Introduction to the 2nd Atlas of Variation in NHS Diagnostic Services in England

In September 2012 a visioning event brought together leaders in diagnostic services from across the NHS to explore what diagnostic services could look like in 2020 and beyond, and how the health system needs to plan and transform to meet the emergent vision.[1] Three principles were identified:

- improving availability and access to information, including access for patients to their own medical records
- acceleration of widespread innovation and adoption which may need 'technology adoption specialists' to support spread
- redesign of pathways to support patients to manage their conditions and improve access to services**: t**est new pathways across systems so patients can access diagnostic services in the most appropriate settings for the complexity of their needs from a flexible workforce working across seven days of provision

The first NHS Atlas of Variation in Diagnostic Services[2], published in November 2013 was a landmark in bringing together information on geographical variation in diagnostic testing in the disciplines of imaging, endoscopy, physiological diagnostics, pathology and genetics across England. The Atlas showed marked geographical variation in levels of service provision and access.

Since this publication, the demand for diagnostic testing services has continued to rise as a result of:

- increased need for diagnosis due to increased life-expectancy as most diseases increase in incidence and prevalence with age
- people living longer with long-term diseases that require regular monitoring
- an increase in evidence-based guidelines for example the NICE Suspected cancer: recognition and referral guidelines (2015)[3] which in addition to describing the indications for GPs to refer to specialists, recommend for some specific suspected cancer-related symptoms that GPs should consider referral directly to diagnostic testing (to be performed within two weeks), which depending on the symptoms/suspected cancer site could be for X-ray, ultrasound, CT-scan, MRI scan or upper gastrointestinal endoscopy
- new evidence for the effectiveness of early interventions which can improve outcomes
- advances in diagnostic technologies and techniques and adoption and dissemination of new diagnostic services
- recognition, following the 2013 diagnostic services Atlas, that there were shortfalls in provision and/or quality of diagnostic services and responsive increases in provision, quality or change in mode of delivery

In this 2nd Atlas of Variation in NHS Diagnostic Services in England we have updated the indicators in the imaging, endoscopy and physiological diagnostics sections, and added a new section for screening indicators. It was unfortunately not possible, on this occasion, to update the indicators for pathology and genetics services as the data could not be accessed. The indicators in this Atlas are presented to show geographical variation in diagnostic services as before, but the presentation of the maps has changed to show whether the local values are statistically significantly different from the England value. The accompanying column chart shows the range of local values compared with the England value as a whole, together with the statistical significance of each local value.

Static (single-period) thematic maps and column charts are interesting but we recognise that it is important to know whether there is improvement, or deterioration in diagnostic services provision and quality.

[1] Department of Health - Diagnostic Services in 2020 and beyond: Visioning for the future v1.9 (December 2012).
[2] The NHS Atlas of Variation in Diagnostic Services (November 2013). www.fingertips.phe.gov.uk/profile/atlas-of-variation
[3] NICE. Suspected cancer: recognition and referral NICE guideline [NG12] (June 2015) www.nice.org.uk/guidance/ng12

Therefore we have introduced a new form of presentation for this Atlas series: time series box and whisker plots which demonstrate not only whether the level is improving, but also whether the degree of variation between local areas is narrowing. Both are tested statistically. Of course a simple narrowing of variation, even if statistically significant, may not be desirable if, for example, the best worsen, even if the worst get better. It is important to look at the shape of the distribution, in other words the variation around the median, and this too is important for the interpretation. In the time series of box and whisker plots, the change in shape of the distribution of variation can clearly be seen over time, for example in time to brain imaging for stroke patients (Map 4a).

This Atlas is part of a series of NHS Atlases of Variation in Healthcare – the first being published in 2010 as a compendium of indicators and updated in September 2015. There is also a number of specialist atlases of variation in NHS healthcare services for example the NHS Atlas of Variation in Liver Disease[4] which also contains data on diagnostic services.

Why are we interested in geographical variation in diagnostic services?

In the National Health Service, we are interested to know whether people in different parts of the country have equal access to the same quality of evidence-based NHS services according to their need. We are also interested in the value which NHS services provide so it is important to identify ineffective practice as well, as this can lead to wasted resources and potential patient harm. Ideally we would like to know whether the level of provision of diagnostic services is appropriate and other aspects of the quality of the services. Examples of level of provision and quality indicators are included in this Atlas. For example, maps 4a through to 6b show geographical variation in the quality of a diagnostic service; time taken to imaging (CT scan) for patients admitted with signs and symptoms of stroke compared with the recommended standard which should be one hour from arrival at hospital. Indeed, the time series accompanying maps 4a through to 6b show marked improvements. Others, for example maps 7 and 8, are indicative showing average time to imaging following admission to hospital with acute trauma to the head or pelvis.

The majority of the indicators in this Atlas are shown at Clinical Commissioning Group (CCG) level. Geographical variation by CCG is important because it is the CCGs who commission health services for their local populations and it is easier to compare the indicators from an equity point of view. It is also important because it reinforces the importance of considering the provision of diagnostic services from a population perspective rather than on the basis simply of their clinical indications. Some of the indicators are shown at provider Trust level and also at upper-tier local authority level.

Is there a 'right' rate of diagnostic testing?

The assessment of variation in the rates of diagnostic testing is more complicated than the assessment of variation in the rates for a treatment intervention. There are several reasons for this:

- there is often not a clear evidence base
- many diagnostic tests or interventions have a range of disease/condition indications for their use. When there are multiple uses of a test, there may be a clear evidence base for one particular indication for which a level of service could be estimated but there is no evidence base for the total use
- where diagnostic tests are used for conditions which vary in their incidence or prevalence with the demography of the population this needs to be taken into account when determining the appropriate level of testing
- benchmarking can be used against a specific standard, the England value, against the highest in England or against European comparisons, as are given for CT and MRI scanning in the text accompanying maps 1 and 2. However, differences in population demographics make this complex as does the availability of other alternative diagnostic tests for the same conditions

[4] The NHS Atlas of Variation in Liver Disease (March 2013), www.fingertips.phe.gov.uk/profile/atlas-of-variation

- several diagnostic tests for example CT scanning or lower GI endoscopy have a range of indications for use not just in diagnosis but also for follow-up monitoring or, in the case of lower GI endoscopy also in population screening for colorectal cancer and surveillance of patients with genetic risk of colorectal cancer
- the introduction of a new method of testing for a specific condition, particularly if the new method is more sensitive, may require a reappraisal of the optimal level of testing

In contrast, to the generality of diagnostic testing there is a particularly strong evidence base underpinning the use of screening tests including evidence on effectiveness, need and level of service provision, risks and costs as well as quality standards[5]. For the screening tests shown in maps 30-38 the aim is to achieve high levels of uptake or adherence with quality standards.

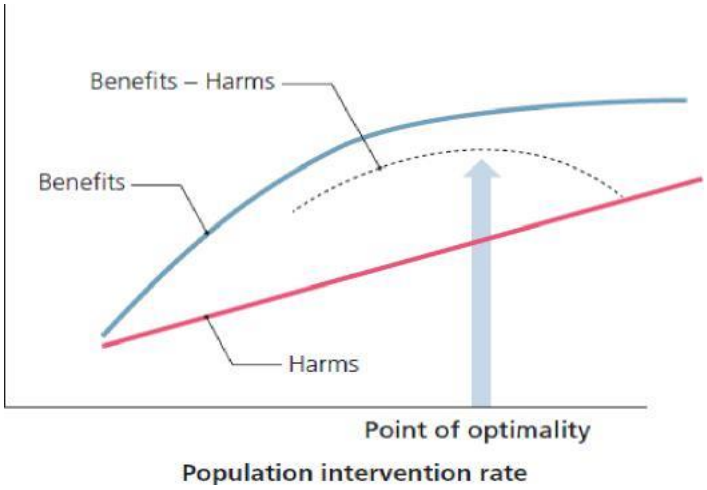
As with everything, it is not always the case that more is better. This is because as in most medical practice, interventions, in this case diagnostic testing, carry risks of harm as well as benefit. For example, there has been concern about the private health sector offering asymptomatic people whole body CT scanning with the rationale to find cancer or other serious problems early. The Committee on Medical Radiation in the Environment (COMARE) highlighted the potential dangers of causing cancer through exposure to radiation and the over diagnosis of conditions which may cause no harm to the patient's health and made strong recommendations against this practice.[6,7]

Avedis Donabedian was the first to highlight the challenges in establishing optimal levels for intervention and demonstrated how at certain levels the benefits of yet more intervention or diagnostic testing plateau and risks increase (Figure 1). This impinges on the value attached to the intervention. As resources are increased, the value derived from them increases quickly at first, but then the rate of increase slows down (known as the Law of Diminishing Returns). This is because when a new test is introduced to diagnose a problem which previously could not readily be detected there is a large pool of undiagnosed cases. As time goes on the undetected pool reduces in prevalence until only the incident (new) cases are being detected. In other words the benefits plateau. Overuse of tests will not only lead to little additional detection of disease for which treatment is indicated but may be associated with overdiagnosis, increased risk of complications, increased cost, and reduced value. Unlike the curve for benefit which initially rises rapidly and then plateaus, harm is directly proportional to the resources invested. For each unit increase of resources invested[8] each increment of benefit, after the initial impact, decreases whereas each increment of harm remains constant. When the increase in both benefit and harm is plotted on the same graph it reveals the point of optimality at which there is maximum benefit compared with harm.

This phenomenon is elegantly demonstrated with the introduction of new screening tests for cancer and underpins the rationale for why cancer screening tests are not performed every year[9]. As with all health service interventions, diagnostic tests may carry a risk of harm as well as benefit and these will need to be weighed up at an individual level by clinicians and at a population level too. Examples of diagnostic tests where harm has been quantified include mammography[10], X-rays[11] and CT scanning[6,7] where the risk is from radiation exposure, and colonoscopy, where the risk is of perforation[12]. All screening programmes are introduced after an evidence-based assessment of the relationship between benefit and harm.[9]

[5] National Screening Committee www.gov.uk/government/groups/uk-national-screening-committee-uk-nsc
[6] Committee on Medical Aspects of Radiation in the Environment (COMARE). Sixteenth Report. Patient radiation dose issues resulting from the use of CT in the UK. Public Health England: 2014. www.gov.uk/government/uploads/system/uploads/attachment_data/file/343836/COMARE_16th_Report.pdf
[7] Committee on Medical Aspects of Radiation in the Environment (COMARE). Twelfth Report. The impact of personally initiated X-ray computed tomography scanning for the health assessment of asymptomatic individuals. Health Protection Agency: 2007. www.gov.uk/government/uploads/system/uploads/attachment_data/file/304607/COMARE12thReport.pdf
[8] Donabedian A. An Introduction to Quality Assurance In Healthcare. Oxford University Press. 2002.
[9] Current UK NSC recommendations: http://legacy.screening.nhs.uk/screening-recommendations.php
[10] Løberg et al. Benefits and harms of mammography screening. Breast Cancer Research (2015).
[11] Linet MS, Slovis TL, Miller DL et al. Cancer Risks Associated With External Radiation From Diagnostic Imaging Procedures. A Cancer Journal for Clinicians 2012;62:75–100.
[12] Gavin D, Valori R, Anderson JT, et al. The National Colonoscopy Audit: a nationwide assessment of the quality and safety of colonoscopy in the UK. Gut 2013;62:242–9.

Figure 1: Donabedian's point of optimality, the point of maximum benefit compared to harm of an intervention for a population



The overuse of testing or increased sensitivity of tests can also lead to the detection of conditions of uncertain or little pathological significance. This causes anxiety for the patients, an increase in the number of people who become patients and may lead to unnecessary medical intervention. There has been much interest particularly in the US[13], in the overuse of diagnostic testing. Overdiagnosis was first described in the literature on cancer, and was defined as:

> *"a condition is diagnosed that would otherwise not go on to cause symptoms or death".*[14]

There are several reasons for overdiagnosis, leading to, and in the likelihood of 'overtreatment', including:

- the provision of a screening service in the absence of strong evidence of a favourable balance of benefit to harm
- the introduction of new tests and technologies with an increased sensitivity to identify lesions and other functional abnormalities that will not develop into harmful disease within the patient's lifespan
- the practice of ordering a battery of tests 'just in case', sometimes referred to as 'defensive medicine'

In addition to radiation exposure, over diagnosis was identified as one of the problems of whole body CT scanning in asymptomatic patients by COMARE[7]. This is also an issue arising from high rates of Prostate Specific Antigen (PSA) testing for prostate cancer[15] which leads to increased rates of detection of early prostate cancer for which the optimal treatment, if any, is uncertain and this is the reason why 'watchful waiting' is one of the options for management. An example of the challenges associated with changing the sensitivity of testing associated with the introduction of new diagnostic technology is provided by a study of time trends in pulmonary embolism. It was found that, since the introduction of Computed Tomography Pulmonary Angiography (CTPA), a highly sensitive imaging technology which had been assumed would improve outcomes for people with this disease, there have been changes consistent with overdiagnosis and overtreatment of pulmonary embolism[16]. The introduction of digital mammography as part of the NHS Breast Cancer Screening Programme is another example of the challenges associated with introducing a new diagnostic test with increased sensitivity. This led not only to better detection of early breast cancer but also greater numbers of women with ductal carcinoma in situ (DCIS), a common type of non-invasive breast cancer. It is not clear what the best management should be for women with low or intermediate DCIS and so it is recommended that these women be entered into clinical trials[17].

Despite the challenges in establishing the optimal level of diagnostic testing at a population level, it is clear from the extent of variation that the reasons for the variation need to be elucidated.

Warranted variation in diagnostic services

It is important to emphasise that some degree of geographical variation is warranted because different populations have different levels of need. The level of need is largely driven by population demographics, need is often higher in older populations and those which are more socioeconomically deprived and is also dependent on current and historical lifestyle choices. The maps in figures 3, 4 and 5,

[13] Welch HG, Schwartz LM, Woloshin S. Overdiagnosed: Making People Sick in the Pursuit of Health. 2011: Beacon Press
[14] Elmore JG, Fletcher SW. Overdiagnosis in Breast Cancer Screening: Time to Tackle an Underappreciated Harm. Ann Intern Med 2012; 156; 536.
[15] Draisma G , Boer R , Otto SJ , et al . Lead times and overdetection due to prostate-specifi c antigen screening: estimates from the European Randomized Study of Screening for Prostate Cancer . J Natl Cancer Inst . 2003 ; 95 (12):868 – 878.
[16] Wiener RS, Schwartz LM, Woloshin S. Time Trends in Pulmonary Embolism in the United States: Evidence of Overdiagnosis. Arch Intern Med 2011; 171; 831-837.
[17] www.cancerresearchuk.org/about-cancer/type/breast-cancer/about/types/dcis-ductal-carcinoma-in-situ

which can be found at the end of this section, show how age and socioeconomic deprivation and ethnicity vary geographically.

These demographic factors not only affect need for diagnostic testing but importantly access to testing. Older people, those from areas of higher socioeconomic deprivation and from Black and Minority Ethnic (BME) groups often have poorer access to NHS services.

If diagnostic services accurately reflected need, then a simple map of level of provision would show variation and this, if it mirrored the map for need, would be classified as warranted variation. In an attempt to identify residual variation which is not simply reflecting need but indicates unwarranted variation due to, for example, under- or over- provision, some of the maps in this Atlas have been standardised for age, gender, socioeconomic deprivation and a composite measure of 'need' to attempt to create a more level playing field for comparison (this can be ascertained from the map's title). Standardisation has been undertaken where the prime condition being tested for increases with age and socioeconomic deprivation.

Unwarranted variation in diagnostic services – does it matter?

In this Atlas we are especially interested in unwarranted variation in NHS diagnostic services. John Wennberg, the pioneer of research into clinical variation and founder of the "Dartmouth Atlas of Health Care", concluded that in the US:

> *".. much of the variation .. is accounted for by the willingness and ability of doctors to offer treatment rather than differences in illness or patient preference."*[18]

Wennberg differentiates between warranted variation and unwarranted variation. He defines unwarranted variation in healthcare as variation that cannot be explained on the basis of illness, medical evidence, or patient preference.[19]

In the 2011 King's Fund report "Variations in Health Care – the Good, the Bad and the Inexplicable"[20], the authors concluded that:

> *"the existence of persistent unwarranted variations in health care directly impacts on equity of access to services, the health outcomes of populations and efficient use of resources".*

The impact of underuse of diagnostic tests

Underuse of diagnostic tests may result from under provision, failure of clinicians to refer patients appropriately or problems in patient access. Diagnostic tests are used to help confirm or refute the diagnosis of a condition in patients presenting to their doctors with signs or symptoms. They are also used in asymptomatic patients either as screening tests or for surveillance to monitor for progression of disease. Underuse of diagnostic services can prevent the early recognition and diagnosis of disease or the identification of changes in its severity. In the worst case for a patient this can lead to late-stage diagnosis and premature death; even in the best case it can lead to a longer and more costly stay in hospital or frequent visits to a general practitioner. In a study of patients presenting with acute abdominal symptoms, surgical outcomes were improved by earlier access to and increased use of CT scanning.[21]

As described above, sometimes there are patient factors which act as obstacles to accessing services, these may include: language barriers, poor health literacy, economic factors or travelling times. These differences in access are unwarranted as they may result in inequalities in health outcomes, despite provision of diagnostic testing being adequate. These patient factors which are barriers to access may be masked by the standardisation used to adjust for variation in need, as both need, and patient-related access issues, can both depend on the same demographic characteristics.

Some of the maps in this Atlas clearly illustrate that there are significant geographical access issues especially where services are delivered by specialist centres. Maps 1, 10, 12, 13, 14, 15, 22, 23, 25 and 26 show evidence of problems with access to specialist diagnostic services.

[18] Wennberg J. Tracking Medicine: A Researcher's Quest to Understand Health Care. Oxford University Press. 2010
[19] Right Care. NHS Atlas of Variation in Healthcare, November 2010. www.rightcare.nhs.uk/atlas/
[20] Appleby J, Raleigh V. Variations in Health Care – the Good, the Bad and the Inexplicable. The King's Fund. 2011. www.kingsfund.org.uk/publications/healthcare_variation.html
[21] Symons NR, Moorthy K, Almoudaris AM et al. Mortality in high-risk emergency general surgical admissions. British Journal of Surgery 2013; 100; 1318-1325. doi: 10.1002/bjs.9208. Epub 2013 Jul 17. www.ncbi.nlm.nih.gov/pubmed/23864490

The impact of overuse or inappropriate use of diagnostic tests

As described above, it is important to also bear in mind that sometimes variation may also represent over- or inappropriate provision of a diagnostic test or increased sensitivity of a diagnostic process.

Map 18 is the most notable example of inappropriate use in this Atlas, showing those CCGs where barium enema is still being used for the diagnosis of lower gastrointestinal problems even though this should be replaced by lower gastrointestinal endoscopy. Interestingly, Figure 2 shows that there is almost no association between the rate of lower GI endoscopy (colonoscopy plus flexible sigmoidoscopy) and the rate of barium enema.

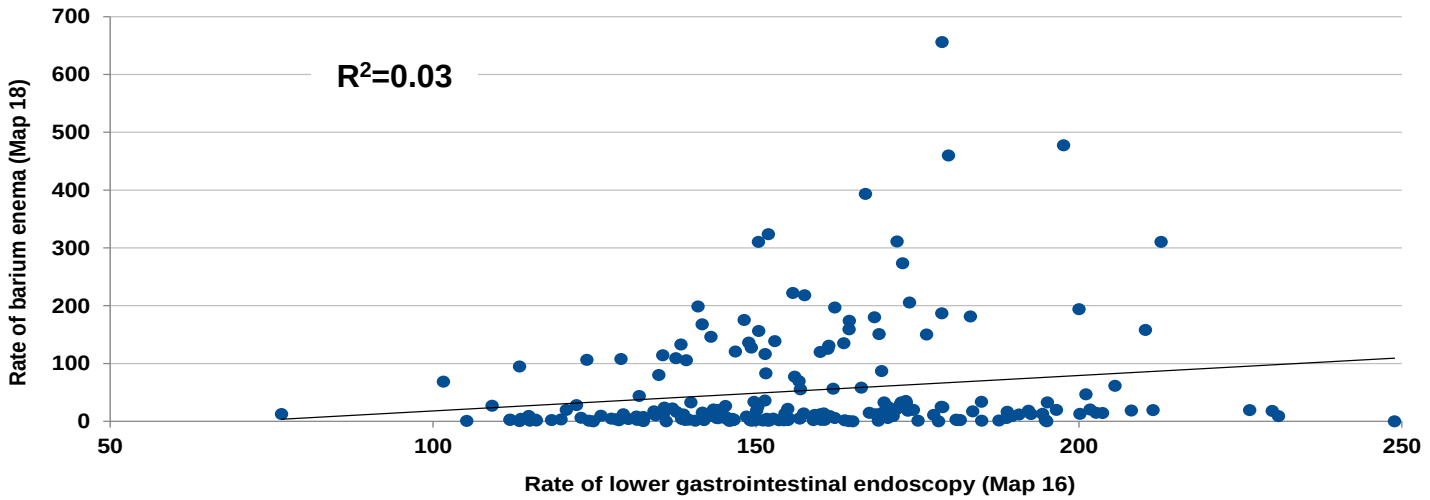
Over- or inappropriate use always wastes resources and sometimes causes harm.

While there are systems of checks and controls in the NHS, including evidence-based referral guidelines to limit the inappropriate use of testing, the NHS often has to deal with the consequences of over-testing in the private sector in the follow-up and reassurance of the people who have been screened in the private sector.

Despite the continuing policy drive to reduce unwarranted variation, there is evidence it persists as a result of the combination of many factors, thereby preventing the NHS from achieving the full potential of improved outcomes and increased value. This is unacceptable, as highlighted in five major recent publications, all of which underline the need to reduce unwarranted variation:

- "NHS Five Year Forward View"[22]
- "Delivering the Forward View: NHS planning guidance 2016/17-2020/2021"[23]
- "From evidence into action: opportunities to protect and improve the nation's health"[24]
- "Protecting resources, promoting value: a doctor's guide to cutting waste in clinical practice"[25]
- Lord Carter of Coles' independent review "Operational productivity and performance in English NHS acute hospitals: Unwarranted variations"[26]
- "Leading Change, Adding Value. A framework for nursing, midwifery and care staff"[27]

Figure 2: Scatterplot of the 2014/15 rate of colonoscopy procedures and flexible sigmoidoscopy procedures per 10,000 population (Map 16) vs the 2015/16 rate of barium enema procedures per 100,000 weighted population (Map 18) by CCG



[22] NHS England, Care Quality Commission, Health Education England, Monitor, Public Health England, Trust Development Agency. Five Year Forward View. October 2014. www.england.nhs.uk/wp-content/uploads/2014/10/5yfv-web.pdf
[23] NHS England, NHS Improvement, Care Quality Commission, Health Education England, NICE, Public Health England. Delivering the Forward View: NHS planning guidance 2016/17-2020/21. 22 December 2015. www.england.nhs.uk/wp-content/uploads/2015/12/planning-guid-16-17-20-21.pdf
[24] Public Health England. From evidence into action: opportunities to protect and improve the nation's health. October 2014. www.gov.uk/government/uploads/system/uploads/attachment_data/file/366852/PHE_Priorities.pdf
[25] Academy of Medical Royal Colleges. Protecting resources, promoting value: a doctor's guide to cutting waste in clinical practice. November 2014. www.aomrc.org.uk/wp-content/uploads/2016/05/Protecting_Resources_Promoting_Value_1114.pdf
[26] Lord Carter of Coles. Operational productivity and performance in English NHS acute hospitals: Unwarranted variations. An independent report for the Department of Health by Lord Carter of Coles. February 2016. www.gov.uk/government/uploads/system/uploads/attachment_data/file/499229/Operational_productivity_A.pdf
[27] NHS England. Leading Change, Adding Value. A framework for nursing, midwifery and care staff. May 2016. https://www.england.nhs.uk/wp-content/uploads/2016/05/nursing-framework.pdf

Does unwarranted variation in diagnostic testing matter to patients?

People in the local population, especially those who are patients or their carers, need to be assured that service providers are addressing their needs. Therefore, they are likely to be concerned about the existence of unwarranted variation and its consequences. If people experience a several-fold difference in their chance of being diagnosed promptly, of receiving the right care to control symptoms or prevent deterioration, of being admitted to hospital as an emergency or of dying prematurely, and if this variation is largely dependent on where they live or on which general practice they are registered with, they have a right to ask why and to demand better.

The key to meeting these challenges is:

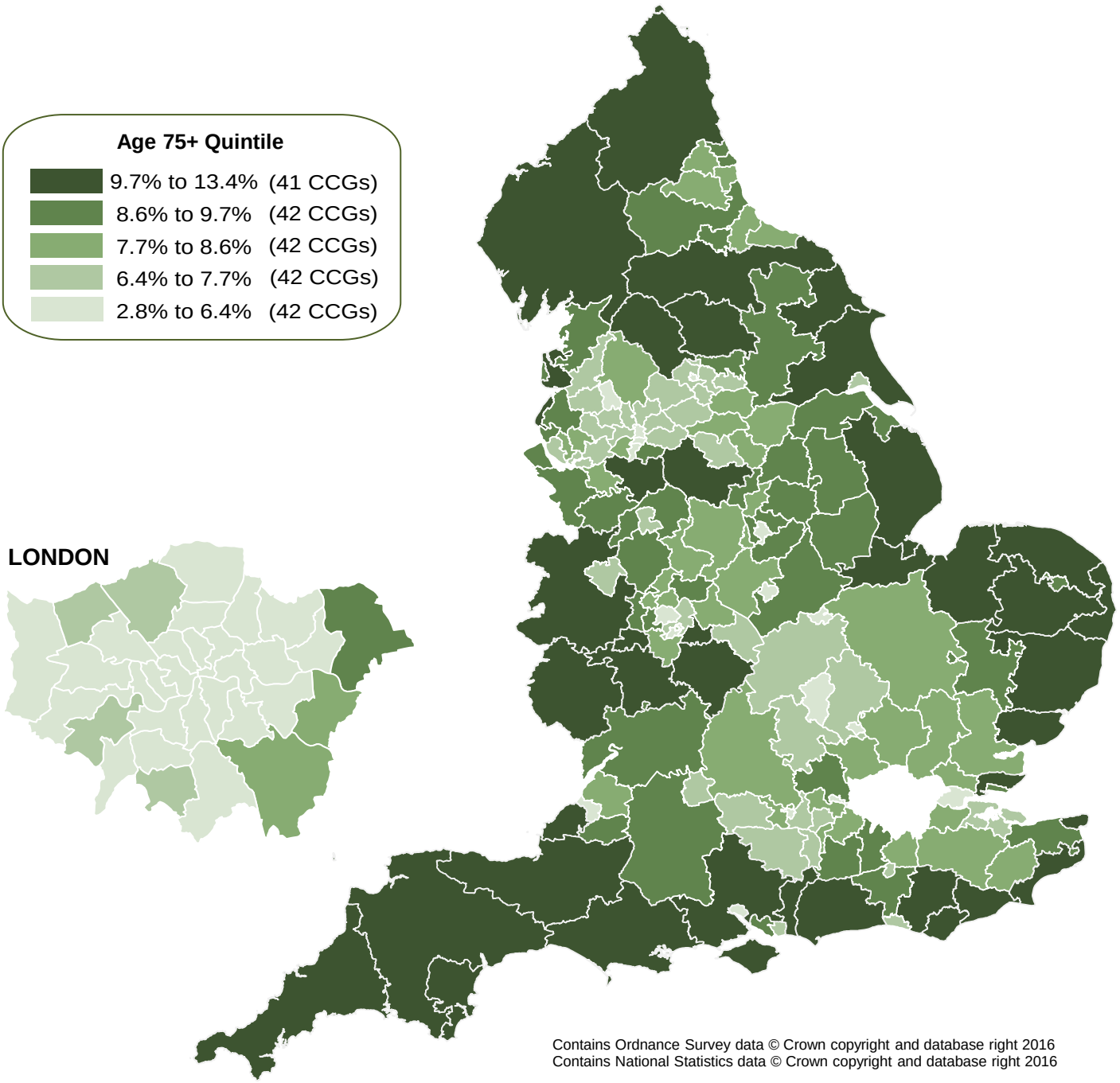
- understanding the concept of variation and its causes
- identifying variation, and ascertaining whether it is warranted or unwarranted and if unwarranted, what the causes are
- reducing unwarranted variation in quality, safety and outcome, and in activity and cost
- in reducing unwarranted variation, the aim is to maximise the value – the relationship between overall outcomes and all costs, including opportunity costs – of healthcare resources both for individual patients and for populations

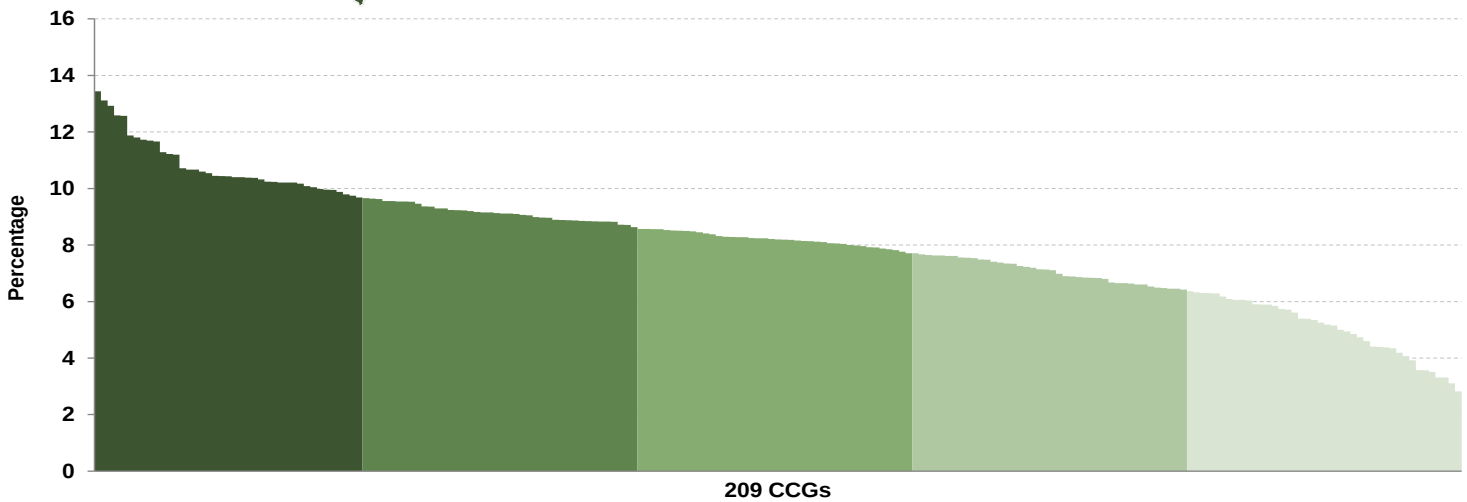
As it is expected that the demand for diagnostic tests will continue to increase, the resources needed to fund such developments will have to be shifted from lower value activities. To facilitate this resource shift it is essential that diagnostic services are viewed as population based services. This is already true of screening programmes.

Planning for the future

The visioning event for leaders in diagnostic services in NHS held in September 2012 created the vision for 2020 and beyond.[1] Overall, the vision for diagnostic services for 2020 was that of an innovative, technologically enabled, integrated service providing the highest quality, convenience and timeliness for patients from a range of locations, in order to accelerate accurate diagnosis, appropriate treatment intervention, and recovery. This Atlas shows, not only the current level of statistically significant variation in quality or provision, but importantly also trend data. The trend data also uses statistical significance testing to assess trend in the England overall value and the spread of variation. Policy makers and local decision makers can use this Atlas to assess progress towards the 2020 and beyond vision. In 2016, we are half way through this anticipated period of change, and while this Atlas shows improvements since 2013, there are still wide variations in levels of service provision and quality which need to be addressed. Commissioners perhaps less frequently monitor the costs of diagnostic services compared with treatment costs, but this will need to change if they are to make business cases to change service provision. The future of diagnostic services is one where the service user will be at the heart of service design, delivery and evaluation.

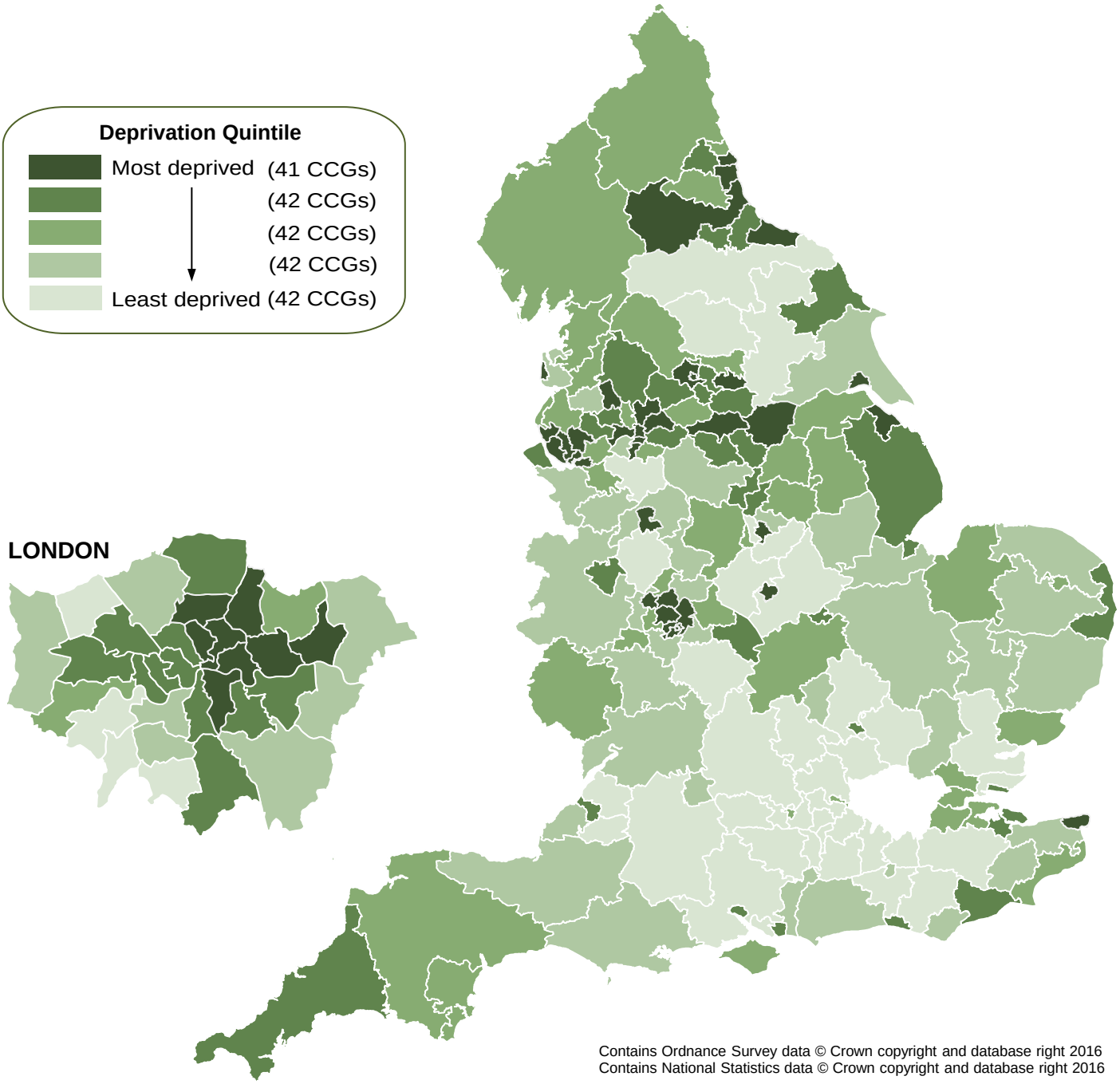
Figure 3: Percentage of the population aged 75 years and over CCG quintiles[28]

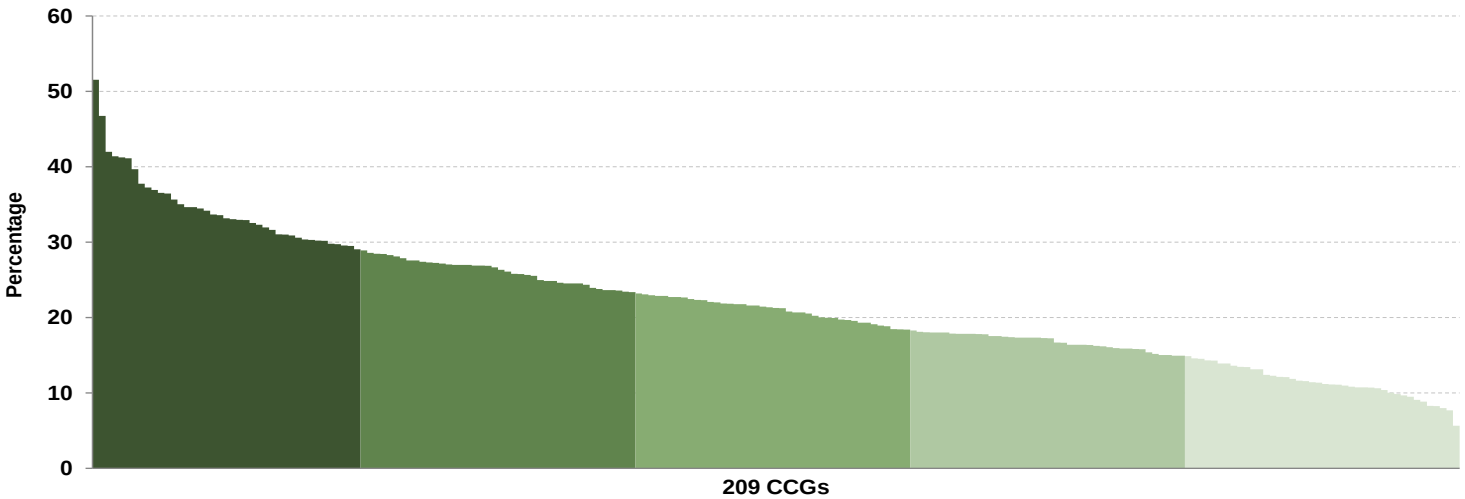




[28] Office for National Statistics 2014 mid-year population estimates (2011 Census based)

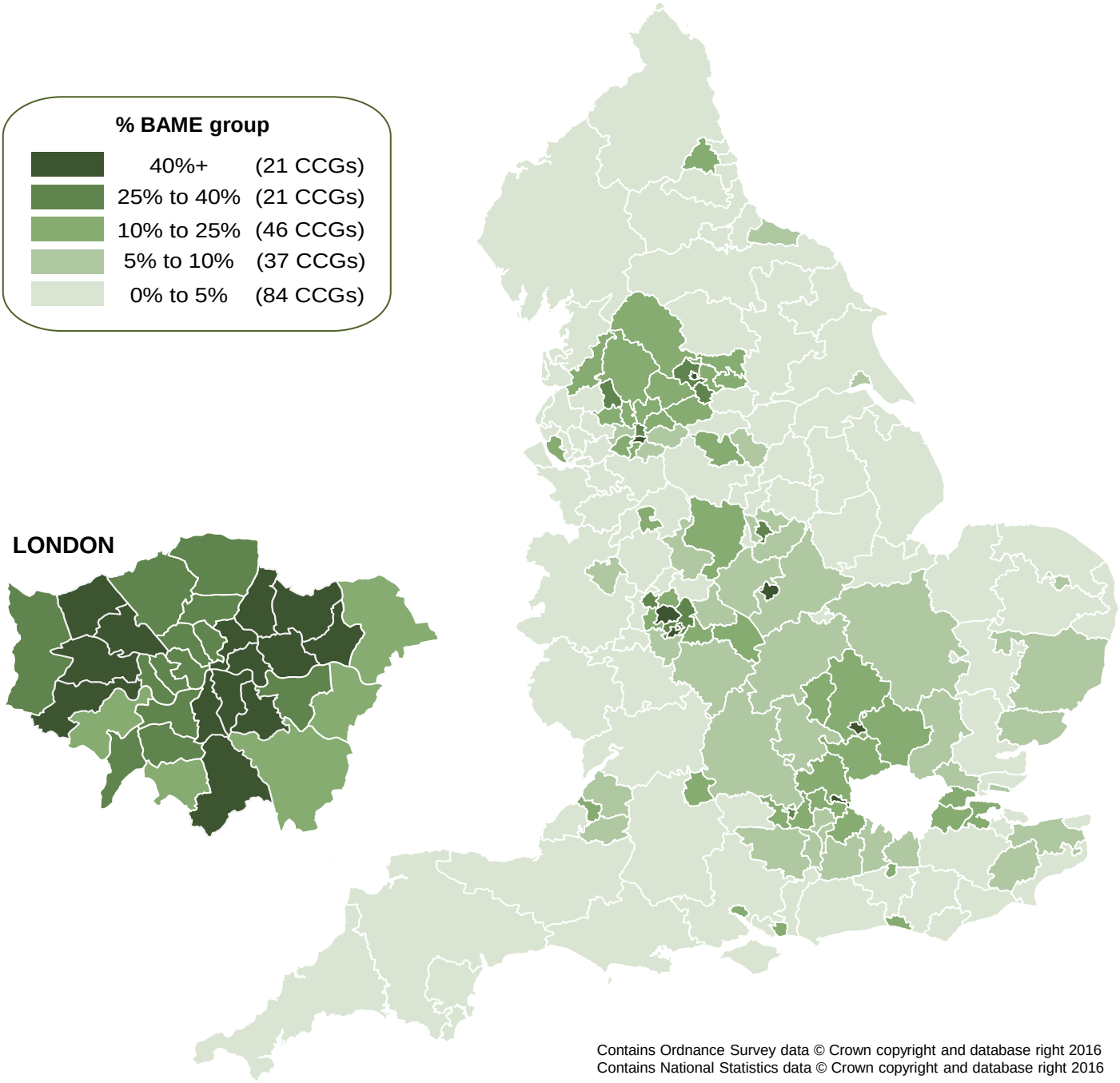
Figure 4: Index of Multiple Deprivation 2015 average LSOA score CCG quintiles[29]

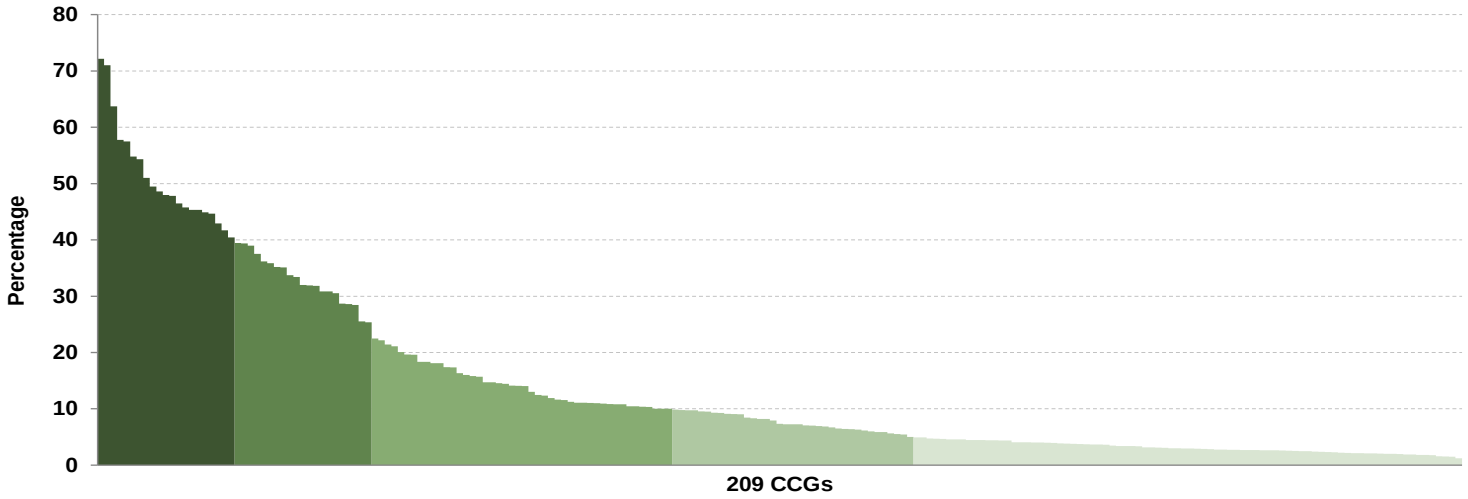




[29] Department for Communities and Local Government, Indices of Deprivation 2015

Figure 5: Percentage of the population with Black, Asian and Minority Ethnic group by CCG[30]





[30] The Office for National Statistics, 2011 Census, table KS201EW

Introduction to the data

Selection of indicators

In devising the 2nd Atlas of Variation in NHS Diagnostic Services we have worked closely with the National Clinical Director (NCD) for Diagnostics and Imaging and the Chief Scientific Officer (CSO) to present indicators within three of the five specialties of diagnostic services:

- imaging
- endoscopy
- physiological diagnostics

We have also worked with other NCDs and clinical leads that have responsibility for certain groups of patients undergoing some of the diagnostic tests, for example, the lead for screening, and NCDs for trauma, musculoskeletal services, respiratory services and heart disease.

Indicators have been calculated using a variety of population denominators including resident and registered CCG populations, and upper-tier local authority populations. For Maps 4a to 6b the data is presented by both the CCG of patient residence and by hospital site of treatment.

Order of appearance

Indicators are grouped under headings of three of the specialties of diagnostic services (see above) plus screening.

Data sources

Data for most of the indicators in the 2nd Atlas of Variation in NHS Diagnostic Services have been provided by the Department of Health (DH), The Office for National Statistics (ONS), Royal College of Physicians, Public Health England (PHE), the Trauma Audit and Research Network (TARN), NHS Digital, NHS England (NHSE) and NHS Improving Quality (NHSIQ) from a variety of sources including:

- Hospital episode statistics (HES)
- ONS mid-year population estimates
- TARN database, University of Manchester
- Sentinel Stroke National Audit Programme (SSNAP), Royal College of Physicians
- NHSE Monthly Diagnostics Waiting times and Activity return (DM01)
- NHSE diagnostic imaging dataset (DID)
- NHS Digital quality and outcomes framework (QOF)
- NHS abdominal aortic aneurysm (AAA) screening programme
- NHS bowel cancer screening programme
- NHS breast cancer screening programme
- NHS cervical cancer screening programme
- NHS newborn blood spot screening programme
- NHS newborn hearing screening programme
- NHS sickle cell and thalassaemia screening programme

A metadata document with methodology, data extraction coding schemes and data sources for each indicator is available at: www.fingertips.phe.gov.uk/profile/atlas-of-variation

The data analysis, column charts and boxplots were produced using Microsoft Excel 2010. The maps were created using MapInfo Professional version 12.5.

Innovations in statistical methods and presentation in this Atlas

In this Atlas two innovations in analysis and presentation have been introduced:

- the presentation of the maps and column charts has changed: shading is now based on statistical significance (difference from the England value)
- the introduction of time series analyses in the form of repeated box and whisker plots, revealing trends in the level and spread of local area indicator values across England

In the map and column charts, the England value is used as the statistical benchmark against which organisations are compared. It is important to note that this does not imply that the England rate is the optimal or aspirational level for that indicator, as this value is often not established, but gives a sense of the performance of organisations compared with the national value.

Maps and column charts

For each indicator, data is presented visually in the form of a thematic map and a column chart, which show the most recent data. London is shown as an enlarged page inset on all maps to keep detail that might otherwise be lost.

The range of local area indicator values and the England value are presented in the column chart accompanying each map. The same statistical methodology is used to determine the shading in the map and column chart. This is based on statistical significance of difference from the England value.

It is important to note that due to the change in statistical presentation, maps and column charts from the first iteration of the Diagnostics Atlas cannot be compared with those presented in this Atlas.

Box and whisker plots

For each indicator, data is presented visually in a time series of box and whisker plots that shows the median and spread of local area values across England at consecutive timepoints. Importantly, the tables accompanying the box and whisker plots show whether there has been any statistically significant change in the median, or in the degree of variation over time. It should be noted that the England value is not represented in the box and whisker plots.

Interpretation of the maps

For each indicator, the data presented in the map is that for the most recent time period shown in the corresponding box and whisker plot time series (excepting Map 18). For each indicator, individual CCGs (or other geographies) are allocated to one of five groups (see Table 1) based on how statistically significantly different their value is from the England value (the horizontal dark blue line across the column charts). The column charts and maps are identically colour classified into thematic displays according to that significance banding. Where data is unavailable for an area/organisation, the corresponding map area/symbol is shaded grey. All data values including the significance banding can be downloaded at www.fingertips.phe.gov.uk/profile/atlas-of-variation

The intensity of shading of each area indicates the degree of statistical significance of each indicator value in terms of its difference from the England value. The key to the map shows the significance level for each of the five shades compared with the England value for that indicator. The two darkest shaded bars indicate that an indicator value is significantly higher than the England value at the 99.8% and 95% significance levels. The two lightest shades indicate that an indicator value is significantly lower than the England value at the 99.8% and 95% significance levels. Mid-shaded areas are those with an indicator value that is not significantly different to the England value.

Table 1 shows the degree of statistical significance associated with each of the five shades used in the maps and column charts.

Table 1: Five shade significance bands used in the maps and column charts

Shade	Significance band
	Significantly higher than England at the 99.8% level
	Significantly higher than England at the 95% level
	Not significantly different from England
	Significantly lower than England at the 95% level
	Significantly lower than England at the 99.8% level

Interpretation of the column charts

For each indicator, the data presented in the column charts is that for the most recent time period shown in the corresponding box and whisker plot time series (excepting maps 1, 2,3 and 18 where annualised rates are presented). The column chart visualisations give the reader two sets of information about the data:

- the height of each bar in the chart shows the indicator value for each geography (such as a clinical commissioning group (CCG) or local authority (LA)) – the columns are ordered from the highest value on the left to the lowest value on the right.

- the shading of each column indicates the degree of statistical significance of each indicator value in terms of its difference from the England value (the blue horizontal line across the chart). The colour shading used in the column charts is the same as that used in the corresponding map. The two darkest shades indicate that an indicator value is significantly higher than the England value at the 99.8% or 95% significance level and are towards the left-hand side. Bars with the two lightest shades indicate that an indicator value is significantly lower than the England value at the 99.8% or 95% level and are towards the right-hand side (see Figure 6). Mid-shade bars are those areas with an indicator value that is not significantly different from the England value

Conventional column charts might display the confidence interval for each column to enable the reader to determine whether or not the local area value is significantly higher or lower than the national value represented by a horizontal line. However, column charts in this Atlas have so many columns and utilise two sets of local area confidence intervals (95% and 99.8%) that it would be very difficult for the reader to assimilate this information. The five blue shades replace the use of displayed confidence intervals on column charts in this Atlas. Consequently the column charts in this Atlas differ from those in previous atlases in terms of methodology and interpretation.

The significance band does not indicate whether a high or low value represents good or bad performance, merely whether or not the indicator value is significantly higher or lower than the England value, and the degree of statistical confidence that the difference is not due to random variation.

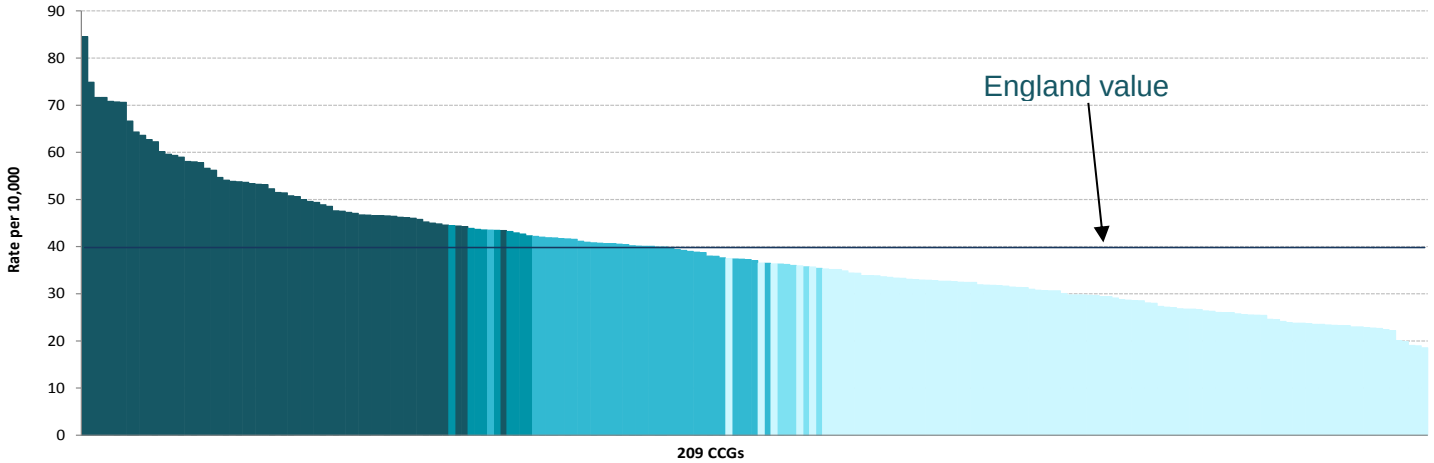
- Indicator values that are not significantly different from the England value (mid-shade) are said to display ‘random’ variation alone
- Indicator values that are higher or lower than the England value at the 95% significance level are deemed statistically significantly different. However, as so many indicator values (209 in the case of CCGs) are being simultaneously tested against the England value, the likelihood of finding indicator values that are significantly different from the England value is raised by chance alone. For this reason a more stringent 99.8% significance level is also applied
- There is much greater certainty that indicator values found to be different from the England value at the 99.8% significance level (the lightest and the darkest shades) are due to a systematic non-random variation that requires investigation. In these localities it is likely that the process or system of generating these values is markedly different from that in other CCGs.

If there is a large number of indicator values significantly different from the national value at the 99.8% level this may be due to what is known as overdispersion, characterised by many localities having indicator values at the extremities of the distribution, and fewer indicator values around the central value of the distribution.

Overdispersion typically occurs when there are factors influencing the values that have not been accounted (or adjusted) for in the method of calculating the statistic, such as demographic risk factors, casemix or localised service configuration, which is particularly relevant to specialised services. These factors may account for the larger than expected volume of areas with values greatly different from the England value. Wherever possible statistics presented in this Atlas have been adjusted for known influences, such as locality based variations in age structure, using techniques such as standardisation (see below). It is important to consider whether all known warranted factors have been adjusted for when assessing whether the observed variation is unwarranted.

Figure 6 is an example of the column charts presented in this Atlas. It shows that differently shaded columns are mixed at both ends of the chart, rather than same-shaded columns appearing in adjacent blocks. This is because being statistically significantly different from the England value depends not only on the magnitude of the indicator value, but also on statistical confidence. This may be influenced by the size of the population for which the indicator value is shown, as smaller populations tend to have wider confidence intervals.

Figure 6: Example column chart showing statistical difference from the England value



Interpretation of the box and whisker plots

For the first time in the NHS Atlas series, time series data is presented in the form of box and whisker plots (referred to as boxplots in following sections). The purpose of the box and whisker plot is to give an impression of the level and spread, or distribution, of the data points. The box and whisker plots presented in this Atlas are a customised version of conventional box and whisker plot used elsewhere (see Figure 7).

The box and whisker plots use a methodology which is unrelated to the method determining the map and column chart shading. The box and whisker plots do not represent statistical significance. They represent the data value at key rank positions when the geographical areas are rank-ordered according to data value size. This graphic shows how variable the indicator is across all of the geographical areas. A single box and whisker plot is displayed for each time period so that comparisons can be made through time of the level and spread of values.

The 'box' and its 'whiskers' represent the data values of the following rank positions in the data:

- maximum (or the greatest and therefore highest ranked data point)
- 95th percentile (the data value that lies in the 95% highest rank position)
- 75th percentile (the data value that lies in the 75% highest rank position, also known as the 'upper quartile' or Q3)
- median (or middle ranked data point also known as Q2)
- 25th percentile (the data value that lies in the 25% highest rank position, also known as the 'lower quartile' or Q1)
- 5th percentile (the data value that lies in the 5% highest rank position)
- minimum (or smallest and therefore lowest ranked data point)

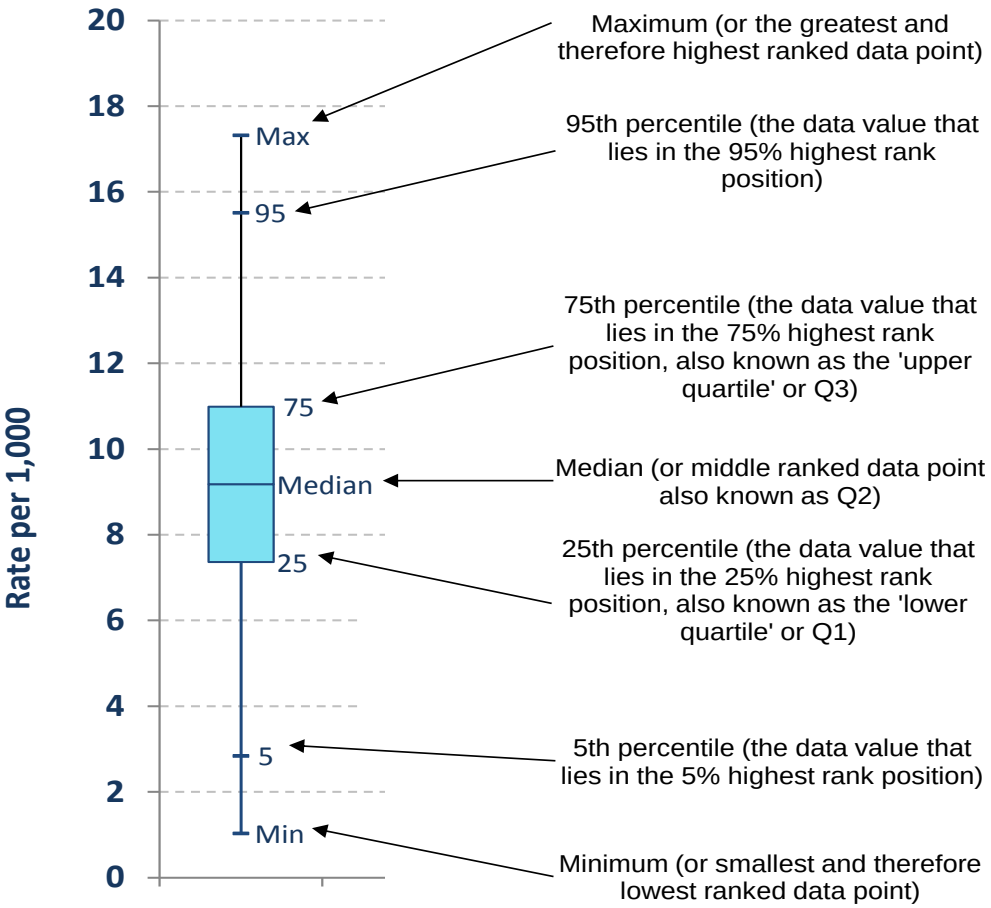
The 'box' runs from the upper quartile (Q3 or 75th percentile) to the lower quartile (Q1 or 25th percentile) and represents the middle 50% of data points. The height of the box between Q1 and Q3 is known as the interquartile range (IQR) and is calculated as Q3 minus Q1.

Inside the box is a horizontal line, which shows where the median (or Q2) lies. The median is the middle point of the dataset. Half of the data points are above the median and half of the data points are below it.

The ‘whiskers’ extend out from either end of the box and show the highest and lowest values contained within the dataset, in other words they show the entire range of values contained within the dataset.

Box and whisker plots split the data presented into four equal parts in terms of the number of data points represented. Twenty-five per cent of data points lie between the maximum and the upper quartile, 25% of data points lie between the upper quartile and the median, 25% of data points lie between the median and the lower quartile, and 25% of data points lie between the lower quartile and the minimum. An unconventional aspect of the box and whisker plots presented in this Atlas, is that the 95th percentile and the 5th percentile are also represented by tick marks on the 'whiskers'.

Figure 7: How to read the box and whisker plots



A box and whisker plot enables the user to obtain information about the shape or spread of the data points and in particular, whether or not the data points have a symmetric or skewed distribution. A dataset with a normal distribution is symmetric (non-skewed) around the mean (average), the mean and the median are equal to each other, and each half of the distribution is a mirror-image of the other half. In a distribution that is skewed there is a lack of symmetry between the upper and lower halves of the dataset. The median and the 'box' is not centrally located between the maximum and minimum.

Box plot summary statistics table

Presented below the boxplot time series is a table of statistics summarising the trend in the absolute degree of variation and the median:

- **max–min (Range)**: This is the absolute difference between the maximum value and the minimum value of the dataset, ie the full range of the data. However, extreme outliers can heavily influence this statistic and consequently mislead about the extent of variability across the majority of the dataset. It may therefore be more helpful to use the 95th to 5th percentile (see below)
- **95th–5th percentile**: This shows the range of the data between the 95th percentile and the 5th percentile of the dataset; if there are extreme outliers this statistic may give a better impression of variation across the majority of data values because the highest 5% of values and lowest 5% of values have been discounted
- **75th–25th percentile**: These percentiles are the upper and lower limits of the middle 50% of data values. This statistic indicates the dispersion or spread of the data for the middle 50% of values. The absolute difference between these percentile is also known as the interquartile range (IQR). It is related to the median (see below): if the IQR is small it indicates that the central 50% of data values are close to the median; if the IQR is large it indicates that the data is spread out from the median and there is more dispersion in the middle 50% of values in the dataset

- **median**: The median is the middle value in a dataset, identified by arranging each of the values in ascending order from the smallest value to the highest value. If there is an even number of values the median will be the average of the two central data points. It is not the mean or average

The final column of the table is a summary of whether each of these four statistics is narrowing or widening (or median increasing/decreasing) and whether the trend is statistically significant at the 95% level. The statistical significance was determined using a two-tailed t-test on the slope of a linear regression line fitted to the values in the table over time, where the null hypothesis is that the slope equals zero. The significance test is only performed for indicators with data at three or more time periods. This regression line and the detailed results of the t-test are not presented in this Atlas.

Data frequency

The data frequency, ie the length of the time period for which data is presented, directly affects the number of observations represented in the visualisations. Statistical power, ie the ability to detect true differences, tends to increase with an increasing number of observations. The following 'data frequency' selected for each Atlas indicator is intended to yield a sufficiently large enough number of observations to reveal patterns and trends that are statistically robust.

- maps 1-3†, 4a-6b, 15, 18†, 24, 25, 27-29, 34, 35, 37 and 38 present quarterly rates
- maps 7, 8, 11-14, 16, 17, 19-22, 26, 30-33 and 36 present annual rates
- maps 9, 10 and 23 present three-year pooled rates

Standardisation

Differences in the number of events, for example incidence of disease, which the diagnostic tests are being used to detect, can be strongly related to the age structure of that population. If the level of diagnostic testing reflected need, for example driven by older age, then we would expect to see geographic variation in the diagnostic testing rate that was strongly correlated with older age as shown in Figure 3 (percentage of the population aged 75 years and over).

In an attempt to identify variation that is beyond that related to different patterns of need, a technique called standardisation is used. This enables the level of testing to be compared between populations with different demographic structures producing a more level playing field.

For instance if we compare two population groups, A and B, and population A has a higher rate of deaths when compared with population B we could conclude that population A has worse mortality outcomes in comparison with population B. However, if population A has a much higher proportion of older people in it we would expect population A to have a higher mortality rate when compared with population B because mortality rates are linked to increasing age. Therefore, it would be misleading to infer that people in population A are dying at a faster rate than people in population B.

There are two main methods of calculating standardised rates:

- direct standardisation
- indirect standardisation

Directly standardised rates may adjust for the differences in age and sex distribution in a population and are usually expressed, for example, as a number of infections per 100,000 population. To calculate a directly standardised rate the observed number of cases from the study population (eg CCG) in each age-band (usually five-year age-bands) is divided by the number of the local population for that age-band and the multiplied by the standard population (in this case the European Standard Population) in the same age-band. These calculations are then summed across the relevant age-bands to obtain the weighted rate per 100,000 population. This method of direct standardisation has been used for Map 9 and Map 23.

Indirectly standardised rates may adjust for differences in age distribution, and possibly other demographic factors such as sex and deprivation, by applying the observed rates for each age-group in a standard population (in this case England) to the population of the same age-groups in the study areas (eg CCG).

† Box plots for maps 1-3 and 18 present quarterly rates, their corresponding thematic maps and column charts present the latest annual rate

Indirect standardisation using age, sex and deprivation decile has been used for the indicators in maps 16, 19, 21 and 22.

The rates derived from the NHS England Diagnostics Imaging Dataset (maps 1-3, 15, 17 to 18, 24 to 25, 27 to 29 use NHS England 'need' weighted CCG populations[1] as the denominator. These populations are weighted for age, sex and 'need' variables, and therefore adjust the rates of activity for these factors.

Confidence intervals

Confidence intervals are used to represent the level of uncertainty of an estimate value (the calculation). Statistical uncertainties usually arise because the indicators are based on a random sample or subset from the population of interest or over a defined time period, both of which may not be representative of the whole population. A smaller confidence interval indicates that the estimate is more reliable, and a larger confidence interval indicates that the estimate is less reliable. Although none of the charts in the 2nd Atlas of Variation in NHS Diagnostics Services are displayed with confidence intervals, confidence intervals were used to determine the shading in the column charts and the thematic maps. The two main methods of calculating confidence intervals in this Atlas are:

- the Wilson score method for maps[2]
- the Byar's method for maps[3]

Exception-reporting

The indicator in Map 26 is from the Quality and Outcomes Framework 2014/15[4]: COPD0045[5]. Under the QOF scheme GPs are rewarded for achieving an agreed level of population coverage for each indicator. The level of achievement recorded depends on the GP practice treating the patients with the relevant problem. However, not all patients are treatable or willing to be treated, for example, when patients do not attend for review despite repeated invitations or if a medication cannot be prescribed due to a contraindication or side effect. In order for the practices not to be penalised due to circumstances beyond their control they can exclude those patients from counting towards their achievement through exception-reporting. Exception-reporting is allowed for a range of reasons. The QOF achievement reported annually is the exception-adjusted population coverage. Map 26 shows the actual population coverage for each CCG in which excepted patients have been included in the denominator.

Use of categorical data

Four of the indicators (maps 11 to 14) are a categorical statistic ('24 hour access' or 'Not 24 hour access'). Since 2011 there has been an annual survey by NHS Improving Quality (NHSIQ) of all hospitals in England to assess the level of provision of weekend and out-of-hours interventional radiology (IR) services. For this series of indicators the 2013 data have been used, although the results of later surveys are available. The 2013 data were selected because it is possible to show not only which NHS Trusts had formal out-of-hours IR provision but also the degree of variation in service provision across England using the strategic health authority (SHA) as a level of geography. Although the SHA is no longer part of the NHS structure it is a useful proxy measure for larger populations; moreover, the larger geography is relevant to the need to develop an optimal system for out of hours IR services via a network of providers across a geographical area.

The survey was sent to all IR services in England, and there are three categories of response for each NHS Trust:

- there is core service provision with a formal rota and formal network pathways to an agreed recipient
- there are some core services available on a formal rota, and there is limited formal network provision
- there is no core service provision and no network pathway

[1] NHS England. Technical Guide to Clinical Commissioning Group and Area Team allocations 2014-15 and 2015-16. https://www.england.nhs.uk/2014/03/allocations-tech-guide/
[2] Wilson EB. Probable inference, the law of succession, and statistical inference. J AM Stat Assoc 1927; 22: 209-212.
[3] Breslow NE, Day NE. Statistical methods in cancer research, volume II: The design and analysis of cohort studies. Lyon: International Agency for Research on Cancer, World Health Organization; 1987: 69.
[4] BMA, NHS England and NHS Employers. 2014/15 General Medical Services (GNS) Contract Quality and Outcomes Framework (QOF). Guidance for GMS Contract 2014/15. March 2014. www.nhsemployers.org/~/media/Employers/Documents/Primary%20care%20contracts/QOF/2014-15/2014-15%20QOF%20guidance%20documents.pdf
[5] In "2013/14 general medical services (GMS) contract quality and outcomes framework (QOF). Guidance for GMS contract 2013/14" http://www.nhsemployers.org/Aboutus/Publications/Documents/qof-2013-14.pdf the indicator number was changed from 'COPD10' to 'COPD

Domains in the NHS Outcomes Framework

Underneath the title for each indicator the domain or domains in the NHS Outcomes Framework 2016/17[6] relevant to the indicator have been listed. The five domains are as follows:

- domain 1: Preventing people from dying prematurely
- domain 2: Enhancing quality of life for people with long-term conditions
- domain 3: Helping people to recover from episodes of ill health or following injury
- domain 4: Ensuring that people have a positive experience of care
- domain 5: Treating and caring for people in a safe environment and protecting them from avoidable harm

[6] Department of Health. The NHS Outcomes Framework 2016-17. www.gov.uk/government/publications/nhs-outcomes-framework-2016-to-2017

Tips for using the Atlas of Variation in NHS Diagnostic Services to deliver healthcare improvement and financial sustainability: the RightCare Approach

The data shown in this Atlas can be used by a range of bodies including Local CCG Commissioners, NHS England, Specialised Commissioning, Public Health England, National Policy Makers, Health Education England and the Royal Colleges to identify the need for action and to assess whether improvements have been made.

The first step is to use the maps and underpinning data to indicate if the geographical area of interest has any cause for concern eg being statistically higher/lower than the England value and whether this has been consistent over the time period presented. The data presented in this Atlas can be downloaded in the form of an Excel spreadsheet[1].

In all maps statistical comparisons are made between the local value for the diagnostic test and the England value. The column charts show the actual range of values with shading reflecting their statistical significance. From the data spreadsheet, local teams can view their own organisational values for all time periods displayed in the boxplots. Alongside this, for each indicator and all time periods, the statistical significance banding is provided (previously unpublished). Local areas will be able to compare their data with England values and identify indicators where they have shown persistence in being significantly different to the England value.

A number of maps show data which can be compared against quality standards, these are maps 4a, 4b, 5a, 5b, 6a, 6b, 7, 8, 11 to 14, 18, 20, 26, 30-38. The other maps show data on the level of diagnostic testing per head of population. For these maps the ideal level of services is not known, thus it is important to bear in mind that if a diagnostic service for a local area is statistically significantly different from the England value this warrants further investigation. Maps 2, 9,10, 23, 25 show data on services which are usually provided in specialised centres. These show evidence of potential problems of access for patients. This may be due to lack of capacity at the centre to deliver to a wider network, travelling distances for patients, lack of awareness of local clinicians or lack of clinical protocols/pathways in areas which do not have local provision or due to commissioning decisions. However, it is clear that every map in this Atlas shows problems with access.

The questions that need to be addressed in order to reduce unwarranted variation in diagnostic services and thereby facilitate a shift in resource use to higher value activities are:

- is there underuse of any tests in the local population?
- if there is underuse is this indicative of ineffective healthcare and/or inequity of access for particular subgroups of the population?
- problems with healthcare provision may include inadequate diagnostic equipment, inadequate levels of trained staff or issues related to the hours of operation of the services or access to theatre time.
- are people from deprived populations, older people or BME groups unfairly disadvantaged, or is it a question of distance between where people live and where services are provided that reduces access?
- is there overuse of any tests in the local population?
- if there is overuse does it represent only waste or is overuse causing harm through over diagnosis or iatrogenic effects?

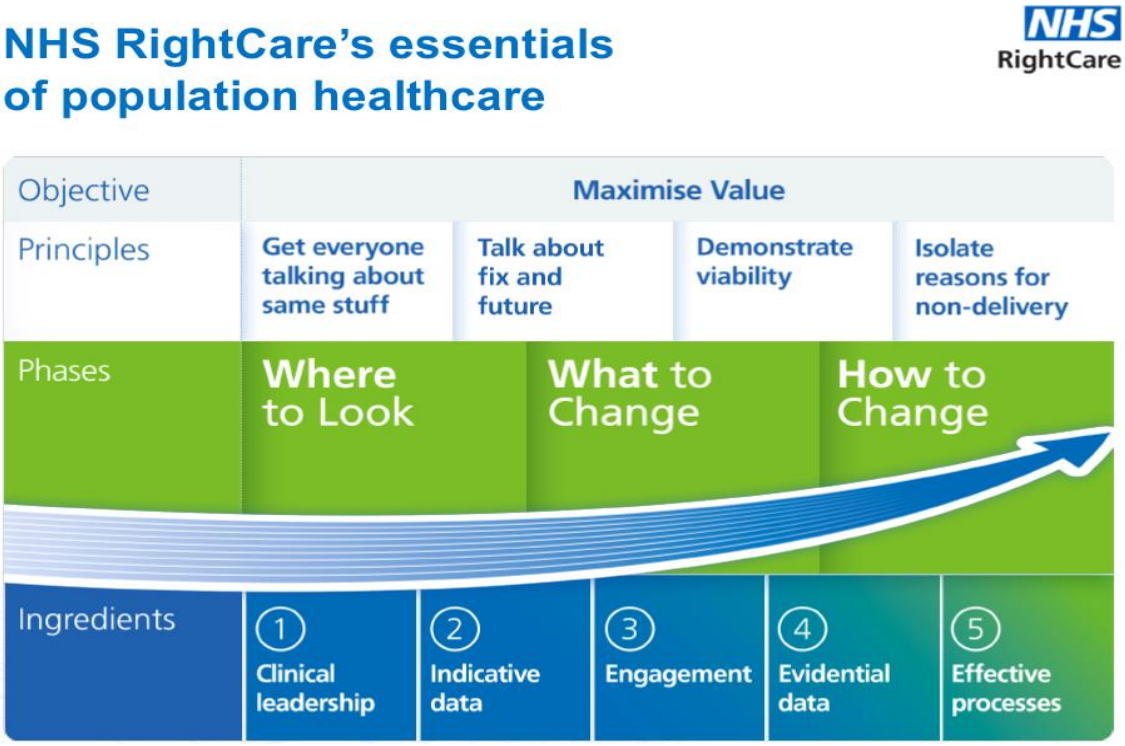
Having identified a potential need for action the NHS RightCare Approach to improving outcomes and value in the NHS provides a helpful framework and set of tools for identifying what needs to change and how to change.

The NHS RightCare Approach

By December 2016 all local health economies will be using the RightCare approach to reduce unwarranted variation and deliver better value population healthcare. The RightCare Approach has three phases and five key ingredients that build on strong evidence as a starting point.

[1] Public Health England. Public Health Profiles. www.fingertips.phe.gov.uk/profile/atlas-of-variation

Figure 8: The RightCare Approach



"*Where to Look*"

Phase 1 of the RightCare Approach begins with a review of indicative data. This highlights the top priorities and best opportunities for transformation and improvement by comparison with a CCGs most similar peers. NHS Rightcare indicative data is supplemented by local data and intelligence to get a comprehensive picture of the greatest opportunity.

The maps in this Atlas provide indicative data for local health economies on their variation relative to England values. This is shown in terms of statistical significance; higher, lower or not significantly different from the England value. To understand the impact of the level of variation on health outcomes it is important to investigate the value for the diagnostic test by undertaking a deep dive of other relevant data, for example the demography of the local population (age, socioeconomic and ethnicity distribution) as shown in figures 3, 4 and 5 and how this may impact on the need for diagnostic testing or access to testing. Other factors which should be considered are location of provision of service and how this may impact on patient access especially where tests or procedures are only provided in specialist centres. The incidence or prevalence of the condition(s) for which the test is used should be ascertained for the local health economy and how these and outcome indicators such as survival (cancers) or mortality compare with others.

Outcome data will indicate how successful the local health economy is at preventing adverse outcomes and enable a focus on the role diagnostic testing is playing in early diagnosis or monitoring of the condition.

The first set of questions relates to whether this difference is real or artefactual due to recording or coding issues and if so what could be the explanation(s), some of these questions are shown in Box 1 and Box 2.

A review of these questions will enable local health economies to determine whether there is a need for action by identifying whether variation is warranted or unwarranted.

Box 1:
What type of indicator is this?

- Does this indicator describe the quality of a diagnostic service, for example time to diagnostic scan for suspected stroke?
- Does this indicator represent level of provision locally, for example colonoscopy and flexible sigmoidoscopy services per 1,000 population?
- Does this indicator reflect levels of access to procedures only provided by specialist units, for example EVAR?

Box 2:
What could be the explanation for the variation seen?

- Could there be a recording or coding issue leading to apparent variation?
- How does the population 'need' for this diagnostic test vary? Has this indicator been standardised to take 'need' into account? Do different indicator values represent variation in provision when accounting for 'need'?
- Is there a problem of underprovision or overprovision?
- Is there evidence of poorer health outcomes related to underprovision of this diagnostic test?
- How do facilities and manpower compare with elsewhere?
- What are the organisational designs for diagnostic services? Are structural differences reflected in both the provision and availability of the full range of services for local populations, and the profile of the workforce?
- How do the diagnostic services perform across a range of indicators which cluster together because they use the same or overlapping facilities and workforce, eg endoscopy services? Are some aspects better than the England average, and others worse?
- Is there variation in the clinical application of testing – revealing the extent of variation in both the referral and the appropriateness of test requests and, therefore, the potential clinical impact of under-testing versus the lack of utility and avoidable cost of over-testing?
- How does productivity of the workforce (tests per whole time equivalent) compare?
- Are there variations in cost (and price) per test – a function of the factors above, plus differences in economies of scale, and the indirect and overhead costs?

The information contained within this Atlas can be used with a variety of other tools which describe data about health and health services to support improvement at the level of local populations. These tools, which support the NHS RightCare Approach include:

- Commissioning for Value Where to Look Packs[2]
- Commissioning for Value Focus Packs[3]
- Spend and Outcome Tools[4]
- Local disease and risk factor specific profiles contained in Fingertips[5]
- National End of Life Care Intelligence Network[6]
- National Cardiovascular Intelligence Network[7]
- Child and Maternal Health Intelligence Network[8]
- Mental Health, Dementia and Neurology Intelligence Network[9]
- National Cancer Registry and Analysis Service (NCRAS)[10]

In NHS diagnostic services there are particular challenges as the optimal number of tests per head of population is not always known. It is important to note that the England value cannot be assumed to be the optimal value and it is important for local health economies to understand more about their variation and to consider the questions in Box 2 to understand what action to take. To investigate indicators which may yield potential opportunities, local analysts should download all of the data used within this Atlas[1] for local interpretation.

[2] NHS England. Commissioning for Value. Commissioning for Value - first stage to identify opportunities to improve outcomes and increase value for local populationswww.england.nhs.uk/rightcare/intel/cfv/data-packs/
[3] NHS England, Commissioning for Value. Commissioning for Value - focus packs provide more detail on seven different topic areas including cancer, MSK & trauma and CVD family of conditions www.england.nhs.uk/rightcare/intel/cfv/data-packs
[4] Public Health England. Spend and Outcome Tool (SPOT). Understand health outcomes and expenditure across all programmes. http://www.yhpho.org.uk/default.aspx?RID=49488
[5] Public Health England. Public Health Profiles https://fingertips.phe.org.uk/
[6] Public Health England. National End of Life Care Intelligence Network. http://www.endoflifecare-intelligence.org.uk/
[7] Public Health England. National Cardiovascular Intelligence Network. www.yhpho.org.uk/default.aspx?RID=182342
[8] Public Health England. Child and Maternal Health Intelligence Network. www.chimat.org.uk
[9] Public Health England. Mental Health, Dementia and Neurology Intelligence Network. https://fingertips.phe.org.uk/profile-group/mental-health
[10] Public Health England. National Cancer Registration and Analysis Service. http://www.ncin.org.uk/home

However, for some of the indicators, for example access to imaging for patients presenting with signs of symptoms of stroke or following major trauma to the head or pelvis, there are clear standards for quality of services. Where there are clear targets, for example uptake of screening tests, or quality markers, such as patients with signs and symptoms of stroke be scanned within an hour of presentation to hospital, the local health economy should also assess how far they are from these targets. For other diagnostic testing, the challenge in deciding on an optimal level of provision for diagnostic services is that the evidence base for this is often lacking.

Provision of diagnostic services should reflect population need and this in turn will be driven by the demographics of the population. Thus, older populations and those with greater socioeconomic deprivation usually have higher levels of incidence and/or prevalence of conditions which require diagnosis and monitoring. If diagnostic services accurately reflected need then areas of higher need would have higher levels of services. Where the condition(s) being tested for vary with age and/or socioeconomic deprivation the data presented has been standardised (data availability permitting) for these factors. In theory, the residual variation presented reflects true differences in provision after removing variation due to population 'need'.

The boxplots attached to each map show the direction of progress at a national level and the Atlas data Excel spreadsheet[1] provides the time series values at a local level.

"What to Change"

Phase 2 of the RightCare approach involved a more detailed review of specific areas, care pathways and optimal design to identify the options for improvement and testing viability. Clinically led service reviews are carried out as necessary and a review of best practice and evidence will inform "what to change".

Having established that there may be a problem, it will be necessary to examine potential reasons. If there appears to be underuse of diagnostic testing it will be important to explore whether there are problems with the level of provision compared to need, for example:

- equipment or staffing
- are there protocols for referral?
- are there barriers to access for the population such as travelling times?
- poor health literacy
- discrimination
- is patient choice important?

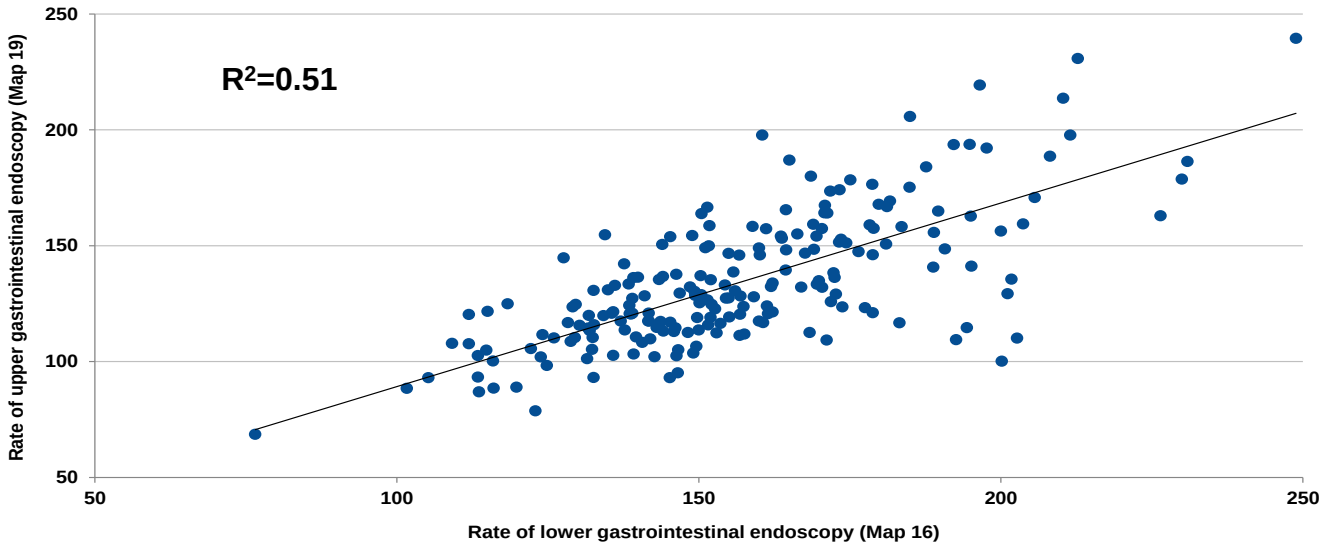
The maps in this Atlas show particular problems of access to new diagnostic services and those which are limited to specialised centres.

If there appears to be overprovision it will be important to explore whether protocols for referral are inadequate or not being adhered to or in the case of barium enema whether the pace of phasing this out with replacement by lower GI endoscopy (flexible sigmoidoscopy, colonoscopy and CT colonoscopy) is too slow.

Many of the indicators of level of diagnostic testing provision, use or quality cannot be considered in isolation. When looking at the level of diagnostic service use it is often important to consider the relationship between different forms of diagnostic testing. For example between the use of MRI scanning and CT scanning where diagnostic pathways may depend on the level of provision of, or access to, MRI scanning locally. Sometimes a composite measure combining tests which are used for a similar purpose is useful. It is for this reason that flexible sigmoidoscopy and colonoscopy (Map 16) have been combined. Other examples are EVAR (Map 9) and open surgery for treatment of abdominal aortic aneurysm (Map 10).

It may be important to consider whether there is any clustering of problems with diagnostic testing, for example endoscopy services where the same gastroenterologists may be performing upper and lower GI endoscopy and a shortage of trained staff therefore impacts on both services. A comparison of maps 16-19 appears to show a similar geographical pattern of provision of lower and upper GI endoscopy services. Figure 9 shows that there is a strong correlation (R^2=0.51) between levels of provision of lower and upper GI endoscopy services (Map 16 vs Map 19) confirming this hypothesis, although a comparison of the thematic maps shows a few notable differences.

Figure 9: Scatterplot of the 2014/15 rate of colonoscopy procedures and flexible sigmoidoscopy procedures per 10,000 population (Map 16) vs the 2014/15 rate of gastroscopy procedures per 10,000 population (Map 19) by CCG



Finally, it is important to consider the role of diagnostics within the entire patient pathway[5] taking into account what is known locally about the incidence and prevalence of the conditions for which the testing is being undertaken and more subtle issues such as, for colorectal cancer, the stage at which patients present with cancer or whether they present as an emergency.

The production of pathways, such as colorectal cancer, in the Where to Look packs[2], and the development of optimal value pathways, for example cardiovascular disease prevention[11], by RightCare will support this.

Case study: Colorectal cancer

One of the prime uses of colonoscopy and flexible sigmoidoscopy is in the diagnosis or exclusion of colorectal cancer in symptomatic patients and following a positive screening test for colorectal cancer. It is also used to diagnose or exclude other non-malignant pathologies of the large bowel. Colonoscopy and to a lesser extent flexible sigmoidoscopy are also used in surveillance for recurrence of colorectal malignancy, surveillance of inflammatory bowel disease and in patients with high genetic risk for colorectal cancer. A new technology CT colonoscopy has been introduced in some Trusts. The relative merits of these tests are described in the text for maps 16, 17, 18. Barium enema should no longer be used for the diagnosis of colorectal cancer and its use should have been phased out.

"Where to Look"

Phase 3 of the Rightcare approach involves taking forward opportunities and making them happen. This is achieved through outlining the case for change and making sure impact assessments and assumptions are explicit. This phase involves ensuring that there is clinical leadership of the change and that programmes of work are planned, delivered and monitored, using established improvement processes.

Using the Atlas data Excel spreadsheet[1] it is possible to see whether the local rate of colonoscopy and flexible sigmoidoscopy (Map 16) is significantly lower than the England value. It is also possible to examine the role that CT colonoscopy plays (Map 17), and it is important to check whether significant numbers of barium enema are still being performed (Map 18). Map 31 shows the percentage of eligible people aged 60-74 years with a screening test result recorded in the previous 2.5 years from the NHS bowel cancer screening programme (NHS BCSP) by upper-tier local authority. There is also useful information in the NHS Atlas of Variation in Healthcare 3.0[1]: Map 9B shows the ratio of colonoscopy procedures to flexible sigmoidoscopy procedures by CCG (2012/13) and Map 13 shows the percentage of new cases of colorectal cancer that were diagnosed at stage 1 or stage 2 by CCG (2013).

[11] NHS England. Commissioning for Value. Commissioning for Value – cardiovascular disease prevention optimal value pathway. https://www.england.nhs.uk/rightcare/intel/cfv/cvd-pathway/

Having established that the levels of diagnostic services are significantly different from the national value and/or demonstrably different from the best performers it is important to undertake a deep-dive using other data sources to assess the potential explanations and consequence of underprovision or overprovision.

For example, whether demographic characteristics or other reasons for warranted variation explain the degree of variation observed, for instance, if all demographic peers show similar degrees of variation.

The PHE National Registration and Analysis Service (NCRAS) analyses and publishes a wealth of data on cancer on its website. For colorectal cancer, data on incidence and mortality[12], stage at presentation[13] and route to diagnosis[14] can be obtained at local level. Colorectal cancer survival at CCG level is produced by ONS.[15,16] Mortality and survival are important outcome measures which reflect the success of the diagnostic and treatment elements of the pathway for colorectal cancer.

"What to Change"

Poor levels of provision of lower GI diagnostic testing could result in late stage of diagnosis of colorectal cancer, higher rates of emergency presentation both of which lead to poor survival and higher mortality rates.

Figures 10 and 11 (at the end of this section) are examples of data available from NCRAS. These show the incidence of colorectal cancer by CCG for males and females respectively. Colorectal cancer incidence increases with age but compared with other cancers it does not have a steep socioeconomic gradient.

At a local level it will be important to establish the stage distribution at presentation. This is shown in Map 13 of the NHS Atlas of Variation in Healthcare Services 3.0[1]. Good access to endoscopy services will help to improve stage at diagnosis although caution should be exercised in interpretation and it should first be verified whether poor stage 1 and 2 could also be due to poor historical rates of cancer registration by stage.

Routes to diagnosis data[14] shows in particular the proportion of patients presenting as an emergency by local health economy, as well as proportions referred through the two-week wait or other routes. A high emergency presentation rate may suggest poor access to lower GI endoscopy services and proportion of patients referred under the two-week wait.

There is a wealth of guidance available on lower GI imaging and colorectal cancer referral pathways, diagnosis and follow-up surveillance from the National Institute of Clinical Excellence (NICE), guidance on screening for colorectal cancer from the National Screening Committee and on diagnosis and surveillance of other conditions.

Implementation of change will require dialogue between commissioners and providers and in particular, clinical leadership and engagement and a business planning processes.

"How to Change"

For most of the indicators in this Atlas there is clear information on what can be done to improve practice. National organisations, such as NICE and the Royal Colleges have defined best practice. Each map in this Atlas contains sections entitled "Context", "Options for action" and "Resources". These provide the background to the use of the diagnostic testing, wider issues for consideration related to patient pathways to which the diagnostic test contributes and in the "Resources" section references to guidelines and policy statements and economic evaluations. This information together with the information of local performance can be used to highlight and improve services.

[12] Public Health England. National Cancer Registration and Analysis Service. https://www.cancerdata.nhs.uk/
[13] Public Health England. National Cancer Registration and Analysis Service. http://www.ncin.org.uk/cancer_type_and_topic_specific_work/topic_specific_work/cancer_outcome_metrics
[14] Public Health England. National Cancer Registration and Analysis Service. http://www.ncin.org.uk/publications/routes_to_diagnosis
[15] The Office for National Statistics. Table 10 to 16: 1-year cancer survival by clinical commissioning group in England, with 95% confidence intervals. https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/conditionsanddiseases/datasets/table10to161yearcancersurvivalbyclinicalcommissioninggroupinenglandwith95confidenceintervals
[16] The Office for National Statistics. Geographic patterns of cancer survival in England for cancer of the colon. https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/conditionsanddiseases/datasets/geographicpatternsofcancersurvivalinenglandforcancerofthecolon

Having assembled the evidence it will be important to discuss with local clinicians to understand how these data relate to each other and to examine local use of referral protocols, for example the two-week wait referral process. It will also be important to consider the balance between new referrals and follow-up testing. Other issues such as facilities and manpower, especially the number of endoscopists need to be considered.

As described in the text accompanying maps 16-18, the Joint Advisory Group on Gastrointestinal Endoscopy (JAG) runs accreditation schemes and surveys of numbers of endoscopists.[17]

Further information can also be determined relatively easily, such as whether the improvement:

- is supported by the clinical community
- is easy and quick to implement, for example, increased adherence to protocols
- will take time because capital investment or recruitment or training of staff is required
- has a fast or slow rate of return on investment

Taking a specialty approach

The case for improving or disinvesting in a diagnostic test can usually not be made in isolation. As described above, the level of provision of one diagnostic test may not be independent of other tests. There are several reasons for this; radiological tests and interventional radiology are provided by the same department and while personnel may be specialised often the staffing level in the department affects the delivery of several modalities of testing. This is true also for endoscopy services. Some examples are given below.

Radiology

In radiology, including interventional radiology it is clear that services are likely to have interdependencies including shared staff, equipment and room/theatre time. If a CCG or NHS Trust notes that there is a problem with one or a number of radiology services it will be useful for commissioners and providers to consider if, and how, the level of provision of diagnostic tests has interdependencies. Are some diagnostic tests or certain disease groups of patients given priority access? Is emergency use equally good across different indications eg acute stroke diagnosis, acute head injury, acute pelvic injury (maps 4a-8). Are there links and dependencies between diagnostic tests and interventional radiology or, for example, for interventional radiology (maps 11 to 14) are there clashes in the need for theatre time and personnel or do the procedures take place in different rooms with different staff?

Although each modality of diagnostic testing has specific indications some diagnostic tests may overlap in their indications for use. This use of alternative modalities, even if less good may become more apparent when there is insufficient capacity. For this reason CT scanning (Map 1), MRI (Map 2) and non-obstetric ultrasound scanning (Map 3) activity rates may need to be considered together and with the use of CT scanning in emergency scenarios (maps 4a-8) and for CT colonoscopy (Map 17).

Management of Abdominal Aortic Aneurysms

In this Atlas there are three maps relevant to the management of Abdominal Aortic Aneurysm (AAA) which should be considered together. Map 30 shows variation in the percentage coverage for initial screening tests for men aged 65 years and over in the NHS AAA screening programme. Map 9 shows the rate of endovascular aneurysm repair (EVAR) for AAA and Map 10 shows the percentage of elective procedures for AAA which were EVAR.

Endoscopy and barium enema

The maps on adult endoscopy and barium enema (maps 16-22) should be considered together as staff and theatres are often used for both upper and lower GI endoscopy. Barium enema should be almost phased out but this requires a lower GI endoscopy service to replace it. Within the endoscopy services issues like the ratio of first diagnostic examinations to follow up examinations should be considered as well as the balance between upper and lower GI endoscopy. Consideration should be given to whether all endoscopy diagnostic tests have high or low rates or whether some procedures, patient groups or referral pathways have priority.

[17] JAG Accreditation System incorporating the Endoscopy Global Rating Scale. https://www.jagaccreditation.org/

Paediatric endoscopy (Map 23) is usually performed by paediatric gastroenterologists and is a specialist services for which there appear to be important access issues.

The way forward: increasing value

The need to address under provision of diagnostic services combined with an ever increasing need for diagnostic testing will have resource consequences. At the time of writing the NHS needs to find over £22 billion in efficiency savings and it is unlikely that there will be any increase in funding for either commissioners or service providers in the next five years. Therefore commissioners and service providers need to work together more closely to identify the resources necessary to meet the increased need for diagnostic testing. Reducing the inappropriate use of diagnostic testing will help to free some resources to fund other priorities.

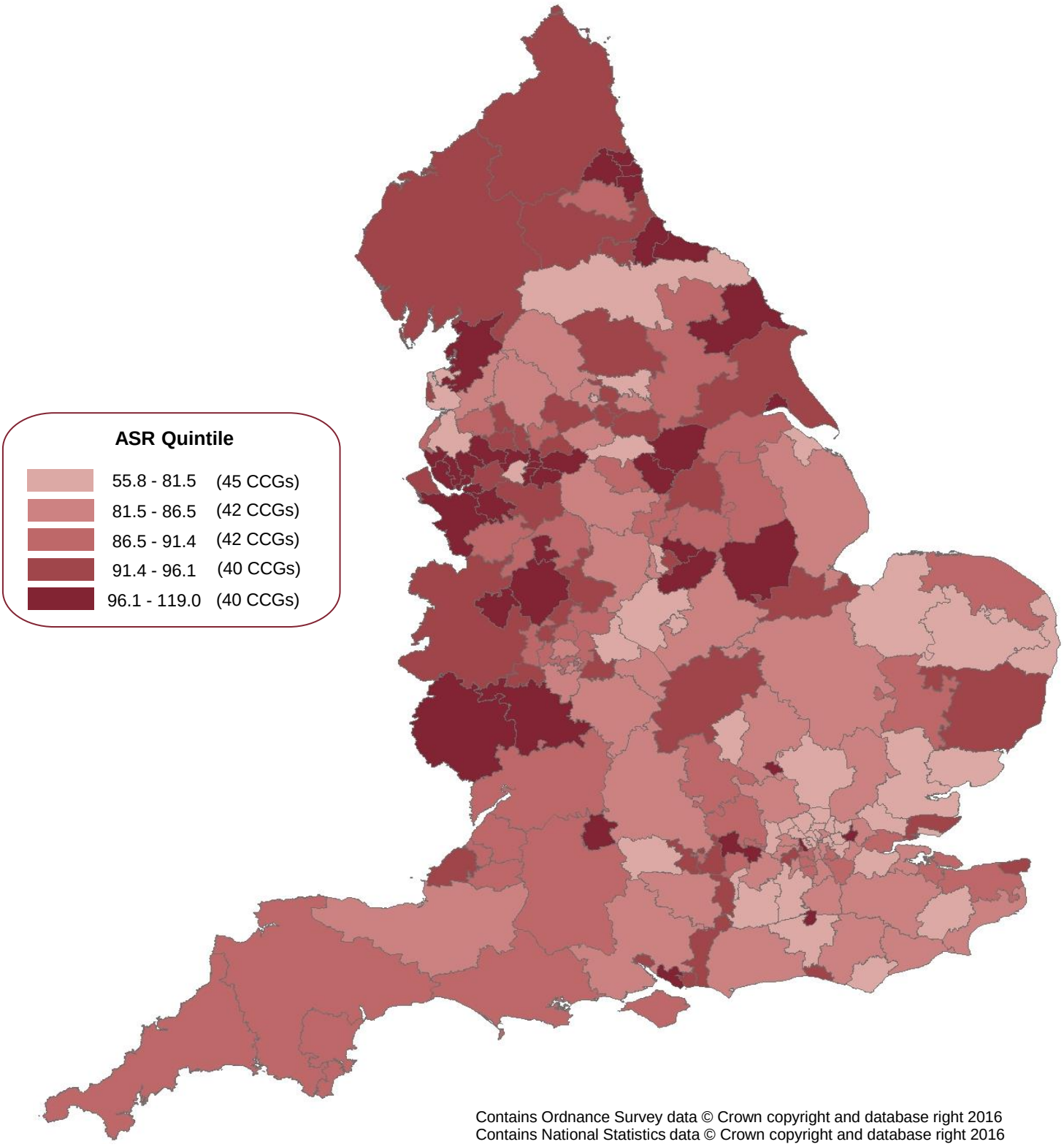
One option available for resourcing high value tests, which has not featured on the commissioners' agenda until now is to shift resources. Shifting resources has particular implications for healthcare scientists and pathologists. For the last 20 years the principal focus of their work has been on quality. Indeed healthcare scientists and pathologists are two professional groups who have achieved high standards in quality assurance and quality improvement, but as value in healthcare becomes the central concern it is not sufficient to focus on quality alone. The challenges are great as money is often ring fenced within Trust directorates so that it can be difficult to shift money between surgery and imaging for example.

Ideally, it would be possible to look at the patient pathway(s) and move some funding to the diagnostic phase of the pathway with the intention of saving costs in treatment further down the line. Many of the maps show examples of diagnostic tests where better provision would lead to better management and fewer complications including hospital admissions. A clear example of the case for investing in diagnostics to save on treatment costs is illustrated in maps 4a to 6b which show variation in time to brain imaging for patients with suspected stroke. There is now good evidence for the effectiveness of treating evolving strokes to prevent death and severe disability supported by NICE accredited guidelines for imaging. Another example would be Map 26 which shows variation in FEV1 testing for patients with COPD in the previous 12 months. Regular review of lung function is important to adjust medication and prevent unnecessary hospital admissions.

The need to shift resources to increase value in both diagnostic services and healthcare overall requires a shift in culture and practice. In addition to focusing on the quality and results of the tests conducted and the experience of patients undergoing those tests, the providers of diagnostic services need to consider the use of diagnostic testing at a population level.

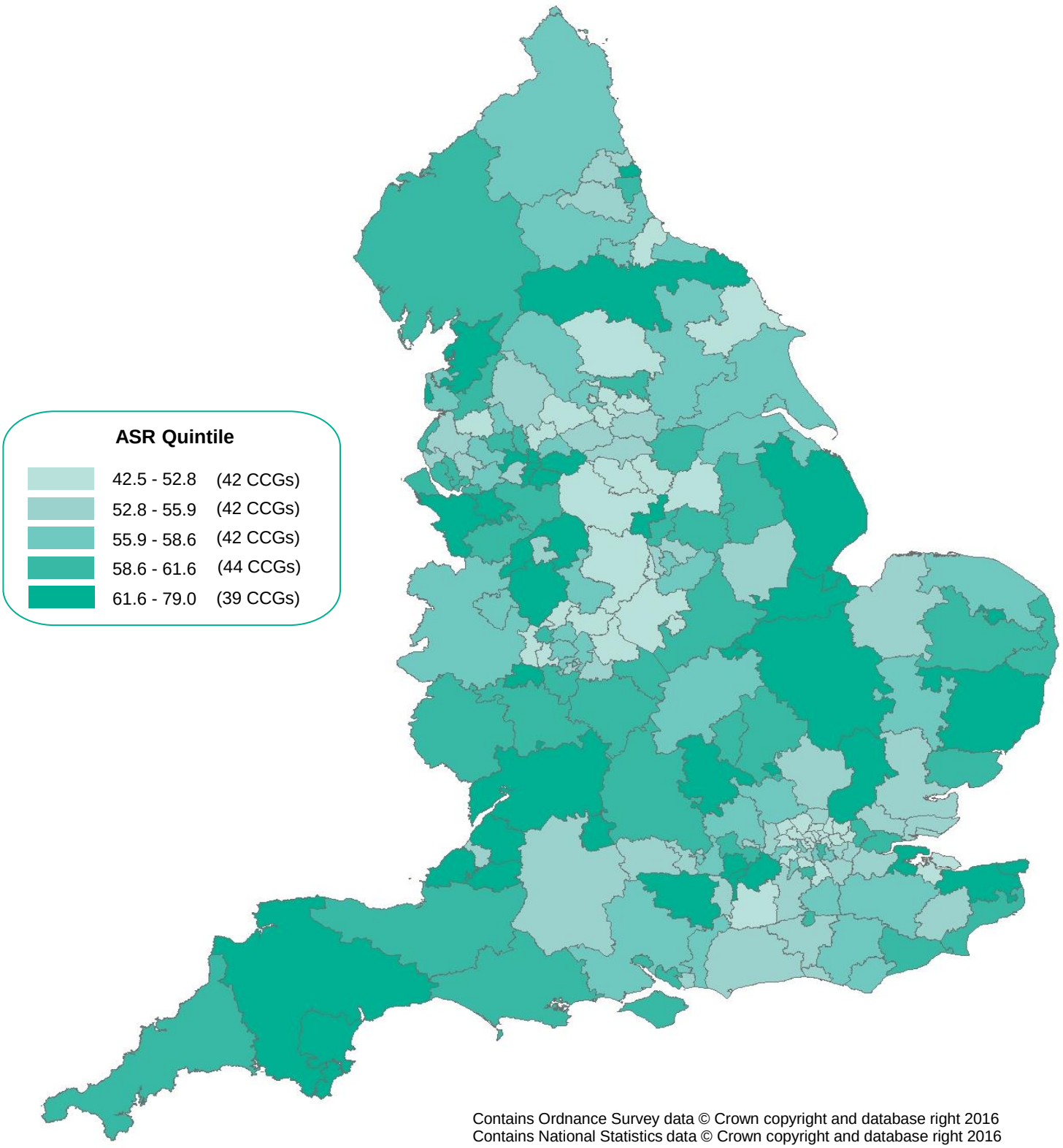
In the three years since the publication of the first NHS Atlas of Variation in Diagnostic Services in 2013 it is apparent from this update that there is still unwarranted variation in diagnostic testing. The elucidation of underuse and overuse are essential to identifying the interventions necessary to reduce it. This must be a priority for diagnostic services in the next five years.

Figure 10: Incidence of colorectal cancer in men by CCG, 2012-2014 age-standardised rate per 100,000[12]



Source: National Cancer Registration and Analysis Service, Public Health England

Figure 11: Incidence of colorectal cancer in women by CCG. 2012-2014 age-standardised rate per 100,000[12]



Source: National Cancer Registration and Analysis Service, Public Health England

Reducing unwarranted variation in individual diagnostic disciplines

In the following sections for each of the individual disciplines in the second Diagnostics Atlas, there is an overview of the discipline and a description of the services provided for patients. The reasons for variation in service provision in each discipline are outlined, some of which are common to all disciplines across diagnostic services, such as patterns of disease prevalence, the availability of a trained workforce and local custom and practices, whereas others are different, arising from the differences in the nature of the specific interventions and tests.

Discussions are currently taking place with the relevant professional groups about ways in which they can contribute to reducing unwarranted variation and increasing value. This role of value improvement can build on the leadership role these professional groups already hold in quality assurance.

Imaging services

Diagnostic imaging is a rapidly evolving field driven by technological developments. Historically in the UK imaging has been used to confirm a diagnosis and to indicate appropriate management of a particular condition. There has been a perception that imaging was inappropriate if it did not lead to a change in the management of a condition. The high costs of new technologies tended to perpetuate this belief, but the use of imaging is now being driven by different factors including changes in patient expectation and the increased speed, safety and capability of new technology.

Effective and good quality imaging is important for further medical decision making and can reduce unnecessary procedures. In some countries it might have been possible to avoid a significant proportion of all abdominal surgical interventions (exploratory laparotomy) if simple diagnostic imaging services such as ultrasound had been available.[1] Most patients now expect a definite diagnosis to be sought irrespective of whether, in the opinion of their clinician, a change of management is likely to ensue. This is likely to give the patient a greater feeling of certainty even if the test(s) is negative. In addition newly trained clinicians have tended to place greater reliance on imaging and other diagnostic tests than their predecessors, which acts as another driver for reliance upon medical imaging technologies.[2] This trend may be further exacerbated by the shortening period of time for medical training, which could mean that imaging diagnosis will become a fundamental guide to the management of most conditions.

Current government policy is to develop primary and community based assessment and treatment services in the NHS, shifting the provision of care closer to patients' homes, and reducing the burden and dependence on secondary and acute care services. A more productive use of resources at an earlier point in the care pathway offers patients a better service.

This re-sequencing has been associated with significant increases in imaging in other countries.[3] A 'significant' increase in imaging in the NHS may not necessarily lead to an overall increase in cost if diagnosis is performed earlier in the care pathway and the number of secondary care outpatient appointments is reduced, thereby improving patient experience; however, this is an aspect of diagnostic services where more research is needed. It is also important to balance access for the community with the need to avoid destabilising all services in the acute setting. Commissioners need to create a population, system wide approach to ensure that the application of local protocols is factored into any planning.

The Picture Archiving and Communications Systems (PACS) enable radiological and other images to be stored electronically and viewed on screens, so that both the image and relevant information, including the report, can be accessed and compared with previous images at the touch of a button.

[1] World Health Organization. Diagnostic imaging. Imaging modalities. 2013. http://www.who.int/diagnostic_imaging/en/
[2] Bosanquet DC, Cho JS, Williams N et al. Requesting radiological investigations – do junior doctors know their patients? A cross-sectional survey. JRSM Short Rep 2013 January 14. doi: 10.1258/shorts.2012.012043 http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3572658/
[3] Organisation for Economic Co-operation and Development (OECD). Health at a Glance. OECD indicators 2005. http://www.oecd-ilibrary.org/social-issues-migration-health/health-at-a-glance-2005_9789264012639-en

With the development of the PACS it is possible to separate the local acquisition of some images from remote reporting. In this way a local service can be provided to patients without the necessity for the reporting clinician to be on the same site. Although there are obvious advantages to such a system, it is important to take into account several considerations including credentialing of reporting clinicians, patient consent and patient confidentiality. Ultrasound and all interventional imaging should be reported by the health professional undertaking the investigation.

It is incumbent on providers of imaging services to demonstrate, among other things, improved patient experience through effective image waiting times and reporting turnaround times for all modalities [see Box 3 for details about the Imaging Services Accreditation Scheme (ISAS)]. This information should be measured and shared with commissioners, users of the service and patients to support monitoring and the achievement of continual improvement in the service. This will also ensure that key policy drivers for healthcare services are being met, including those for cancer, stroke and emergency care.

Box 3: The Imaging Services Accreditation Scheme (ISAS)[4]

- ISAS is a patient-focused accreditation scheme available to UK imaging services
- Accreditation is independent attestation of an organisation's competence to provide diagnostic imaging services such that the users have confidence in the outcomes
- The United Kingdom Accreditation Service (UKAS) was selected by The Royal College of Radiologists and The College of Radiographers to deliver and manage ISAS
- UKAS assesses imaging services against the ISAS standard and ensures, through regular monitoring, that required standards are maintained
- The scheme includes an enhanced package of support and an optional staged pathway to help imaging services preparing for and going through initial assessment for ISAS

The Diagnostic Imaging Dataset (DID) is the central collection of detailed information about diagnostic imaging tests carried out on NHS patients, extracted and submitted monthly (see Box 4 for the type of information captured in the DID). The dataset is collected at patient level and includes patient identifiers to enable linkage to other datasets, most notably cancer registration data. Combined, these data items give powerful information about access of NHS patients to diagnostic imaging tests across the country, and will help to address unwarranted variation.

Box 4: Information captured by the Diagnostic Imaging Dataset (DID)[5]

- Referral source and patient type
- Details of the test (type of test and body site)
- Demographic information such as GP registered practice, patient postcode, ethnicity, gender and date of birth
- Waiting times for each diagnostic imaging event, from time of test request through to time of reporting

In addition, the use of the most up-to-date evidence through the application of referral guidelines, such as iRefer (see Box 5), and those produced by NICE and professional bodies such as the Royal College of Radiologists (RCR) will help to reduce unwarranted variation.

Box 5: iRefer – The Royal College of Radiologists' Radiology Referral Guidelines[6]

- iRefer, the 7th edition of the adult and paediatric imaging referral guidelines from RCR, is now available via the N3 platform free of charge to all NHS organisations in England
- The iRefer guidelines are evidence-based, and designed to help clinicians, healthcare professionals, radiographers and radiologists determine the most appropriate imaging procedures for a range of clinical problems
- The radiology referral guidelines have an important role in improving the quality of care for patients

Although the healthcare professionals in the NHS who provide imaging services are leaders in quality improvement, the variation observed for some of the indicators in the imaging services section of this Atlas underlines the necessity for radiologists to be given responsibility not only for the quality of imaging services that patients receive but also for the value that can be realised for the population as a whole.

[4] UKAS Assessment and Accreditation for ISAS. http://isas-uk.org/default.shtml
[5] Diagnostic Imaging Dataset Statistics. http://data.gov.uk/dataset/diagnostic_imaging_dataset_statistics
[6] About iRefer. https://www.rcr.ac.uk/clinical-radiology/being-consultant/rcr-referral-guidelines/about-irefer

It is clear there is a need for certain types of high value imaging to be increased, but the resources necessary to fund this increase will have to be found by reducing activity for imaging tests of lower value. The amount of time, however, that radiologists have available is a limited resource, and they require support in ensuring that any referrals make the best use of finite resources. A workshop organised with the RCR focused on the role of imaging in 21st century healthcare, with the aim of increasing the value derived from imaging services as a complement to the quality improvements already achieved.

Endoscopy services

Endoscopy is a subspecialty housed principally within medical and surgical gastroenterology; however, endoscopic procedures are also performed by radiologists, general practitioners and nurses. Endoscopy is vital to:

- the diagnosis and ongoing surveillance of gastrointestinal (GI) cancers
- the diagnosis, treatment and surveillance of a range of conditions and diseases that are not related to cancer

In 2012 it was estimated that the demand for lower GI endoscopy (colonoscopy and flexible sigmoidoscopy) would double by the end of the financial year 2016/17[7] due to:

- the extension to the faecal occult blood (FOB) testing screening programme for people aged 70–75 years
- the introduction of the flexible sigmoidoscopy bowel screening programme aimed at people aged 55 years of age

In addition the demand for endoscopy for patients with symptoms was thought to be increasing alongside the need for surveillance of patients at increased risk, and in England demand was expected to continue to rise due to projected increases in the proportion of the population older than 65 years.

Since then Cancer Research UK commissioned a study of the endoscopy service in England[8] to understand the pressures resulting from increasing demand generated by the 62-day wait target[9], relatively recent NICE guidelines on referral for suspected cancer [NG12][10], and changes to the bowel cancer screening programme. The aims of the study are shown in Box 6.

Box 6: Aims of the Cancer Research UK study of the endoscopy service in England[7]

- Improve knowledge of current upper and lower GI endoscopy capacity in England
- Ascertain by how much demand is likely to increase
- Identify levels of resource (including staffing, equipment and facilities) necessary to meet growing demand
- Estimate shortfalls in these resources
- Understand what is causing this and how it can be addressed

Several challenges facing endoscopy services were identified, including:

- rising demand and a lack of capacity to respond to increasing demand
- an estimated increase of more than 750,000 additional endoscopy procedures a year will be undertaken by 2020, representing a 4.4% increase on current activity (see Figure 12)
- recruitment and retention of the workforce
- weekend working
- training and development
- lack of ‘headspace’ to respond to the need to improve productivity and efficiency
- data availability, quality and use[7]

In addition there is known to be variation in endoscopy across several factors: from referral rates and conversion to test rates, through to the identification of polyps, and cancers detected. In localities where there are low intervention rates for endoscopy services the shortage of appropriately trained health professionals is an important contributory factor.

[7] NHS Improvement. Rapid review of endoscopy services. 5 March 2012. https://www.gov.uk/government/publications/rapid-review-of-endoscopy-services
[8] Health Services Management Centre, University of Birmingham, and the Strategy Unit, NHS Midlands and Lancashire Commissioning Support Unit. Scoping the Future. An evaluation of endoscopy capacity across the NHS in England. September 2015. Commissioned by Cancer Research UK. https://www.cancerresearchuk.org/sites/default/files/scoping_the_future_-_final.pdf
[9] The 62-day wait target states that 85% of cancer patients should receive treatment within 62 days of being urgently referred for suspected cancer by their GP.
[10] NICE. Suspected cancer: recognition and referral. NICE guidelines [NG12]. June 2015. https://www.nice.org.uk/guidance/ng12

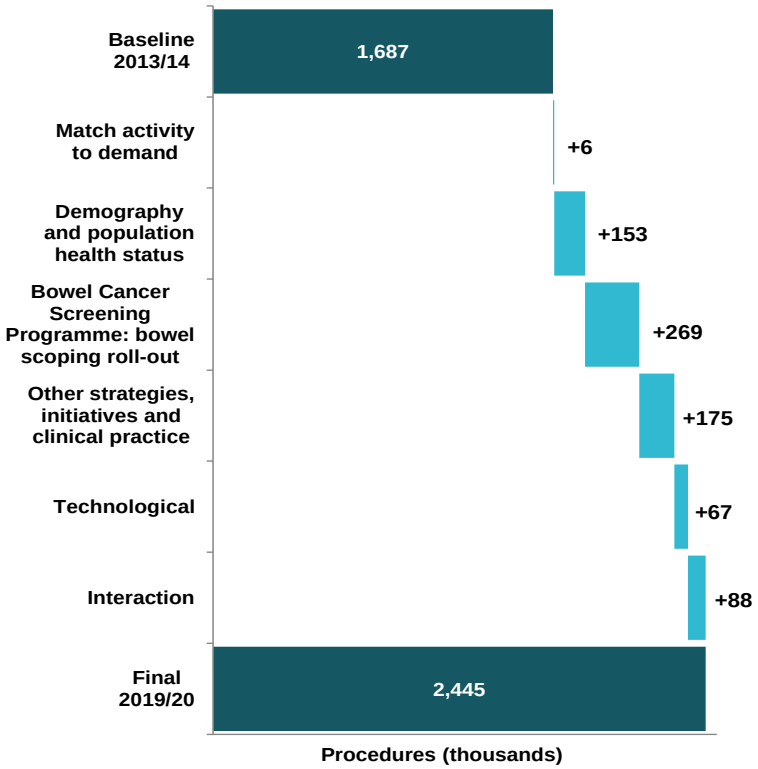


Figure 12: **Modelled changes in endoscopy activity 2013/14 to 2019/20. Reproduced with kind permission from "Scoping the Future: An evaluation of endoscopy capacity across the NHS in England" commissioned by Cancer Research UK and written by the Health Services Management Centre at the University of Birmingham and the Strategy Unit at NHS Midlands and Lancashire Commissioning Support Unit.**[8]

As for other diagnostic disciplines the emergence of new technology will also influence the number, use and costs of endoscopic techniques, and contribute to the degree of variation. Examples of emerging new technologies include:

- capsule endoscopy (Map 21), which allows direct visualisation of the entire small bowel, inaccessible to an endoscope, in a non-invasive manner – it is the gold standard in evaluating obscure GI bleeds unidentified by traditional endoscopic techniques[11] and it facilitates diagnosis of small-bowel Crohn's disease and the assessment of coeliac disease
- the introduction of the faecal immunochemical test (FIT) to replace the FOBT as the primary test in the NHS bowel cancer screening programme

In the same way as for other medical and diagnostic disciplines, identifying and understanding variation in any system can be helpful in monitoring, managing and improving a clinical service, and in identifying innovative and exemplar practice. Potential factors on which to focus in order to reduce variation in endoscopy services include:

- the quality and appropriateness of GP referrals, and the links between primary and secondary care
- the quality of consultant to consultant referrals
- the development and evaluation of alternative pathways and processes, such as 'Straight to Test' access to endoscopy
- the development of training programmes for non-medical endoscopists
- the degree to which training lists are protected and staff are adequately trained
- the use of appropriate productivity tools
- the achievement and maintenance of accreditation by the Joint Advisory Group on Gastrointestinal Endoscopy (JAG)

The JAG operates within the Clinical Standards Department of the Royal College of Physicians (RCP). The JAG has a UK-wide remit to agree and set acceptable standards for competence in endoscopic procedures and to provide quality assurance for endoscopy units, training and services. The JAG also runs an accreditation process (see Box 7), which is recognised internationally as improving quality and productivity within endoscopy services[7].

Box 7: The Joint Advisory Group on Gastrointestinal Endoscopy (JAG) Accreditation Scheme [12]

- JAG is a patient-centred and workforce-focused accreditation scheme
- Accreditation is independent against recognised standards
- JAG has been developed for all endoscopy services and providers across the UK in both the NHS and the independent sector
- It gives local commissioners assurance that an endoscopy service has the competence to deliver against the measures in the endoscopy Global Rating Scale (GRS) Standards

[11] Appleyard M, Glukhovsky A, Swain P. Wireless-capsule diagnostic endoscopy for recurrent small-bowel bleeding. N Engl J Med 2001; 344; 232–3.
[12] JAG Accreditation System incorporating the Endoscopy Global Rating Scale. https://www.jagaccreditation.org/

Implementing interventions to reduce unwarranted variation in endoscopy services will help to improve patient outcomes and increase value for local populations.

Physiological services

There are eight physiological science specialisms involved in providing diagnostic investigations:

- audiology
- cardiac physiology
- GI physiology
- ophthalmic and vision science
- respiratory and sleep physiology
- urodynamics
- neurophysiology
- vascular science

Each specialism provides diagnostic investigations that asses the function of major organ systems. For example, neurophysiology diagnostic services are used to investigate the function of the central and peripheral nervous systems. Investigations will provide information to identify pathology, and to underpin diagnosis, and treatment and care regimes. In some cases physiological services may also restore and monitor function through the provision of a range of therapeutic intervention strategies.

The demand for physiological investigations is increasing as a result of:

- the introduction of scientific and technological advances, for example, telemedicine and remote monitoring
- the increased prevalence of long-term conditions, coupled with an ageing population
- an increase in the demand for long-term follow-up of patients with complex conditions, and of patients receiving extended drug therapy
- delivering services seven days a week, and supporting both emergency and elective care
- reducing inequalities in the provision of and access to treatment and care
- supporting the implementation of NICE and other evidence-based guidance

Physiological services investigations are a key component in most clinical pathways, underpinning clinical decision making and contributing across the entire pathway of care. In England around 300 specialist physiological services investigations are available, with over 15 million procedures undertaken each year (excluding routine electrocardiograms (ECGs)).[13] These investigations are key to improving outcomes for patients through:

- the earlier identification and diagnosis of disease
- more rapid treatment of conditions
- responsive and effective monitoring

Although some physiological services have been brought together within a physiological services hub, it is more usual for services to be co-located with or adjacent to the relevant clinical specialty, even when they have a broader range of input and provide investigations across several specialties. For example, only 60% of the activity of both cardiac and respiratory physiological services is delivered to the associated clinical specialties of cardiology and respiratory medicine.

Scientific and technological developments in the delivery of physiological services have conferred considerable benefit on patients.

- The miniaturisation and portability of equipment allows investigations to be taken to the location of the patient, and enables the results to be delivered rapidly in support of clinical decision-making, thereby improving patients' experiences of healthcare
- Innovation in physiological services means that many investigations can be delivered in the community closer to where patients reside
- Innovation is also driving the delivery of non-invasive investigations that protect patient dignity: for instance, the use of carotid duplex investigations delivered by vascular scientists can streamline pathways for transient ischaemic attack (TIA) and stroke, and reduce the need for invasive treatment procedures

[13] Department of Health. What is Physiological Measurement? A guide to the tests and procedures conducted by Physiological Measurement diagnostic services. 2007. http://www.ahcs.ac.uk/wordpress/wp-content/uploads/2013/09/WhatisPhysiologicalMeasurement-dh274038.pdf

To improve patient outcomes commissioners need to work with local service providers to ensure that the adoption of innovation is timely, appropriate and effective. The systematic and consistent adoption of innovation is pivotal in reducing unwarranted variation in provision.

The existence of variation in access to physiological services is well documented; a shortage of appropriately trained healthcare scientists is a contributory factor to unwarranted variation in the provision of services. The implementation of the Any Qualified Provider policy, which introduced a choice of provider services, has improved access to adult hearing services by reducing inequalities in access, and has improved the quality of hearing services offered to all adult patients. To support the primary assessment of presenting symptoms this policy of extended choice has also instituted the delivery of some diagnostic tests closer to where patients reside. Certain cardiac and respiratory investigations are also provided in this way.

The introduction and uptake of the Improving Quality In Physiological Services (IQIPS) accreditation programme establishes a drive for quality and improved outcomes at the heart of physiological services, encourages the sharing of best practice and provides a mark of quality across all service providers (see Box 8). In addition accreditation through IQIPS plays a central role in delivering service improvement, and driving quality and innovation to meet the challenges of healthcare provision in the future.

The physiological services that are commissioned must meet local need, reflect proven innovations and good practice, realise improved health outcomes for patients, and be delivered by a healthcare science workforce that is fit for purpose and affordable.

To increase value for the populations served it is essential that the role of physiological services is not seen solely as supplying high-quality services as rapidly as possible in response to referrals. Instead those responsible for managing these services need to be given the authority and skills to ensure that resources are used to investigate and monitor individuals in the population who would derive the most value from testing.

Box 8: The Improving Quality In Physiological Services (IQIPS) programme[14]

- IQIPS accreditation gives patients assurance of the quality of physiological services investigations
- It gives commissioners assurance of the quality delivery of the physiological diagnostics services they commission from providers
- IQIPS is hosted by the RCP, and accreditation is independently delivered by the UKAS against the recognised IQIPS standard
- It demonstrates commitment to quality by promoting a responsive and learning culture
- It is a professionally owned and led programme to improve service quality, privileging patient experience, improved outcomes and safe practice

Screening services

Screening is a process of identifying apparently healthy people who may be at increased risk of a disease or condition. They can then be offered information, further tests and appropriate treatment to reduce their risk and/or any complications arising from the disease or condition.

Screening in the UK is guided by an expert scientific committee called the UK National Screening Committee (UK NSC)[15]. The UK NSC makes recommendations on all aspects of population screening. It advises ministers and the NHS in the four UK countries about screening policy, and supports the implementation of screening programmes.

The UK NSC makes recommendations whether to screen for a condition based on internationally recognised criteria and a rigorous evidence review and consultation process. It maintains an active horizon-scanning function and encourages and supports research and innovation.

The UK NSC's database of recommendations sets out more than 100 conditions, including recommendations to screen for more than 30 of them. It meets three times a year to make new recommendations or update existing ones, based on reviews of the best-quality evidence available at the time.

[14] Improving Quality In Physiological Services (IQIPS). https://www.iqips.org.uk/
[15] National Screening Committe. www.gov.uk/government/groups/uk-national-screening-committee-uk-nsc

The process of evidence review includes details of how to propose a new topic for consideration, how to request an early update of a topic where there is new evidence or how to suggest a change to an existing screening programme.

A national screening programme is established only if certain conditions are met. These include the existence of an accurate and acceptable screening test, the ability to provide treatment and advice for people who are found to have a particular condition and the ability to ensure the programme does more good than harm to the people who are screened.

There are eleven population screening programmes in England, seven of which are covered in this Atlas, as follows:

- NHS Abdominal Aortic Aneurysm Screening Programme
- NHS Bowel Cancer Screening Programme
- NHS Breast Screening Programme
- NHS Cervical Screening Programme
- NHS Newborn Blood Spot Screening Programme
- NHS Newborn Hearing Screening Programme
- NHS Sickle Cell and Thalassaemia Screening Programme

The Public Health England Screening Division leads the NHS screening programmes nationally. A range of NHS and private providers deliver screening locally in line with national service specifications, standards and care pathways.

Screening is a balance of potential benefits and harms. The decision whether to accept the offer of screening is a choice for the eligible people invited. The NHS screening programmes aim to ensure individuals have the consistent and factually accurate information they need to make an informed decision about the offer of screening.

The uptake and coverage of screening can vary between geographical areas due to different population groups being more or less likely to accept the offer of screening. This can be due to a range of factors such as the prevalence of a condition, levels of deprivation and ethnic and cultural issues.

In geographical areas with large transient populations it can be difficult to track the people eligible for screening which can lead to individuals being ‘lost’ to screening.
A range of factors, including the age and gender profile of the population, can also lead to variations in the proportion of individuals who test positive for a condition.

The NHS screening programmes set national standards to help ensure local screening services provide a consistent, high-quality service to all those people eligible for screening wherever they live in the country. Screening providers have a statutory duty to ensure all eligible people have equitable access to screening services and information about screening.

The national Screening Quality Assurance Service (SQAS) monitors the performance and assesses the quality of local services using self-assessments and independent external experts.

Consistent data collection, including the publication of key performance indicators, enables fair and transparent comparisons to be made across the country. This helps to identify outliers, and allows examples of good practice to be shared. This in turn helps to improve the quality and to increase the consistency of screening services.

The national programmes set service specifications that must be followed when:

- commissioning any local screening services
- providing any local screening services

Failsafe processes help to reduce variation by minimising the risk of avoidable errors within local screening pathways.

The NHS screening programmes aim to offer more benefit than harm at a reasonable cost to the NHS, an important part of which is to reduce variation in the way screening is delivered locally, to improve quality and to increase safety.

Good-quality, meaningful and standardised data about screening is essential:

- to manage services
- to improve quality
- to identify unwarranted variation