochemistry test was around 2 to 3 times higher at the end of the period.

	Odds Ratio of Test (2019/20 vs. 2012/13)	
	Plain	**Case-mix adjusted**
CT	2.9	3.4
MRI	3.7	4.7
X-ray	0.8	0.8
Haematology	1.8	2.1
Electrocardiogram	1.6	1.7
Biochemistry	2.2	3.0

Table 3: Odds ratio of investigation (2019/20 vs. 2012/13) for common A&E tests

[26] “Similar” in the dimensions we controlled for (age, sex, diagnosis, arrival mode…)

These findings - which follow earlier work by the Strategy Unit – suggest that clinicians in A&E are more likely to request tests than they were a decade ago, particularly when they are investigating less serious conditions.[27] Explanations for this might include the "Home First" policy and rising admission thresholds, meaning clinicians may increasingly rely on tests to rule out conditions that would otherwise require admission. [28] It may also be that, in some cases, clinical guidelines now recommend a test where in the past they did not, or that tests that would have been carried out after admission are now being carried out in A&E.

For Meera, this means that her A&E consultant is much more likely to order a test to assess her condition than would have been the case just a few years ago.

2.1.2 Finding 2: Tests take time. In many cases, additional tests will slow a patient's passage through A&E

While the particulars of Meera's experience will depend on her condition and the tests she receives, the upcoming series of events will be similar regardless of the test. Meera will have to wait for the test to be organised and administered. She will likely wait while her clinician or clinical team interprets and communicates the results. And if treatment is required, she may have to wait before (and possibly after) receiving it. This process might engage A&E staff across the department.

Meera's clinician, like all clinicians working in A&E, relies on diagnostic tests to guide her main decision: Should Meera be admitted to hospital or discharged home.

[27] Wyatt, S. (2019). Waiting Times and Attendance Durations at English Accident and Emergency Departments.

[28] Reducing long stays: Where best next campaign. NHSE Available at: https://www.england.nhs.uk/urgent-emergency-care/reducing-length-of-stay/reducing-long-term-stays/ (accessed 1st March 2023)

We will look at two scenarios:

- **Scenario A**: In which Meera's clinician requests 2 tests.
- **Scenario B**: In which Meera's clinician requests 3 tests (the same two tests from Scenario A, plus an X-ray). [29]

In Scenario B, the clinician concludes that, by requesting a further test (an X-ray) for Meera, she may better understand Meera's condition. With this additional information she will be more confident that her ultimate decision - to admit Meera or send her home – will be the correct one.

So, on balance, how long might an additional test add to Meera's stay in A&E?

To investigate this question, we used half a million SUS records from 2019/20 to estimate the time that each test added to a patient's stay in A&E. Figure 4 shows the effect, on average, that adding each test to a patient's existing care will have on their overall stay in the department. The results suggested, for example, that a patient who was given one or more MRI scan stayed, on average, 70 minutes longer in A&E than similar patient (the control case) who was not sent for one of these procedures. [30] Likewise, we see that one or more haematology or biochemistry test added, again, on average, about 70 minutes to a patient's A&E stay. Established imaging procedures were also associated with an increased waiting time: plain film X-ray and ultrasound added, on average, over 20 minutes to an attendance.

These estimates include the wait for results of the test and the time taken to administer care or treatment when compared to the overall wait experienced by the control case. The time taken to

[29] We might expect a clinician to request an additional test only if they see diagnostic value in the test. We shall assume Meera's case is on the borderline, such that the clinician's decision can be thought of as random.

[30] "Similar" in the dimensions we controlled for (age, sex, diagnosis, arrival mode …).

administer the test itself might thus be longer or shorter than the estimates we see in Figure 4.

Whilst we partially controlled for a patient’s condition (with, for example, diagnosis and arrival mode), we did not take into account the fact that a clinician requested (or did not request) a test. This information is also likely to be indicative of a patient’s condition. [31]

We also see that some tests have estimated times that are less than zero. This indicates that a patient given the test will, on average, stay in the department for a shorter period than the control case (who did not receive the additional test). This suggests that these tests tend to expedite a clinician’s decision about whether and how to treat the patient.

[31] When estimating the time consequence of test, we controlled for several variables that might indicate a patient's need for a test. In practice however, a clinician would have access to wider set of information, when deciding whether to order a test. Because we are unable to control for these unrecorded variables, our time estimates may be biased.

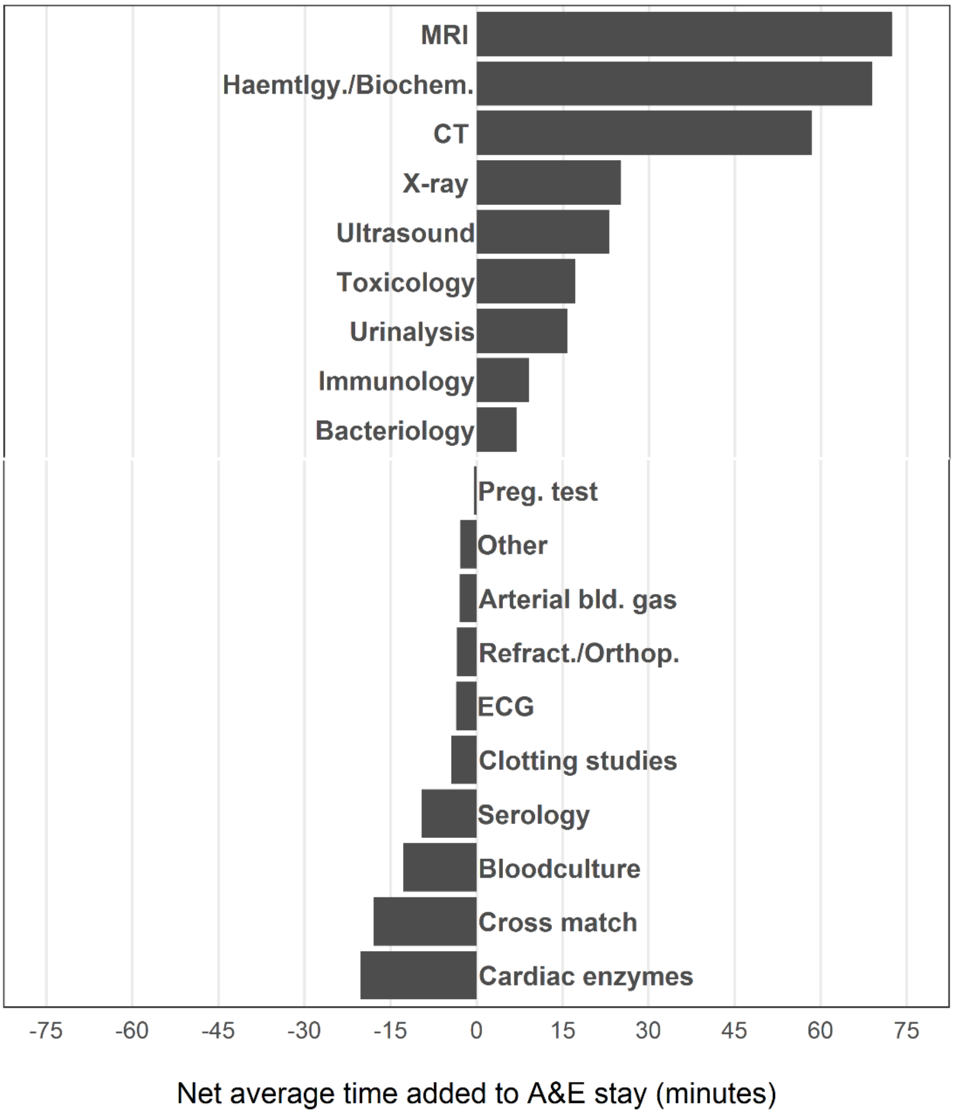

Figure 4: Net average time that each test adds to a stay in A&E.

2.1.3 Finding 3: In 2018/19, over 300,000 patients missed the 4-hour target as a direct result of growth in the rate of testing. [32]

We have seen that clinicians in A&E are increasingly likely to request investigations and that, in many cases, additional investigations added time to a patient's stay in A&E. We may therefore already have enough to conclude that the growth in investigation rates has led to longer A&E waits. But we can also explicitly link the growth in investigation rates to increased waiting times for patients.

In a report published in 2020, the Strategy Unit estimated the influence of factors contributing to the decline in A&E waiting time performance. [33] One of the factors assessed was the change in the number and type of investigations requested by clinicians.

The analysis covered A&E departments of 38 hospital trusts between the years 2011/12 and 2018/19. For these departments, the number of attendances breaching the 4-hour target increased from 5.7% to 16.5% over the period. Of this total change (10.8%), the rise in the investigation rate contributed 2.0 percentage points. Put another way, at the start of 2011/12, about 6 A&E attendances per 100 missed the four-hour target. Over the following seven-years, the growth in testing increased waiting times for all patients such that an additional 2 attendances per 100 missed the four-hour target. This effect size was second only to the (decreased) ability of a service to recover following a period of pressure.

Whilst 2 in 100 A&E attendances may sound insignificant, if we apply this outcome to the 16 million (type 1) A&E attendances in 2018/19, the result is startling: [34] Over 300,000 patients breached

[32] As a result of growth in investigation rates between 2011/12 and 2018/19

[33] Wyatt, S. (2020). Exploring the decline in performance against the 4-hour A&E target

[34] A&E waiting times, Nuffield Trust. Available at: https://www.nuffieldtrust.org.uk/resource/a-e-waiting-times (accessed March 1st 2023)

the 4-hour target as a direct result of the growth in investigation rates.

2.1.4 Discussion: Should Meera's clinician order an additional test?

Additional testing has benefits. To Meera's clinician (and Meera herself), an extra wait of 25 minutes for an X-ray – as modelled above – may be worth the chance of further evidence to support the opinion that Meera's chest pain is not life-threatening.

But, of course, with each additional test, Meera's case becomes more complex. For each additional test, staff must analyse the results within the context of others. Each additional test will likely take more staff time (and possibly involve more individuals), with an ever-growing potential for delays and lapses in communication.

And, at this point, we should take a few steps back from Meera and her clinician. We can then picture them within a bustling department, discussing Meera's condition over the ambient hubbub and intermittent bleeps from machines in adjoining cubicles. Meanwhile, in the waiting room, we see 40 poorly adults, 4 children, and 6 crying infants anticipating the attention of a few clinicians and access to limited resources. In truth, Meera's experience in the A&E department cannot be disconnected from these 50 others.

If Meera receives an additional test, it will not only be Meera who stays longer in A&E. This additional test will divert a share of attention and resources away from other patients in the department. Thus, Meera's extra test has the potential to make each of their waits longer. This - the effect of an individual's tests on the waiting times of the group - we will call the "indirect effect" of increased diagnostic testing. It is difficult to estimate indirect effects. But we can imagine that, if most patients in the department are receiving an additional test as part of their care (as indicated by Fig. 3), the extra demands on staff and resources

– and, as a consequence, the impact on waiting times for all – must be considerable.

From this perspective (the system perspective), the question of whether Meera's clinician should order the X-ray is more complicated to answer. Yes, there is a chance that Meera's clinician will gain new information from an additional test. This information may enhance the quality of clinical decision making and the quality of care for Meera.

But there is a downside. Additional testing ties up resources and may undermine the quality and safety of care for other patients. Longer waits in A&E (and the subsequent increased crowding) are associated with increased mortality rates; increased patient harm; staff burnout; and poor levels of patient and staff satisfaction.[35, 36]

This section highlights the balances that exist in our health system. It is possible that rapid growth in diagnostic testing is jeopardising overall health and care. To date, it is not clear whether the NHS has examined and noted the adverse consequences of increased diagnostic testing, including the effect on A&E waiting times.

2.2 Has increased diagnostic testing affected elective care waits?

To help illustrate events in a typical elective care pathway, we will look at Jon's experience. Jon's particular pathway involved several appointments with a consultant and her team. The consultant also referred Jon to two different diagnostic services for two tests (Figure 5).

[35] Boyle, A., Higginson, I., Sarsfield, K., & Kumari, P. (2022). RCEM Acute Insight Series: Crowding and its consequences.

[36] Jones, S., Moulton, C., Swift, S., Molyneux, P., Black, S., Mason, N., ... & Mann, C. (2022). Association between delays to patient admission from the emergency department and all-cause 30-day mortality. *Emergency Medicine Journal*, *39*(3), 168-173.

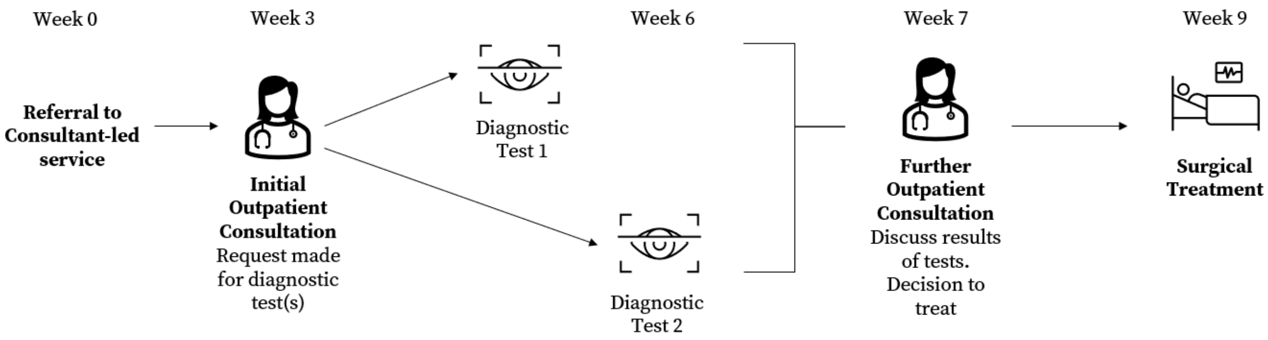

Figure 5. Elective pathways are often made up of a series of care contacts. Up to 85% may include one or more referrals to diagnostic services. [37, 38]

The results of the tests indicated that Jon required treatment. They even helped his consultant to choose a particular treatment. Yet, both referrals to diagnostic services took several weeks. Jon joined a separate waiting list for each of the diagnostic tests requested by his consultant. He then re-visited his consultant to discuss the results and the implications of these tests.

It is probable, therefore, that Jon's pathway - which involved several separate diagnostic tests - was longer in duration than pathways involving one test or fewer.

If we now step back from Jon's case, to think about all elective pathways, we would expect that, if clinicians request more diagnostic procedures per pathway (and all else is equal), pathways will become more complex, diagnostic waiting lists will grow, and patients will wait longer to receive treatment.

[37] There are many ways in which events may differ. For instance, treatment may commence at the first outpatient appointment, or the pathway may support a "straight-to-test" arrangement.

[38] McCaughey H, Powis S (2020). 'Diagnostics: recovery and renewal'. Board meeting paper. NHS England and NHS Improvement website. Available at: www.england.nhs.uk/wp-content/uploads/2020/10/BM2025Pu-item-5-diagnostics-capacity.pdf (accessed on 14th Feb. 2023).

2.2.1 So how has the number of diagnostic procedures per elective care pathway changed in recent years?

Every month, the NHS publishes data on waiting times and activity levels for 15 "key" diagnostic procedures.[39, 40] This publication includes a time series providing the number of diagnostic procedures delivered to elective patients, as shown in Figure 6 (left).

Figure 6. For the period between August 2007 and January 2020, we show: Diagnostic activity from the waiting list, per month, as measured by the DM01 data collection (left) and the number of RTT pathways completed per month (right).

[39] Monthly Diagnostics Waiting Times and Activity Data. NHSE.
[40] "Key" is the descriptor used in the official documentation.

The NHS also publishes monthly data about the number of open and completed "Referral to Treatment" (RTT) pathways and the median waiting times for these pathways. [41] Figure 6 (right) shows numbers of completed pathways each month since August 2007.

We combined these two series to estimate how the number of tests per RTT pathway – which we will call the **diagnostic referral rate** - has changed in recent years. [42] From the resulting timeseries, shown in Figure 7, we can see that in August 2007, the NHS performed 62 tests for every 100 completed RTT pathways. By April 2015, this had risen to 107 tests for every 100 pathways (an increase of 45 tests for every 100 pathways completed – that is, almost one additional test for every two pathways completed).

[41] According to the NHS constitution, patients seeking elective care should have to wait no longer than 18 weeks from referral to the start of their consultant-led treatment [Ref: Handbook to the NHS Constitution]. This interval is also known as the Referral to Treatment (RTT) time. RTT data - published monthly – are a valuable indicator of NHS elective care performance.

An RTT pathway opens (the RTT clock starts) when a care professional (be it GP, nurse practitioner, allied health professional or consultant) refers a patient to a consultant-led service for specialist attention. The pathway will end (the clock stops) either when:

- the patient begins their first 'definitive' treatment (as defined by the Referral to treatment consultant-led waiting times Rules Suite, DH, Oct 2015); or
- there is clinical or patient-led decision that treatment is unnecessary; or
- the patient does not attend after the initial referral.

[42] This is a rough estimation. There will be referrals for diagnostic procedures that are not recorded in the DM01 collection. Moreover, for an individual pathway, the month in which a diagnostic procedure is completed may not be the same as the month in which the pathway is completed.

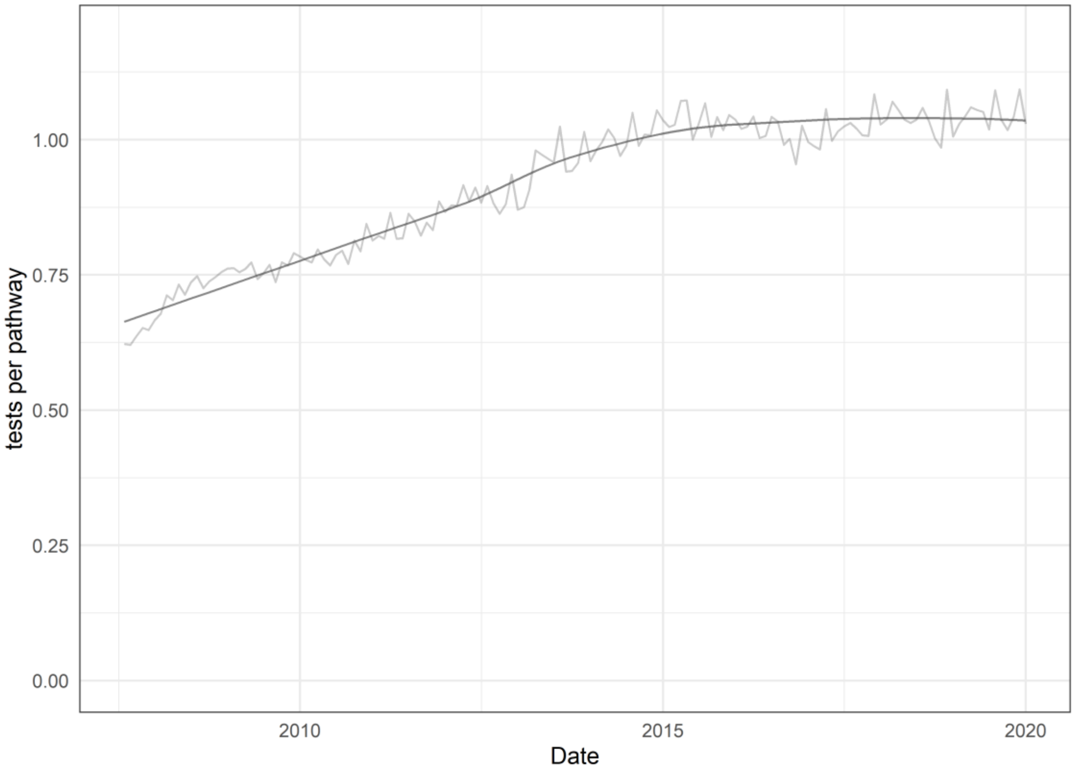

Figure 7. The number of diagnostic procedures per completed RTT pathway between August 2007 and January 2020.

From 2015 to 2020 the diagnostic referral rate remained stable. We can see, looking again at Figure 6 (left), that this latter period of stability is not due to a slowing of the growth in diagnostic tests. In fact, the stability appears to be due to a recent rise in the number of RTT pathways completed each month (Figure 6, right).

Yet, if we observe the nature of these two trends over the long-term and add this information to what we read about the current diagnostic strategy, we believe it is quite possible that, in the coming years, we will see the number of diagnostic tests per pathway start to rise once more. [43, 44, 45]

[43] Looking at both long-term trends in Figure 6, we see that growth in the number of pathways completed per month has been inconsistent and rarely sustained. Diagnostic activity for elective patients, on the other hand, has a history of sizeable, yet steady, growth.

[44] NHSE. (2022). 2022/23 priorities and operational planning guidance

[45] Richards, M., Maskell, G., Halliday, K., & Allen, M. (2022). Diagnostics: a major priority for the NHS. *Future Healthcare Journal*, *9*(2), 133.

2.2.2 If the number of tests per RTT pathway starts to rise once more, how might this affect referral to treatment times and the elective waiting list?

One way to explore this question is to examine the impact of past increases in the number of diagnostic procedures per RTT pathway.

We prepared a simple model to contrast the true course of events over the last decade (a rise in the diagnostic referral rate) with a scenario in which the referral rate remained constant. We will name the latter scenario a "counterfactual", meaning a scenario that might have happened, but did not.

Our aim was to study how a relatively *modest* change in the diagnostic referral rate might affect RTT times and elective care flows over several years. Consequently, we set our starting point as January 2012, at which time health professionals requested, on average, 87 diagnostic procedures per 100 RTT pathways.[46] Our end point for this exercise was 8 years later, January 2020, the same month that COVID-19 first appeared in the UK. At this time, we saw 103 tests per 100 pathways but the level had remained comparatively stable for 5 years.

The counterfactual model

We sought some indication of the outcomes we might have seen had there been no growth in diagnostic referral rates over this period. We imagined, therefore, that diagnostic capacity increased as it did in reality, but that the diagnostic referral rate remained steady (at 87 tests for every 100 pathways from January 2012 until January 2020). In this case - all else being equal – waiting times for tests would have *decreased.* We have assumed that this decrease would have been proportional to the difference between the factual and counterfactual diagnostic activity levels. So, for example, if

[46] Completed pathways

we saw half the activity in the counterfactual scenario, waits for tests would have been half as long. Now, since RTT times include the waiting time for diagnostic tests, RTT times in the counterfactual scenario would have also decreased. New pathways might therefore have begun earlier, thus more pathways could be completed in a given time period.

This counterfactual scenario might seem contrived: In practice, if diagnostic referral rates on RTT pathways had not increased, then diagnostic capacity might not have grown so quickly. Alternatively, our counterfactual scenario (constant referral rate, increasing capacity) might have led to increased demand for diagnostics from other pathways. Nonetheless, the counterfactual scenario provides us with a means of estimating the impact of diagnostics referral rate growth, if all other factors had not changed. These estimates – even if they are based on a somewhat unrealistic counterfactual - can help us understand the scale of the effect.

Otherwise, we made conservative assumptions so that this simple model does not overestimate the impact of increases in the referral rate. For example, we have assumed that tests are conducted in parallel (by which we mean that health professionals request a patient’s tests all at the same time). This is likely to lead to us underestimating the impact on RTT times and the waiting list. We have also assumed that 50% of all RTT pathways involve a diagnostic referral. Despite the limitations, we believe the model is good enough to illustrate the overall impact on elective care and, importantly, to stimulate discussion.

So, Figure 8 shows that, for the individual patient, changes to RTT times would have been modest. When the referral rate was held constant, the median RTT time for a single pathway – often around 40 days - was reduced by 5%, or 2 days. Yet, over the 8-year period we examined, the NHS completed more than 120 million pathways. The cumulative effect of these modest reductions therefore has a considerable impact on the numbers of additional RTT pathways that can be completed (Figure 9) and, consequently, on the size of the RTT waiting list (Figure 10). Thus, if we contrast our counterfactual scenario – which we reiterate is based on a simple model that has several limitations – with reality, around 3 million more patients might have received treatment by the end of this period. Alternatively, if we look at the situation from an operations perspective, the NHS would have entered the pandemic with a comparably modest waiting list of 1.5 million, compared to the all-time high of 4.4 million that we saw in reality.

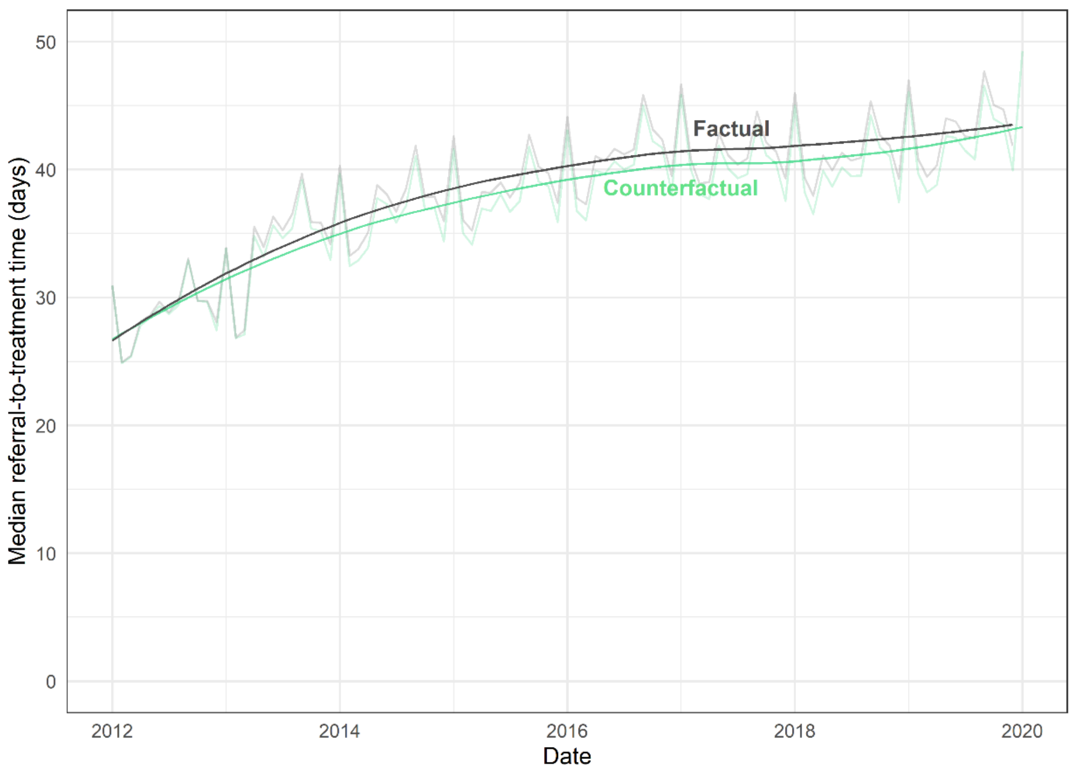

Figure 8. Monthly median RTT times for factual and counterfactual cases. In any given month, the difference in RTT times would be small (less than 2 days) for the average pathway. However, as the NHS completes over a million elective pathways each month, the cumulative effect of this outcome is substantial.

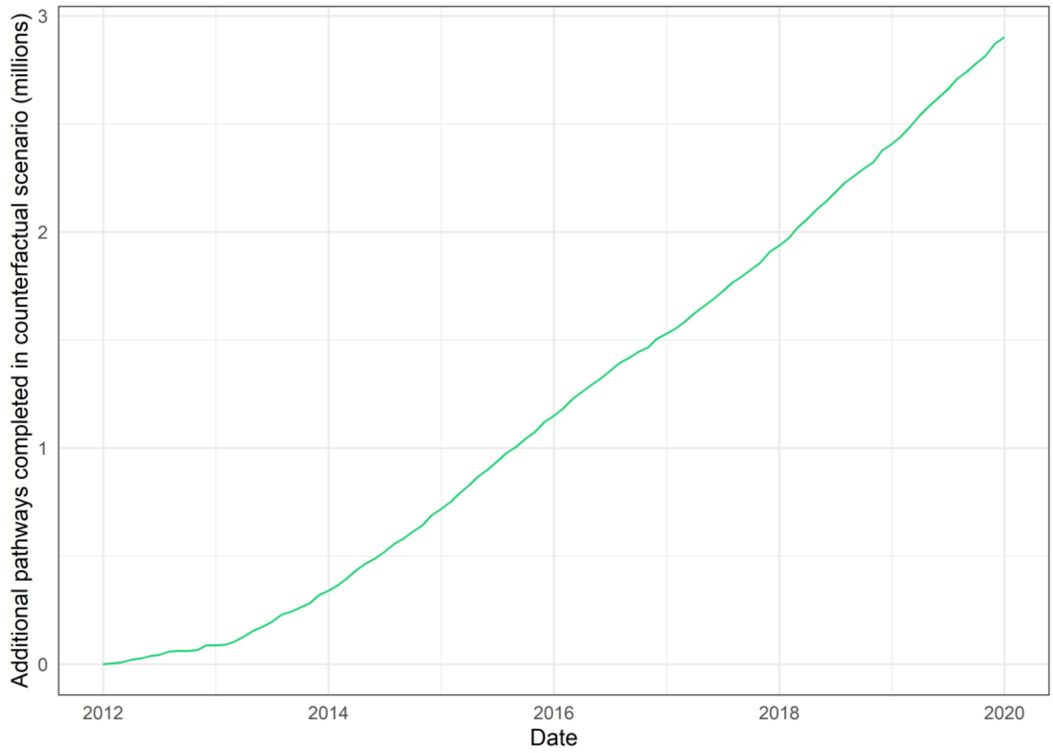

Figure 9. Additional pathways completed (in millions) in the counterfactual scenario when compared to actual outcomes.

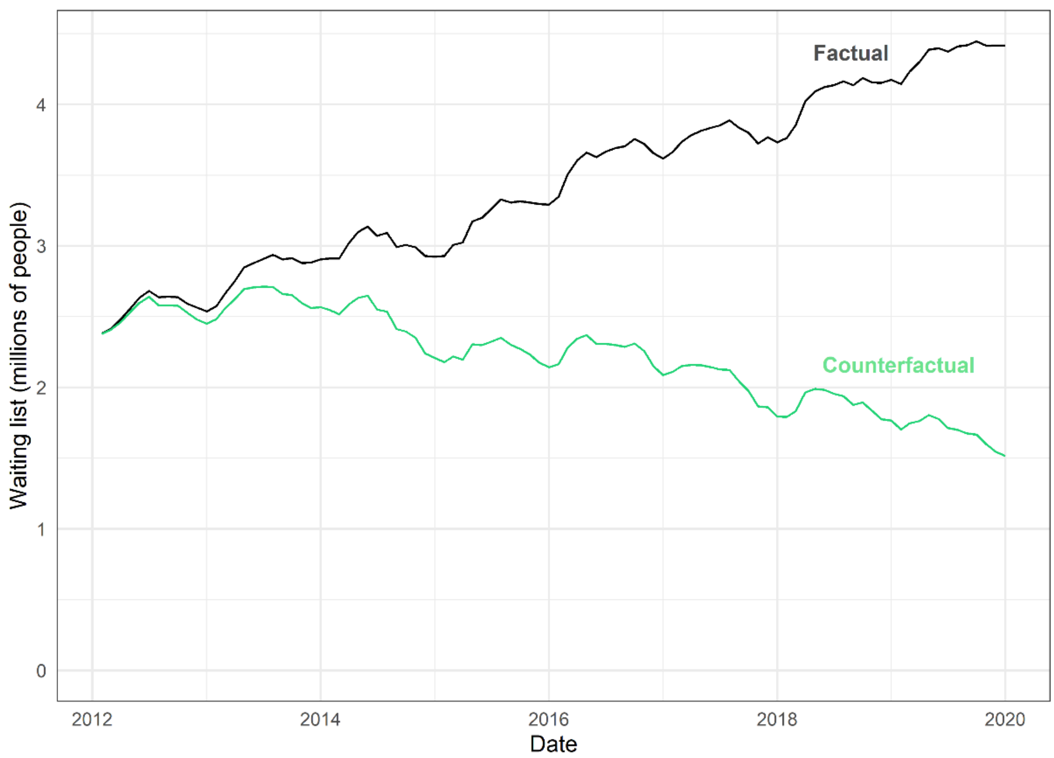

Figure 10. The size of the RTT waiting list, over time, for factual (black) and counterfactual (green) scenarios.

Now, we are not suggesting that holding the diagnostic referral rate constant over the last decade would have been a desirable course of action. But we have tried to illustrate that along with the benefits of increased testing comes the potential for harm. Increased access to diagnostic services may improve outcomes for some, but, if millions of people have to wait longer to receive treatment, outcomes for others will deteriorate. Again, the NHS needs to better understand this balance, and whether (and how) it might accommodate more tests without further increasing the waiting times for elective patients or adding to the pressure on diagnostic services.

2.3 Has increased diagnostic testing affected admitted patient length of stay and the availability of hospital beds?

Back in 2011/12, just over 20% of admitted-patient spells involved at least one "key" diagnostic test. [47] By 2021/22, this figure had risen to 30%.

In this section, we will look at the growth of three of these key tests:

- CT scans,
- MRI scans, and
- echocardiograms.

In each case, the percentage of spells involving one or more of these tests has risen appreciably over the last decade (Figure 11). At the present time, around 25% of patients admitted to hospital can expect to receive a CT scan, 5% will receive an echocardiogram and 5% an MRI scan.

[47] "Key" is the descriptor used in the Monthly Diagnostics Activity Data (DM01) documentation.

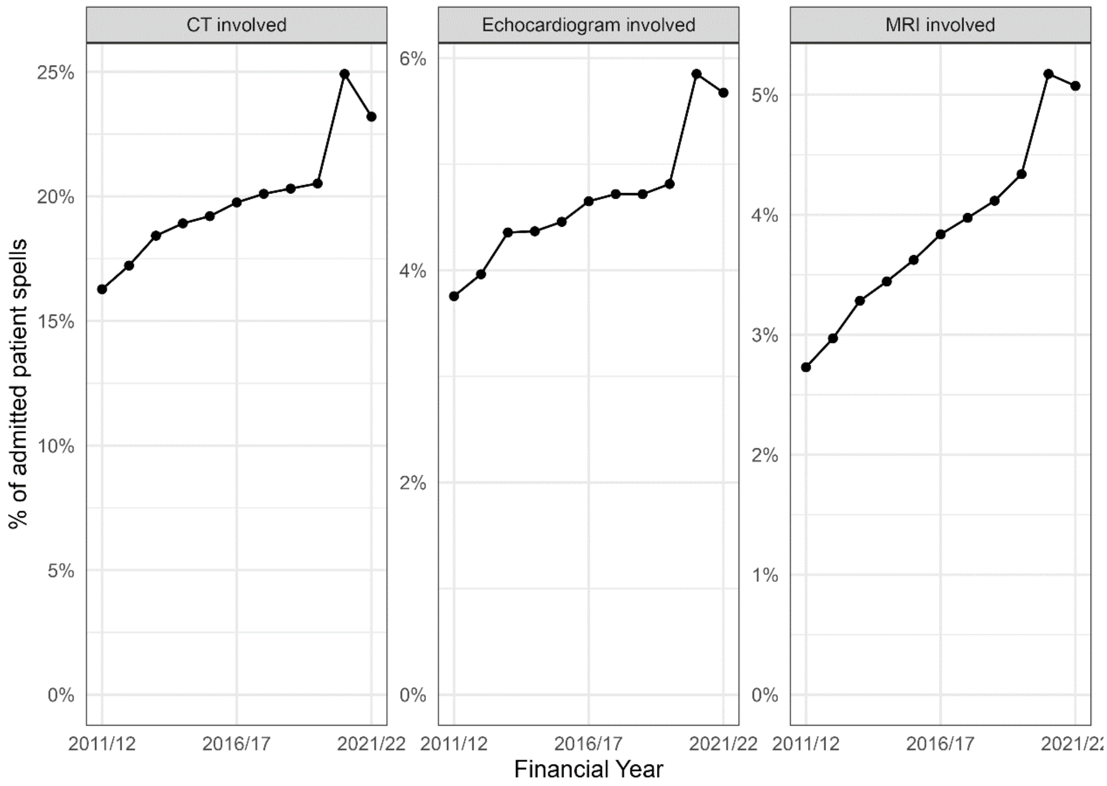

Figure 11. Percentage of admitted patient spells containing at least one: CT scan (left); echocardiogram (centre); MR scan (right), for the years between 2011/12 and 2021/22.

How long might these diagnostic tests add to a patient's stay in hospital?

To help explain our ideas in this section, we will follow Alexis. Alexis was admitted to hospital under General Surgery with unexplained abdominal pain. Today is Alexis's third day in hospital and ward rounds are imminent.

We will look at two scenarios:

- Scenario X: Alexis's clinician requests a CT scan of the abdomen
- Scenario Y: Alexis's clinician does not request a CT scan [48]

In scenario X, Alexis will have to wait for resources to become available. Alexis's wait will depend on (among other factors) whether their case is classed as "urgent"; the availability of diagnostic staff and equipment; and on whether the hospital is busy or not. This latter point is important: in many cases, admitted patients share imaging resources with emergency patients. Since emergency patients are necessarily prioritised, if the emergency department is busy, inpatient scans may be delayed.[49] So, how long might this CT scan add to Alexis's stay in hospital, when compared to scenario Y (no CT scan)?

We used one million SUS records from 2021/22 to estimate the average time that each of the three diagnostic tests (CT, MR, and echocardiogram) added to a patient's stay in hospital. The exercise suggests that patients who received at least one CT scan stayed in hospital 14 hours longer (on average) than a similar patient who was not sent for one of these procedures (Figure 12).[50, 51] If a patient received an MRI scan or an echocardiogram, this added around 30 hours to their stay. And if a patient received more than one of these test types, their length of stay was likely to be longer still.

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[48] We would expect a clinician to request a CT scan only if they see diagnostic or prognostic value in the scan. However, we shall assume Alexis's case is on the borderline, such that the clinician's decision can be thought of as random. We cannot make the same assumption for the modelling exercise that follows.

[49] Halliday, K., Maskell, G., Beeley, L., Quick, E., & Advisors, R. (2020). Radiology GIRFT programme national specialty report. NHS.

[50] "Similar" in the dimensions we controlled for (age, sex, primary diagnosis, secondary diagnosis….)

[51] As with the A&E modelling exercise, whilst we tried to control for a patient's condition, we did not take into account the fact that a clinician requested (or did not request) a test. This information may also be indicative of a patient's condition. Because we are unable to control for this, and other unrecorded variables, our time estimates may be biased.

So, on average, each of the three diagnostic tests adds time to an admitted patient's length of stay. Alexis, for example, might expect to stay in hospital 14 hours longer if their clinician requests a CT. Of course, only a fraction of the additional time is due to the test itself. For example, a CT scan typically takes 10-20 minutes.[52] For the most part, Alexis will be waiting for resources to become available. However, there will also be a wait while the test is reported and then, of course, Alexis's clinician may decide to act on the results. All of these steps are included in our estimated times.

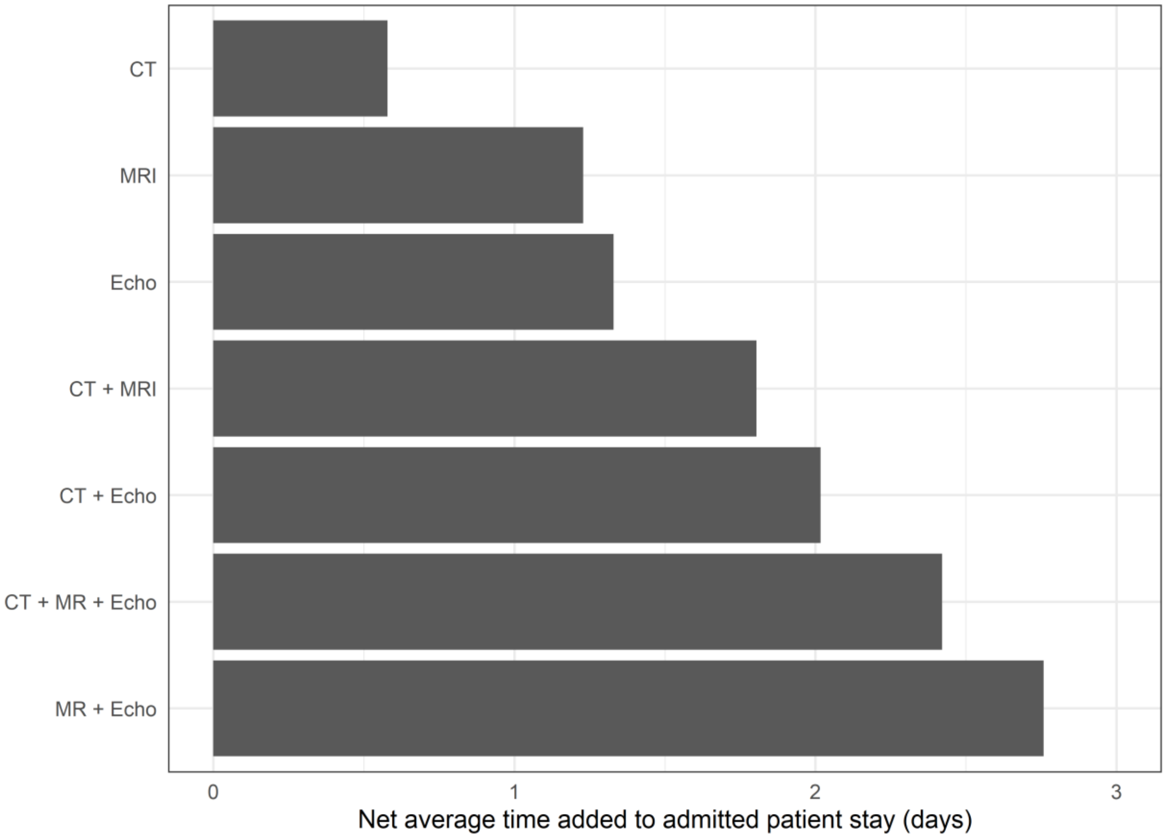

Figure 12. Net average time (in days) that diagnostic procedures, and combinations of diagnostic procedures, add to an admitted patient length of stay.

[52] An echocardiogram typically takes 30-60 minutes, an MRI 15 -90 minutes.

Now it's true that, in some cases, these tests will facilitate discharge. That is, the test may give a clinician confidence to discharge a patient earlier than they otherwise would have (and avoid a readmission). But the average times, given above, include the impact of this effect. The average times also include referrals that are classified as "urgent" and will therefore be prioritised. Thus, if Alexis's test is classed as "routine", their stay is likely to be longer than the time we estimated here.

How have increases in diagnostic testing over the last decade affected bed occupancy?

We have seen that diagnostic testing for admitted patients has increased over the last decade. We have also seen that, on balance, each additional test that a patient receives will further extend their stay in hospital. It is therefore likely that increased diagnostic testing will have increased demand for hospital beds.

To give an indication of the size of this bed-occupancy effect, we will again make use of a counterfactual scenario. In this case, we will imagine that the proportion of spells containing at least one of our three diagnostic tests did not change between 2011/12 and 2021/22.

In the 2021/22 counterfactual scenario, then, these three diagnostic tests would have been involved in a total of 1.25 million spells compared to the observed 1.75 million. If we then apply the test times from Figure 12 to the difference in activity for these two cases, we can estimate the additional bed days that have been required due to the increase in testing.

Thus, if the proportion of spells with these three diagnostic tests had not changed between 2011/12 and 2021/22, the NHS would have approximately 1,500 more beds available each day. For the average ICS this means about 35 beds a day, or the equivalent to freeing 3 beds in every 200 currently open. [53]

In recent years, the NHS has reported very high levels of bed occupancy. Research has demonstrated that patient mortality and readmission rates rise when bed occupancy rates reach certain levels. So, whilst Alexis might benefit if their clinician requests a CT scan, other patients may experience negative effects.

[53] Assuming 100k general and acute beds, as per *NHS Key Statistics: England, November 2022.*

3. The future: How might the NHS mitigate the unintended consequences of diagnostic growth?

Earlier in this paper, in Section 1.1, we outlined factors influencing diagnostic demand over the last decade. All these factors continue to drive demand, and, in many cases, their influence is growing.

Looking ahead, the Richards' review suggests that ICSs should, "plan for [demand] growth to continue at current levels over the next five years for most modalities." [54] And demand for complex imaging modalities – like CT– is likely to grow faster; perhaps by as much as 100% over the next five years. [55]

In response, current diagnostic policy aims to increase access to diagnostic services by increasing both their capacity (e.g., through CDCs) and their efficiency (e.g., with improved digitalisation, pathway reform, AI reporting tools, and CDCs). [56, 57, 58, 59]

These policies may increase diagnostic throughput but, without careful planning, they are also likely to create further (supply-induced) demand: our analysis has highlighted that, as diagnostic capacity increases and testing becomes easier, so health professionals have become increasingly likely to use tests. As a result, un-moderated increases in diagnostic activity may be just as likely to exacerbate the undesirable consequences of past

[54] Richards, M. (2020). Diagnostics: recovery and renewal–report of the independent review of diagnostic services for NHS England. NHS England.
[55] ibid
[56] DHSC Press release: £250 million in NHS technology to modernise diagnostics Available at: https://www.gov.uk/government/news/250-million-in-nhs-technology-to-modernise-diagnostics (accessed 21 Feb. 2023)
[57] NHSE. (2022). 2023/24 priorities and operational planning guidance
[58] Wickens, C. (2022) Why do diagnostics matter? Maximising the potential of diagnostics services. The King's Fund.
[59] Richards, M., Maskell, G., Halliday, K., & Allen, M. (2022). Diagnostics: a major priority for the NHS. *Future Healthcare Journal*, *9*(2), 133.

growth (slower patient flow, delayed care, greater strain on allied services) as they will mitigate them.

It may be, however, that capacity growth will be involuntarily constrained. Recent activity trends and anecdotal evidence suggest that increases in capacity may be limited not by equipment or by facilities, but by shortages in the workforce.

In early 2022, NHS England asked ICSs to increase the supply of diagnostic services to 120% of pre-pandemic levels throughout 2022/23. This target aimed to address both continuing growth in demand and the activity backlog due to COVID-19.[60] Yet, for the first nine months of the financial year, it appears that, at a national level, the target was missed by some distance.[61] According to members of the diagnostic community who we interviewed during this project, such a result is largely a consequence of workforce shortages. In many cases, equipment is available – assuming that Jon (from Section 2.2), for example, is willing to attend an appointment on a Sunday evening - but there may not be staff to operate the equipment or report the findings.

While investment in new physical capacity (equipment and CDCs) may be forthcoming, it is widely acknowledged that, for the time being, the staff needed to operate this will have to come from the existing workforce. [62, 63] At present, diagnostic services have a limited pool of skilled workers from which to recruit. [64, 65] And training people in these skills (growing the pool) cannot be solved by financial investment alone: time will also be required (a minimum of 5 years is needed to train a radiologist, for example).

[60] NHSE. (2022). 2022/23 priorities and operational planning guidance

[61] Examining Monthly Diagnostics Waiting Times and Activity Data, CT scans seem to be the notable exception here.

[62] Wickens, C. (2022) Why do diagnostics matter? Maximising the potential of diagnostics services. The King's Fund.

[63] Richards, M., Maskell, G., Halliday, K., & Allen, M. (2022). Diagnostics: a major priority for the NHS. *Future Healthcare Journal*, *9*(2), 133.

[64] Richards, M. (2020). Diagnostics: recovery and renewal–report of the independent review of diagnostic services for NHS England. NHS England.

[65] Wickens, C. (2022) Why do diagnostics matter? Maximising the potential of diagnostics services. The King's Fund.

It may be that attention to this crucial topic is unintentionally deflected by - for instance - international comparisons of scanners per person. Such metrics are immaterial if there are insufficient diagnostic staff to conduct tests or operate new equipment. [66]

Manage growth and build firm foundations

If the NHS succeeds in growing diagnostic capacity, then, as we have seen in the past, this may lead to further delays in care pathways. We tentatively propose three strategies that might ameliorate these effects:

1. Reduce unnecessary testing. Estimates suggest this may account for 10% (or more) of all diagnostic activity. [67] Reducing diagnostic waste has numerous benefits, including improved patient safety, shorter waiting lists, and reduced costs. Moreover, it frees diagnostic capacity and may allow allied services to stabilise before further growth. The last two of these benefits may make it easier for services to implement pathway reform.

   Resources and technology to reduce diagnostic waste already exist. One solution is to employ tools that aid diagnostic referral decisions. The key point here is that such tools must be *embedded* into processes and practice, or they will not be used.

2. Take full advantage of risk stratification tools. In many diagnostic modalities, rapid growth in demand coupled with an activity backlog means that individuals with urgent need are not receiving a timely diagnostic test. Risk stratification tools allow services to direct capacity to those in most need of

[66] We heard accounts of new scanners sitting idle for months because there were not the staff to operate them.

[67] Müskens, J. L., Kool, R. B., van Dulmen, S. A., & Westert, G. P. (2022). Overuse of diagnostic testing in healthcare: a systematic review. *BMJ quality & safety*, *31*(1), 54-63.

a test. [68] Risk stratification is also vital when thinking about groups who, without intervention, will experience worse outcomes than the general population (for example, those with learning disabilities). Furthermore, these tools can reduce waste by reducing diagnostic testing when there are no clear benefits, or where the benefits are outweighed by the risks.

3. Direct a share of the resources that are made available to increase diagnostic capacity to those services that order and use diagnostic tests (such as A&E). These resources might, for example, be used to increase staffing levels (to accommodate the additional workload associated with ordering tests and processing the results). Resources might also be used to facilitate service redesign or to purchase technologies that increase service efficiency.

These three approaches will provide firmer foundations on which to build diagnostic services. If ignored, then the indirect effects of continued diagnostic growth will include increased waste and inequity.

Conclusion

Increased diagnostic testing has demonstrable benefits. But there is, equally, no shortage of evidence to demonstrate that the unintended consequences of growth offset – to a greater or lesser extent – these benefits.

Our intention has been to bring the hidden consequences of increased diagnostic testing to light. We have illustrated the mechanisms at work across a range of services.

We hope that the NHS will undertake further studies to understand and quantify the risks of pursuing rapid diagnostic

[68] Wickens, C. (2022) Why do diagnostics matter? Maximising the potential of diagnostics services. The King's Fund.

growth. Ultimately, better healthcare for the population is not achieved simply by maximising diagnostic test rates, or by minimising waits and waiting lists, or by focusing on any one intermediate outcome. In a system with limited resources, the challenge is to find a balance that will improve overall health and care.

Midlands Decision Support Network

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