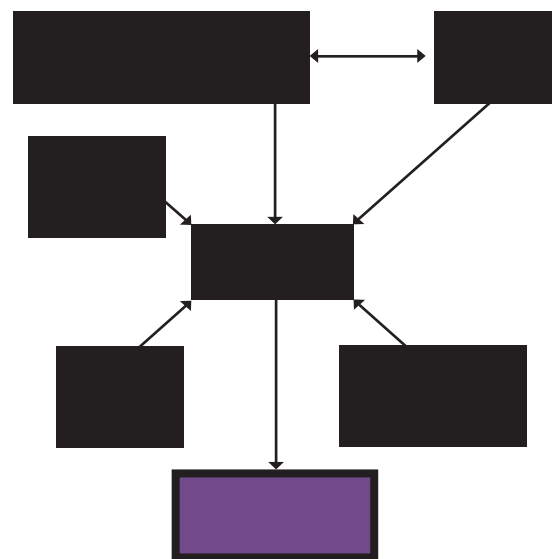
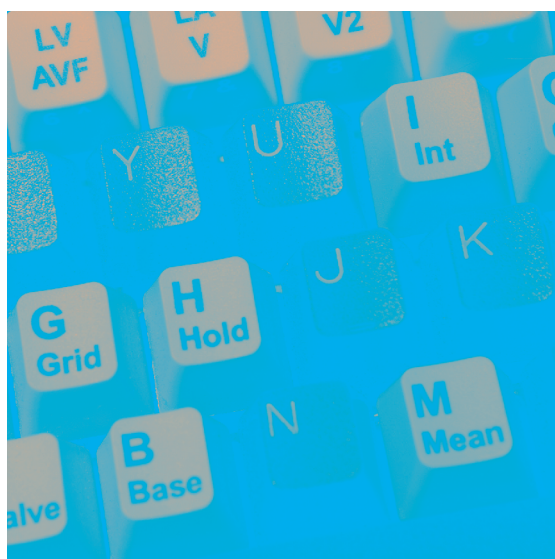


Understanding analytical capability in health care

Do we have more data than insight?

Martin Bardsley

2 / 6 1 ♀ 0 5 9 ♀ 3 ♀ 1
2 2 ♀ 9 7 ♀ 1 9 2 ♀ 3 ♀
→ ♀ 1 ♀ 7 ♀ £ 0 8 4
1 ♀ 7 = 2 * 6 6 2 ~ ♀ 9
(♀ 6 1 ♀ 2 ♀ ? 1 9 2 ♀
7 ↑ 6 ? 4 8 4 ♀ 7 * 5 ?
9 ↙ 1 ♀ 5 4 9 £ 1
♀ 6 3 4 * 3 8 ♀ * ♀ ?
6 > 9 ! 6 ♀ 8 1 ♀ 3 ♀
♀ 0 ♀ ♀ 2 4 7 = ♀ 0 9 ↓



About the author

Martin Bardsley has over 20 years' experience in health services research and analysis. He was formerly Director of Research at the Nuffield Trust. Over seven years he led the Nuffield research team in a series of innovative projects on applied health services research and is currently working part time as a Senior Fellow. He is also working as a Senior Fellow at the Health Foundation.

He has previously worked in regulation at the Commission for Health Improvement before moving to the Healthcare Commission, where he led their work on new ways to use information to target regulatory activity.

Martin is a Fellow of the Faculty of Public Health and in the 1990s he established a London-wide resource on public health information. This work led to a number of reports on health in London, including the first Public Health Report for Greater London in 1998.

Prior to that Martin had worked on the application of outcome measurement which formed the basis of his PhD. He was also involved in early stages of the application of Diagnosis Related Groups (DRGs) in the UK – work that eventually led to Healthcare Resource Groups (HRGs) and Payment by Results.

Acknowledgements

I would like to thank the many people who have given me advice and comments over the past few months and especially those interviewed in connection with this report (see Appendix A).

I am also grateful for the advice and help of colleagues at the Health Foundation including Sarah Deeny, Isaac Barker, Penny Pereira, Ruth Knox, Adam Roberts, Shaun Leamon, Helen Crisp, Sushma Sangyam, Alastair Brett, Adam Steventon and Jennifer Dixon.

Note, however, that the views in this paper are those of the author alone.

Contents

Executive summary	3
Background	3
Factors driving analytical capability	4
What is to be done?	6
Who should do what?	7
Conclusions	8
Section 1: Introduction and background	9
Introduction	9
Why do we need analysts?	10
What do we mean by analysts?	13
Section 2: Factors that shape analytical capability	16
Supply side factors	19
Demand side factors	23
Section 3: What is to be done?	26
Promoting development and learning through better networking and communication	27
Tools for analysis	29
Working at scale	29
Environments for innovation	31
Supporting applied training and development programmes for the analytical leaders of tomorrow	32
Managing demand	32
Specific recommendations for action	34
Conclusions	35
Appendix A: Interviewees	36
Appendix B: How many analysts does it take to... support a health service?	38
References	41

Key points

- The ability to use information is an essential element in any health care system.
- Analysis is critical to a range of issues facing the health service in the UK. These include the implementation and evaluation of new models of care in England, planning across organisational boundaries, as well as implementing and tracking initiatives to assure and improve the quality of care.
- A skilled workforce that is able to manipulate, analyse and interpret data is essential for a modern health care system. However, there is a widely acknowledged problem that health services often cannot access the right level of skilled analysts.
- While this is partly a question of the number of analysts, it is also a problem that the health service is not making best use of the analysts it does have.
- There are key issues around both supply and demand that need to be addressed. Supply is about providing the means for health care organisations to recruit, retain and develop analysts and provide them with the tools to do the job. Managing demand will involve raising awareness among senior managers of the importance and potential of good quality analysis.
- There are a number of groups and initiatives that can support improvements in the analytical workforce, including education and training, professional development and networking.
- There are also some key issues that are more challenging, and subject to the wider change agenda. These include:
 - supporting training and development opportunities that are linked to the needs of the service
 - helping analysts work in larger teams that span across organisations
 - providing room for innovation, development and testing of new analytical applications
 - creating new relationships with the experts to improve the quality of support and evidence
 - stimulating the demand for good quality analysis among NHS leaders.

Executive summary

Background

People that are able to manipulate, analyse and interpret data are essential for a modern health care system. But there is an acknowledged problem that health services in the UK often cannot access the right level of skilled analysts and data scientists to support decision making. This deficit exists across all sectors and levels within health care. Therefore it is important that, in addition to strategies for investment in new information technology and big data, the data analysis workforce is also considered.

This paper is intended to outline to policymakers and analytical leaders in the health service the nature of the problems caused by limited analytical capability in health services in the UK. It also looks at some different ways that these issues can be addressed. While the paper considers the UK as a whole, many of the examples are focused on the English health service in particular. The paper is based on a series of discussions and interviews with analysts, academics, clinicians and managers. The people I spoke to raised many examples of good analysis, as well as variations between organisations. The general picture that emerged is:

- decision-makers in health care cannot always access the type of analysis they need
- in some cases, there are too few analysts and those that are there are too busy working on mundane data manipulation (known as ‘lifting and shifting’)
- where there are analysts within health care, their skills can be limited and, in addition, they often work in small units with little chance to develop professionally
- the increasing amount (rightly) being spent on information is not being matched by investment in people to analyse this data.

Good analytical support is important at all levels of the health service. Analysis can help shape care for individual patients as well as across organisations and health systems. Good analysis is especially important for the current NHS if it is to make progress in key areas including – in England – the implementation of the *NHS five year forward view* and the development and implementation of sustainability and transformation plans (STPs). It also has a role in addressing the important agenda on quality and safety in identifying areas for improvement and monitoring change. Perhaps most importantly, analysis is central to learning health care systems* and has been shown to be a vital aspect of high performing organisations. The problems caused by limited analytical capacity and capability have been acknowledged by the National Information Board in England, who have created a working group to address the issue.

* A learning health care system is defined by the Institute of Medicine (IoM), as a system in which, 'science, informatics, incentives, and culture are aligned for continuous improvement and innovation, with best practices seamlessly embedded in the delivery process and new knowledge captured as an integral by-product of the delivery experience.' See www.learninghealthcareproject.org/section/background/learning-healthcare-system

Some examples of where health and care services can suffer through a lack of analysts include the following:

- **Board level oversight of complex organisations/systems.** All boards do some routine monitoring of organisational performance and activity but the quality of this routine analysis in some organisations is not always clear.
- **Informing strategic choices of investment and disinvestment.** There is a question about the nature of the evidence available to support major organisational, system level decisions.
- **Understanding the impacts of change and new service models.** The NHS is awash with innovations in how to deliver care – changes triggered by either a desire to improve service quality, the need for financial solvency or both. Yet despite the hunger for new models of care, it is hard to know what really works.
- **Operational and clinical management for quality improvement.** At a service level, quality improvement relies on a level of analytical support to drive change – yet often this is absent and as a result there are weaknesses in the systems for monitoring and evaluating changes.

Factors driving analytical capability

There is no definitive count of the number of analysts working in health care in the UK – I estimate that it is in the region of 10,000 across the UK (see Appendix B). Analysts span many different disciplines and skills and do not form a homogenous occupational group. This paper focuses on a set of skills/people that make sense of data/information in order to create intelligence. This represents a subset of the wider group of people working in informatics, which also includes people working on IT systems and data management.

My interviews suggested that the critical attributes for analysts in health care are the ability to:

- understand and structure the problems faced by managers/clinicians
- access and understand the evidence and information that can be brought to bear on a problem
- apply appropriate and robust methods to manipulate information and data
- communicate the findings accurately and clearly.

It seems that there is no simple explanation for why there is a shortage of analytical capability in parts of the system. Rather, explanations that came up in my interviews spanned factors linked with the supply of analysts as well as the demand for their services. Table 1 sets out the key factors that were identified by interviewees.

Table 1: The key factors behind lack of analytical capacity and capability in health care in the UK

Analyst numbers and priorities	In some areas there were just not enough analysts, but there was also a strong message that the existing workforce is not always used to its full potential.
Analyst skills	Some analytical teams cannot easily access people with skills in more academic disciplines such as statisticians and economists. There was also a strong message about the importance of analysts having good communication skills and the ability to explain complex ideas to senior managers clearly and concisely.
Access to data and tools	Though not all analytic tasks require specialist tools, or even access to special data, there are occasions where the lack of the right data can hamper the analysis undertaken. There was a sense in the interviews that better software tools could free up analysts' time from mundane tasks. The problems in terms of access to data mainly revolve around the challenges of obtaining data at the right level that satisfies information governance requirements.
Professional and personal development	There is a lack of opportunities for analysts to progress their career to a senior level while still being an analyst.
Fragmentation and isolation	For any professional or occupational grouping, the ability to share experiences and learn new methods and techniques is essential. Yet very often health care analysts can become isolated – as individuals or in small teams spread across organisations.
Getting senior management recognition	Though it is dangerous to generalise across all organisations, a number of interviewees suggested that senior managers did not always see the need for or value in analytics.
Analytical leadership	Many interviewees described the importance of analytical leadership – people who understand the supply side of the issues yet could also engage with managers at the highest levels to influence and shape demand.

What is to be done?

In a situation where the problems are multifaceted, so, it seems, are the solutions. Indeed, there is already a range of activity on these issues being undertaken by a variety of local and national organisations – discussed in more detail in Section 3 (page 26). It is clear that the following areas will need particular attention:

1. **Supporting professional development and training** that is focused on the application of analysis. There is clearly a role for a wide array of training resources, either in the form of dedicated fellowships or more general training and education. It is important that these are seen as opportunities for people working in the service – not an academic career. There is also a need to consolidate work on professional competencies for analysts. This can form the basis for individual career planning and establishing relevant training programmes.
2. **Support for analytical networks.** Networks are important to overcome the fragmentation and isolation that analysts can face in health services. There are a number of analyst groups but coverage across the country is patchy relative to needs. Steps that could encourage analysts to participate in networks include covering subscription costs and giving people time to attend networking events.
3. **Investing in supporting tools for analysis.** There are a number of software tools that can help the existing analytical workforce work more efficiently. Better ways to incentivise investment and sharing in these are needed. This includes ways to speed up routine data manipulation and the recognition of common problems and solutions across organisations. There also needs to be simplification of, and support for, access to data and information governance. Although individual organisations will have their own requirements, there is a role for the centre in supporting the spread of good practice in both the creation and sharing of common tools and in clarifying information governance.
4. **Encouraging cross-organisational working and collaboration.** The problems of fragmented communities of analysts and the need to develop teams that encompass an array of different skills are strong arguments in favour of working across current organisational boundaries. For example, this could be in regional groups or ad-hoc consortia of providers, commissioners or regulators. Successfully working in this may involve the following:
 - **Recognising the importance of cross-organisational analytical work (at scale).** Whether in organisations like commissioning support units (CSUs) or part of processes such as planning for STPs, there are benefits in creating specialist teams that serve a number of organisations. This can mean creating specialist roles that support a range of organisations, as well as finding ways for individual analysts to move in and out of these wider organisational forms.
 - **Creating environments for innovation.** In addition to the supply of analytical expertise there is also scope to achieve economies of scale in terms of analytical methods. There is an emerging model of using specialist centres

to act as laboratories for common analysis. These need to be established in ways that work directly on analytical issues relevant to the service and include NHS analysts in generating solutions.

- **Developing new relationship with experts.** One of the most effective ways to improve the skills of analytical teams is to establish the link with topic experts – typically from academic settings. There are examples where senior academics have worked with the NHS on problem solving outside of the traditional commissioned research models, as well as projects jointly developed by the NHS and academic groups. There are also a growing number of areas where ‘researcher-in-residence’ models are being used. Such initiatives are to be encouraged as one way to bridge the sometimes conflicting demands of an academic career and applied analysis in the service.
5. **Stimulating demand for analysis.** There are a number of strategies that can help reinforce the value of analytics at a local level. These might include:
- ways to help prove the value of analytics
 - developing tools for auditing analytical development
 - raising awareness of the role analysis can play in training and existing management development initiatives
 - making more explicit central requirements about the use of particular analytical methods.
6. Finally, it is important to ensure that analysis is recognised as an essential ingredient in addressing a range of current concerns. The growth of clinical informatics, especially among medical professionals, can be an important lever for change.

Who should do what?

Addressing the issues caused by lack of analytical capability requires action at a number of levels in the health service. The following key actions are needed:

For those in provider or commissioning organisations:

- support local analysts in their own development and engagement with networks
- review organisational analytical capability and look at the range of skills in, and organisation of, local teams
- look for opportunities to share analytical expertise between organisations and where possible look for flexible working patterns across organisations.

For those involved in education and training:

- prioritise in-work training programmes to develop analytical skills
- include an understanding of analytical work in general management and leadership training.

For academics, researchers and research funders:

- work with local health agencies on an agenda of applied analysis, including shared posts and researchers-in-residence
- look for ways to support hubs for analytical innovation that span a range of disciplines and have an agenda set by health care organisations.

For central/national organisations:

- support the development/dissemination of shared analytical tools that initiates and improves communication and learning among analysts
- support the use of cross-organisational analytical teams, including working with analysts from central organisations, and the use of centres for innovation in analytical methods
- look at ways to support existing and emerging analytical leaders as well as chief clinical information officers.

Conclusions

The ability to use information is an essential element in any health care system. Analysis can help shape care for individual patients as well as across organisations and health systems. It also has a role in helping to improve quality and safety by identifying areas for improvement and monitoring service delivery.

Despite major changes in the way data are used in health care, having the right people in place at the local level is a critical factor that has in the past suffered from underinvestment. In the current financial climate, choosing to invest in better information and management systems is not easy given the pressure on front-line services. Health systems cannot function without management or without information and there is always a need to use information and intelligence to support big decisions on how things are run and where money is spent.

To support efficient and effective health care systems, delivering the best possible care for patients and service users, we cannot ignore the need to build the infrastructure of intelligence that helps make better choices. This means not just investing in the new technology of health information but also in the people who know how to make the most of that information to support a better service.

Section 1: Introduction and background

Introduction

We live in an age in which the scope and volume of information available to inform decision making is growing exponentially. Computerisation of our everyday lives means that data about us is accumulating at an ever-increasing pace. There are increasing opportunities to use this information in new ways – as the government’s 2013 strategy for UK data capability put it, *‘one of the greatest opportunities and challenges facing policymakers today is the ever-increasing significance of data’*.¹

This applies across public and private sectors,^{2,3,4,5} as well as in health care, where the digital future appears pregnant with possibilities. As Robert Wachter said, *‘Big-data techniques will guide the treatment of individual patients, as well as the best ways to organize our systems of care’*.⁶ The recent report from the National Advisory Group on Health Information Technology in England, *Making IT work*, emphasises the scale of change required.

*‘In order for the National Health Service (NHS) to continue to provide a high level of healthcare at an affordable cost, it simply must modernise and transform. This transformation will involve enormous changes in culture, structure, governance, workforce, and training. But none of the changes are likely to be as sweeping, as important, or as challenging as creating a fully digitised NHS.’*⁷

In planning for this new world, there are three key elements that need to be in place:

- The data itself – how it is captured, used and shared across applications.
- The tools and infrastructure to collect, store and analyse data – including the boxes, wires, devices and software.
- People – a skilled workforce and data confident citizens.⁸

In health and care services, people often debate (or lament) progress on the first two in this list but less often do we – those working to improve UK health services – think about the human element. Yet in many cases, this can be a rate-limiting step to improvement, critically affecting our ability to exploit all the data that is being collected.⁹ Though there is currently much excitement over ‘big data’, there are many who believe that it has not yet been possible to exploit the data that currently exists. Without a skilled workforce to manipulate, analyse and interpret data, the ability to exploit new technology is limited. *‘Unleashing the power of computerization depends on two keys, like a safe-deposit box: the technology itself, but also changes in the workforce and culture.’*¹⁰

Yet it seems this is an area where UK health services face a real problem.¹¹ There is a widespread view that that we don’t have sufficient analytical capacity to inform important decisions about health care – whether at the level of individual professionals/patients or up

to board level. As England's Chief Knowledge Officer, John Newton observed in 2015, the NHS is 'underinvesting in capability and capacity for the use of data', compared with the amount it generates and collects.¹²

The National Information Board has created a working group to look at the issue in England¹³ and there are a number of initiatives which recognise the challenge. It is worth noting that this issue is not unique to the health sector^{14,15,16} and some people suggest that the advance of digital technologies is likely to exacerbate the demand for those with specialist skills.¹⁷

In order to explore these issues in the health sector, during a few months in 2016, I interviewed over 80 people who know something about these matters (see Appendix A for details of interviewees). This paper draws on these discussions (and includes a selection of quotations from them). Interviewees were selected initially on the basis of their knowledge of the area or following recommendations from others. Interviews were loosely structured around a series of basic questions with data collected as free text that was used as the basis for a thematic analysis.

The vast majority of interviewees felt that, although there are examples of really good analytical working being undertaken, the distribution of this capability is patchy and in many organisations there is a shortage of the right types of analytical skills. Though this paper focuses on health care, a number of interviewees felt that similar challenges exist across social care and other parts of the public sector.

Why do we need analysts?

The ability to use information is an essential element in any health care delivery system. It happens in many ways and at many different levels.

*'One of the greatest opportunities of the 21st century is the potential to safely harness the power of the technology revolution, which has transformed our society, to meet the challenges of improving health and providing better, safer, sustainable care for all.'*¹⁸

Data analytics is a fundamental part of many of these activities – not just measuring and communicating impact, but also identifying and solving problems, and ensuring execution and implementation. Table 2 lists some of the ways that analysis is involved in modern health care systems.

If there is a shortage of analytical expertise the consequences are not always obvious or immediately visible. Rather, the shortage of analysis can lead to a range of suboptimal decisions and choices based on limited or inappropriate evidence.

Pages 12–13 give some examples of areas where health and care services can suffer through a lack of analysts.

Table2: What sort of things do analysts do?

Information and intelligence for...	Examples of what analysts do in different contexts
General population about services available	<ul style="list-style-type: none"> • Identify information sources that might be useful to patients • Test impacts of different presentation styles aimed at patients and general population • Look at the impact of new information systems
Care users or patients	<ul style="list-style-type: none"> • Design and test the impact of new approaches to sharing information with patients
Clinical teams	<ul style="list-style-type: none"> • Develop decision aids/tools that exploit data, eg risk scoring • Inform improvement initiatives
Service managers/ team leaders	<ul style="list-style-type: none"> • Support data collection and analysis of clinical audits • Identify service objectives and monitoring tools (performance indicators) • Track new care initiatives and improvement • Devise and adapt mathematical modelling tools, eg scheduling • Synthesise and summarise the literature on effectiveness of new interventions and service models
Commissioning and planning	<ul style="list-style-type: none"> • Assess needs and priorities • Review evidence of effectiveness and efficiency • Identify need/demand and forecast for populations • Model capacity requirements and business planning • Agree evaluation frameworks and monitor impacts of service models • Monitor the quality of services
Running organisations	<ul style="list-style-type: none"> • Analyse performance • Economic studies • Quality monitoring • Assess impacts of change, eg closure of A&E • Business and strategic planning
System and national level	<ul style="list-style-type: none"> • Develop and apply mathematical models to inform policy, eg on vaccination or urgent care • Regulate efficiency and quality • Resource allocation • Monitor against strategic priorities • Programme evaluation

Areas that can suffer from lack of analytical capability

- **Board level oversight or complex organisations/systems.** All boards do some routine monitoring of organisational performance and activity but there are questions raised about the quality of such routine analysis in some organisations. So, for example, a board report that runs to 80 pages of bewildering tables and graphs with no attempt to highlight key issues will not necessarily help board members tackle big decisions or develop an improvement agenda to tackle issues like safety.¹⁹ It seems that sometimes the problem is not a shortage of information but *'an overabundance of irrelevant information'*.²⁰ Similar problems have been observed at national level in a recent UK Statistics Authority review that highlighted some of the problems at national level in supporting basic nationally accredited statistics.²¹

This extends beyond routine internal reporting to the ability to respond to an externally set agenda around performance management and assessment – for example, when targets and ratings are generated using complex methodologies (eg Standardised Hospital Mortality Index statistics) or when centrally generated tools are used to assess wider aspects of performance.* These often require some analytical time locally to make sense of and put into local context. It can be difficult for an individual organisation to ignore some of the centrally identified resources as they will often be used in performance management or regulatory discussions. An organisation without the analytical capacity or capability will not be able to engage in such discussions.²²

- **Informing strategic choices of investment and disinvestment.** The question here is about the nature of the evidence available to support major organisational system level decisions. In this area the more structured approach to intelligence has to pitch against some of the local politics around decisions. For example, one trust was looking at where to locate local clinic facilities – yet they were not able to use relatively easily obtainable information about the flows of where patients were coming from. Very often the best way to understand health care systems is through the use of more sophisticated methods such as modelling, yet uptake of these has been patchy. The challenge in adopting these tools routinely has been linked to a lack of capacity in health services, where too few staff members are felt to have the training or capability to use these models.²³ This is especially relevant considering current concerns about managing urgent and emergency care flows.^{24,25,26}
- **Understanding the impacts of change and new service models.** The NHS is awash with innovations in how to deliver care – changes triggered by either a desire to improve quality of care, the need for financial solvency, or both. Yet despite the hunger for new models of care, there is often no way of knowing what really works. Often, there is not the capability to know whether the changes people are working so hard to implement are having the desired effects, eg reducing emergency admissions.^{27,28}

For example, in England, the Prime Minister's Challenge Fund has meant that there is a lot of money and effort going into setting up primary care hubs. As one interviewee noted: *'Those people implementing these services need access to data on who is using that service when and how – this is all data that sits in the CSU. We need analytical skills to get at the data and manipulate it so we can get useful intelligence to the board'*.

* Examples include CCG outcomes tool (available from www.england.nhs.uk/resources/resources-for-ccgs/ccg-out-tool/) or the NHS atlas of variations (available from www.rightcare.nhs.uk/index.php/nhs-atlas/)

- **Operational and clinical management for quality improvement.** At a service level, successful quality improvement relies on a level of analytical support to drive change – yet often this is absent and as a result there are weaknesses in the systems for monitoring and evaluating change.²⁹ One example in recent years has been the increasing efforts to use information on in-hospital mortality as an indicator of possible problems in care. However such information is used, it is important to have some grasp on such a basic outcome marker, yet many have found this difficult and have had to rely on external support to understand what is happening in their own organisation.

In terms of basic operational management, there are many opportunities for good analysis to make all kinds of everyday tasks that little bit more effective or efficient. For example, one interviewee mentioned that they were working on helping an organisation with nurse scheduling – somethings that has to be done regularly around the country. There must be something in the order of 10–20,000 ward managers spending 1–2 shifts every month doing ward scheduling. The interviewee said that while there are software tools that could help, these were not being used effectively and the trust had been lacking analytical support to get a system that worked.

What do we mean by analysts?

The people who undertake the sorts of activities described in Table 2 do not neatly fit within an occupational or professional group or in an academic discipline. The skills are most commonly found as a subset of informatics or data science,^{*} which are themselves broad groups. Within informatics, Health Education England includes a number of roles covering areas such as: education and training; health records and patient administrators; information and communication technology; libraries and knowledge management; project and programme management.³⁰ These are organised within a wider framework with linked descriptions of job roles and competencies in the Health Informatics Career Framework (see Figure 4).³¹

In discussions of analytical capability, it seems that the people and skills sought can be located in different places. However, many of the people I interviewed identified a number of recurrent themes that distinguish the types of skills required. These include:

- being able to understand and structure a problem
- accessing and understanding the evidence and information that can be brought to bear³²
- applying appropriate and robust methods to manipulate information and data
- producing and communicating the findings.

A number of interviews emphasised that this is not about purely technical or academic skills but included elements such as a '*spirit of inquiry and ability to derive insights from information*'. In my view, these skills embrace both quantitative and qualitative analysis. Though they often rely on the ability to exploit big data,[†] this is not always the case. There is important analysis to be done even when there is limited data available.

* These can be described as: (1) data science: 'extraction of knowledge from large volumes of data that are structured or unstructured'; (2) health informatics: 'the knowledge, skills and tools which enable information to be collected, managed, used and shared safely to support the delivery of health care and promote health'. Neither quite match the analyst described here and I tend to use both terms interchangeably.

† Big data is a term for data sets that are so large or complex that traditional data processing applications are inadequate to deal with them.

Table 3: The role of analysts?

Roles that support decision making by...	
Things we do mean	Things we do not mean
<ul style="list-style-type: none"> • ...looking at information to extract key meaning • ...exploring/knowning what information is available and relevant to a particular problem • ...devising ways to collect better data and ways to monitor change • ...clarifying goals and ways to measure progress towards them, ie actively monitoring performance • ...communication of information and evidence • ...evaluating the consequences of change • ...using quantitative and qualitative data to identify or test solutions to organisational problems • ...showing a heightened degree of methodological rigour in looking at evidence. 	<ul style="list-style-type: none"> • ...running/developing information/IT systems • ...devising new hardware/software systems • ...mapping activities of care – process engineering • ...managing hardware/software systems for data collection or storage • ...academic researcher eg within a higher education institute and funded by national grants.

Most important is to stress that the role of an analyst is not necessarily about implementing or supporting information technology or developing/maintaining data warehouses. Confusingly, it's also not about being a system analyst who designs information technology solutions. Nor is it about routine administrative processes to stream information around and across organisations. It is also not about research per se – though there are many research roles that are important to analysts. Rather, the key output of analysts is intelligence to inform decision making. That said, good quality analytics needs to draw on skills and methods that typically exist in academic settings. Yet getting the best fit with the academic world can be a challenge.

When describing analysts it is clear that we are actually referring to a team of people with a range of skills and expertise. For example, these might include skills in: statistics; manipulating and linking large data sets; social research methods such as survey design; mathematical skills (eg operational research and modelling); economics; epidemiology; methods and measurement; public health; improvement science; health policy; evaluation; and so on. In an organisation employing only one or two analysts, it is not possible to cover this breadth.

This places an increasing importance on communicating and working across virtual groups, networking and organising analysts to reach a critical mass. Yet people have observed increasing fragmentation of NHS organisations in England – and some organisations like clinical commissioning groups (CCGs) have only one or two analysts. The fragmentation on the commissioning side has been linked to the 2012 Health and Social Care Act. Whatever the merits of primary care trusts (PCTs), they did include public health analysts, health service business intelligence and finance all working in one organisation. These have now largely been split off into three organisations – CCGs, local authorities (LAs) and commissioning support units (CSUs).

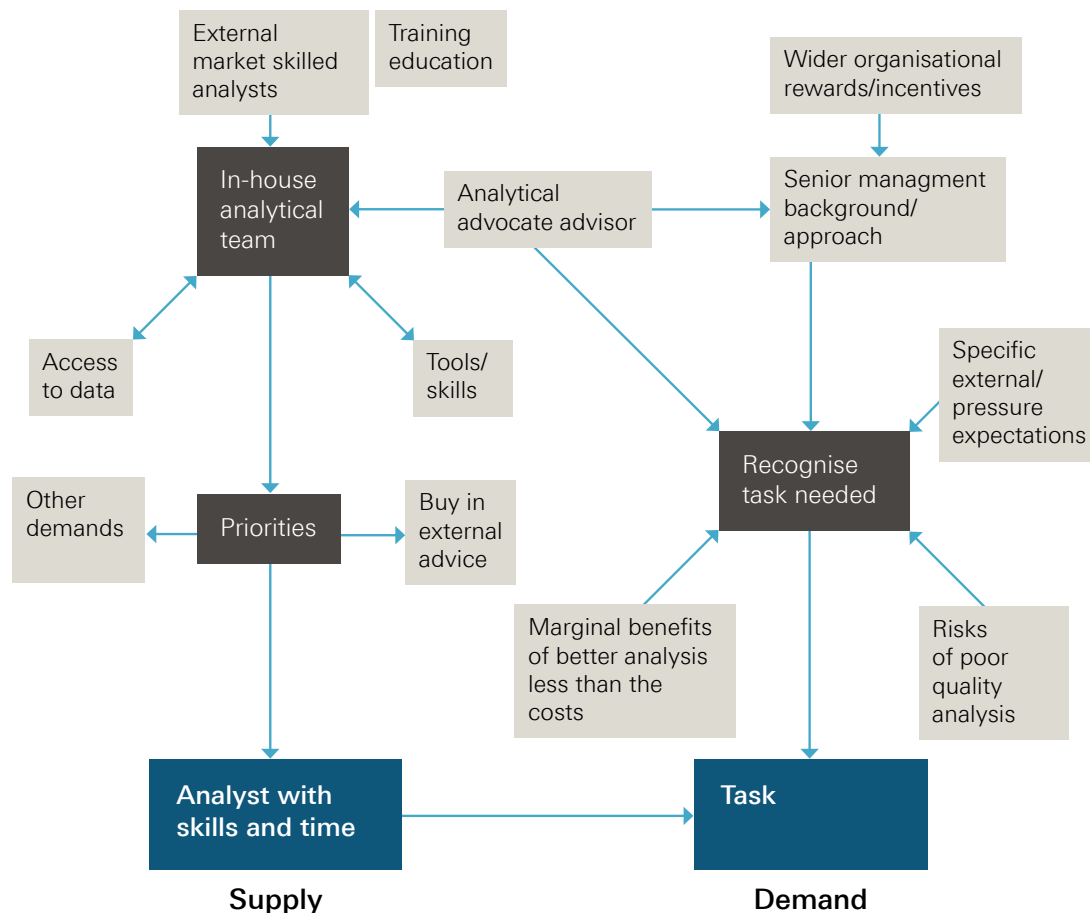
There are no reliable figures on how many people are working as what we describe as analysts. Appendix B shows how I estimated the number of these analysts in the UK NHS and public health, using a combination of information sources and some guesswork. The result of that is a figure of around 10,000. This is much smaller than the number of people working across informatics as a whole, which probably exceeds 50,000 (based on extrapolation of an annual survey of information leads in the North West undertaken by ISD North West).

Section 2: Factors that shape analytical capability

Having spoken to many people about analytical capability (see Appendix A), it seems that the overwhelming view is that, while there are some great examples of good practice, these are unevenly distributed across the service. Overall there is a problem for the NHS in recruiting, retaining and using the right type of analysts.

So why is this? It seems that there is no one simple explanation but rather a combination of generic and specific factors. Figure 1 outlines a generalised picture of some of the factors that shape the roles of analysts. At the centre of this model is the conjunction of analyst and task. The model is based on the belief that the problem not only involves issues around how analysts are recruited and used, but also how the tasks undertaken by analysts are identified. These two elements represent the supply (left-hand) and demand (right-hand) sides of the equation. It is worth emphasising the way that these factors can be reinforcing: if analytical tasks are not regarded as important, then investment in analysts will not be great so there will be fewer of them and they may lack certain skills.

Figure 1: Factors that shape the recruitment and use of analysts



The interviews identified a range of different views about the key underlying issues (see Table 4). All of these explanations will undoubtedly play some part. The rest of this section discusses these factors in more detail.

Table 4: Reasons given for the lack of analytical capability

Supply side issues	Paraphrased quotes from interviews
Number of analysts	We just don't have the numbers of skilled people to meet the demand – and we have no money to recruit.
Other priorities	Most of our analysts' time is spent doing rather pointless tasks that are demanded to keep the system running, eg generating information for those above us in the hierarchy – 'feeding the beast'.
Analyst skills – quantitative	Some analysts have very limited quantitative skills. They spend all their time manipulating data in Excel/SQL. Some analysts fail to apply reasoning skills – too much handle turning and low level data manipulation tasks.
Analyst skills – communication	Sometimes our analysts have done great work but they are unable to explain clearly and concisely... so they get ignored.
Access to data	The data we have is so limited it inhibits the types of analysis we can do. In particular our ability to use clinical data is really dependent on basic systems for collection... which still need improvement. Too often we measure using what we can use rather than what we should.
Access to tools	We really need to automate some of the routine tasks that take up so much of our analysts' time. And/or we need to create tools that managers/others can use directly so we spend less time on 'lifting and shifting'.
Access to peer support	Difficult when analysts are fragmented. There is a danger when analysts get isolated – we used to have an informal network across the region but nowadays providers are bad at getting together – but there is an opportunity for sharing and learning. There is not a formal community of analysts.
Professional and personal development	The imprecise nature of what we mean by an analyst means that there are no clear qualifications – or even competencies that you need to be called analyst. Too many analysts work in isolated small units – there is little chance to develop skills and learn from others.

No career progression	You rarely get analysts going above band 8 and still doing analysis. There is usually no place for the higher skilled analysts – they get dragged into management roles or attracted to the private sector.
Use of external analytical support	So a private consultancy was drafted in to develop a dashboard – which was poorly specified and pretty meaningless. Private sector brought in as there is a need to deliver in the short term when there is no local capability.
Demand side issues	Paraphrased quotes from interviews
Recognition by senior leaders	<p>The head of our organisation doesn't take analytics seriously. One of the first jobs of a new CEO was to get rid of the analytics team – he didn't see the point.</p> <p>Some of our senior management team can know embarrassingly little about information and data. Scope to train the customers – not good if they don't know the right questions to ask.</p>
Fear of numbers	Some CEOs/senior leaders don't understand analysis and what they are missing. Sometimes the questions they are given to analyse are naïve and simple... good analysts need to unpick what lies behind these.
Leadership	There isn't the same awareness of information leaders as, say, finance. Everybody knows who the director of finance is – but who knows the CIO? We need a broadly based strategy for 5–10 years. Start at the board level – ask questions about the level of analytical support they get at present, and then move down through the executive team.
Setting the standard for analysis	Problem that some policy areas are not getting the attention they should. Too often we measure using what we can use rather than what we should use. Need training for front line and better tools for measurement... There will never be enough analysts so how do we deliver and support local initiatives.
Distraction of technology	People get too excited by new technology – they don't recognise the need to think about how you use the information we have already, or are about to acquire.

Supply side factors

The numbers of analysts and priorities

Almost all the people I spoke to suggested that one of the problems was that the analysts we do have spend most of their team doing rather menial data manipulation in order to satisfy reporting requirements from somebody higher up – aka ‘feeding the beast’. Typical comments from interviewees included:

‘Lots of capacity in the system but it’s in the wrong place; too much focus on performance stats.’

‘Data not used properly and in most organisations it’s old school data processing rather than analysis.’

‘There is lots of demand for low value dashboards and metrics... the crap dashboard industry proliferates.’

Why is it like that? There are two types of potential explanation – and each is probably important to some extent.

1. There is an over-developed appetite for management information that has generated the need for data to be parcelled up and sent up the hierarchy. It is not uncommon for organisations to feel, with some justification, that this is the case and that central organisations’ demand for information can be overly burdensome.
2. A number of interviewees suggested that the tools needed to automate routine data manipulation, and so free up analysts’ time, were not available. *‘We don’t use technology well enough to do basic tasks and end up with a shortage of higher skills (because they spend time on basic data manipulation).’*

Having the right skills and recruiting the right people

As I noted earlier, there is a range of different skills associated with analysis – and these rarely reside in one person. Many organisations report problems in recruiting analysts with the higher level skills and expertise. *‘PCTs and CSUs have found it difficult to recruit people with right competencies, in particular in-depth understanding of information... which is vital for liaison with customers.’* As a consequence, many larger organisations use a combination of graduate recruitment and in-house training programmes, linked to local frameworks of competencies and a route to promotion.

However, there were felt to be some skills that were in particular demand. Expertise most commonly cited as hard to get was:

- health economists – or people who can include some aspects of costing resource use in their analysis
- epidemiological and methodological skills – these are often linked with public health specialists.

Aside from these academic disciplines, the two most commonly desired attributes were people who could structure problems and understand the needs of senior managers and clinicians. This is not always simple. As Ackoff described:

‘Managers are not confronted with problems that are independent of each other, but with dynamic situations that consist of complex systems of changing problems that interact with each other. I call such situations messes. Problems are extracted from messes by analysis. Managers do not solve problems, they manage messes.’³³

The analyst’s skill should be to interpret the manager’s mess and see what information and intelligence can be brought to bear.

Another general skill that was felt to be lacking was around communication. As one interviewee said, *‘The problem is that often analysts are too techy and present things as too complex and unintelligible’*. There was widespread recognition of the importance of being able to communicate methods and findings to senior managers clearly. The implication is that an analytical team needs people who can communicate with managers and clinicians, as well as people who can write good code.

Access to tools and data

Not all analytic tasks require specialist tools, or even access to special data, but there are occasions where the lack of the right data can hamper the analysis undertaken. The most commonly cited problems relating to data access are the barriers created by the confusion and uncertainty around information governance rules for person level data. Yet it is this type of information that is becoming more abundant and offers such great potential – especially when linking patient events over time or across services. Yet despite this potential, the information governance situation means people are unsure what can be accessed – and in some cases systems to clarify what is required to make the best use of person level records are non-existent. Similarly, there was also a belief that access to the right tools – usually software – was also important, especially in relieving the burden of routine work and freeing up capacity for more sophisticated analysis.

Access to peer support and networks for sharing and learning

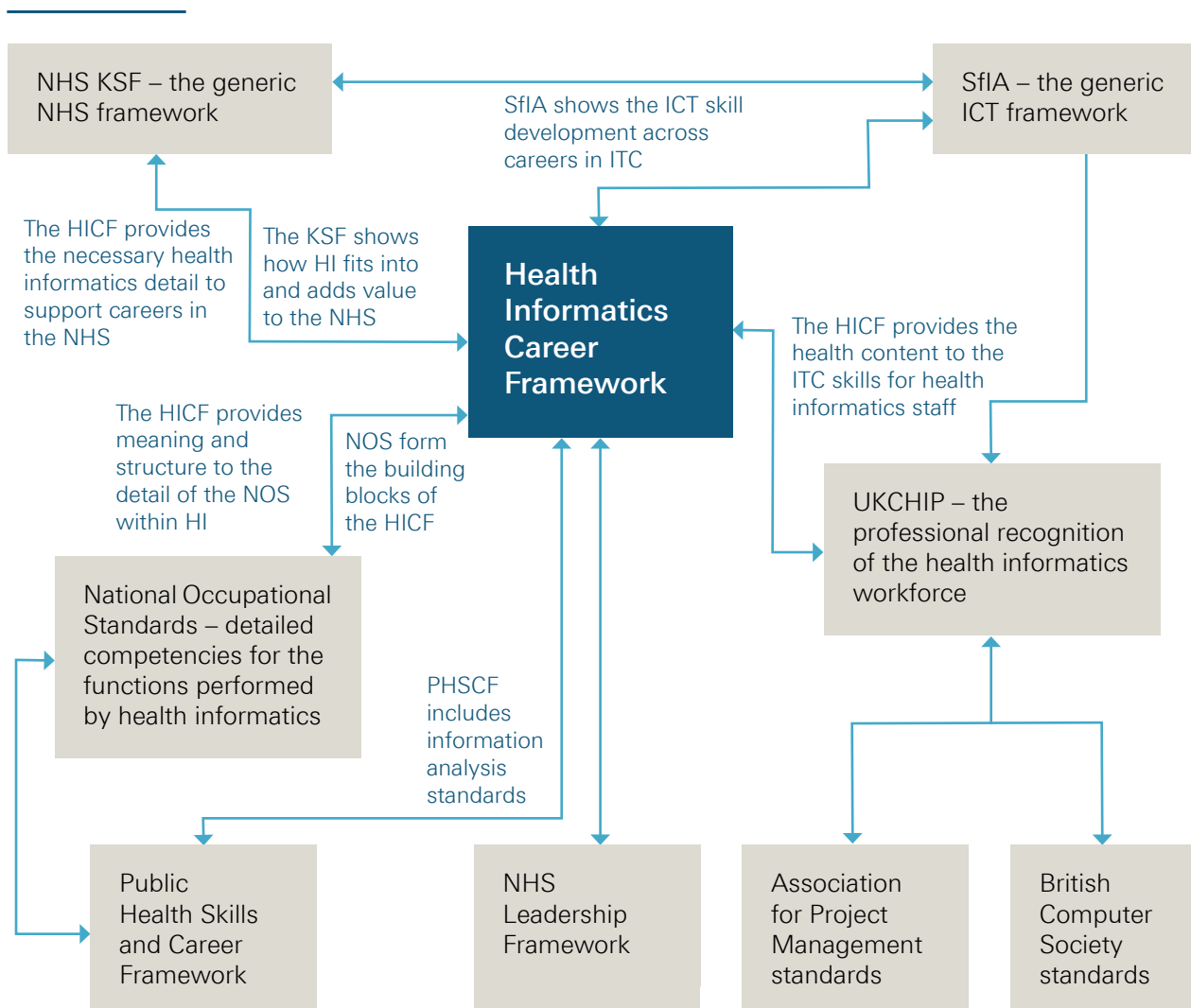
For any professional or occupational grouping, the ability to share experiences and learn new methods and techniques is essential. Yet very often, analysts can become isolated – as individuals or in small teams spread across organisations. It seems the most recent wave of health service reorganisation has not helped. As one interviewee noted, the failure to share experiences means that there is *‘Lots of activity reinventing stuff locally eg patient experience measures; ignorance of information governance requirements – there is plenty of scope for sharing’*. The fragmentation of analysts is felt to be worse after recent organisational changes – and there is a sense that nowadays analysts working on the front line get few chances to share experiences with colleagues in similar organisations.

Career development

The fact that analysts work in different settings and have such a wide range of skills means that there is not a clear career path. The view of many people is that very often there is little opportunity for analysts to progress their career as an analyst. Very often people have to leave an organisation to progress. ‘Analysts’ careers seem to stop at a certain level. There are not enough senior roles created and people are often asked to do other general management roles. There are also limited training and development opportunities to see analysts as leaders.

Within the broader field of health informatics there are some groups who have mapped out roles and created some broad frameworks³⁴ and there has been a considerable amount of work looking at a careers framework across the wider field of health informatics – see Figure 2. However the situation that exists today has been contrasted with that of somebody working in finance where there is a similar degree of specialist knowledge and skills, yet a clear development and career path. There is no such clarity for those wishing to follow a future in analysis.

Figure 2: An overview of the different standards and frameworks and their links to the Health Informatics Careers Framework⁴⁰



The relative scarcity – in general – of people undertaking analytical roles at a senior level can in itself reinforce the problem of a lack of analytical capability and the ability of an organisation to recognise the need for advanced analysis and implement such methods. As one interviewee noted, *‘There is something missing in the middle between academic expert and lower grade analysts – need a cadre of senior analyst leaders who sit in between the two.’*

There are exceptions to this general picture in individual organisations or in schemes like the civil service streams of expertise on statistics (GSS), operational research (GORS) and economics that work across government departments and include health. More recently there has been an attempt to define career pathways for data scientists within government.³⁵

A number of groups have been promoting the development of professionalisation as a way to improve analytical capability. A clearer professional structure is seen as a way to provide national leadership and enhance the reputation of informatics through higher standards and registration accompanied by accredited training and development as well as networking opportunities. At present analysts can register with a range of different groups. The Federation of Informatics Professionals (Fed-IP) was created to bring together a range of organisations and harmonise the process of setting professional standards and registration requirements.³⁶

One of the important elements in health service analytics is that often good analytics may be catalysed by the involvement of interested clinicians. These are most commonly doctors though examples from nursing and allied health professionals (AHPs) also exist. In fact there is a strong group of medically qualified people with an interest in informatics, data science and IT – as can be seen by the work of the networks of chief clinical information officers (CCIOs).³⁷ In the USA, informatics has become recognised as a professional subspecialty through the American Medical Informatics Association (AMIA).³⁸ More recently in the UK moves are underway with the Royal College of Physicians and the Royal College of GPs working to establish a Faculty for Clinical Informatics.

The recent Wachter review on using information technology to improve the NHS in England³⁹ included explicit recommendations to strengthen and grow the CCIO field, including investment in workforce development. The review observed that,

‘In addition to the CCIOs, the workforce of clinician and non-clinician informaticians, researchers with expertise in clinical informatics, programme evaluators, and system optimisers (data processors, analysts, quality and safety leads) needs to be increased and nurtured. Without the right people and skills, digitisation will fail, or at least not achieve its full potential.’

Using expertise from outside the organisation

If in-house analysts are not able to undertake a task, and there is an urgent need for delivery, individual health care sectors will often draw on expertise that is bought in – either from big management consultancies or some smaller but specialist analytic services. While private sector organisations can and do provide appropriate support, there can be the problem that the solution is short term and rarely about building capacity within NHS analysts. This may be partly because the health service does not want to pay extra for that sort of input, or that the business needs of the consultants might seek to guarantee future income.

In 2013 commissioning support units (CSUs) were set up to support NHS commissioners (CCGs and NHS England). Much of the analytical capacity that was in primary care trusts (PCTs) now sits within CSUs: for example, analysts supporting performance and contract monitoring and planning functions. The CSUs, as new organisations, were in part created to achieve some economies of scale in terms of supporting commissioning. However, already in their short lives they have already been subject to some fairly drastic changes. There are some excellent examples of how CSUs offer a higher level of analytical capability – for example, they have been involved in supporting new care models. However, there is a feeling among many that, as a group, they have yet to fulfil their potential. However, CSUs are well placed to support analytics requirements of STPs and collaborations between NHS organisations, and to deliver the benefits of working on a larger scale.

Aside from CSUs there are also some other groups that offer support across a range of organisations and can include analytical support. For example, the Advancing Quality Alliance (AQuA) in the north west of England which supports local quality improvement initiatives in member organisations,^{*} or the North East Quality Observatory Service (NEQOS).[†] There is no standard model for these types of agencies – they seem to evolve on the basis of strong local relationships between care organisations.

Demand side factors

As noted earlier, recognition that the right sort of analysis is needed can be as important as its supply. But, as with supply, the situation is variable and some senior managers complain about the problems they have accessing the right level of skills. So demand-side issues need to be treated with some caution and should be linked with issues of supply.

Getting senior level recognition

Does an organisation's senior management team recognise the need for analysts? Can the organisation identify which decisions would benefit from additional analytical support? Although it is dangerous to generalise across all organisations, a number of interviewees suggested that senior managers did not always see the need or value in analytics. As one public health specialist noted, *'We have missed out on intellectual leadership – not appreciated the need. In general we do not appreciate the need for good analysts'*.

There was felt to be some scope for raising awareness among senior leaders of the value that analytics can bring. This might take a variety of forms, from formal or informal leadership development to lobbying or auditing organisational capabilities. This is clearly a two-way street. The ability to communicate and engage with the problems and challenges of senior managers is critical to establishing recognition of the right types of analytical support. This also helps to align analysis to the 'core business' of the organisation.

'Within the NHS there is a fear of numbers... We therefore need to keep things simple – sometimes we overcomplicate.'

'...it is important to recognise the wider breadth of skills needed by analysts – not just techy stuff but leadership/challenge/professionalism.'

* See: www.aquanw.nhs.uk/

† See: www.neqos.nhs.uk

There is also a case for education and development of managers in order to ensure that they appreciate the value of analysis. Some people see this as critical to the future, although it may not be necessary for everyone. A perception from the US was that top performing health care organisations recognised the value of analytics.

*'...the recent IBM Global CIO Study, [found that] more than 90 percent of healthcare CIOs for top-performing organizations cited insight and intelligence as a key focus for their organizations over the next three to five years, compared to 65 percent of underperformers. Further, when these CIOs were asked about visionary plans to increase competitiveness, 83 percent of healthcare CIOs listed business intelligence and analytics as their top priority.'*⁴¹

Analytical leadership

Many interviewees described the importance of analytical leadership – and in particular that tribe of people who understand the possibilities of good analysis (and the supply side of the issues) yet can also engage with managers at the highest levels to influence and shape demand. Organisations that have a better developed analytical workforce also tend to have strong leaders who are influential within the organisation. These do not have to be CIO roles – and in some cases may be strong clinical professionals. The implication is that developing the profile of good quality analytics will need to involve recognising the current generation of leaders as well as investing in the next generation.

Knowing when something is done well

If better analysis leads to better health care, then it is important that people can recognise what is better – it is not always obvious when there are different ways of doing things. For example, consider rankings and league tables which are common enough currency in management. How often does an organisation lament a slip down the league table from 53rd to 60th – or celebrate its climb up them – when such rankings are really not a very good way of telling whether the organisation is getting better or worse.

So, who sets the expectation for the quality of analytical work? This in part goes back to organisational senior leadership. For example, a study of the uptake of simulation tools noted the importance of senior management buy-in.⁴² Within the context of the civil service, Clive Smee has pointed to the importance of establishing the right relationship between analysts and senior decision makers.

*'Joint working between specialist and policy leads is essential to ensure the integration of analysis with policy making... Virtuous circles arise from joint working. The provision of data and analysis leads to more policy questions being asked and this in turn leads to a demand for more data and informed analysis.'*⁴³

It is also worth noting that external expectations can play an important part in setting an analytical agenda. In fact many of the key analytical tasks that are now routinely undertaken have arisen through central requirements. For example, the use of case mix based reimbursement in health care resource groups (HRGs) has been a central initiative that local providers and commissioners have had to learn.

Distraction of technology

The link between analysis and technology is strong – but they are different things and for many the lines are blurred. There is a clear case for investment in new information technologies – and these can offer exciting opportunities that energise an organisation’s approach to information. However, these are also multimillion pound investments that require a lot of management to put in place and therefore understandably creep high up a management agenda.

But it is important to recognise that though the future holds the promise of new and better information sources, we do not really make the most of what we have at present. See, for example, the work by the Beautiful Information team on using established NHS systems.⁴⁴

‘People get too excited by new technology – that they don’t recognise the need to think about how you use the information we have already – or are about to acquire.’

‘All I hear nowadays is “big data” – everyone wants to be in that business. But I have yet to see much of value emerge. Contrarily, regular structured data has hardly been exhausted in terms of what it can do with traditional tools.’

It is worth noting that good analysis does not necessarily depend on some massive increase in quantity or quality of data and existing data can be quite powerful – it just needs the skills to know what is available and what can be done with it.

Section 3: What is to be done?

In thinking through the practical steps of what to do about analytical capability, it is clear that there is more than one approach. It is not just a process of plugging in specific skills, or even certain types of people, but rather longer-term planning to build organisational capability – at different levels and over longer time periods.⁴⁵

Given the current financial position of the health service, there are few organisations in a position to rush and invest in new analytical teams. Changes will have to happen at the margin – in the ways resources are used in terms of training, recruitment and organisation of the workforce. Perhaps most important is the need for the system to operate slightly differently – developing new relationships and interfaces. Of course, this means that change will not happen overnight but needs to be seen as a long-term programme.

It is worth noting that the problems linked with analytical capability have already been recognised by a number of groups. For example, a range of initiatives and approaches are currently underway:

- There is a national strategy on data capability as well as interest at the highest level in promoting data science. There is also a programme on ‘Building a digital ready workforce’.⁴⁶ In the English health sector, the National Information Board has identified analytical capability as a key area for action.⁴⁷ Similar issues have also been raised in other settings, eg by the UK administrative data research network,⁴⁸ UK Statistics Authority⁴⁹ and Nesta.⁵⁰
- There are a number of groups looking at professional registration, eg UKCHIP (UK Council for Health Informatics Professions)⁵¹ and AphA (Association of Professional Healthcare Analysts).⁵² The Federation of Informatics Professionals (Fed-IP) was established to consolidate some of this activity.
- Similar work on professional standards has been explored by Health Education England (HEE)⁵³ and HSCIC (now NHS Digital).⁵⁴ There is also some progress on frameworks of competencies such as the Health Informatics Career Framework (see Figure 2 on page 21).⁵⁵
- There are also a range of networks for specific groups, eg chief clinical information officers, UKCHIP (computer science) and Mashnet (operational research and modelling). NHS Providers has a CIO network and the CHAIN network⁵⁶ also includes many analysts.
- The UK Statistics Authority has been exploring the nature of health and care statistics published for a wider array of users.⁵⁷
- Following the Wachter report there is to be investment in leadership development for clinical informatics leads through England's new NHS Digital Academy.
- There is an increasing array of health informatics-related educational opportunities, ranging from apprenticeships and short courses up to full- and part-time PhDs.

Much of this activity has a broader focus than the subject of this paper, in that it includes a wider group of people working on information technology. As outlined earlier (see Table 3, page 14), this paper focuses on a subgroup of that workforce.

Promoting development and learning through better networking and communication

Analysts working in the NHS are in danger of becoming isolated and there are accepted benefits from providing ways for analysts to meet, share ideas and learn from others. A healthy analytical community would be one where such events were more common than they are at present. The problem is that the analytical community is dispersed across many organisations. As already noted, there are a number of existing national and regional groups in this space. There are already some strong regional networks and a variety of organisations are implementing or developing training programmes for analysts, eg East Midlands AHSN, some CSUs and ISD North West (see Table 5). There are also the work programmes based on the network of Farr Institutes that conduct research in informatics.⁵⁸ Public Health England has also been developing local knowledge and intelligence networks.

Table 5: North West Skills Development Network for Informatics

A membership organisation funded on a subscription basis by organisations in the north west. The purpose of the Informatics Skills Development Network is to:

- provide excellent opportunities for individuals to network with colleagues from other organisations and enable good practice to be shared across the patch
- address development needs beyond those of technical competence and positions
- provide high quality, low cost tailored development linked to the challenges faced by informatics staff following NHS reforms
- put informatics at the heart of an organisation's business agenda where other leadership competencies are required.

The network supplements the training and development offered locally by organisations. Among the various products and services offered by the network are:

- a skills development website to provide support and guidance to staff within their specialist area
- an annual workforce profile exercise
- networking events for all levels and sharing of best practice
- workforce accreditation scheme – Excellence in Informatics
- annual connect conference and networks for directors and chief clinical information officers (CCIOs)
- skills development: the learning and development programme 'Focus' offers a wide range of development opportunities from personal, professional and business to management and leadership
- informatics apprenticeship – a two-year programme
- MSc data science – student placements in the NHS and undergraduate sandwich placement
- a range of specialist analytical courses run jointly with the University of Manchester
- management and leadership development programmes.

It is important that analysts are supported to use networks – and in practical terms this might mean offering financial support to cover the costs of membership and ensuring that managers give analysts time to participate in networking.

The importance of making connections between people in the NHS has been emphasised in a recent report from the GovLab group. Some of their recommendations (see Table 6) emphasise approaches that exploit skills that may already exist within an organisation – ‘finding what is hiding in plain sight’ – and using technology to make better connections.⁵⁹

Table 6: Summary recommendations from GovLab report⁶⁰

<p>Use technology to coordinate talent</p> <ul style="list-style-type: none"> • Build a project marketplace like the Environmental Protection Agency’s ‘One EPA skills marketplace’ and help supply find the demand. • Build an NHS data lab modelled on the Ministry of Justice data lab to make better use of sensitive personal data.* <p>Find what is hiding in plain sight</p> <ul style="list-style-type: none"> • Build an expert network like Health and Human Services’ ‘HHS Profile’ and help the demand find the supply. • Build a web-based help desk like the World Bank’s ‘Skill finder’ to accelerate the process of matching demand to supply. • Build an employee expert network modelled on the New York City Mayor’s Office ‘volunteer language bank’, focused on a single skill. <p>Attracting outside analytical talent</p> <ul style="list-style-type: none"> • Use more systematic and two-stage prize-backed challenges like the Harvard ‘Catalyst diabetes challenge’ to augment the supply of internal data science capacity with external know-how. • Use more fellowships modelled on the Presidential Innovation Fellowship to augment the supply of internal data science capacity with external know-how. • Create an open data learning hub like the Commerce Data Usability Project for data scientists. • Establish a process to explore the creation of data collaboratives. • Pilot a network of innovators or a public data science brains trust in a controlled trial to test the effectiveness of tapping internal and external expertise. <p>* Reflecting this recommendation, the Health Foundation and NHS England are working together on an Improvement Analytics Unit. The unit will provide quantitative evidence to show whether new, local health care initiatives are improving care and efficiency. See: www.health.org.uk/programmes/projects/improvement-analytics-unit</p>
--

One option would be to focus on analytical leaders – who are seen as pivotal, bridging the world of the senior managers and analysts. There are already some networks for chief information officers (CIOs), as well as the network for chief clinical information officers (CCIOs) that grew from e-health insider (now Digital Health Intelligence). This seems to work well as a network though I believe its focus is more on the implementation of new clinical information systems than the secondary analysis of derived data. In addition, NHS England has appointed Professor Keith McNeil (a doctor and former trust chief executive) as the first NHS Chief Clinical Information Officer.

Tools for analysis

There are some basic tools that can help make more efficient use of the analytical workforce already in place. These are areas that need some investment – which is already happening in some places. My interviews suggested three key areas that should be focused on:

- Exploitation of tools to speed up manipulation of complex data sets within organisations – and getting the balance right between end-user control of data and analysis (eg, through a business manager interrogating data sets vs tasks undertaken by specialist analysts).
- Recognition of common problems and solutions across organisations. There is scope for organisations to share, or jointly develop, standard reporting informatics and analyses. This could help them find ways to exploit the best the technology can offer.
- Clarification and support around information governance. Many organisations spend a considerable amount of effort trying to get to grips with an ever-changing set of information governance requirements and expectations. The cloud of uncertainty over what is possible and feasible is a major problem – especially when looking at new models of care. Those at the centre have a responsibility to clarify this and support the responsible use of local data for patient benefit – and that includes better managerial decision making.

Working at scale

The problems of fragmented communities of analysts and the need to develop teams that encompass an array of different skills are strong arguments in favour of working across current organisational boundaries.

While, in England, the CSUs are capable of fulfilling this role on the commissioning side, they are variable in their approach to advanced analytics – and face some degree of organisational turbulence. There are also examples of analytic functions working across providers as well as commissioners. The most recent development in cross-organisational planning in England is linked to the footprints of the sustainability and transformation plans (STPs).⁶¹ These operate at a scale that is more suited to wider analytical teams, as does work around devolution, for example in Manchester. In a way these are creating structures akin to older regional analytical roles – something that has been lost in various reorganisations. There have also been some interesting developments in provider analytics where the economies of scale in business intelligence are being recognised, with a number of providers sharing information tools for real-time reporting of activity.⁶² It does seem that some regional capacity – across commissioners and providers – should be part of the overall picture.

In fact these arguments are often played out within an organisation – for example, should you create a central analytical team or disperse analysts to be closer to where care is delivered? Most operational managers would argue for their own localised analytical support to help them deal with everyday problems in the ways they want. It has been argued that operational managers can be very reluctant to relinquish control of good analysts – they are too important. A central team enables a wider mix of skills and gives better support

and flexibility – but runs the risk of becoming remote and divorced from day-to-day needs. The concern seems to be that for analysts some degree of centralisation is preferable – but it needs to be supported by good communication and interaction with the front line.

Table 7: Good practice in developing analytical teams (adapted from Bakshi et al)⁶³

<p>Finding data talent</p>	<ul style="list-style-type: none"> • Building a reputation for doing interesting data work by publicising data analyses, participating in conferences and meet-ups, and contributing open data and source code back to the community. • Going where the talent is, including online communities and competitions. • Working with universities to identify promising new talent. • Always testing candidates for their technical skills.
<p>Building data teams</p>	<ul style="list-style-type: none"> • Creating balanced teams; does data analysis inside the company require specialists or generalists? • Creating diversity by design, because teams with varied skills and mindsets are more flexible, innovative and able to learn. • Developing a shared language to make communication more efficient.
<p>Placing talent in the right parts of the organisation</p>	<ul style="list-style-type: none"> • Setting up central data teams helps build a critical mass of data skills, but there is a risk these teams can become ivory towers. This can be avoided by creating strong communication channels with the rest of the organisation. • Embedding data talent in other business functions improves communications, but can result in silos. This can be avoided by creating data talent communities spanning the organisation.
<p>Data playing and doing</p>	<ul style="list-style-type: none"> • Empowering data talent: creative data analysts are most productive when working on interesting projects over which they have a feeling of ownership. • At the same time, it is important to channel talent into activities that create business value, preventing data analysts from going down analytical rabbit holes where there is little business value. • Failure is a reality of all innovative projects – including data analysis work. This risk of failure has to be accepted and managed.

Environments for innovation

In addition to the supply of analytical expertise there is also scope to achieve economies of scale in terms of analytical methods. As Bakshi and colleagues noted (see Table 7), there is also something about empowering analysts by giving them opportunities to innovate – not just in the health sector.⁶⁴

The idea of ‘laboratories’ for change has been growing in popularity⁶⁵ and there are examples where these are specifically focused on better analytics. For example, as part of the Improvement Analytics Unit,^{*} the Health Foundation and NHS England are working on the application of new analytical methods that can be used to look at new models of care. This approach means that relatively scarce methodological skills (eg retrospective matching)⁶⁶ can be used – with the right data – across many different sites. The approach can build into a wider data and skills platform that could be used for many different studies.

The Ministry of Justice has set up a data lab to support the voluntary sector. In this model, organisations submit details of offenders they have worked with to the Ministry of Justice. Statisticians find them in the Police National Computer (PNC) and report back the aggregate reoffending rate and frequency of reoffending. The Ministry of Justice also provides a reoffending rate for a statistically matched control group, using a technique called propensity score matching, to show more robustly if a particular scheme to reduce reoffending has made an impact.⁶⁷

New relationship with the experts

Good analysis will require the use of new methods and techniques that build on specialist knowledge and expertise, which can often be from academics. One of the ways to improve the quality of analytical work is to create the right links between these experts and the running of services. There is of course the traditional research funding approach – but this is not appropriate for many problems or issues. Setting up a research project typically runs too slowly for managerial decision makers. Moreover, the realities of a career in research can be in conflict with developing practical, implementable solutions in the service and seeing them through to fruition.

There is also no guarantee that the researchers’ expertise is linked with in-house capability. It is recognised that the way evidence is assimilated by individuals and organisations is complex and that *‘the translation of research evidence into practice has to be supported by developing the internal capacity of healthcare organisations to engage with and apply research.’*⁶⁸

Despite these problems, it is still important that we get the right links to the experts – and it is possible. These links can be developed and fostered in a range of ways – for example, through joint projects including training programmes, secondments and shared staff, and consultancy-like arrangements. Linking specialist skills with local organisations can also be achieved through roles akin to ‘researcher-in-residence’ models. There are a number of examples of these initiatives and some that are specially aimed at embedding researchers/analysts (whole or part time) within health service organisations. Such models are common in knowledge mobilisation⁶⁹ and translational research as an attempt to address

^{*} See: www.health.org.uk/programmes/projects/improvement-analytics-unit

the ‘messiness of management decision making... by making greater use of established health service research evidence, and through a stronger commitment to developing new evidence.’⁷⁰

Perhaps more common are collaborations between research groups and the local health service and the development of a joint programme of research. In England, groups such as CLAHRCs (Collaboration for Leadership in Applied Health Research and Care) and AHSNs (Academic Health Science Networks) can help foster these links.

Supporting applied training and development programmes for the analytical leaders of tomorrow

In addition to informal networking and sharing there are also ways to bolster professional development through more formal education. There has been some progress over the past few years in terms of the growth in postgraduate training in informatics and data science – many universities offer postgraduate courses on health informatics (or similar), including work in the Farr institutes.⁷¹

There is clearly a role for a wide array of training resources, either in the form of dedicated fellowships or more generalised training and education, ranging from apprenticeships to post-doctoral training. There are also some schemes to enable new graduates in data science to work on health service problems. It is important that these are seen as opportunities for people working in the service – not as an academic career. Elsewhere the NHS Leadership Academy does include some management training roles specifically tailored to informatics.

Managing demand

As noted earlier, the nature of the demand for analytical services can be an important driver for change. Though many senior leaders may actively want better analytical support, the problem for them is whether such investment is an organisational priority – especially in times of constrained resources.

Proving business benefit

One of the key challenges for analysts is to be able to demonstrate the value of the work they do in ways that convince senior managers. A number of the people I interviewed mentioned the importance of analytical leaders and engaging with senior managers in the right way – examples of the need to provide a better business justification for analytical work. One route to this is to support analysts to develop a breadth of experience in different organisations and settings – something that will help with that vital task of interpreting managers’ needs in ways the analysts can address.

Auditing analytical development

One way to understand better the gaps in the current system is through tools that help organisations assess their own position. As one senior manager said, ‘*We need a broadly based strategy over 5–10 years – starting at the board level and asking questions about the level of analytical support they get at present.*’

This approach is similar to recent initiatives such as the digital maturity index.⁷² Though this included elements looking at capability, it is more aimed at routine operational requirements, for example: records, assessments and plans; transfers of care; orders and results management; medicines management and optimisation; remote and assistive care; asset and resource optimisation and standards. Should there be a similar tool explicitly looking at use and access of analytical skills?

Awareness raising and training for managers and clinicians

There is undoubtedly a place for raising awareness of the potential value of new analytical methods to managers and organisational leaders as well as analysts. One strategy is to spread knowledge and analytical skills not just to ‘analysts’ but also managers. This is an approach that is being adopted quite widely in the quality improvement field, whereby training purposely seeks to raise the capabilities of all clinicians to effect improvement – for an example see SAASoft’s course, Fundamentals of Improvement Science in Healthcare.⁷³

There are some who see the future not in terms of a specialist cadre of analytical experts but of much wider competencies among both operational managers and clinicians. Some of the best examples of this approach are seen in initiatives supporting quality improvement – where the emphasis is on moving people along a developmental ladder of competence. So for example in Newport, Wales, the Aneurin Bevan Continuous Improvement team provides support to local improvement initiatives and includes a team with advanced analytical skills. They also provide a range of training programmes for clinicians and managers within the local health community.⁷⁴

Setting external expectations

I noted earlier how often innovation in analytical methods could be driven by requirements from the centre. So, for example, the introduction of case mix based reimbursement created the need for expertise in understanding and accounting for case mix. Similarly, requirements such as public reporting of quality accounts have meant that some provider organisations produced a better overview of quality of care than was previously available.⁷⁵

The centre has a role to play in setting expectations for the types of analysis that are appropriate and acceptable. However, this needs to be handled with care — making too complex a demand on local providers or commissioners may backfire. The potential dangers are:

- analyses may not be done properly and the centre has neither the interest nor capability to check
- a central requirement may absorb too many local resources
- money is diverted to short-term solutions rather than long-term capability building.

These issues are not new – and are part of the long-running debates about balancing the roles of local managers and central requirements.

Specific recommendations for action

Addressing the issues caused by lack of analytical capability requires action at a number of levels in the health service. The following key actions are needed:

For those in provider or commissioning organisations:

- support local analysts in their own development and engagement with networks
- review organisational analytical capability and look at the range of skills in, and organisation of, local teams
- look for opportunities to share analytical expertise between organisations and where possible look for flexible working patterns across organisations.

For those involved in education and training:

- prioritise in-work training programmes to develop analytical skills
- include an understanding of analytical work in general management and leadership training.

For academics, researchers and research funders:

- work with local health agencies on an agenda of applied analysis, including shared posts and researchers-in-residence
- look for ways to support hubs for analytical innovation that span a range of disciplines and have an agenda set by health care organisations.

For central/national organisations:

- support the development/dissemination of shared analytical tools that initiates and improves communication and learning among analysts
- support the use of cross-organisational analytical teams, including working with analysts from central organisations, and the use of centres for innovation in analytical methods
- look at ways to support existing and emerging analytical leaders as well as chief clinical information officers.

Conclusions

The ability to use information is an essential element in any health care system. Analysis can help shape care for individual patients as well as across organisations and health systems. It also has a role in helping to improve quality and safety by identifying areas for improvement and monitoring service delivery. If there is a shortage of analytical expertise the consequences are not always obvious or immediately visible. Rather, the shortage of analysis can lead to a range of decisions and choices based on limited or inappropriate evidence.

I have worked in and around analysis and research on health services for over 30 years. I have been lucky enough to work on a number of different innovative uses of information that I think can play some part in making health services better. This field has come a long way since I first started. However, throughout this time it has been clear that the best ideas in terms of analytics will not gain traction within the service without local analysts who can see the potential and apply it to their local problems. The recent growth in data and computing power has made these issues more prominent.

Despite major changes in the way data are used in health care, having the right people in place at the local level is a critical factor that has in the past suffered from underinvestment. In the current financial climate, choosing to invest in better information and management systems is not easy given the pressure on front-line services. Health systems cannot function without management or without information and there is always a need to use information and intelligence to support big decisions on how things are run and where money is spent.

To support efficient and effective health care systems, delivering the best possible care for patients and service users, we cannot ignore the need to build the infrastructure of intelligence that helps make better choices. This means not just investing in the new technology of health information but also in the people who know how to make the most of that information to support a better service.

Appendix A: Interviewees

I would like to thank the many people who have given me advice and comments over the past few months and especially those interviewed in connection with this report. Note, however, that the views in this paper of are those of the author alone.

Name	Organisation
Siva Anandaciva	NHS Providers
Mahmood Adil	ISD Scotland
Mohammad Asbar	NE London CSU
Fraser Battye	West Midlands and Lancs CSU
Christine Banks	ISD North West
Gwyn Bevan	LSE
Andrew Boddle	Methods Analytics
Nadine Boczkowski	AQUA
John Boulton	Aneurin Bevan CI Unit
Di Bullman	HSCIC
Tom Buckley	NHS Mgt trainee informatics
Kate Cheema	S Central and West CSU
Todd Chenore	Devon CCG
Xavier Chitnis	Royal Marsden
Nigel Columbine	NEL CSU
Matthew Cooke	NHS Improvement
Edie Copeland	NESTA

Name	Organisation
Sonya Crowe	Embedded researcher at UCL and HF fellow
Mike Davidge	ECIST
Simon Dodds	Heart of England NHS Trust and SAASoft
Sarah Dougan	LB Camden
Emma Doyle	NHS England
David Evans	CHAIN
Jillian Evans	NHS Grampian
Marc Farr	CIO East Kent
Cindy Fedell	CIO Bradford
Ben Fitzgerald	NHS Mgt Trainee informatics
Julian Flowers	PHE
Steve Francis	Royal Marsden
John Frankish	Aneurin Bevan CI Unit
Naomi Fulop	UCL
Bethan George	Tower Hamlets CCG
Julie George	Farr Institute, Surrey CC
Richard Glover	North of England Commissioning Support (NECS)
Sylvia Godden	London Borough of Sutton
Tracey Gyatung	New Philanthropy Capital

Name	Organisation
Richard Harrety	North of England Commissioning Support (NECS)
Lisa Harrod-Rothwell	HSCIC/NHS England
Jim Hatton	Nottingham UHT/E Midlands AHSN
Lorraine Hawkins	NHS England
Torsten Hecke	Techniker Krankenkasse
Cath Hill	AQUA
Peter Homa	Nottingham UHT
Ed Humpherson	UK Statistics Authority
Andrew Jackson	NHS England
Alex Kafetz	ZPB Associates
Phil Koczan	UCLP/CCIOs
Geraint Lewis	NHS England
Isabel Lobo	NHS Providers
Tom Mason	Leeds CCG
Bruce Martin	Centre for Workforce Intelligence
Colin McCowan	University Glasgow and Farr Inst
Liz Miller	PHE
Andrew Morris	Univ Edinburgh and Farr Inst
Beth Novack	NYU
Chris Parkin	Methods Analytics
Lawrence Pelly	NEL CSU
Neil Pettinger	Kurtosis

Name	Organisation
Martin Pitt	Exeter University/Pen Chord
Daniel Ray	NHS Digital
Emma Rourke	COC
Sarah Scobie	S & SW CSU
Kirstie Scott	NHS Leadership Academy
Peter Spilsbury	WM & L CSU
Paul Stroner	TDA/AphA
Kim Sutherland	NSW Bureau of Health Information
Simon Swift	Methods Analytics
Charles Tallack	NHS England
Martin Utley	CORS UCL
Janet Valentine	CPRD
Christos Vasilakis	Univ Bath
Dalina Vekinis	LB Camden
Rob Webster	SW Yorkshire Partnership Trust
Lyn Whitfield	Digital Health
Paula Whitty	NQO
Chris Weston	NEL CSU
Jeremy Wyatt	University Southampton
Steve Wyatt	West Midlands and Lancs CSU
Lesley Wye	Bristol University

Appendix B:

How many analysts does it take to... support a health service?

Given the imprecise nature of what I mean by 'analysts' it is perhaps not surprising that there are not readily available figures on how many analysts are working on health care issues. The most detailed information seems to be collected by the Informatics Skills group in north west England who have, for the past few years, asked for information from providers and commissioners across the region. This gives some really useful information across a wide range of job roles. While this is useful, it unfortunately does not provide all the answers, as firstly it excludes central national roles and, perhaps more problematic, there is not a precise fit to the analysts' category we have discussed in this paper.

So, in addition to using data from this audit I have also drawn on the views of a range of people to estimate analyst numbers by organisational type – based on the definitions I gave them. This was initially based on organisations in England then crudely scaled up to a UK-wide figure. Note this is an imprecise process and only intended to give ballpark estimates. It also hides some big variations between organisations within the health and care sector.

The numbers are based on analysts in the NHS and in local authority health planning (including public health), as well as some national roles. The results in Table B1 are the starting point for discussion. They suggest that over half the analysts are located in providers. The calculations indicate that there are around 10,500 analysts working in the UK. That's roughly equal to one analyst for every £11m NHS spend per year.

Note this is a smaller number than estimates of the total informatics workforce. Table B2 is taken from the audit in NW England and covers a much wider range of roles. Using a crude method to extrapolate to the whole of the UK gives a figure of over 40,000 in this wider informatics workforce – of which about one quarter may be closer to the analysts roles discussed in this paper. Given that this list excluded central functions, the number is roughly in line with Table B1.

Table B1: Educated guesses at the numbers of analysts around the system in the UK

Area of activity (England)	Estimated number of analysts	% total	Sources/assumptions/guesses
NHS providers. Information/finance/business intelligence.	5140	60%	Based on average 20 per trust and 257 trusts. Estimates from East Midlands suggest 1 per 10,000 finished consultant episodes. NW audit suggests 15–25 – see Table B2.
CCGs/LA commissioners	1000	12%	Average 5 per organisation across 200 CCGs. NW audit suggested average of 4.6. CSU contact suggested 15–20 per million population.
CSUs	240	3%	Average 40 for 6 CSUs. Based on figures from NW audit. Note CSUs also work on central functions, eg for NHS England.
Other regional cross-organisational support	150	2%	Covers support functions and specialist groups like quality and improvement agencies, eg NEQOS, AQuA.
Public health local	395	5%	The Centre for Workforce Intelligence (CFWI) estimated 640–940 public health staff. Optimistic estimate that half of them are ‘analysts’.
Public health national	250	3%	CFWI said 430 people on PHE payroll, say just over half analysts. In addition, there are 200 academic public health staff, many of who are analysts.
DH and related national groups like MHRA/CPRD/NHSBSA etc	150	2%	A guess.
HSCIC	200	2%	About 2,000 people work at HSCIC... say 10% analysts.
NHS England	250	3%	Crude summing across teams within NHSE.
Other national regulators	300	3%	CQC 150, NHS Improvement 150.
Private sector/management consultants	300	3%	Four large management consultancies with about 50 each, plus about 10 health intelligence consultancies with about 10 each. There is a growing market of smaller consultancies.
Applied researchers	150	2%	Guess aimed at joint NHS posts/researchers in residence plus 100 public health academics. Excludes larger numbers in technology appraisal, pharma and researchers in HEE.
Other – voluntary sector/think tanks	100	1%	
Sum England	8,625		This is only an indicator that the number in England is probably in a range from 7,000 to 10,000 for this subset of analysts.
Estimate for UK	10,415		Scaling up to UK estimate by population (64m/53m).

Table B2: Summary stats on whole time equivalents by role in NW England

Job role	Provider	Other	Shared services	CSU	CCGs	Sum	Estimate for UK**
A - Director	25	1	2	0	1	29	263
B - Application developer	119	21	3	19	3	165	1,498
C - End user	375	3	80	87	0	545	4,948
D - Infrastructure	295	5	30	81	1	412	3,740
E - System and storage management	97	3	9	18	0	127	1,153
F - Systems administration	278	5	25	18	5	331	3,005
G - Technical data manager/Date repository	88	0	2	23	3	116	1,053
H - Data analyst*	308	1	4	37	11	361	3,277
I - Business intelligence*	206	4	0	30	52	292	2,651
J - Data quality	190	5	30	26	0	251	2,279
K - Clinical coding	603	7	2	0	0	612	5,556
L - Information governance	155	7	4	17	0	183	1,661
M - Database administrator	34	7	0	3	1	45	409
N - Web development	23	9	4	11	0	47	427
O - Knowledge management*	132	30	5	6	0	173	1,570
P - HI educators and trainers	164	1	19	8	0	192	1,743
Q - Clinical informatics staff*	231	0	0	0	0	231	2,097
R - Project and programme management	405	13	79	55	5	557	5,056
S - Health records and patient administration	206	0	9	20	0	235	2,133
Sum	3,976	123	309	459	83	4,904	44,519
Analysts subset*	877	35	9	73	63	1,057	9,595

*Assuming the nearest to the analysts roles covered by data analyst, business analyst, knowledge management and clinical informatics staff.

**UK estimates based on extrapolation by resident population assuming NW typical of rest of UK (NW 7.05m and UK 64m).

References

1. HM Government. *Seizing the data opportunity: A strategy for UK data capability*. London: Department for Business, Innovation and Skills; 2013. Available from: www.gov.uk/government/uploads/system/uploads/attachment_data/file/254136/bis-13-1250-strategy-for-uk-data-capability-v4.pdf
2. Administrative Data Workforce. *The UK Administrative Data Research Network: Improving Access for Research and Policy*. Economic & Social Research Council; 2012. Available from: www.esrc.ac.uk/files/research/administrative-data-taskforce-adt/improving-access-for-research-and-policy
3. Beresford M. *Demystifying data: The data revolution and what it means for local government*. London: New Local Government Network; 2015. Available from: www.nlgn.org.uk/public/wp-content/uploads/DEMYSTIFYING-DATA2.pdf
4. Mateos-Garcia J, Windsor G, Rosevare S. *Analytic Britain: Securing the right skills for the data-driven economy*. London: Nesta; 2015. Available from: www.nesta.org.uk/publications/analytic-britain-securing-right-skills-data-driven-economy
5. Yiu C. *The big data opportunity: Making government faster, smarter and more personal*. London: Policy Exchange; 2012.
6. Wachter R. *The Digital Doctor: Hope, hype and harm at the dawn of medicine's computer age*. Chicago: McGraw Hill Education; 2015.
7. Wachter R. *Making IT work: Harnessing the power of health information technology to improve care in England*. London: National Advisory Group on Health Information Technology in England; 2016. Available from: www.gov.uk/government/uploads/system/uploads/attachment_data/file/550866/Wachter_Review_Accessible.pdf
8. HM Government. *Seizing the data opportunity: A strategy for UK data capability*. London: Department for Business, Innovation and Skills; 2013. Available from: www.gov.uk/government/uploads/system/uploads/attachment_data/file/254136/bis-13-1250-strategy-for-uk-data-capability-v4.pdf
9. Brailsford SC, Bolt TB, Bucci G, et al. Overcoming the barriers: a qualitative study of simulation adoption in the NHS. *Journal of the Operational Research Society*. 2013;64: 157–168. Available from doi:10.1057/jors.2011.130
10. Wachter R. Why Health Care Tech Is Still So Bad. *New York Times*. 21 March 2015. Available from: www.nytimes.com/2015/03/22/opinion/sunday/why-health-care-tech-is-still-so-bad.html?_r=0
11. National Information Board. *Personalised Health and Care 2020: Work Stream 6 Roadmap – Support care professionals to make the best use of data and technology*. London: Department of Health; 2015. Available from: www.gov.uk/government/uploads/system/uploads/attachment_data/file/442827/Work_Stream_6.pdf
12. Evenstad L. NHS underinvests in data capabilities, says Public Health England chief knowledge officer. *Computer Weekly*. 1 October 2015. Available from: www.computerweekly.com/news/4500254558/NHS-underinvests-in-data-capabilities-says-PHE-chief-knowledge-officer
13. National Information Board. *Personalised Health and Care 2020: Work Stream 6 Roadmap – Support care professionals to make the best use of data and technology*. London: Department of Health; 2015. Available from: www.gov.uk/government/uploads/system/uploads/attachment_data/file/442827/Work_Stream_6.pdf
14. Gothard P. Bridging the data science skills gap: How serious is the data science skills gap now, and what can CIOs do to overcome it? *Computing*. 21 November 2014. Available from: www.computing.co.uk/ctg/news/2382894/bridging-the-data-science-skills-gap
15. Mateos-Garcia J, Windsor G, Rosevare S. *Analytic Britain: Securing the right skills for the data-driven economy*. London: Nesta; 2015. Available from: www.nesta.org.uk/publications/analytic-britain-securing-right-skills-data-driven-economy
16. Bakhshi H, Mateos-Garcia J, Whitby A. *Model workers: How leading companies are recruiting and managing their data talent*. London: Nesta; 2014. Available from: www.nesta.org.uk/sites/default/files/model_workers_web_2.pdf
17. Bernstein A, Raman A. The Great Decoupling: An Interview with Erik Brynjolfsson and Andrew McAfee. *Harvard Business Review*. June 2015. Available from: <https://hbr.org/2015/06/the-great-decoupling>
18. National Information Board. *Personalised Health and Care 2020: Using Data and Technology to Transform Outcomes for Patients and Citizens – A Framework for Action*. London: HM Government; 2014. Available from: www.gov.uk/government/uploads/system/uploads/attachment_data/file/384650/NIB_Report.pdf
19. Illingworth J. *Continuous improvement of patient safety: The case for change in the NHS*. London: The Health Foundation; 2015. Available from: www.health.org.uk/sites/health/files/ContinuousImprovementPatientSafety.pdf
20. Ackoff RL. Management Misinformation Systems. *Management Sciences*. 1967;14(4): B147–B156. Available from: www.jstor.org/stable/2628680
21. UK Statistics Authority (UKSA). *Health and Care Statistics in England – The Statistics Authority's direction of travel*. London: UKSA; 2016. Available from: www.statisticsauthority.gov.uk/publication/health-and-care-statistics-in-england-the-statistics-authoritys-direction-of-travel/
22. Burnett S, Mendel P, Nunes F, et al. Using institutional theory to analyse hospital responses to external demands for finance and quality in five European countries. *Journal of Health Services Research & Policy*. 2015;21(2): 109–117. Available from doi:10.1177/1355819615622655

23. Pitt M, Monks T, Crowe S, Vasilaki C. Systems modelling and simulation in health service design, delivery and decision making. *BMJ Quality and Safety*: Online First. 26 June 2015. Available from: doi:10.1136/bmjqs-2015-004430
24. Brailsford SC, Lattimer VA, Tarnaras P and Turnbull JC. Emergency and on-demand health care: modelling a large complex system. *Journal of the Operational Research Society*. 2004;55: 34. Available from doi:10.1057/palgrave.jors.2601667NHS
25. NHS Scotland Quality Improvement Hub. *Emergency Care Pathways Programme*. Available from: www.qihub.scot.nhs.uk/quality-and-efficiency/emergency-care-pathways.aspx
26. Health Foundation. *How to help health care flow around winter pressures*. Available from: www.health.org.uk/how-help-health-care-flow-around-winter-pressure
27. Bardsley M, Steventon A, Smith J, Dixon J. *Evaluating integrated and community-based care: How do we know what works?* London: Nuffield Trust; 2013. Available from: www.nuffieldtrust.org.uk/sites/files/nuffield/publication/evaluation_summary_final.pdf
28. Purdy S, Paranjothy S, Huntley A, et al. *Interventions to reduce unplanned hospital admission: a series of systematic reviews*. Bristol: University of Bristol; 2012. www.bristol.ac.uk/media-library/sites/primaryhealthcare/migrated/documents/unplannedadmissions.pdf
29. Allcock C, Dormon F, Taunt R, Dixon J. *Constructive Comfort: accelerating change in the NHS*. London: The Health Foundation; 2015. Available from: www.health.org.uk/sites/health/files/ConstructiveComfortAcceleratingChangeInTheNHS.pdf
30. Health Education England. *Health careers: Health informatics*. Available from: www.healthcareers.nhs.uk/explore-roles/health-informatics
31. Velindre NHS Trust. *Health Informatics Career Framework*. Available from: www.hicf.org.uk/Index.aspx
32. Kurtosis. *The NHS Information Analyst Skillset V2.0: What NHS number-crunchers need to be able to do*. Available from: www.kurtosis.co.uk/ideas/skillset_v2.htm
33. Meadows DH. *Thinking in Systems: A Primer*. Vermont: Chelsea Green Publishing; 2008.
34. Health Education England. *Health careers: Health informatics*. Available from: www.healthcareers.nhs.uk/explore-roles/health-informatics
35. Civil Service. *Digital, data and technology professions*. Available from: www.gov.uk/government/organisations/digital-data-and-technology-professions
36. The Federation for Informatics Professionals (Fed-IP). *Working in Health and Social Care: Prospectus January 2015*. Fed-IP; 2015. Available from: www.ukchip.org/wp-content/uploads/Fed-IP-Prospectus-Jan-2015.pdf
37. Digitalhealth.net. *CCIO Network*. Available from: www.digitalhealth.net/ccio
38. Detmer DE and Shortliffe EH. Clinical informatics: prospects for a new medical subspecialty. *Journal of the American Medical Association*. 2014;311(20): 2067–8. Available from: doi:10.1001/jama.2014.3514
39. Wachter R. *Making IT work: Harnessing the power of health information technology to improve care in England*. London: National Advisory Group on Health Information Technology in England; 2016. Available from: www.gov.uk/government/uploads/system/uploads/attachment_data/file/550866/Wachter_Review_Accessible.pdf
40. Velindre NHS Trust. *Health Informatics Career Framework: Other frameworks and links*. Available from: https://www.hicf.org.uk/OtherFrameworks.aspx
41. Cortada JW, Gordon D, Leniban B. *The value of analytics in healthcare: From insights to outcomes*. IBM Institute for Business Value; 2012. Available from: www-935.ibm.com/services/us/gbs/thoughtleadership/ibv-healthcare-analytics.html
42. SC Brailsford, TB Bolt, G Bucci, et al. Overcoming the barriers: a qualitative study of simulation adoption in the NHS. *Journal of the Operational Research Society*. 2013;64: 157–168. Available from doi:10.1057/jors.2011.130
43. Smee C. *Speaking Truth to Power: Two Decades of Analysis in the Department of Health*. Radcliffe; 2005.
44. Beautiful information. See: <http://beautifulinformation.org>
45. Kislov R, Waterman H, Harvey G, Boaden R. Rethinking capacity building for knowledge mobilisation: developing multilevel capabilities in healthcare organisations. *Implementation Science*. 2014;9: 166. Available from doi:10.1186/s13012-014-0166-0
46. HM Government. *Seizing the data opportunity: A strategy for UK data capability*. London: Department for Business, Innovation and Skills; 2013. Available from: www.gov.uk/government/uploads/system/uploads/attachment_data/file/254136/bis-13-1250-strategy-for-uk-data-capability-v4.pdf
47. National Information Board. *Personalised Health and Care 2020: Work Stream 6 Roadmap – Support care professionals to make the best use of data and technology*. London: Department of Health; 2015. Available from: www.gov.uk/government/uploads/system/uploads/attachment_data/file/442827/Work_Stream_6.pdf
48. Administrative Data Workforce. *The UK Administrative Data Research Network: Improving Access for Research and Policy*. Economic & Social Research Council; 2012. Available from: www.esrc.ac.uk/files/research/administrative-data-taskforce-adt/improving-access-for-research-and-policy
49. UK Statistics Authority (UKSA). *Health and Care Statistics in England – The Statistics Authority’s direction of travel*. London: UKSA; 2016. Available from: www.statisticsauthority.gov.uk/publication/health-and-care-statistics-in-england-the-statistics-authoritys-direction-of-travel/
50. Nesta. *The Local DataVores programme*. See: www.nesta.org.uk/project/local-datavores

51. UK Council for Health Informatics Professionals. See: www.ukchip.org/
52. Association of Professional Healthcare Analysts. See: www.aphamembers.org/
53. Health Education England (HEE). *HEE Business Plan 2015/16*. London: HEE; 2015. Available from: www.hee.nhs.uk/sites/default/files/documents/HEE-Business-Plan-2015-16_1.pdf
54. NHS Digital. *Informatics in practice*. Available from: www.hscic.gov.uk/informaticsintr
55. Velindre NHS Trust. Health Informatics Career Framework. Available from: www.hicf.org.uk/Index.aspx
56. Contact, Help, Advice and Information Network (CHAIN). See: www.chain-network.org.uk/
57. UK Statistics Authority (UKSA). *Health and Care Statistics in England – The Statistics Authority’s direction of travel*. London: UKSA; 2016. Available from: www.statisticsauthority.gov.uk/publication/health-and-care-statistics-in-england-the-statistics-authoritys-direction-of-travel/
58. The Farr Institute of Health Informatics Research. See: www.farrinstitute.org/
59. New York University, GovLab. *Smarter Health: Boosting Analytical Capability at NHS*. Final report in preparation. As reported to NIB Workstream 6 Meeting. May 2016.
60. New York University, GovLab. *Smarter Health: Boosting Analytical Capability at NHS*. Final report in preparation. As reported to NIB Workstream 6 Meeting. May 2016.
61. NHS England. *Sustainability and Transformation Plans*. Available from: www.england.nhs.uk/ourwork/futurenhs/deliver-forward-view/stp/
62. Beautiful information. See: <http://beautifulinformation.org>
63. Bakhshi H, Mateos-Garcia J, Whitby A. *Model workers: How leading companies are recruiting and managing their data talent*. London: Nesta; 2014. Available from: www.nesta.org.uk/sites/default/files/model_workers_web_2.pdf
64. Williams P. *Embedding Analytics at the heart of Marks & Spencer*. [Presentation] Annual Analytics Summit. 21 June 2016. Available from: www.theorsociety.com/Blog/features/20160718101718.aspx
65. Price A. *World of Labs*. Nesta; 2015. www.nesta.org.uk/blog/world-labs
66. Davies A, Ariti C, Georghiou T, Bardsley M. *Evaluation of complex health and care interventions using retrospective matched control methods*. London: Nuffield Trust; 2015. Available from: www.nuffieldtrust.org.uk/publications/evaluation-complex-health-care-interventions-using-retrospective-matched-control-analysis
67. New Philanthropy Capital. *Justice Data Lab*. Available from: www.thinknpc.org/our-work/projects/data-labs/justice-data-lab/
68. Kislov R, Waterman H, Harvey G and Boaden R. *Rethinking capacity building for knowledge mobilisation: developing multilevel capabilities in healthcare organisations*. Implementation Science. 2014;9: 166. Available from doi:10.1186/s13012-014-0166-0
69. National Institute for Health Research. *NIHR Knowledge Mobilisation Research Fellowship Programme*. See: www.nihr.ac.uk/funding-and-support/funding-for-training-and-career-development/training-programmes/knowledge-mobilisation-research-fellowships.htm
70. Marshall MN. Bridging the ivory towers and the swampy lowlands; increasing the impact of health services research on quality improvement. *International Journal for Quality in Health Care*. 2014;26(1) 1–5 Available from doi:10.1093/intqhc/mzt076
71. The Farr Institute of Health Informatics Research. *Education*. Available from: www.farrinstitute.org/research-education/education
72. NHS England. *Digital Maturity Assessment*. Available from: www.england.nhs.uk/digitaltechnology/info-revolution/maturity-index/
73. SAASoft. *Foundations of Improvement Science in Healthcare*. Available from: www.saasoft.com/fish/
74. Aneurin Bevan University Health Board. *ABCI – Training & Methodology*. Available from: www.wales.nhs.uk/sitesplus/866/page/69771
75. Foot C, Raleigh V, Ross S, Lyscom T. *How do quality accounts measure up? Findings from the first year*. London: The King’s Fund; 2011. Available from: www.kingsfund.org.uk/publications/how-do-quality-accounts-measure

The Health Foundation is an independent charity committed to bringing about better health and health care for people in the UK.

Our aim is a healthier population, supported by high quality health care that can be equitably accessed. We learn what works to make people's lives healthier and improve the health care system. From giving grants to those working at the front line to carrying out research and policy analysis, we shine a light on how to make successful change happen.

We make links between the knowledge we gain from working with those delivering health and health care and our research and analysis. Our aspiration is to create a virtuous circle, using what we know works on the ground to inform effective policymaking and vice versa.

We believe good health and health care are key to a flourishing society. Through sharing what we learn, collaborating with others and building people's skills and knowledge, we aim to make a difference and contribute to a healthier population.

The Health Foundation

90 Long Acre, London WC2E 9RA

T +44 (0)20 7257 8000

E info@health.org.uk

🐦 [@HealthFdn](https://twitter.com/HealthFdn)

www.health.org.uk

ISBN: 978-1-906461-85-0

Registered charity number: 286967

Registered company number: 1714937

© 2016 The Health Foundation