CENTRE
FOR
WORKFORCE
INTELLIGENCE

A strategic review of the future healthcare workforce

Informing medical and dental student intakes

www.cfwi.org.uk

December 2012

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1 CONTEXT

This report describes the work carried out by the Centre for Workforce Intelligence (CfWI) in support of the Health and Education National Strategic Exchange (HENSE) review group on medical and dental student intakes.

Note that the HENSE review group's own report (including its recommendations) was published by the Department of Health (DH) and the Higher Education Funding Council for England (HEFCE) in December 2012 on the DH website. For the terms of reference and membership of the review group please see APPENDIX A and APPENDIX B. For a glossary of terms used in this report please see APPENDIX C.

In this section you will find:

- an introduction to the work
- stakeholder involvement
- outline of our approach
- more about the approach and the new demand and supply models
- summary of the data used
- sensitivity analysis
- uncertainty analysis
- productivity analysis.

1.1 Introduction

This review was driven by the need to provide sustainable, high-quality healthcare for patients, and therefore the need to ensure effective longer-term workforce planning and better decision making. The CfWI had previously forecast medical workforce supply to the year 2020 based on the current workforce and training pipeline, i.e. those already in the system. A new approach was needed to support decisions that impact further into the future.

1.2 Stakeholder involvement

This work needed to be done with the support and collaboration of people who understand the system and who have an interest in improving the quality of services for the future. The CfWI approach involved stakeholders - professionals, employers, students and trainees, lay people and policymakers - extensively throughout this work, both to improve the quality and credibility of its models and to improve stakeholders' understanding of the intelligence that would underpin the decisions of the review group. The HENSE review group was encouraged by the level of interest and engagement in this work. A table outlining the approach to stakeholder engagement is included in APPENDIX D.

1.3 An outline of our approach

Rather than attempt to predict the future, the CfWI developed a scenario-based approach (outlined in figure 1) that recognises the complexity of factors influencing **demand and supply** and the intrinsic uncertainty of the future. The key benefits of this work were to

- support **longer-term planning**, up to 2040
- support more **robust decision making**, taking account of the uncertainties of the future
- **help decision makers be more alert to emerging risks as the future unfolds.**

This is the first time an approach of this kind has been used in healthcare workforce planning. The CfWI started with horizon scanning, to identify the key drivers stakeholders are concerned will impact on the future workforce. Next the stakeholders worked to generate future scenarios: plausible futures based on the factors that will impact most on the future healthcare workforce yet which are the most uncertain.

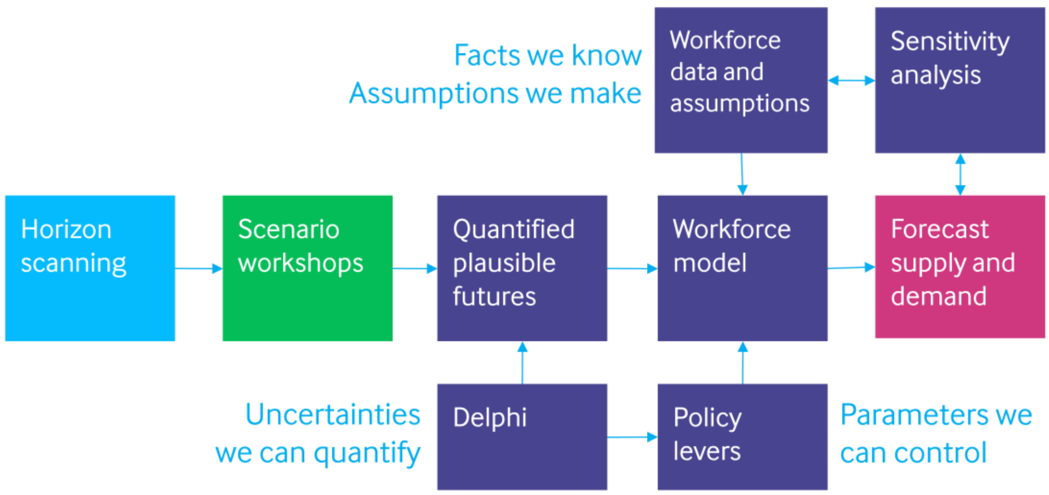
The CfWI team compiled data from a range of sources to populate the medical and dental models, and sought a consensus view using a Delphi[1] process to quantify key uncertain parameters for modelling, such as future retirement patterns, as these could vary across the scenarios (plausible futures).

The team then put supply-related data into system dynamics models built using Vensim software. The demand models used Microsoft Excel. The supply and demand models were integrated and driven from an Excel spreadsheet that allows users to set up scenarios and model the impact of policy changes. This tool 'calls' Vensim to calculate supply, uses Excel to calculate demand, and then combines the outputs.

The robustness of the new medical and dental supply and demand models was validated with stakeholders. A sensitivity analysis helped the HENSE review group understand the large impact of small changes in some data sources and the importance of accuracy.

[1] APPENDIX C glossary of terms

Figure 1: An overview of the CfWI's new approach to workforce planning illustrating how factors influencing supply and demand are identified and quantified for modelling



1.4 New approach and workforce models

At the end of 2011 the CfWI began **horizon scanning**. The CfWI horizon scanning team asked experts to identify the drivers that may influence requirements of the future workforce. Their ideas – whether frequently mentioned or not – were included in the horizon scanning reports published on the CfWI website http://www.cfwi.org.uk/publications.

In early 2012 the CfWI gathered groups of stakeholders to develop four **challenging but plausible future scenarios to 2040** for each of the medical and dental workforces, taking into account the plausible technological, economic, environmental, political, social and ethical drivers of both demand and supply. Figures 2 and 3 show the two dimensions of greatest uncertainty deemed by each group to be of highest impact, combined to create four scenarios. The scenarios stories are provided in full in APPENDIX E. The scenarios are not intended to be exhaustive nor necessarily 'likely' but rather a plausible range of ways the future could unfold, which can be used to test policy options for robustness. Any number of additional scenarios could also be modelled. Key variables in the scenarios were later quantified with the help of **Delphi panels**.

Figure 2: Dental scenarios	Desires of dentists prevail	Desires of patients prevail
Lower resource environment	*Scenario 1*	*Scenario 2*
Higher resource environment	*Scenario 3*	*Scenario 4*

Figure 3: Medical scenarios	'Compression' of morbidity	'Expansion' of morbidity
Lower resource environment	*Scenario 2*	*Scenario 4*
Higher resource environment	*Scenario 1*	*Scenario 3*

As expected, some elements of the full scenario stories are already playing out in reality. For example, some 'big pharma' companies are relocating outside the UK.

The CfWI's new approach models both demand and supply. Their **demand modelling** used a framework from a Canadian research programme on health human resources[2]. The framework separates out four key elements of demand:

1. **Population** – the size of the population being served, by age and gender.
2. **Level of need** – the needs of this population given the distribution of health and illness, and future risk factors.

[2] Birch, S. Kephart, G. Tomblin-Murphy, G., O'Brien-Pallas, L., Alder, R., MacKenzie, A. (2011) *Human resource planning and the production of heath: a needs-based analytical framework*, Canadian Public Policy, 33:S1-S16.

3. **Level of service** – the service planned to be provided according to the population's level of need.
4. **Productivity** – the ability of the workforce to deliver the necessary services, taking into account factors such as skill mix and technology (see later section for more on productivity in healthcare).

The CfWI chose this framework because it provides a clear logical separation of the key factors, and this allowed the CfWI to use a Delphi process to quantify them.

System dynamics modelling makes extensive use of simulation in order to understand how a system changes over time. It represents changes to a system over time by using the analogy of flows of stocks (people, money, materials) accumulating and depleting over time. In the CfWI models, 'stocks' of people can be segmented by age, gender and country of origin, where data exists. This simplifies the modelling of changes over time, for example migration, stage of training and ageing of the workforce.

After considering several potential suppliers of software, the CfWI chose *Vensim DSS* to model the complex flows of medical and dental training and workforces in order to project the future supply of doctors and dentists. The chosen software was able to handle the complexity of modelling supply including the ageing of the workforce, and also offered sophisticated sensitivity and uncertainty analysis functionality, an important feature given the variable quality of key data and assumptions available to the CfWI.

System dynamics is a modelling technique for studying and managing complex feedback systems, such as business and other social systems. The advantage of using commercial system dynamics (SD) modelling software like Vensim is that it enables the user to model the complexities of workforce supply and an ageing workforce in an intuitive, graphical fashion. This greatly reduces the likelihood of errors, in comparison with using spreadsheets or other methods, and enables the model to be developed and tested[3] quickly, which was important due to the time constraints on this in-depth work.

The models are highly flexible (stocks and flows can be added, removed or altered) and adaptable (for example to other workforces). The CfWI formally tested and validated the models to ensure reliability, and conducted sensitivity analysis of the medical model to ascertain which input variables have the greatest effect on the outputs from the model if the data or assumption is

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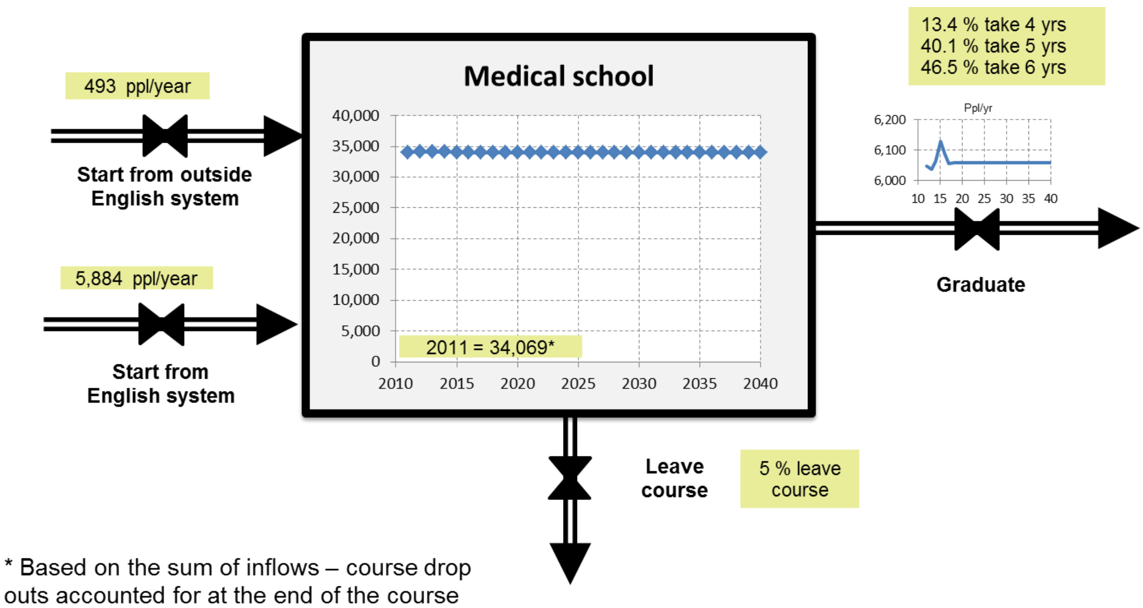
[3] An overview of how the models were tested is provided in APPENDIX K.

changed by a set amount. This identifies the variables for which it is most important to seek better data.

This piece of work aimed to better reflect the dynamic nature of the workforces, to encourage longer-term and better-informed decision making. The CfWI can now do this by sharing intuitive, visual representations of the workforce stages (as compared with previous models built using spreadsheets). Overviews of the dental and medical supply models are included in APPENDIX F, showing 2010 and 2011 stock levels.

Figure 4 is an example of the first stock in the medical supply model: medical school. The graph shows that the number of people in this stock will remain constant – assuming the student intake and current time-to-complete and attrition remain the same.

Figure 4: An example 'stock' from the medical supply model that remains constant over time



Source: Various, see below for key sources.

Note that the medical workforce model includes all medical specialties and academic doctors, but does not deal with individual specialities. Similarly, both models deal with the whole of England but do not deal with geographical distribution. In addition, although the model has been set up to handle workforce migration (including visa status), in practice data relating to this is not collected, and so not available for the CfWI to use.

1.5 The variable quality of workforce data is a risk

The models the CfWI has built rely on data from a number of sources, including:

- 2007–11 accepted applicants to preclinical dentistry (UCAS);
- 2007–11 medical school intakes (Higher Education Funding Council for England);
- 2011 foundation programme data (Foundation Programme Annual Report);
- 2008–11 medical and general practice (GP) workforce census for England (Health and Social Care Information Centre);
- Collective judgments of a Delphi panel about future demand and supply factors;
- 2010 national population projections (Office for National Statistics);
- 2010–11 hospital episode statistics for England (Health and Social Care Information Centre).

Where data are needed, but do not exist, the CfWI made assumptions, which were tested with stakeholders. Some of the key overarching modelling assumptions are included in APPENDIX G.

A full list of modelling assumptions is provided in APPENDICES I (dental) and J (medical).

1.6 Sensitivity analysis

Figure 6 and APPENDIX H both set out some of the key parameters to which the **medical model** is highly sensitive. The CfWI team tested the sensitivity of the medical supply model to its input data and assumptions, by either increasing each input parameter by 10 per cent or shifting age profiles by one year. They removed capacity constraints on training courses to determine the impact.

Impact is defined as the maximum percentage difference to the activity level (availability to provide service) of GPs and trained hospital doctors[4] (for brevity referred to as THDs throughout this report) by 2040, as a result of a change to a

[4] APPENDIX C glossary of terms

particular input variable. The CfWI classifies data quality as very high (VH), high (H), medium (M), low (L) or none (N), defined in figure 5.

Figure 5: Definitions of high, medium and low data quality

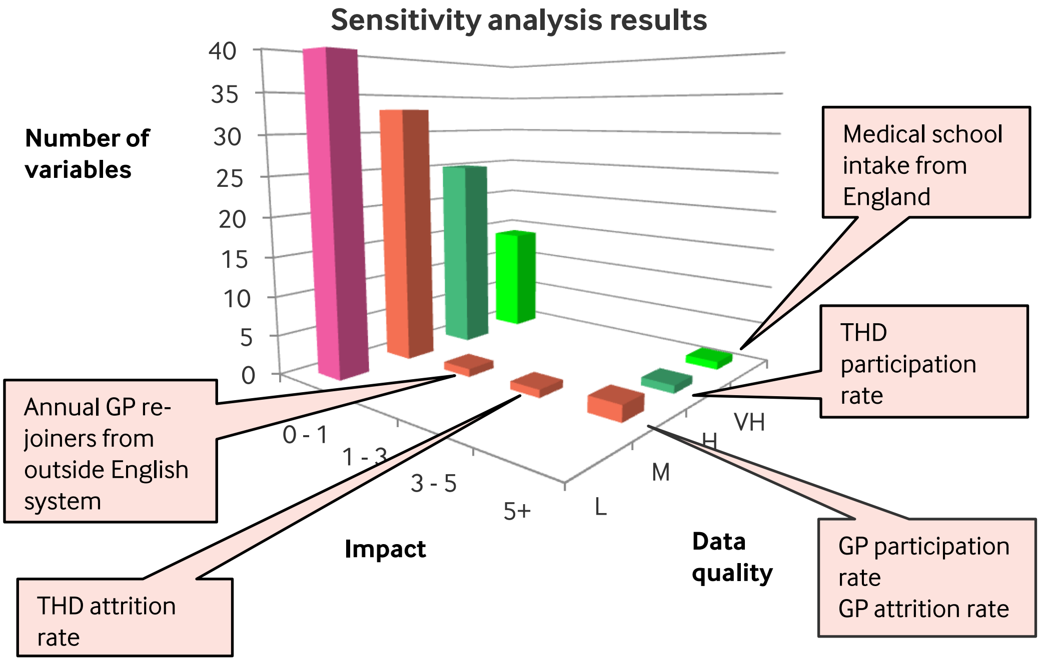
	CfWI judgment of data quality	Definition of data quality level
VH	Very high	Referenced data source, direct one-to-one mapping of data to input variable
H	High	Referenced data source, but not a direct one-to-one mapping to the variable
M	Medium	Subject matter expert judgement, including Delphi panel collective judgment
L	Low	Referenced to similar medical data (if dental) / CfWI expert judgement
N	None	Value assigned but no confidence in the data value

The three-dimensional chart in figure 6 summarises the findings from the CfWI's sensitivity analysis of the medical supply model. The coloured columns show the number of input variables in the supply model that have a greater or lesser impact on the model output, and the number of those input variables relying on data of lower or higher quality.

For example, the orange square in the foreground represents the GP participation and attrition rates (the extent to which GPs work full or part time and how many of them leave the workforce), both of which have a significant impact on the model outputs and currently rely on medium-quality data. The tall pink column on the far left represents the high number (approximately 40) of input variables that rely on low-quality data but which only have a low impact on the model – we need worry less about each of these individually, though their combined impact may be significant.

In figure 6, six variables are highlighted using callout boxes.

Figure 6: Chart showing the number of model variables that are sensitive (or not) to poor data quality and highlighting the importance of attrition and participation rates for accuracy of modelling



Source: CfWI Analysis

APPENDIX H details the top ten variables to which the medical supply model is most sensitive that currently rely on low- or medium-quality data, i.e. the variables where data quality is of most concern. To improve the reliability of the model, it would be advisable for the NHS to focus its efforts on improving the quality of data for these variables, many of which relate to the GP workforce. We are aware that the Health Education England workforce information architecture (WIA) project is making progress in this area.

Future CfWI work will complete the sensitivity analysis for the dental model, where the data quality is less good than that for the medical model. For example, dentist attrition data by age and gender is not available.

1.7 Improving workforce data

The CfWI's recent work for the WIA project recommended ways in which data, information and intelligence could be improved to support more effective workforce planning and education commissioning. Addressing gaps in data will require a concerted effort over time by a range of organisations within the health and social care sector. A number of initiatives are already underway. To ensure a more flexible data system able to support the needs of the emerging local education and training boards (LETBs) our WIA report identified four priorities:

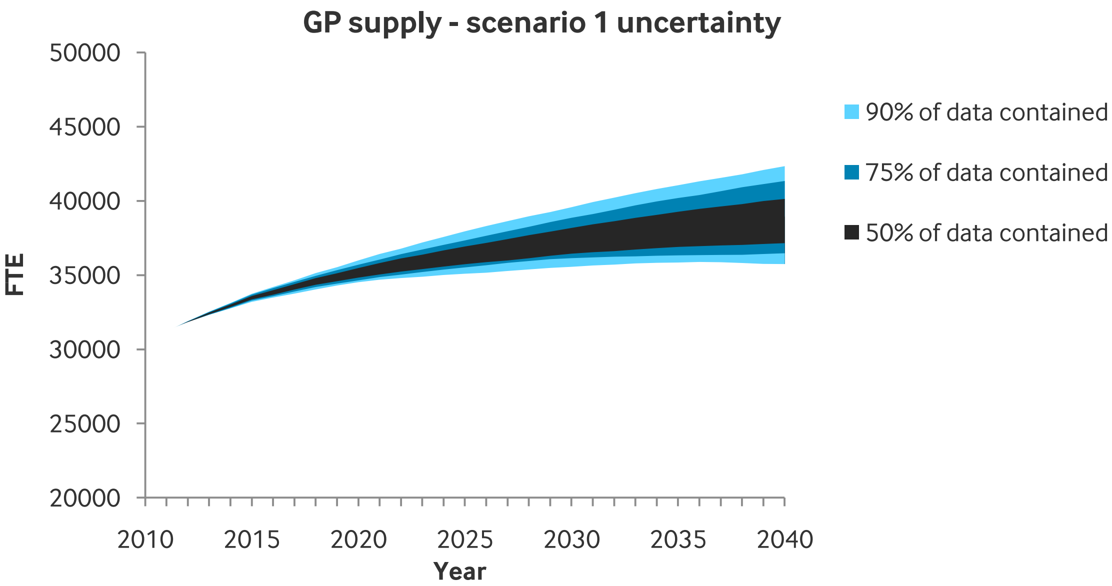
- Supporting the DH's workforce information architecture programme to improve data quality through the NHS electronic staff record
- Availability of core workforce information across all qualified providers of NHS-funded services
- An agreed standardised approach to data and information collected by regulators, royal colleges and professional bodies
- Improved access to raw data and information to enable analysis and benchmarking.

1.8 Uncertainty analysis

It is best practice in modelling to quantify the uncertainty that is inherent in any forecast of the future, in this case: workforce demand and supply. Decision makers need to understand this to inform their analysis of findings and to make effective decisions. Here the CfWI is forecasting up to 2040. It is not possible to predict the future with certainty, which is why the CfWI uses a scenario-based approach, to characterise this uncertainty and identify plausible future conditions. However, although a Delphi process was used to quantify each individual scenario, the experts involved were – as might be expected – not in perfect agreement.

Figure 7 provides an example of this uncertainty as a fan chart, giving a probability distribution for supply under one specific scenario.

Figure 7: An example 'fan chart' illustrating a probability distribution for GP supply under one specific scenario and showing the increasing uncertainty over time



Source: CfWI analysis

Figure 7 shows the most likely forecast (90 per cent probability) and the spread of uncertainty. All model outputs, including demand, will exhibit a degree of uncertainty that increases towards 2040. However, the scenarios taken as a whole provide a realistic estimate of the spread of uncertainty for both demand and supply, so the CfWI does not plot all individual lines as fan charts. However, the inherent difficulty and uncertainty of forecasting to 2040 should be considered in any decision-making process, especially given the issues around data accuracy and sensitivity.

1.9 Impact of productivity gains on demand

In this section you will find:

- potential impact of productivity on projected demand

One way of closing a gap between healthcare demand and workforce supply is to boost supply, but this takes time. Another method is to boost the efficiency or productivity of care delivery. Clearly, the greater the capacity of the NHS to improve productivity through new ways of working, technological innovation and changes to the skill mix, the less need there is for an increase in supply.

The medical Delphi panel's advice was that although healthcare demand is expected to rise substantially by 2040 in all scenarios, the net amount of service provided by doctors will not change as a result of skill mix. The Delphi panel also considered that the amount of service delivered by doctors as a result of technology would increase, but only in scenarios 1 and 3. In other words, both the medical demand baseline and demand scenarios 2 and 4 describe no productivity improvement in the NHS services delivered by doctors over the forecast horizon.

This is a conservative assumption. It is likely that some level of productivity improvement in the delivery of NHS medical services by doctors is both necessary and achievable between now and 2040. However, estimating healthcare productivity is notoriously difficult, and results are often inconclusive.

Following the OECD (2006)[5], Office for Budget Responsibility (2012)[6] central projections assume that real health spending per head grows in line with real incomes, and that annual productivity growth in healthcare keeps pace with the whole economy rate of 2.2 per cent. However, given the labour intensity of healthcare provision:

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[5] OECD (2006), Projecting OECD Health and Long-Term Care Expenditures: What Are the Main Drivers?, OECD Economics Department Working Papers No.477, OECD. Available at: http://www.oecd.org/tax/publicfinanceandfiscalpolicy/36085940.pdf

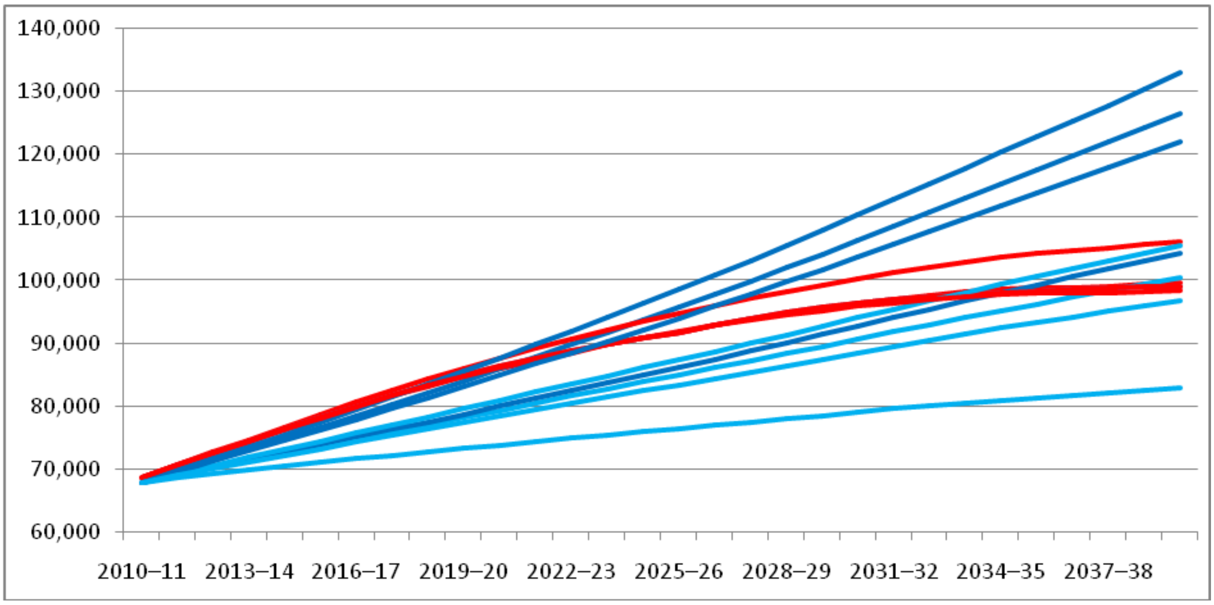
[6] Office for Budget Responsibility (2012), 'Appendix B: Long-term pressures on health spending', in Fiscal Sustainability Report 2012, OBR, London. Available at: http://budgetresponsibility.independent.gov.uk/pubs/FSR2012WEB.pdf

'In practice, productivity growth in the health sector may lag behind whole economy productivity growth ...while real wages in the health care sector keep pace with whole economy incomes.' (OBR 2012: 135).

The OBR presents four long-term scenarios for healthcare productivity growth: 0.8%, 1.7%, 2.2% (central projection) and 2.7% per annum. Even opting for the OBR's lowest productivity growth assumption (0.8% per annum) would be enough to curb projected growth in healthcare demand significantly over the forecast period, as figure 8 demonstrates.

The CfWI is aware of the latest ONS productivity estimates for the NHS, published 7 December 2012, and will take these into account in future work. However as the HENSE review group's report was published on 6 December we have not revised this section. To do so would result in two differing versions of the report in circulation, which might prove confusing to readers.

Figure 8: Demand (and supply) scenarios for combined medical workforce with and without productivity growth, showing how productivity growth can close the supply and demand gap



Source: CfWI medical model

Note: The figure shows demand and supply scenarios for the combined medical workforce – GPs and trained hospital doctors. Dark blue lines are the standard demand scenarios, while the light blue demand scenarios include the additional assumption of 0.8% pa productivity growth. The standard supply scenarios (red) are also shown. Baselines are not shown.

However, both the UK and US evidence suggests that achieving significant and persistent productivity improvement in healthcare services is challenging. While the CfWI does not consider the 'no productivity change' assumption to be realistic (especially in light of challenging health settlements and rising demand), the assumption of 2.2 per cent annual productivity growth is on the high side of likely outcomes, given that the available data suggest much weaker NHS productivity growth (ONS 2011[7]). This is an area that merits further research.

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[7] ONS (2011) Public Service Output, Inputs and Productivity: Healthcare 2011, Office for National Statistics, Newport. Available at: http://www.ons.gov.uk/ons/rel/psa/public-service-productivity/healthcare-2011/public-service-output--input-and-productivity.pdf

2 WORKFORCE FORECASTS AND THE IMPACT OF SKILL MIX AND POLICY CHANGES

2.1 Dental workforce

In this section you will find forecast model outputs for:

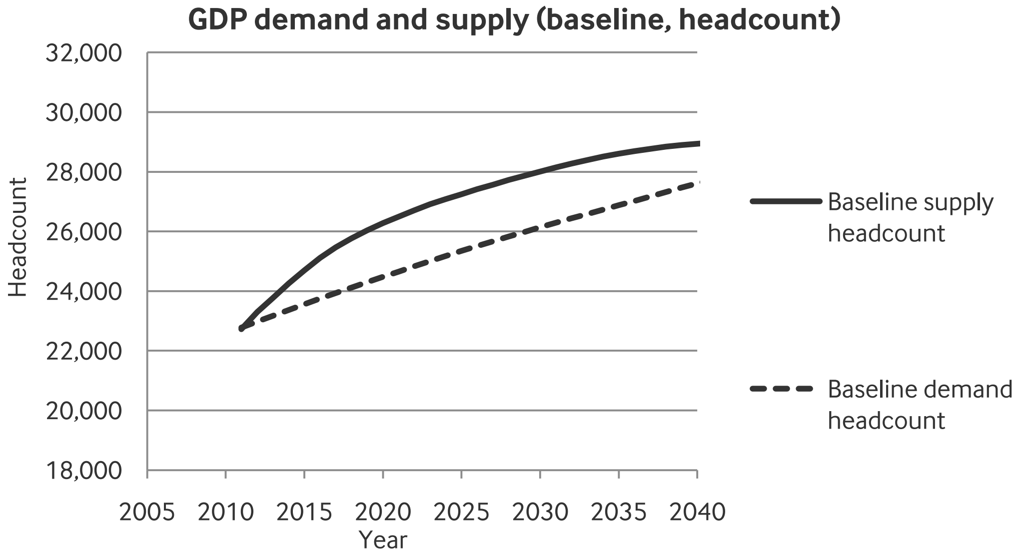
- baseline projections for general dental practitioners
- future demand and supply projections based on the future scenarios
- impact of increasing expected change in skill mix
- impact of changing average retirement age.

Figure 9 shows the CfWI's 'baseline' forecasts of demand and supply for general dental practitioners (GDPs). **The baseline forecasts show where demand and supply in England will end up by 2040 if we stay on our current course.** This enables comparison of alternative policies in terms of doing 'better' or 'worse' than the baseline. The CfWI does not have modelling and baseline graphs for specialist dentists, as data was not available.

Defining a 'baseline' is problematic. Despite the fact that some trends can be predicted to continue with a high degree of certainty, for example growth and ageing of the population, others, such as retirement age of dentists, are far less certain. This is particularly problematic because of major policy reforms that will impact health and social care, plus the uncertainty around the pace of economic recovery.

For these reasons the CfWI baseline only includes population growth, following the Office of National Statistics national population projection (principal projection). All training and workforce intakes, exits and returns are assumed to be maintained at current values, by age and gender. The baseline forecast suggests a potential oversupply of GDPs.

Figure 9: Baseline forecasts of demand and supply for GDPs showing potential oversupply

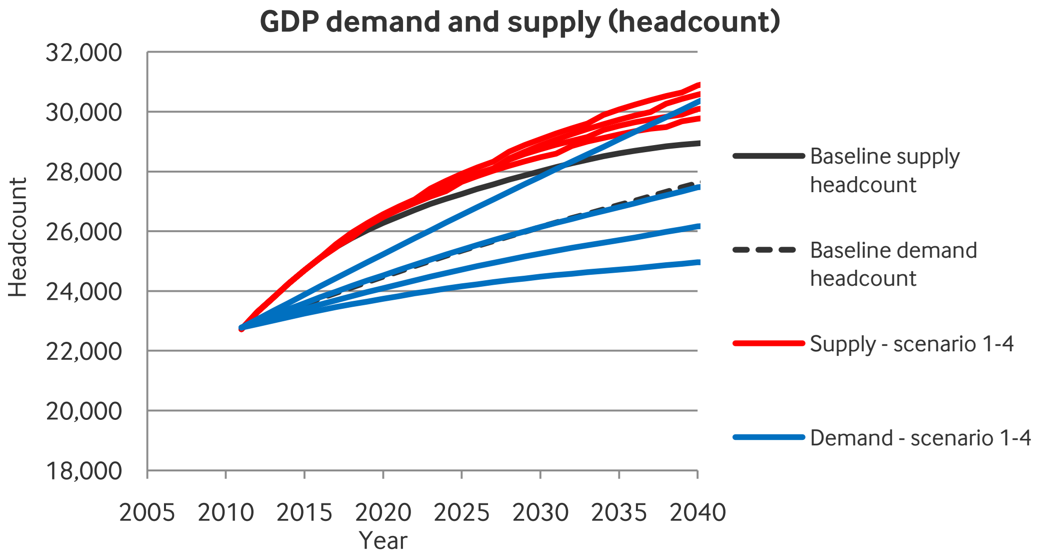


Primary data sources: NHS Dental Statistics for England 2010-2011, population projections for England 2010 (ONS), hospital episode statistics 2010-11 (HSCIC)

Figure 10 shows the CfWI's forecasts of demand (blue lines) and supply (red lines) for GDPs for the four future scenarios, compared with the baseline (shown throughout as black lines). The variation between the scenarios represents the judgment of the expert Delphi panel about the range of ways the future might plausibly unfold. The individual scenarios are not of particular interest; what matters most is the range of uncertainty they represent.

Figure 10 shows considerable uncertainty about future demand (as indicated by the divergent blue lines). Future supply is somewhat more certain (as indicated by the red lines running closer together), notwithstanding the data quality issues described in sections 2.4 and 2.5. All of the supply scenarios (red lines) are above the baseline case, indicating that the Delphi panel felt in all scenarios dentists will work longer and/or more hours by 2040 than they do today. Due to the uncertainty about both demand and supply, it remains uncertain whether we might face an oversupply of GDPs in the future (as indicated by figure 10).

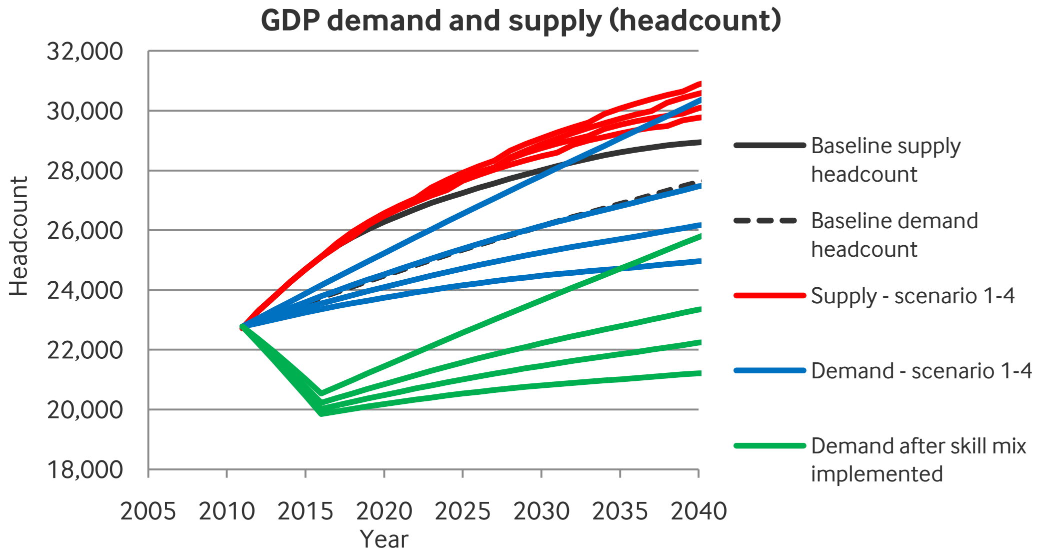
Figure 10: Forecast demand and supply for GDPs in the four scenarios showing the greater uncertainty of demand



Source: CfWI system dynamics modelling, September 2012

Figure 11 gives an indication of the impact of increasing skill mix on demand for GDPs. If employers increase their dental skill mix (that is, dental care professionals do an increasing amount of the work previously done by dentists) the demand for general dental practitioners will decrease. Figure 11 shows the impact (indicated by green lines) of a 3 per cent reduction in demand for GDPs for each of the next five years, as a result of skill mix. The review group feels that if a moderate number of small dental practices choose to employ a different skill mix, this drop in demand for GDPs could result. Such a shift might result in a significant oversupply of GDPs, with immediate effect.

Figure 11: Forecast demand and supply for GDPs in the four scenarios, showing the potential for oversupply resulting from a three per cent reduction in demand for GDPs for each of the next five years, as a result of skill mix

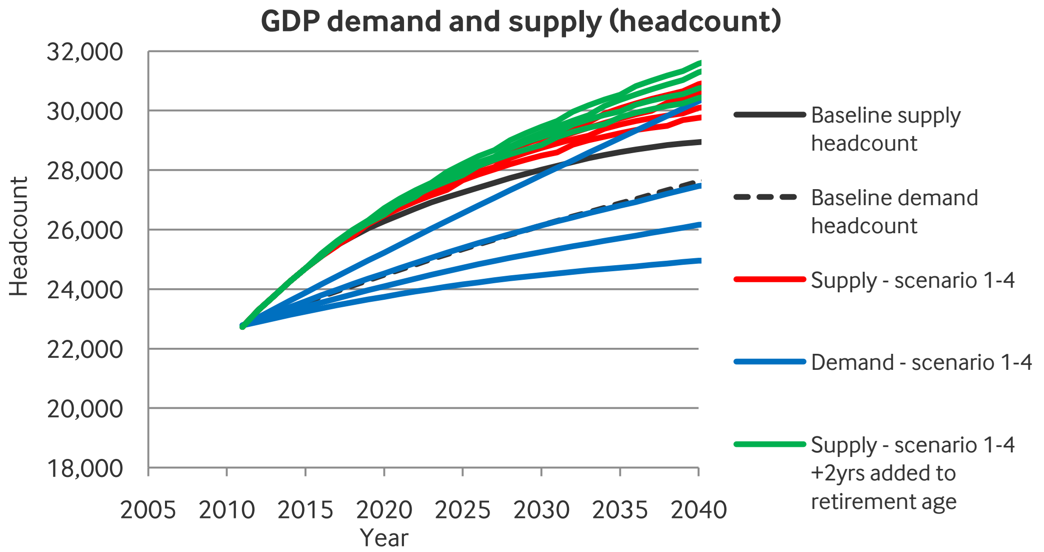


Source: CfWI system dynamics modelling, September 2012

Figure 12 gives an indication of the impact of dentists working two years longer on average, assuming the minimum retirement age for dentists rises to 67 (and the average retirement age also rises by two years).

Dentists working longer will increase supply across all scenarios. In an oversupply situation the policy change would rapidly exacerbate the oversupply. The impact of this policy change is shown as green lines in figure 12.

Figure 12: Forecast demand and supply for GDPs in the four scenarios, showing the increase in supply of dentists if they work two years longer on average than they do today



Source: CfWI system dynamics modelling, September 2012

The CfWI has not included analysis relating to dental specialists due to data limitations. Key data sources were not available, for example specialty attrition rates by gender and age.

2.2 Medical workforce

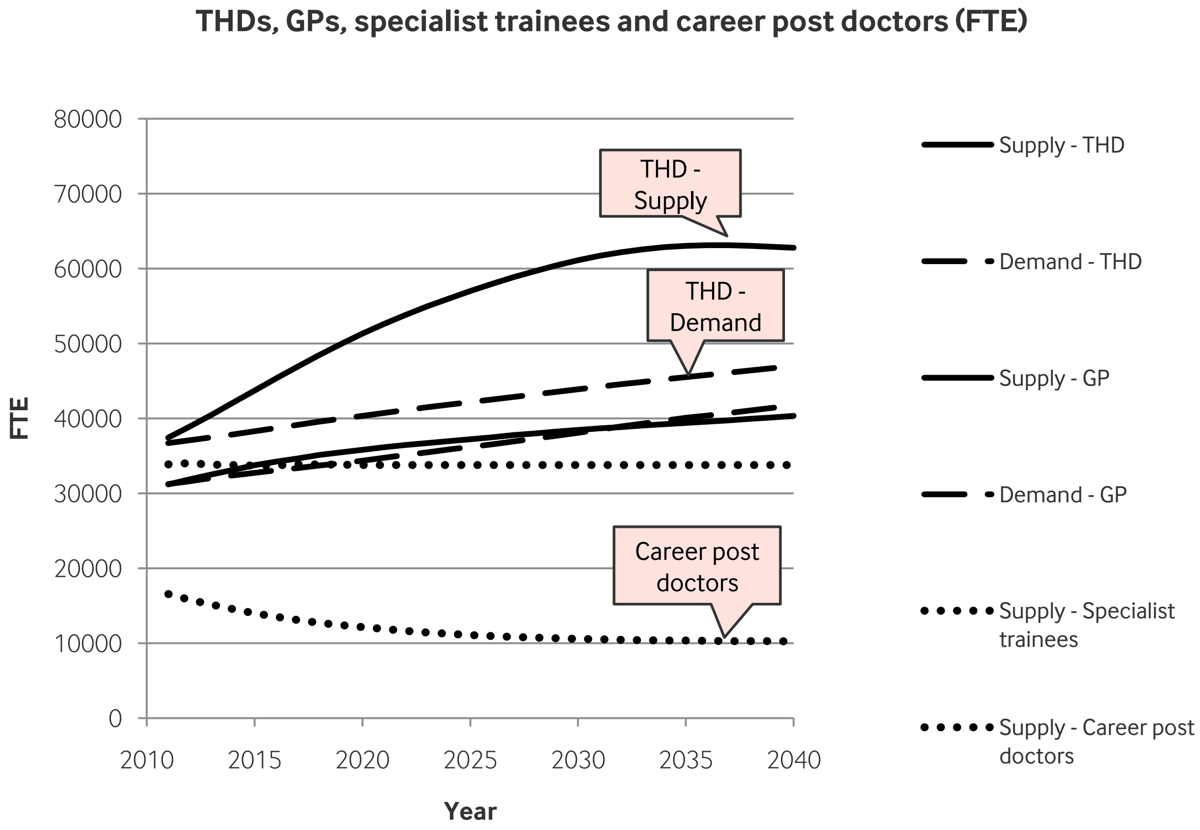
In this section you will find:

- our 'baseline' forecasts of demand and supply for general practitioners (GPs) and trained hospital doctors (THDs which in the current NHS environment means trained hospital doctors)
- forecasts of demand and supply for GPs and THDs for each of the four plausible future scenarios compared with the baseline forecasts
- an indication of the impact of increasing skill mix on demand for THDs
- an indication of the impact of all doctors working two years longer on average
- an indication of the impact of achieving a 50:50 ratio of GP:hospital specialty entry-level training posts in the near future
- an indication of the impact of extending GP training to four years in the near future
- an indication of the impact of increasing the international student limit to 10 per cent or decreasing it to 5 per cent (from 7.5 per cent as at present)
- an indication of when the medical workforce could be available to deliver a seven-day service.

Figure 13 shows the CfWI's baseline forecasts of demand and supply for GPs and for trained hospital doctors (THDs). For an explanation of what is meant by 'baseline' forecasts, please see the dental section above.

The baseline forecasts show a balance of demand and supply for GPs, and an overall oversupply of THDs. Please note that the model does not deal with individual specialties or geographical differences, so the overall oversupply of THDs is likely to mask shortages in specific specialties or areas. The figure also shows, for comparison, the forecast supply of specialty trainees and career post doctors. This forecast shows a drop off in career post doctors over time. This is because the model assumes that career post doctors will continue to enter specialty training at the rate they do now, and fewer will be recruited in the future, based on current trends.

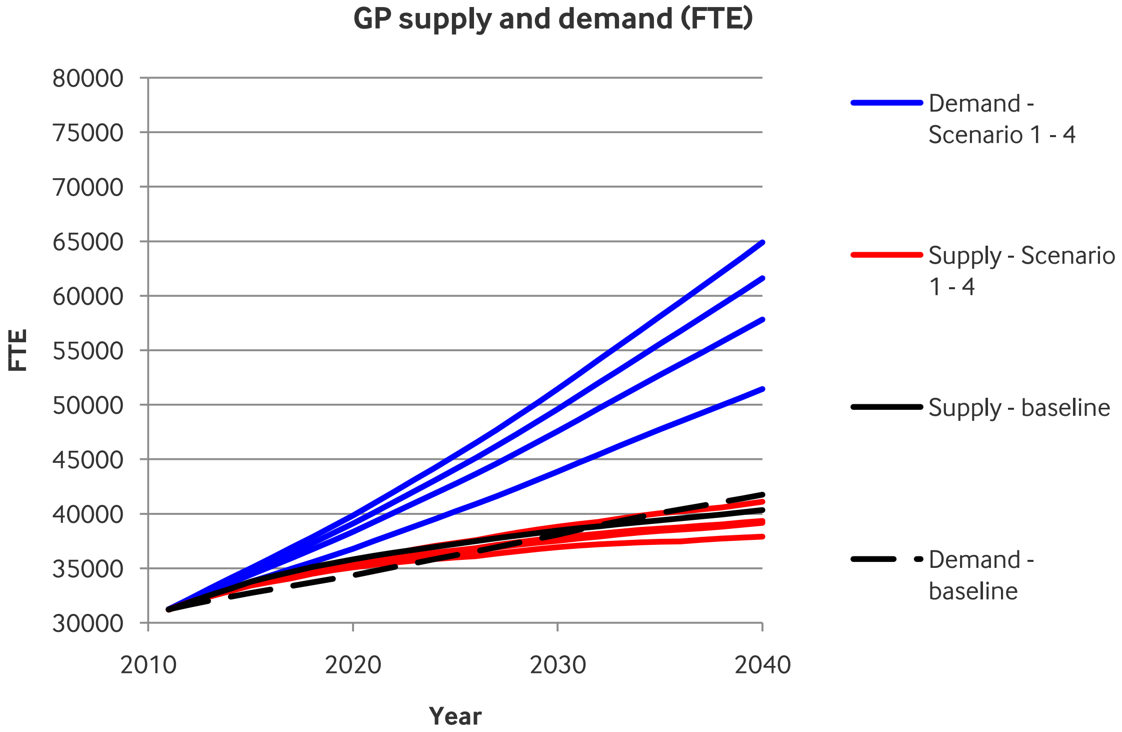
Figure 13: Baseline forecasts of demand and supply for trained hospital doctors and GPs. Career post doctor and trainee numbers are also shown for comparison. Note that the legend lists the forecasts from top to bottom, with the top line representing the baseline supply forecast for trained hospital doctors, and so on.



Primary data sources: medical census for England 2011 (HSCIC), medical school student data 2011 (HEFCE), population projections for England 2010 (ONS), hospital episode statistics 2010-11 (HSCIC)

Figures 14 and 15 show the CfWI's forecasts of demand and supply for fulltime equivalent (FTE) GPs and trained hospital doctors for each of the four future scenarios compared with the baseline forecasts. Figure 14 indicates a sustained rise in demand for GPs and a significant undersupply in all scenarios if no rebalancing (from other specialties to general practice) occurs.

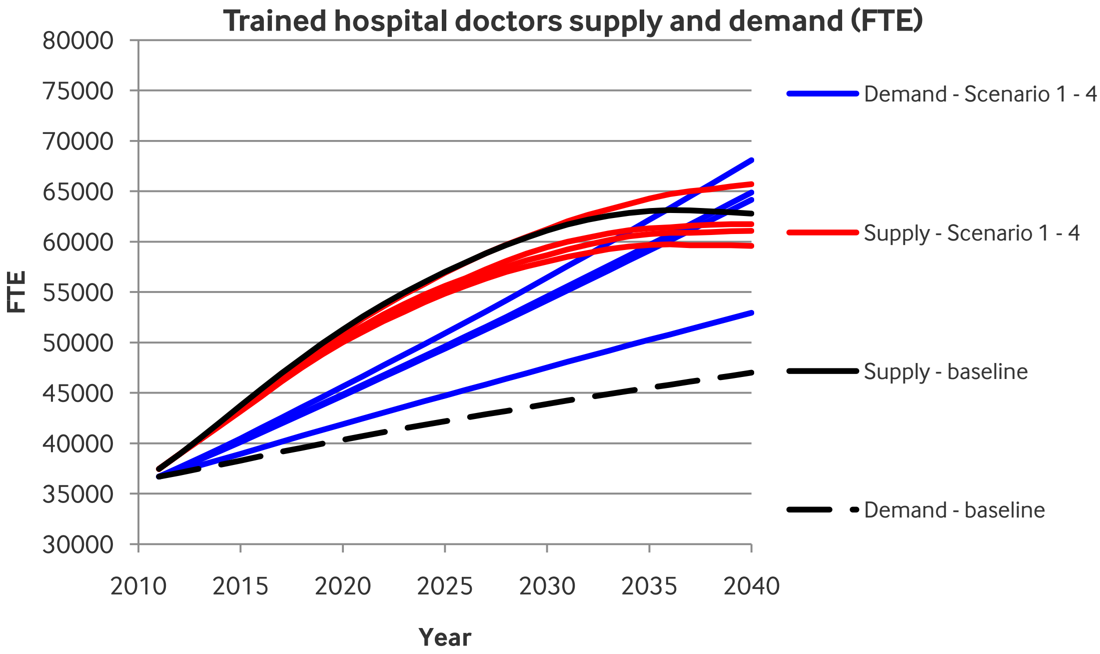
Figure 14: Demand and supply forecasts for GPs in the four medical scenarios showing a sustained oversupply



Source: CfWI system dynamics modelling, September 2012

Figure 15 indicates a sustained rise in demand for trained hospital doctors, but despite this a significant oversupply of trained hospital doctors in all scenarios for approximately two decades if no rebalancing (from other specialties to general practice) occurs.

Figure 15: Demand and supply forecasts for THDs in the four medical scenarios showing oversupply for approximately twenty years

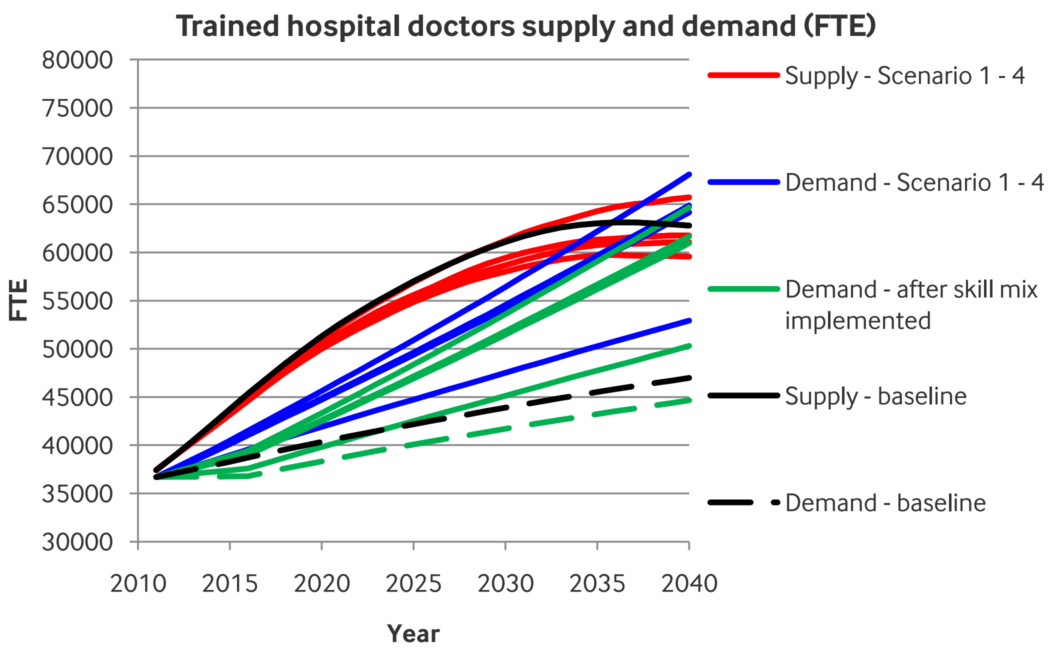


Source: CfWI system dynamics modelling, September 2012

The clear implication of figures 14 and 15 is that the system must do more to ensure a greater proportion of trainees choose to specialise in general practice.

Figure 16 gives an indication of the potential impact of skill mix on workforce productivity for THDs, modelled as a 1 per cent reduction in demand for THDs for each of the next five years as a result of local employer decisions about skill mix. The CfWI has established from employer organisations that this productivity goal is not implausible. The green lines represent the reduced demand.

Figure 16: The increase in oversupply resulting from a one per cent reduction in demand for THDs for each of the next five years as a result of local employer decisions about skill mix

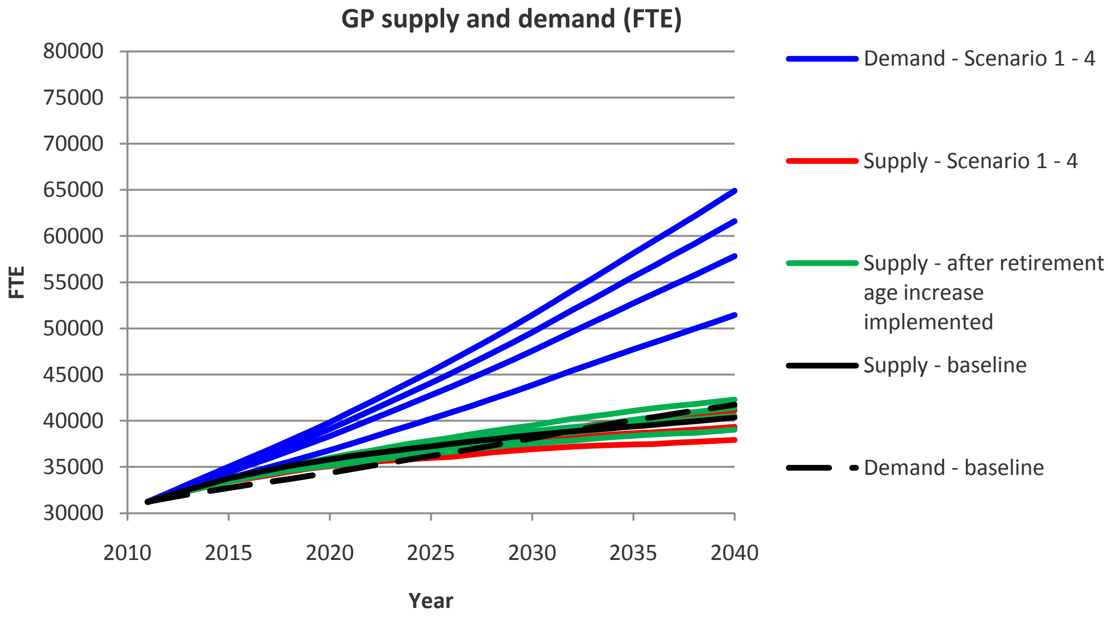


Source: CfWI system dynamics modelling, September 2012

In case of an imbalance of demand and supply as suggested by the graphs above, the CfWI's analysis shows that student intakes are not the most effective 'lever' to close the gap. For example, in an undersupply situation if the system could decrease attrition in training and from the workforce, encourage return to work or increase productivity, these changes would have a more immediate impact. The following graphs give an indication of the impact of various other potential policy changes on the balance of demand and supply.

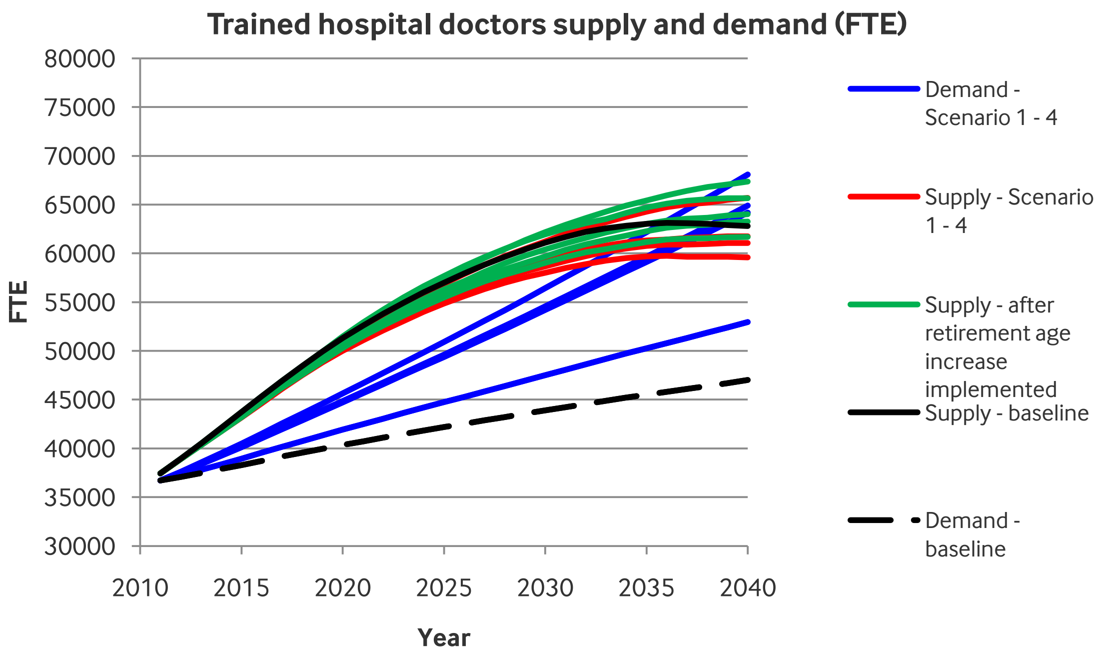
What might be the impact if the minimum retirement age for doctors rises to 67 (and the average retirement age also rises by two years)? Figures 17 and 18 indicate the impact of doctors working for two years longer on average than they do today. If GPs work for two years longer, this will help to relieve the anticipated undersupply. If hospital doctors do so, this will exacerbate the anticipated oversupply.

Figure 17: Forecast demand and supply for GPs in the four scenarios, showing the small decrease in undersupply resulting from GPs working for two years longer on average than they do today



Source: CfWI system dynamics modelling, September 2012

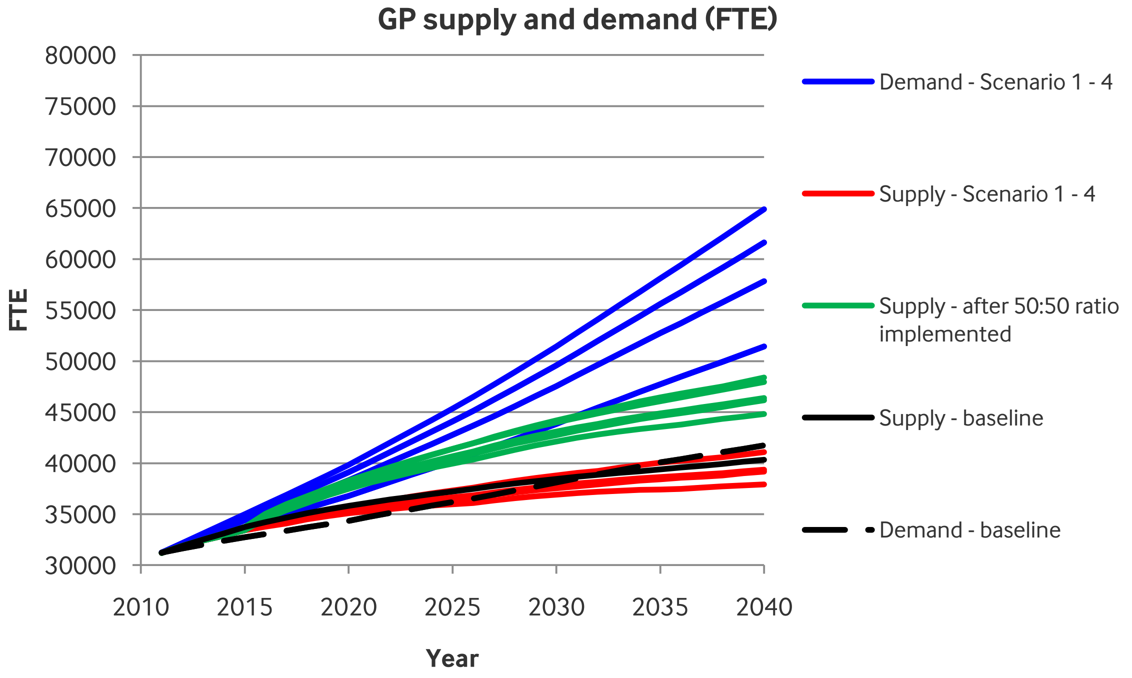
Figure 18: Forecast demand and supply for THDs in the four scenarios, showing the small increase in oversupply resulting from THDs working for two years longer on average than they do today



Source: CfWI system dynamics modelling, September 2012

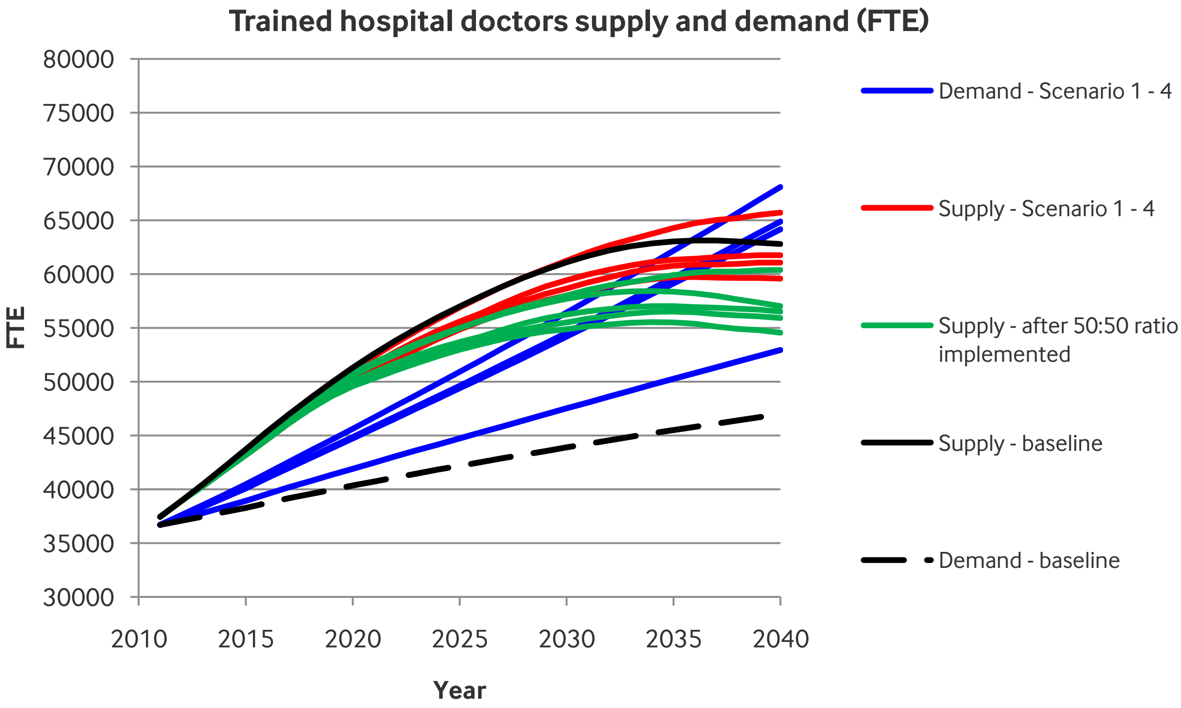
Figures 19 and 20 give an indication of the impact of achieving the intended 50:50 ratio of GP:hospital specialty entry-level training posts in the near future. Figures 19 and 20 show that this slight rebalancing in favour of general practice leads to a significant improvement, both in the undersupply of GPs and the oversupply of trained hospital doctors. The 50:50 policy will reduce the undersupply of GPs, but will not be sufficient to resolve it.

Figure 19: The reduction in GP undersupply if we achieve in the near future a 50:50 ratio of GP:hospital specialty entry-level training posts



Source: CfWI system dynamics modelling, September 2012

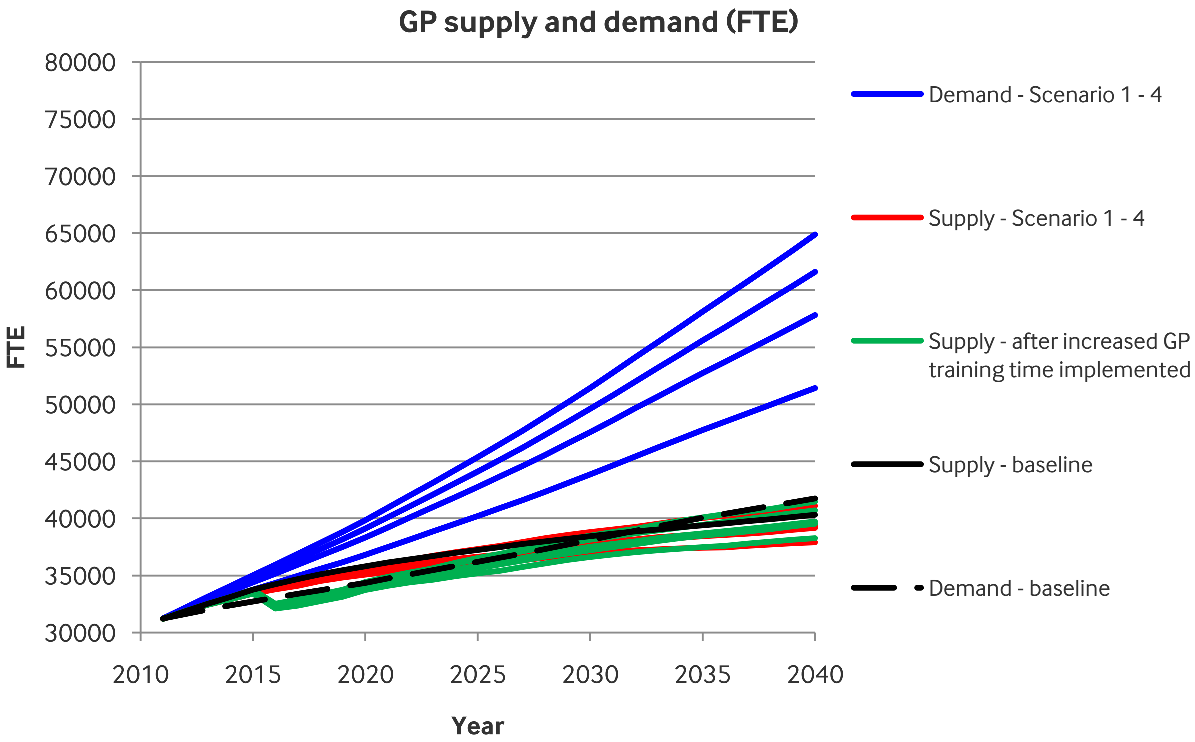
Figure 20: The reduction in THD oversupply if we achieve in the near future a 50:50 ratio of GP:hospital specialty entry-level training posts



Source: CfWI system dynamics modelling, September 2012

Figure 21 gives an indication of the impact of extending GP training to four years in the near future. It shows a sudden and significant drop in GP supply, which then takes a number of years to reach the level that would be maintained without the policy change. Caution would be needed, as well as a clear plan for a safe transition, if a policy to extend GP training were to be implemented.

Figure 21: The limited impact on GP supply of extending GP training to four years



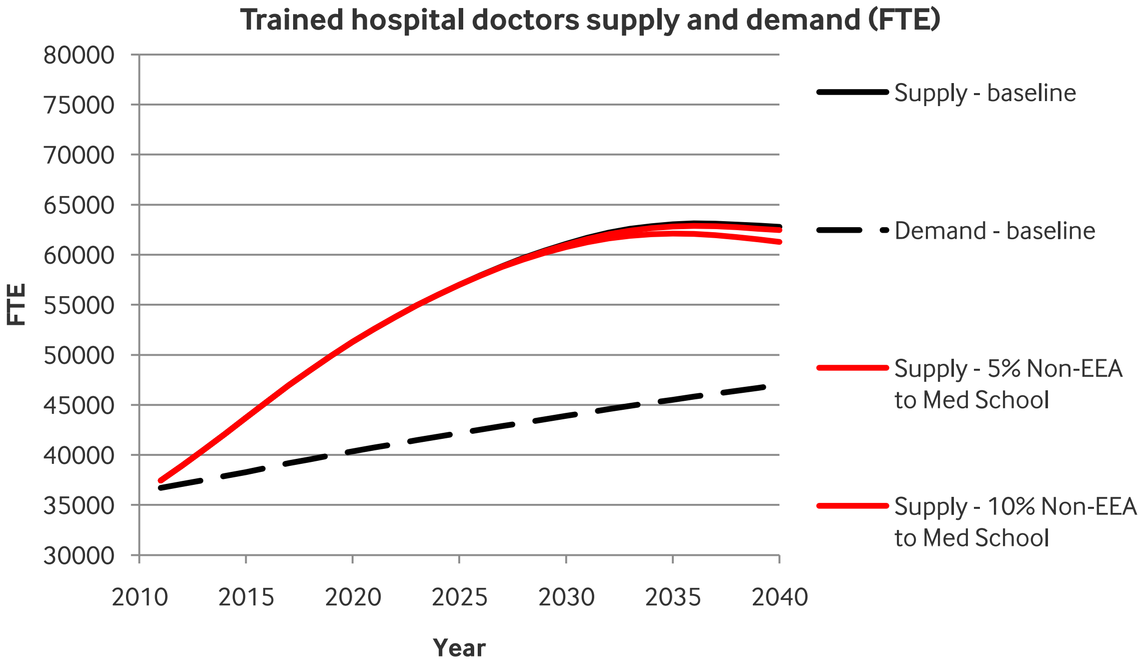
Source: CfWI system dynamics modelling, September 2012

Figure 22 gives an indication of the impact on demand and supply for trained hospital doctors of increasing the international student limit to 10 per cent or decreasing it to 5 per cent (from 7.5 per cent as at present) with no changes in current behaviour and no changes in total number of students.

The baseline assumption is that 5 per cent of all current foundation year 2 (F2) doctors leave at the end of their F2 year, which implies that not all of the current non-EEA medical school students leave after F2. The two policy scenarios show the case where, from 2012 onward, the total number of medical school students remains constant, but the fraction of non-EEA medical school students is either 5 per cent or 10 per cent, as opposed to the current level of 7.5 per cent. The policy scenarios, in red in the graph, assume that all the non-EEA students leave at F2. Therefore the baseline and 5 per cent non-EEA lines overlap because there is a similar rate of leavers as we have now. However, the 10 per cent non-EEA supply line is lower than the baseline, as more F2 doctors leave.

If this modelling is applied to the possible policy lever that all non-EEA graduates must leave the UK after completion of foundation year 1 (F1) and attaining full registration, we can estimate an increase of 7.5 per cent leaving on an increased 'headroom' of 10 per cent compared to today. By around 2033 there would be a small reduction in supply emerging with a growing but still small gap by 2040.

Figure 22: The limited impact of changing the non-EEA student intake to medical schools from 7.5 per cent to 5 per cent or 10 per cent

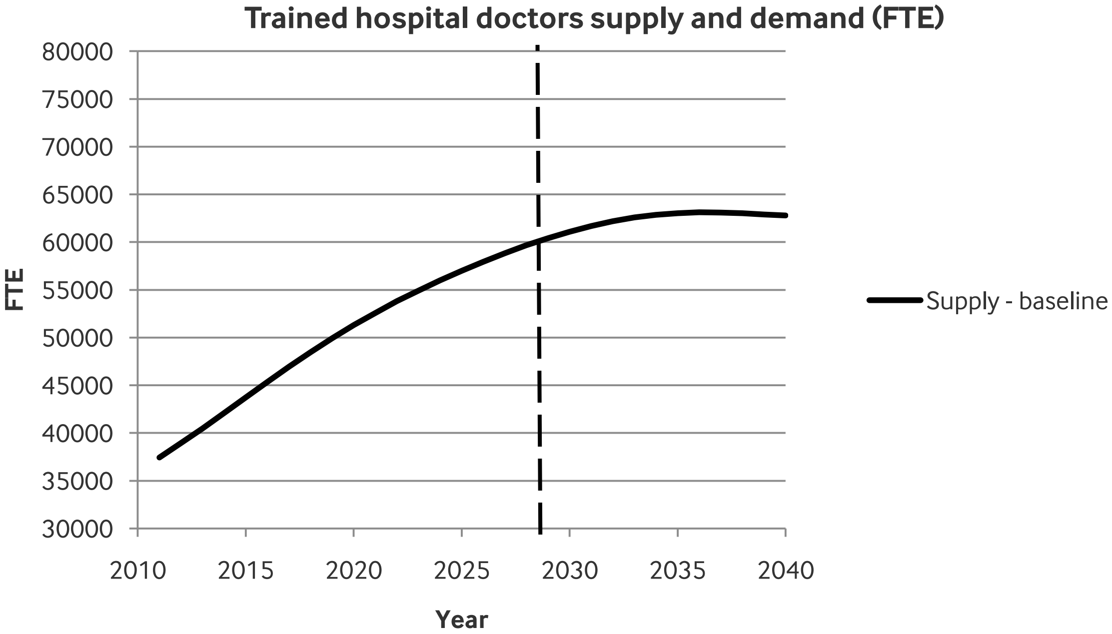


Source: CfWI system dynamics modelling, September 2012

Finally, figure 23 gives an indication of when there may be enough trained hospital doctors to deliver seven-day services in key specialties. Referring to the baseline supply curve for THDs, there would be enough doctors by around 2030 (see dashed vertical line), but without intervention there is a risk of 'overshooting' this level.

[NB this work was extrapolated from work carried out by the CfWI in 2010 with the specialties to understand what is meant by a trained-doctor service and which services were considered, by the specialties, as being likely to need 24/7 service delivered by trained doctors].

Figure 23: The baseline forecast of THD supply, showing that by 2030 there could be enough doctors to provide seven-day services



Source: CfWI system dynamics modelling, September 2012

3 FUNDING SCENARIOS

The CfWI has considered funding and cost constraints in order to support the review group's discussion about affordability

In this section you will find:

- funding scenarios
- projections of baseline supply against realistic funding scenarios.

The HENSE review group recommendations about student intakes need to take into account not just future workforce demand and supply, but also whether or not projected staff numbers are affordable. To support this objective, the CfWI reviewed the funding and cost constraints likely to face the English NHS over the forecast period.

The CfWI's starting point is the recent Institute for Fiscal Studies (IFS, 2012)8 report for the Nuffield Trust, which outlines three funding scenarios for English NHS spending between 2015–16 and 2021–22:

- spending is frozen in real terms (extending the current Spending Review freeze)
- spending grows in line with national income (i.e. constant share of national income)
- spending grows in line with its long-run average for the UK (around 4.0% per annum since 1950/51).

The CfWI has extended these three scenarios to 2039–40 and revised them using the latest Office for Budget Responsibility (OBR) (2012)[9] long-term growth projections.

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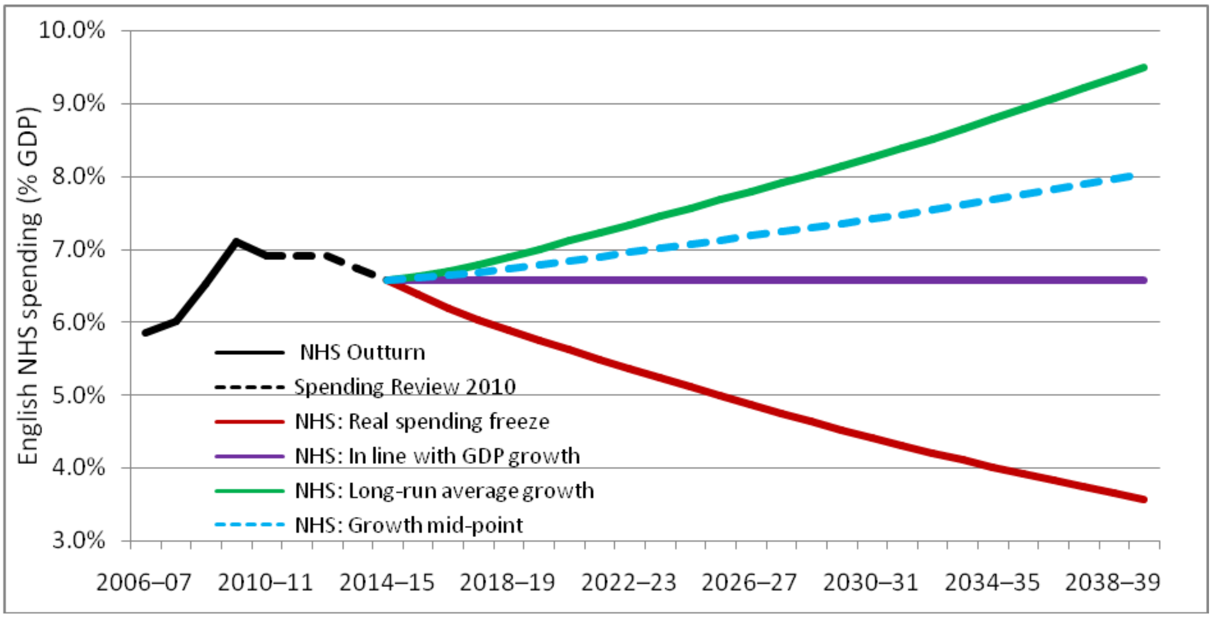
[8] Institute for Fiscal Studies (2012) *NHS and social care funding: the outlook to 2021/22*, Nuffield Trust, London. Available at: http://www.nuffieldtrust.org.uk/nhs-financial-challenge

[9] Office for Budget Responsibility (2012a), Fiscal sustainability report – Supplementary data series July 2012, Available at: http://budgetresponsibility.independent.gov.uk/pubs/FSR-2012-Supplementary-Tables.xls

Figure 24: NHS England funding scenarios (percentage of national income)



Based on Figure 2b from the Institute for Fiscal Studies (2012) revised and extended to 2039–40. Data sources: NHS (Health) Total Departmental Expenditure Limit. Outturn data are from HM Treasury (HMT, 2011), Table 1.8. Spending Review forecasts are from HM Treasury (2012)[10]. Forecasts for real national income growth 2012–13 to 2016–17 are from HM Treasury (2012)[11]. For 2017–18 onwards these are from the Office for Budget Responsibility (2012).

As figure 24 shows, however, a 30-year real spending freeze is unsustainable. Freezing real spending to 2039–40 would halve public health spending from around 7 per cent to around 3½ per cent of national income. This would create large unmet demand for healthcare services, and is at odds with the history of healthcare spending across developed economies. Analysis of Organisation for Economic Cooperation and Development (OECD) data found that 'health spending as a share of Gross Domestic Product (GDP) has increased in all countries since 1970', typically by 3–6 percentage points (+¾ to 1½ percentage points a decade) (OBR, 2012).

Given the possibility, however, that NHS healthcare spending may not increase in coming decades at the rapid pace seen over the past fifty or sixty years, the CfWI

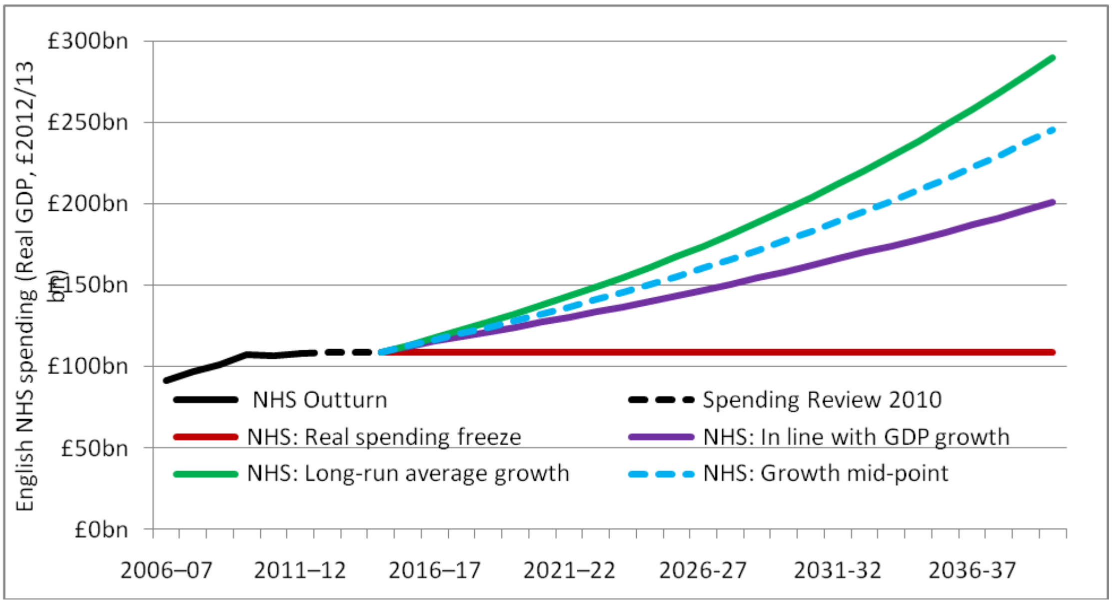
[10] HM Treasury (2011) Public Expenditure Statistical Analyses 2011. Available at: www.hm-treasury.gov.uk/pespub_pesa11.htm

[11] HM Treasury (2012) Budget 2012. Available at: www.hm-treasury.gov.uk/budget2012.htm

has added a fourth funding scenario – the mid-point of the high (4 per cent pa) and constant GDP growth scenarios. This would take NHS spending from around 6.6 per cent of national income at the end of the Spending Review period to 8 per cent by 2039–40 (+0.6 percentage points a decade). This is the CfWI's central projection for NHS funding over the forecast horizon: a real spending freeze to 2014–15, followed by sub-trend growth.

Figure 25 shows what those funding scenarios look like in real (constant price) billions of pounds. Omitting the real spending freeze scenario for reasons already outlined, they provide for real budget increases of between 88 per cent and 171 per cent between 2010–11 and 2039–40 (central projection: +129 per cent).

Figure 25: Four NHS England funding scenarios in constant pounds (real £2012/13 billion)



Sources: CfWI estimates. Based on HMT, IFS and OBR sources as per figure 24.

3.1 Cost and budget scenarios

What are the implications of these funding scenarios on the ability of the NHS to employ additional staff? That depends on four cost-related factors: changes to the skill mix of the NHS workforce over the next three decades, changes to terms and conditions, pay increases over the period, and changes to non-wage NHS costs.

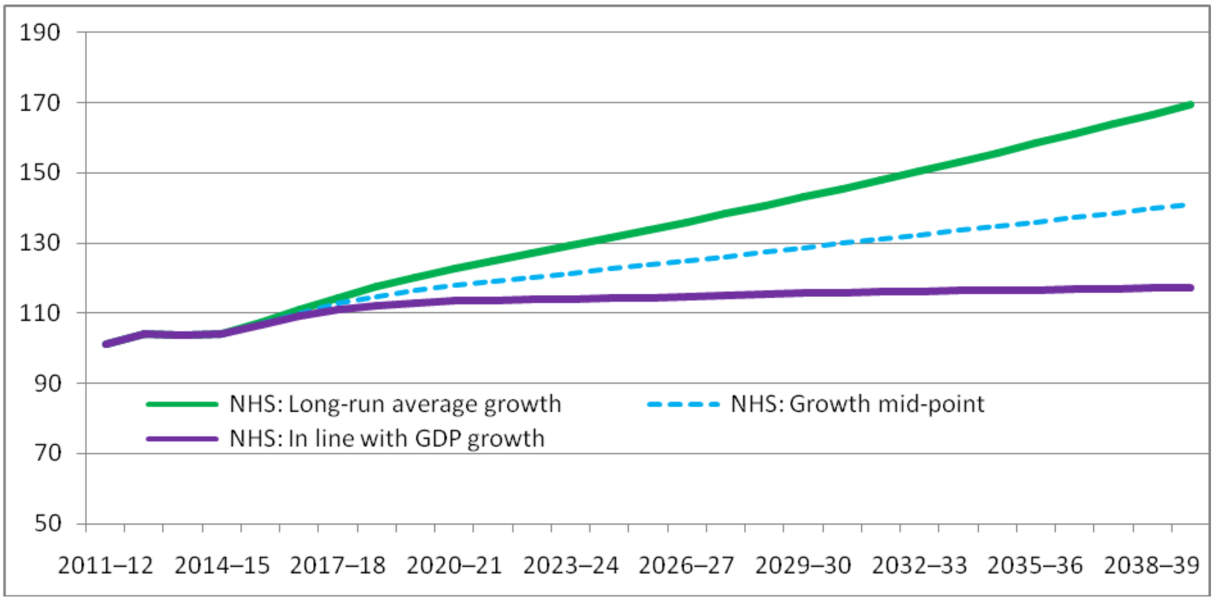
The CfWI has assumed that:

- the composition of the NHS workforce remains broadly unchanged

- average terms and conditions – aside from pay – remain around present levels
- NHS non-wage costs (property, medical equipment, drugs, etc.) rise in line with overall price trends in the economy (GDP price deflator).

On those simplifying assumptions, changes in remuneration are the key cost driver. What is the outlook for pay growth in the NHS? The CfWI expects it to be similar to the rest of the public sector, so for its cost scenarios, the CfWI has used the OBR's latest central projections for public sector average earnings growth. These forecast nominal pay growth to remain weak (below 1 per cent per annum) through to 2017–18, then pick up to average 2¼ per cent per annum from 2021–22 onwards. After adjusting for price increases, real public sector pay is projected to rise by a total of 60 per cent by 2039–40. As wages account for around two-thirds of NHS spending, and these are substantial real pay increases, the budget remaining for managers to be able to hire additional staff (or increase other spending) would be significantly reduced compared with figure 25 above.

Figure 26: Available real NHS England budgets after adjusting for estimated pay rises (100% = 2010–11)



Source: CfWI estimates of percentage change compared to 2010-11 baseline (100%). Based on HMT, IFS and OBR sources as per figure 24

After adjusting the funding scenarios for real pay growth (OBR 2012), and making the simplifying assumptions outlined above, the CfWI estimates that there may be scope to hire extra NHS staff by 2040, ranging from +17 per cent (growth in line with national income) to +69 per cent (long-run average growth). The CfWI's central funding scenario (growth mid-point) could accommodate increases in NHS staff of around 41 per cent over the forecast horizon, subject to the important caveats above.

The CfWI's baseline supply forecasts (full-time equivalent basis) between 2010–11 and 2039–40 are for:

- the supply of dentists to increase by 27 per cent
- the supply of GPs to increase by 29 per cent
- the supply of trained hospital doctors to increase by 64 per cent .

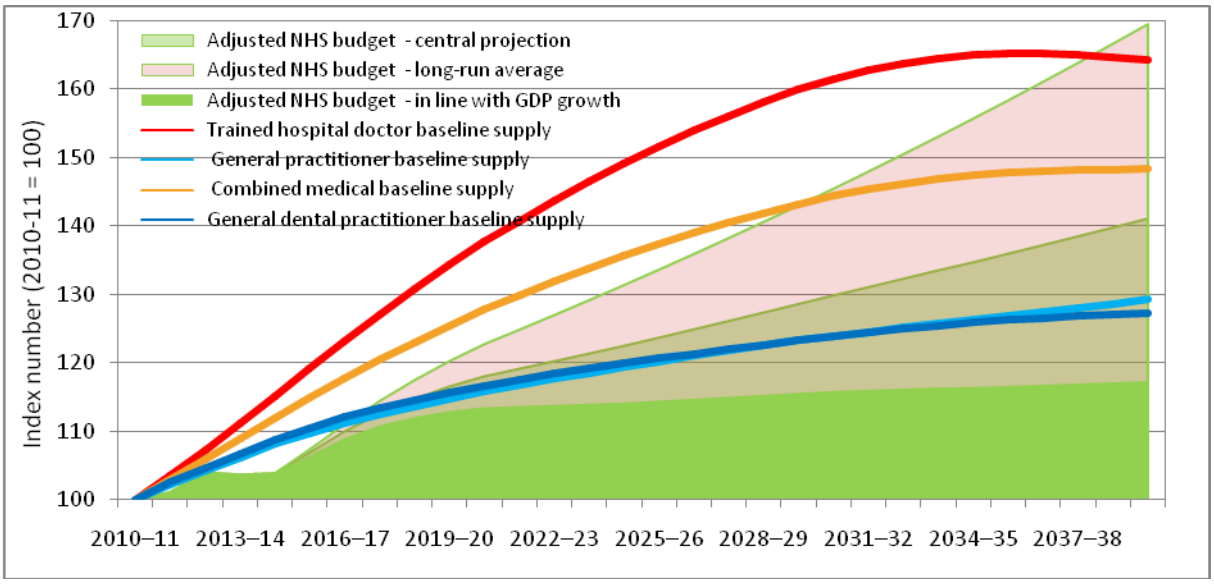
As increases in both dentists and GPs are well below the central projection of a 41 per cent increase in available real NHS England budgets (after adjusting for pay rises), **there is a reasonable prospect that the costs of hiring additional dentists and GPs may be accommodated** within projected NHS budgets.

An important caveat to this conclusion is that it relies upon:

- average pay growth being broadly in line with the OBR's central projections
- no major change in average staff terms and conditions (e.g. pensions and benefits)
- NHS non-wage costs not strongly outpacing overall price trends
- the NHS not moving towards a skill mix that is considerably more expensive than at present.

If any of these assumptions were not to hold, the additional costs would reduce the capacity of future NHS England budgets to pay for extra clinical staff, and would lower these budget projections accordingly.

Figure 27: Medical and dental baseline supply projections and adjusted NHS real budget scenario, 2010-11 to 2039-40



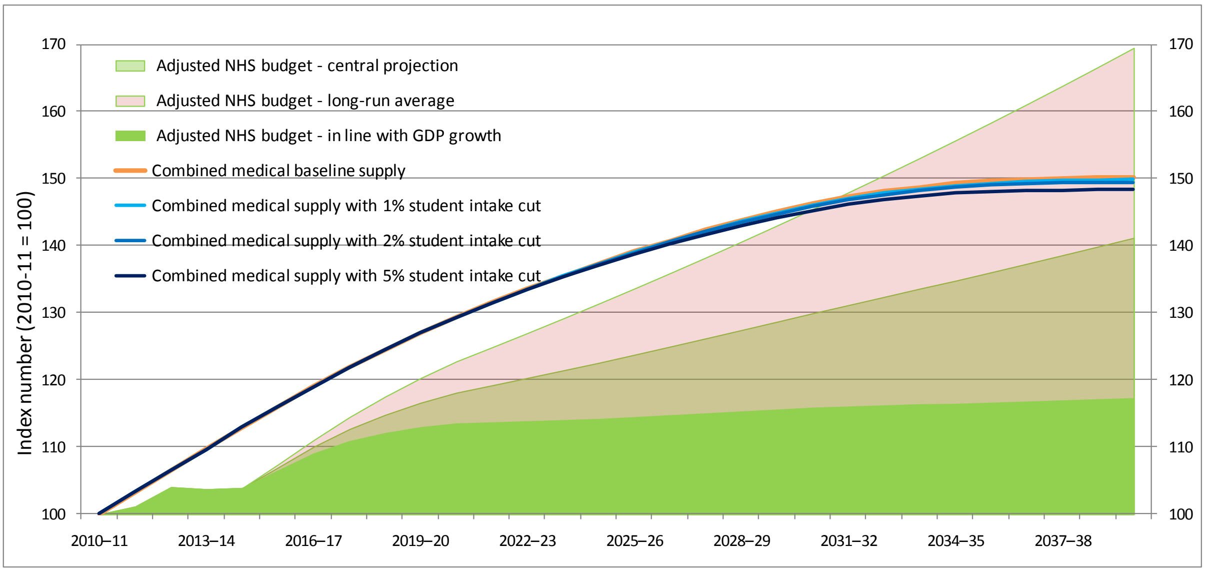
Source: CfWI estimates, as outlined above. Supply lines show the percentage growth on a full-time equivalent basis.

By contrast, the projected 64 per cent increase in trained hospital doctors is near the top of the 17–69 per cent forecast range of the three budget scenarios, and well above the central budget projection. Such a large increase in the trained hospital doctor workforce could have serious budget implications for the NHS. **It is doubtful that the cost burden of a 64 per cent increase in trained hospital doctors could easily be accommodated within projected NHS England budgets.** An increase of this magnitude, were it to occur, may necessitate substantial offsetting cost savings to be made in other areas.

This is not just about the need to rebalance the THD/GP mix, however. The combined medical baseline supply is projected to increase by 48 per cent over the forecast period, which is also above the CfWI's central budget projection. This suggests that the NHS may encounter difficulties in seeking to fund all of the projected growth in baseline supply of doctors over the forecast period.

Figure 28 illustrates the impact on the combined medical baseline supply (the orange line in figure 27) of reducing the annual medical school intake by one, two and five per cent.

Figure 28: Combined medical baseline supply projections showing the limited impact of reducing the annual medical school intake by one, two and five per cent.



Source: CfWI estimates, as outlined above. Supply lines show the percentage growth on a full-time equivalent basis.

4 APPENDIX A

4.1 HENSE review group terms of reference

To ensure an adequate and affordable supply of good quality trained doctors and dentists to improve health outcomes and ensure high quality patient care and the sustainability of the healthcare and research sectors, to advise on future:

- total intakes to undergraduate medical and dental training in England; and
- within that total, the respective limits on overseas medical and dental students.

The review should take account of:

- a system-wide analysis of long-term overall workforce supply and demand;
- changing roles within the health workforce and similarly, the growth of skill mix within dentistry;
- the evolving nature of care with, for example, greater emphasis on community services;
- the development of private medical and dental schools and faculties of UK medical school overseas;
- the UK dimension - given that undergraduate education is a UK-wide market, a consistent approach to intakes across the UK would be desirable. In particular, account should be taken of the decisions arising from the Scotland Review of Medical Undergraduate Numbers that will be implemented for the intake to medical schools in Scotland in 2012 – and any parallel reviews of the dental workforce by the other UK Health Departments;
- the EEA and overseas dimension – similarly, account will need to be taken of likely demand for places from overseas applicants and forecast numbers of migrant doctors and dentists in the UK workforce;
- the potential impact upon the sustainability of English medical and dental schools;
- the risk to graduate career intentions following training; and

- the development of Health Education England and its emerging agenda and strategic direction.

Recommendations should be made so that decisions can be taken to determine the intake to medical and dental schools in England in 2013/14 and beyond.

5 APPENDIX B

5.1 HENSE review group membership

Co-chairs

Sir Graeme Catto	Emeritus Professor of Medicine at University of Aberdeen
Sir Bruce Keogh	NHS Medical Director, DH

Members

Professor Hilary Chapman	Chief Nurse/Chief Operating Officer. Sheffield Teaching Hospitals NHS Foundation Trust
Barry Cockcroft	Chief Dental Officer, DH
David Noyce	Higher Education Funding Council for England
Sir Keith Pearson	Chair, Health Education England
Professor Bill Saunders	Honorary Consultant in Restorative Dentistry, University of Dundee
Professor Steve Tomlinson	Emeritus Professor of Medicine, Cardiff University
Professor Chris Welsh	Medical Director, NHS Midlands and East

Professor Steve West	Vice-Chancellor, University of the West of England
Robert Winter	Director, Academic Health Science Systems, Cambridge University Health Partners

Observers

Debbie Mellor/ David Sowden	DH
Jane Gardner	BIS
Professor Malcolm Lewis	Welsh Government
Professor Paul Padfield	Scottish Government

Secretariat

Andrew Matthewman	DH

6 APPENDIX C

6.1 Glossary of key terms used in this report

Career post doctor	A doctor working in a non-training post who does not typically hold a CCT or CESR. The HSCIC categories included in this stock are: associate specialist, specialty doctor, staff grade, senior house officer, hospital practitioner/ clinical assistant and other staff.
CCT **CESR**	Certificate of Completion of Training (CCT) Certificate of Eligibility for Specialist Registration (CESR)
Delphi panel	The Delphi method is a structured communication technique, originally developed as a systematic, interactive forecasting method which relies on a panel of experts. Delphi is based on the principle that forecasts (or decisions) from a structured group of individuals are more accurate than those from unstructured groups.
FTE	Full time equivalent (as opposed to headcount).
Skill mix	Healthcare employers strive for the most effective mix of staff to provide sustainable, high-quality healthcare that can be achieved with the available resources while also taking into consideration local priorities.
Trained hospital doctor (THD)	A CCT or CESR-holder in a specialty other than general practice. These doctors are typically known as 'consultants', but we have used the term THD throughout this report.

7 APPENDIX D

7.1 Summary of CfWI stakeholder engagement during the project

Nature of engagement	Impact
Horizon scanning telephone interviews	The CfWI interviewed 44 people from across the medical and dental sectors to ensure that no key driver of workforce requirements was excluded from consideration.
Scenario generation	Approximately 30 participants from across the medical and dental sectors attended two-day workshops facilitated by Professor George Wright. Participants including clinicians, professional leaders, educators, employers, policymakers, students, trainees, lay people, and other healthcare professionals. For the outputs of these workshops, see APPENDIX E.
Scenarios video	116 people downloaded the video from the CfWI's website.
Publications on website	CfWI publications (scoping report, technical reports parts 1 and 2, and two horizon scanning reports) have been downloaded more than 600 times.
Scenario quantification by a Delphi panel	58 people spent 2–4 hours each giving their judgment about how 'need', 'service', workforce participation, average retirement age and workforce attrition would shift by 2040 in each of the four scenarios. The CfWI then used the panels' median judgments as modelling assumptions.
Regional cluster roadshows	Approximately 180 people attended half-day roadshows at which the CfWI demonstrated the new models and sought input on key uncertainties such as future skill mix and migration behaviour.

Nature of engagement	Impact
Checking model accuracy, gathering and checking data and modelling assumptions	Numerous stakeholders helped to sense-check the accuracy of the models themselves or helped to provide or sense-check the data and modelling assumptions used. Key sources of help were the Department of Health's Workforce Data and Analysis Team (WDAT), the Health and Social Care Information Centre (HSCIC), the BMA, GMC and specific deaneries, UCAS, NHS Pensions, and members of the medical project reference group.
Medical project reference group and dental project reference group	Members of the medical project reference group commented on the robustness of the CfWI's approach, participated in the Delphi panel, sense-checked the supply model and commented on key modelling assumptions. The Dental Programme Board acted in the capacity of dental reference group and made a similar contribution.
Attendance at standing committees/briefings	The CfWI has presented this work at least once to the Dental Schools Council, Dental Programme Board (which acts as the CfWI's dental project reference group), COPDenD, Royal College of Surgeons' Faculty of Dental Surgery, dental students and trainees (via BDA committees), Medical Schools' Council, Medical Programme Board, COPMeD, English Deans, JACTAG, WAPPIG, UK Scrutiny Group, UKHEAC, Academy of Medical Royal Colleges and individual royal colleges, medical students and trainees (via a focus group), employers (through NHS Employers and via CEOs/medical directors participating in scenario generation and so on), LETBs, and Health Education England.
e-briefings	The CfWI has sent periodic e-briefings (to date, six) to 608 stakeholders.

8 APPENDIX E

8.1 Dental scenarios

In early 2012 the CfWI held a scenario generation workshop with dental stakeholders to define four plausible future scenarios as a basis for modelling.

The first step in the process was to identify about two hundred **driving forces** that were seen by the expert stakeholders to comprehensively document the trends/certainties and major uncertainties that would have lesser or greater impact on the number and proportions of the dental workforce required in England up to the year 2040 – our major issue of concern.

Participants were then asked to look for causal and chronological relationships between the driving forces, which resulted in eight **'clusters'** (or higher level factors). Each is described below. Four of the clusters contained components that were viewed as in-the-pipeline, pre-determined or more certain and therefore perceived as a part of all plausible futures by the workshop participants. The components of four of the clusters were seen as much more uncertain by the workshop participants. Of these four more uncertain clusters, two were seen to have a higher impact on the issue of concern. It was these two high impact/high uncertainty clusters that were then used by the participants to develop four plausible scenarios for how the future might unfold.

First, the four pre-determined clusters:

1. Attractiveness of a dental career for university applicants.

Here the number of applicants for university-based entry courses to dentistry does not reduce significantly from the current level of 150 applicants per place. This over-supply of applicants means that selection for the 'right quality' is possible over the next 30 years –such that the practitioner-base and the academic-base of the profession are not eroded. The profile of applicants continues to change and the proportion of women students continues to increase. Meanwhile the values and attitudes of a 'Generation Y and Z' dental workforce (both women and men) – for example in relation to work-life balance and therefore the number of hours worked – are unknown. However, the high overall number of applicants still allows the targeted selection of suitable candidates for dental careers.

2. International mobility of dentists.

Here England is seen to continue to be a net importer of dentists because the money invested in public dental education is seen, at best, not to increase. At the same time, research output and standing diminish somewhat with, at best, a resultant neutral impact on the quality of post-graduate education. Nevertheless, non-UK dental graduates retain a positive attitude to working, at least for a period, in the UK – with its relative affluence.

3. Aging population and service provision.

Here the increasing proportion of English patients who are in the older age bracket – so-called 'silver voters' – become more vocal and influential, and create pressure for high-quality, often complex, dental treatments. This pressure for access to necessarily limited resources in the NHS results in greater demand from wealthier patients for private care to supplement NHS provision, where the recall interval is extended to some degree. The desire for 'perfect teeth' from all segments of the patient population, including the elderly, results in strong demand for cosmetic dentistry – but access is only for those who can pay.

4. Demography and dental disease.

Here the overall prevalence of dental disease (caries and periodontal disease) is seen to remain relatively unchanged over the next 30 years: the better dental health of patients currently under 40 (resulting from the introduction of fluoride toothpaste) is balanced by the increased needs and expectations of the older 'heavy metal' generations (who have retained much of their natural dentition but with high levels of dental disease treated by fillings and other restorations). Changes in diet have no immediate impact on general dental health and health advice continues to have only a marginal impact. Demand for and provision of cosmetic dentistry continues increasing and litigation rises somewhat as a result. At the same time, the disease burden remains fairly constant with a cost-conscious NHS increasing the scope of practice by dental care professionals.

The two clusters whose outcomes were seen as having both high impact on the issue of concern and low predictability were:

5. Economic state of the nation.

Here there is a focus on the impact of economic factors and – linked to these – NHS commissioning of dental services. How long will the economic downturn continue? What will be the political priorities in the NHS/private provision balance? Will inequalities in oral health and health outcomes widen? Two plausible outcomes were envisaged for this cluster:

Lower or fluctuating resource environment: here the economic downturn is sustained over much of the 30-year period and investment in the NHS reduces. Basic NHS services are targeted at the needy and, at the same time, private dentistry becomes less-sought by all but the rich. NHS commissioners demand greater service levels from the dental workforce. There are widening inequalities in oral health and in oral health outcomes. Waiting lists for treatment grow and

Salaried Primary Dental Care Services (SPDCS) become a 'safety net' for the general public's dental care needs. Dental training becomes a somewhat less popular choice amongst university applicants.

Higher resource environment: here there is a return to sustained economic growth which makes possible increased investment in NHS dentistry. Clinical needs are largely met in the NHS but at the same time there is a growth in private cosmetic dentistry, with dentistry becoming more attractive as a career. The NHS releases additional funding for new contracts - some of which attract private bids. Overall, there is increased patient access to NHS provision – resulting in an increase in demand for places in dental schools.

Coupled with the components of the cluster **attractiveness of a dental career,** this cluster will result in an adequate supply of graduate dentists except towards the end of the end of the sustained downturn. Coupled with the components of the cluster **international mobility of dentists**, this cluster will also mean the supply of imported dentists will adjust to satisfy English demand in all of the scenarios. Coupled with the components of the cluster **aging population and service provision** the cluster will mean that debates over priorities for young, working and retired patients will intensify in a sustained economic downturn.

6. Professional power and patient health needs.

Here there is a focus on the relative influence of the general patient population and the dental profession on the provision of dental services. Will service provision mainly be provided in 'nice areas' with patient access limited to times that suit dentists, or will patient expectations of 24-hour access in convenient locations prevail? Two plausible outcomes were envisaged for this cluster:

The desires of the profession prevail: here dental services are provided, by dentists' preference, in 'nice areas' and during the day-time only. The adverse geographic variation in dental service provision and health outcomes increases somewhat. Dentistry is seen as an attractive career. Non-UK origin dentists work in the less 'leafy' geographical areas – often for piece-work dentistry corporate chains.

The needs of patients prevail: here the higher expectations of patients are, to the extent possible, met. Whatever funding is available for dental services is directed to provide ease-of-access to these services at point-of-need. As a result, the dental profession becomes somewhat less attractive as a career choice.

Coupled with the components of the cluster **attractiveness of a dental career,** this cluster will result in an adequate supply of graduate dentists in all scenarios. Coupled with the components of the cluster **international mobility of dentists**, it will also mean that the supply of imported dentists will adjust to satisfy English demand in all future scenarios. Coupled with the components of the cluster

aging population and service provision this cluster will mean that debate over priorities for young, working, and retired patients will intensify in all scenarios but will become especially intense where there are geographical inequalities in dental care.

The two clusters whose outcomes were seen as having both lower impact on the issue of concern and lower predictability were:

7. Environment change and dental health.

Here the impact of global warming on food and water supply was seen to impact the nature of food eaten in England and so an impact on dental disease and oral health. However, this impact was viewed not to be salient to the patients' dental health until after 2040 – the time horizon of the scenarios. The impact of global warming on green-issue sensitivity and on the availability and desirability of using raw dental materials containing specific metals was also seen as uncertain - but of low impact on the issue of concern: the number and proportions of the dental workforce required in England up to the year 2040. For this reason, this cluster was not taken further in our analyses.

8.Technology and the shape of the dental workforce.

Here the focus is on the nature of technological advances and the resultant impact on the nature of the dental workforce. What will be the skill mix in the dental workforce? What will be the specialist/generalist balance? The resolution of this cluster was seen to be less uncertain than clusters (5) and (6), however workshop participants felt the cluster important to include in each of the scenario stories. Furthermore, the Delphi process will help to tease out further views on the impacts of skill mix and technology on the dental workforce.

Creation of four scenarios

Our next step was to create four scenarios by creating permutations of the four plausible outcomes of clusters (5) and (6)

This gave us:

Scenario1: which combined a negative economic position with the desires of the profession prevailing. The group labelled this combination **America** – since it captures the essence of the current US situation in the provision of dental services.

Scenario 2: which combined a negative economic position with the desires of patients prevailing. The group labelled this combination **Argos** – since, within the scenario, patients have a good choice of basic provision.

Scenario 3: which combined a positive economic position with the desires of the profession prevailing. The group labelled this combination **Kyklos** – a term used by some classical Greek authors to describe what they saw as the political cycle of government in a society.

Scenario 4: which combined a positive economic position with the desires of patients prevailing. The group labelled this combination **Utopiaaaaagh!** – since the scenario initially unfolds positively but ends with a poor outcome.

The detail of these four scenarios, combined with essential elements of clusters (1), (2), (3) and (4), are outlined below.

'America' (Scenario 1)

From 2012 there was a sustained economic downturn for a number of years and spending on dentistry (both by the state and by individuals) reduced. Reduced state investment resulted in rationing of dental care, with a basic service based on need and something of a postcode lottery. During the downturn, the less-well-off segments of the population drowned their sorrows in sugar, alcohol and tobacco.

By 2020 most of the profession had 'gone private' in pursuit of a better lifestyle. Dental services could only be found in nicer areas of the country and the adverse geographic variation in service increased.

By 2025 the reduction in state investment in dentistry meant access to funded services had worsened still. Waiting lists were long and salaried dentists provided a safety net at best. Private dentistry prices rose, becoming unaffordable for many and resulting in increased inequalities in oral health. Within the profession there was increased protectionism due to lower incomes, with dentists tending to refer less work to others in their teams. Some dentists chose to become clinical academics (or left the profession completely) as front-line dental practice became a less appealing career choice.

Despite the prevalence of dental disease remaining the same, with large numbers of people unable to access dental services many people suffered with untreated disease. Self-care was initially seen as a viable alternative but many problems still went untreated. Pressure for fairer access to treatments increased, especially from 'silver voters'. Alternative funding streams like dental insurance plans were used in some cases but did not become widespread.

By 2035 commissioners started to make greater demands on the NHS dental workforce and the nature of the workforce changed. Specialists such as technicians were required to do less specialised, complex work. For example, they worked less with metal ceramic and more with acrylic. Across the board, treatments became simpler, with teeth tending to be removed and replaced with plastic dentures as they had a hundred years before.

Approaching 2040, although the economy was strengthening, previous events meant that the dental workforce had less knowledge of complex procedures and dentists were, in any case, in relative short supply. The government started to hire from overseas and became a strong net importer of dentists. In addition, a 'skills escalator' came into effect with team members up-skilling to dentistry in order to meet demand.

In terms of stakeholders, dental corporations became gradually less powerful as individual dentists moved to take care of their own interests. Patients lobbied for better access to treatment, but some resorted to private insurance. State-funded higher education institutions (HEIs) did not interfere with the structure of the profession but had to adapt the way they teach and train.

'Argos' (Scenario 2)

From 2012 the UK experienced a sustained economic downturn. To manage its budget the government reduced investment in the NHS. This had a disproportionate impact on funding for dentistry, as dentistry was not seen as a priority during the downturn. Commissioners of dental services began to make unrealistic demands on dentists through the contracting process, with high levels of service expected for reduced levels of payment. As a consequence a high proportion of dentists decided to end their NHS contracts and either worked solely in private practice or left the profession. As a safety net to provide minimal state-funded dental services (and avoid a political outcry) there was a slight increase in the number of salaried practitioners.

Overall, this meant there was reduced access to dental services, particularly for those people who could not pay for treatment. Waiting lists lengthened, rationing of treatment became a way of managing limited resources and a postcode lottery ensued. Inequality of access to dental care was the result.

The roles and skills of dentists changed, with those in the NHS providing more basic treatment based on need (e.g. more extractions and less restorative work). Dentists became deskilled as a result, and morale in the profession decreased.

Conversely, dentists working in private practice became more specialised, using a wider range of skills and technology that their wealthy customers were willing and able to pay for. Private dentists were also able to support a better 'skill mix' amongst their staff.

These changes destabilised the profession, primary dentistry reduced and the attractiveness of a dental career diminished, making recruitment to dental training somewhat harder.

During this phase of the cycle the prevalence of oral disease didn't change and the lack of availability of treatment led to a greater incidence of more complex cases.

With the growth in population, people living longer and the power of 'silver voters', patients lobbied their MPs about services. The government was pressured into improving services. This happened at the same time as the economy began an upturn, leading to the re-emergence of high quality, NHS-funded dentistry, a massive growth in provision and a surge of treatment. Dentists returned to a six monthly recall system and available treatments included cosmetic work.

This high demand resulted in an immediate-term shortage of dentists, so the UK recruited from overseas to fill these vacancies and became a strong net importer of dentists. For a while the profession became stable. However, eventually the expansion became unaffordable for the government, patients' demands became undeliverable, and the number of complaints about inappropriate treatment and poor quality services began to increase dramatically.

The economic cycle then moved into another downturn, with a significant reduction in investment in dental care. By the time the next economic upturn arrived dentistry had become a commodity. The practitioner-patient relationship had changed, with little if any long-term care being given. This changed the nature of the dentistry 'business': traditional family-owned dental practices and small businesses lost out because they couldn't deliver services at the price demanded by commissioners. Many small businesses were bought by large dental services corporations. Dental 'customers' now wanted 24 hour access to dental care in convenient locations. Their expectations increased and demand for aesthetic dentistry exploded.

Growth was exponential and there were not enough dentists to meet demand; the UK again became a strong net importer of dentists.

'Kyklos' (Scenario 3)

From 2012 to 2040 there were at least five general elections and a growing population within which the 'silver voter' age bracket became proportionally bigger and increasingly influential. Whilst the economic position was relatively positive throughout, political cycles resulted in abrupt, time-limited changes to NHS dental funding provision.

From 2012, outcomes-based commissioning drove a greater proliferation of 'skill mix'. The new contract pilots became a reality. There was an increase in vocational training and access to NHS dentistry increased from 2013. Social marketing worked more effectively to drive demand.

After the election c. 2014 funding for dentistry increased and private dentists competed for contracts. More patients accessed private dental services whilst a core NHS service was introduced for all, resulting in more dental care professionals. Poly clinics arrived on the scene and employed many dental care professionals; 'skill mix' was seen as less threatening in that context. Planning was seen as more effective and research also had some impact.

Dentists increasingly wanted to live and work in 'nice' areas, resulting in rising health inequalities. The oral health disease burden changed somewhat as the population got proportionately older and many more lived in care homes requiring long-term care closer to home. Conurbations saw many dentist shortages but these were met, to a degree, by corporate dentists who adopted a piece-work approach - staffed largely by dentists from overseas on short-term contracts. Aesthetic dentistry often failed, putting an additional burden on the NHS. New dental specialties emerged and the training curriculum changed to reflect this. Some dentists moved to specialise in caring for long-term complex conditions, leaving dental care professionals to pick up more routine tasks. Overall, the workforce expanded slightly.

'Utopiaaaaagh!' (Scenario 4)

From the second decade of the twenty-first century and onwards more investment was made into NHS dentistry and resources and technology became more readily available. This was a result of three factors: general economic recovery, the commitment of the government (all parties) to the results of the contract pilots, and the increased emphasis on dentistry within the NHS.

The implementation of the contract pilots also impacted the shape of the dental workforce, as it increased incentives to employ dental care professionals. In the transition period that followed, some associate dentists were made redundant as 'skill mix' increased and more dental care professionals were employed. Overall though, this did not reduce the popularity of dentistry as a career choice and the number of dental undergraduate applicants remained high.

Patient expectations, which were increasing during this period, played a huge role in defining the requirements of the dental workforce. Patients expected to see dentists at convenient times, which led to changes in patterns of service delivery; dentists began delivering services at evenings and weekends, and then eventually 24 hours a day, seven days a week. Moreover, internet-savvy, increasingly health-conscious patients wanted to see their dentist more regularly for checkups - which increased the demand for dentists. Patients also wanted cosmetic treatments to be carried out on the NHS. These rising patient expectations, coupled with the pressures of treating a demographically larger, older population started to put serious pressure on the system.

Despite the favourable economic climate and increased investment in dentistry, eventually patient demand outstripped the resources available. The demands made on the system became too expensive for taxpayers. Queues and waiting lists for dentists increased and access worsened. Dentists from the EU who had come in to top up the number of dentists in the system left England at unpredictable times - their English language skills giving them international mobility - and this increased instability.

Eventually this necessarily led to a contraction of services and stabilisation of the dental economy at a level above that at the beginning of the period but well below that of its peak.

Our thanks to all the dental workshop attendees:

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8.2 Medical scenarios

In early 2012 the CfWI held a scenario generation workshop with medical stakeholders to define **four plausible future scenarios** as a basis for modelling. The first step in the process was to identify about two hundred **driving forces** that were seen by the expert stakeholders to comprehensively document the trends/certainties and major uncertainties that would have lesser or greater impact on the number and proportions of the medical workforce required in England up to the year 2040 – our major issue of concern.

Participants were then asked to look for causal and chronological relationships between the driving forces, which resulted in five **'clusters'** (or higher level factors), described below. Three of the clusters contained components that were viewed as in-the-pipeline, pre-determined or more certain and therefore perceived as a part of all plausible futures by the workshop participants. The components of two of the clusters were seen as much more uncertain by the workshop participants. It was these two high impact/high uncertainty clusters that were then used by the participants to develop four plausible scenarios for how the future might unfold.

First, the three more pre-determined clusters:

1. Patient empowerment.

Here the general English population are seen to become more 'expert' in medical matters over the coming thirty years. Use of the internet and other information technologies increasingly enable the transfer of knowledge about what treatments are possible and effective in the world. The information technologies remove geographical barriers to knowledge and the global market for some services/treatments/practitioners - such as infertility treatment – develops rapidly. Witness the current travel by sick children and their parents to the USA to seek treatment from specialist practitioners – the travel and costs funded by friends and their fund-raising efforts, and the rise of websites promoting health tourism. Demand and expectations for the 'best possible' care will rise. Being healthy will be a strong and – for the wealthy or funded – a realisable aspiration for some. Healthcare technology will also advance such that some diagnoses and treatments can, potentially, be delivered by technology in the home. At the same time, advances in DNA profiling will enable the concerned public to make early, beneficial lifestyle changes and, in addition, molecular and therapeutic genetic techniques will provide targeted treatments of disease and disability. Both clinicians and the public will expect increased access to screening and intervention including genetic screening, despite the high cost. 'Personalised' health planning will become commonplace for those who have access to it. Health aspirations, medical advances and instant access to knowledge of what is possible in treatments will drive demand for health services. Social networking will act to amplify concerns about any inequity in supply of treatments and will also identify poor-performing NHS services and individuals. Citizens will want to self-refer to self-identified specialists and have access to services seven days a week from fully qualified healthcare professionals. The general-practitioner/patient relationship will change and the general practitioner will increasingly be viewed by the public as a gate-keeper to already-identified specialist health services. However, the public will still value face to face contact with a doctor and the role of the GP may evolve into that of a health advocate for patients.

2. Skill mix and the delivery and location of care.

The two related but not correlated themes of care closer to home versus in-patient care further from home, and generalist versus specialist care will continue to be debated. Meanwhile, technology advances that reduce diagnostic uncertainty and, to a degree, replace human expertise will be coupled with less invasive surgical procedures that are, to an extent, drug-based. Remote monitoring of patients will become the norm and concerned patients can video-conference with English-speaking physicians, anywhere in the world, to discuss issues that concern them. Within England, citizens will want prompt 'consultant-delivered' or trained specialist care and access to a seven days a week service. The desire to be at home rather than in a hospital - coupled with advances in remote monitoring and tele-medicine - results in further demand to monitor and treat patients in the community. Health and social care provision will blend, there will be more integration between secondary and primary care, and the confidence and influence of other health professionals (e.g. nurses, midwives, healthcare scientists/technicians, the professions allied to health, pharmacists, and the wider health team including support staff and assistants) will continue to increase. At the same time, the demand for specialist clinical centres – which have leading-edge knowledge and technology – will increase.

3. Student engagement and medical careers.

Here the financial downturn of the 2010s continues to exert an impact on the attractiveness of a medical career in England, making it difficult to recruit and retain the brightest students. The cost of tuition fees for medical training reduces UK-origin (and perhaps also overseas) student numbers somewhat. The social-class profile of the UK-origin students becomes proportionally more middle-class. A few poorer but bright students seek to train more cheaply overseas, where many medical schools have adopted English-language delivery of tuition. The abolition of the compulsory retirement age in 2011 and the degrading of pensions for UK medics – both in practice and in academic roles – coupled with the aftermath of the financial downturn results in fewer career openings for newly graduated medics in England unless the structure of medical care changes. The overall effect is that young people look to other professions for advancement or will look overseas to study medicine – since the English language is now a common currency. Furthermore, emigration can result in the temporary escape from the immediate need for pay-back of student debt. The situation is further complicated by increasing desire for improved work/life balance and acts a disincentive for medicine in general and in some of the more acute specialties in particular.

The two clusters whose outcomes were seen as having both high impact on the issue of concern and low predictability were:

4. Demographics and health demand.

Here there is a focus on the impact of in-the-pipeline demographic change and less certain 'expansion' or 'compression' (contraction) of morbidity within an extended life-span. Will the older population live longer with relatively better health, or will the co-morbidities of aging expand to take up a larger proportion of an extended lifespan?

Two plausible outcomes were envisaged for this cluster:

Expansion of morbidity: here an older population wants/needs to work longer but their longer lives are accompanied by a relatively earlier onset of the chronic diseases of old-age. Poorer groups are particularly impacted.

'Compression' of morbidity: here an older but somewhat healthier population work and live longer with the chronic diseases of old-age occurring relatively later.

Broadly speaking, the distinction here is between an ageing population that is not quite as unwell as we expect (but still very health resource heavy) or that is worse than we fear.

Coupled with the components of the cluster patient empowerment, this will result in a desire and demand for leading-edge health over the whole of the lifespan of an aging population (many of whom will work longer). Coupled with the components of the cluster skill mix and the location and delivery of care, it will also mean people will demand and, in due course, receive a combination of remote interaction with specialists and community-based local support.

5. Innovation, health and wealth.

Here there is a focus on the economic backdrop and its impact on both Government investment in life science research and on its provision of day-to-day healthcare. Will investment in research be maintained and/or increased or will it decline? Will healthcare spending remain static or will it decline? The group envisaged two plausible outcomes for this cluster:

Stability/increase in investment in life sciences research: here centres of world class research are maintained and develop further. Clinical training and clinical outcomes both improve over time. The impact on medicine and its status in society is positive and competition both within the UK and with the rest-of-the-world drive up quality. Population-wide health interventions will, likely, increase and be successful and clinicians will, likely, become more entrepreneurial – on the basis of their world-leading innovations. Healthcare provision will, likely, not decline from present levels.

Decline in investment in life sciences research: here the UK gradually loses its ability to innovate and its leading-edge capability. Large pharmaceutical companies find stronger research environments in other parts of the world. Pressure on research budgets and underpinning infrastructure make UK-based research-orientated medical careers less rewarding academically. At the same time resources for day-to-day healthcare provision decline and the priority is, necessarily, the provision of basic services, despite the vocal interventions of empowered – and often elderly – patients. The medical profession, in general, declines in status – most medics deliver basic, less-than-cutting-edge services to a well-informed – and so unsatisfied – population.

Coupled with the components of the cluster patient empowerment, the English population will be aware of healthcare advances in the world and will demand access to these advances although the innovations are not made in the UK. The components of the cluster skill mix and the location and delivery of care do not lessen this demand for leading-edge but community-delivered treatment. However, the components of the cluster student engagement and medical careers mean that, with any decline in investment in life science research, young academics will look overseas for opportunities and career enhancements – whilst the aging cadre of senior academics remained rooted in their positions.

Creation of four scenarios

The group's next step was to create four scenarios by creating permutations of the four plausible outcomes of clusters (4) and (5).

This gave us:

Scenario1: which combined 'compression' of morbidity with stability/increase in investment in life science research.

Scenario 2: which combined 'compression' of morbidity with decrease in investment in life science research.

Scenario 3: which combined expansion of morbidity with stability/increase in life sciences research.

Scenario 4: which combined expansion of morbidity with a decrease in life sciences research.

The detail of these four scenarios, combined with essential elements of clusters (1), (2) and (3) are outlined below.

Scenario 1 ('compression' of morbidity, high resource environment)

In the second decade of the twenty-first century, the UK government decided to sustain and, to the degree possible, increase its investment in the life sciences with the ambition of creating a sustainable stream of knowledge-produced wealth for the UK. Naturally, some investments work and others don't. Nevertheless, due to this increased funding, more organisations, institutions and individuals were motivated to research and innovate. This led to the formation of 'NHS Research Centres' where excellence was located in regions of the county – so that current University-based expertise could be built upon.

Given the investment and subsequent innovations, NHS organisations and clinicians began – after a mixture of Government prompting and incentives – to commercially exploit the healthcare innovations developed by the NHS Research Centres. As the FTs and clinicians became more entrepreneurial they, in turn, motivated the research centres to continuing innovating, thus creating a positive feedback loop.

By 2030, these practical innovations in healthcare prompted increasing investments in education and training and this drove up competition and standards across the NHS. This led to improved quality outcomes for patients. Greater competition and improved quality was followed by increased investments in education and training. Due to the improving quality of medical education and training, the status of medicine within the UK and internationally rose and the country attracted the brightest and best students from across the world. Expectations increased with the public expecting access to seven days a week NHS services from fully trained specialists. The UK was often at the forefront of innovation. Medical careers – both practitioner and academic – were attractive prospects for both UK-origin and overseas-origin professionals.

Many of the innovations between 2020 and 2030 were focused on improving the care and treatment of the elderly. Government receipts were not increasing fast enough to cope with increasing demand, so there was a re-focus on cost-effective interventions to contain increasing costs. As a there was a focus on developing innovations to 'curb' disease not 'cure' disease. Although innovations improved treatments, new diseases were identified and thus there was a neutral impact on the increasing proportion of older people in the population. The cure to curb reconfiguration led to a 'compression' of morbidity and thus older people living longer and relatively healthier lives. This, in turn, reduced the financial pressures on the NHS, allowing more available resources to be spent on developing medical innovations which led to improved quality of care.

Innovations extended to improve research and understanding into integrated care models. Areas of best practice developed rapidly so patients could be managed at optimum cost effectiveness without at reduction in quality either in their locality or in as integrated a fashion as possible. New career paths for integrated care became accepted and old hierarchies of generalist and specialist were broken down.

The NHS workforce, due to a mixture of decrements in retirement benefits, changing job planning and service roles and relatively improved health compared to their previous generation, worked to an increased age in keeping with trends in the rest of the population. Those working in more physically-demanding specialities were pleased with new possibilities of working in varied clinical settings and became more flexible in their choice of specialist areas. Specifically, there was an identifiable increase in those returning, often towards the ends of their careers, to address the general medical needs of the population – many of whom wanted to be treated at home and treated, often remotely, by world-class specialists in primary and secondary care. Thus doctors' careers were not like they used to be: doctors changed their jobs more frequently and work-life balance became increasingly important.

Scenario 2 ('compression' of morbidity, low resource environment)

In the early part of the second decade of the twenty-first century, increased production costs, higher energy costs and national debt led to a higher rate of inflation in the UK; as a consequence a smaller percentage of goods and services could be purchased with the same amount of money. Consumers cut back on overall spending, luxury spending, and restricted themselves towards basic necessities and paid off their accumulated credit-card debts. Businesses in turn felt the lack of demand and cost pressures – and they downsized their workforces and general unemployment increased.

The large pharmaceutical companies did not invest so strongly in England and chose to locate their companies in other countries, following the skills. The decline in GDP also led to pressures on government education spending. Tuition fees rose somewhat and student loans became a little more expensive. The UK government cut back on investment in all research – including life science research – by the end of that second decade.

As new technologies become affordable only to some parts of the NHS and via private providers, the impact of these technologies only reaches parts of the UK population, with resulting significant differences that continues to show preventable morbidity in poorer groups, and is also a source of political conflict.

There was evident financial pressure on the health service, which in turn led to cutting-edge research moving overseas, moves to secure the provision of basic services, a re-focus on cost-effective interventions to contain increasing costs, and a shift towards less complex services being provided within a primary community-care setting – which the public desired. As a future-cost-saving measure, a shift in policy emphasis to a 'curb' policy of healthcare rather than a 'cure' policy was made explicit – and gained approval from some sections of the public.

From 2020, breakthrough technological advancements made overseas such as diagnostic technologies enabled non-specialist practitioners to deliver services at a lower cost to the community. Domestic adaptation and adoption of technology led to patient empowerment through self-care and treatment and the potential for a different skill mix in the workforce. Breakthrough genomic sequencing permitted personalised health planning over a patient's lifetime. This led to an initial increase in demand for national health services. However, over the longer term, demand decreased as health inequalities decreased in society. Continued improvements in technology led to improved population health and a general decrease in demand for services. Globalisation and the unfettered flow of information over the internet continued to have a great impact – including the public seeking diagnosis electronically as well as travelling internationally for treatment.

Reduced state pensions that were received much later on in extended working lives led to an increase in the average age of the NHS medical workforce. This change acted to increase medical workforce costs as the aging, but well-paid, workforce left fewer posts for the younger entrants into workforce. Additionally, increases in both student tuition fees and in the cost-of-living deterred entrants to medical training and education. Some new graduates emigrated overseas to avoid repaying their student loans. There was a move towards a greater reliance on the use of international medical graduates and role substitution to fill the workforce gap.

Medical schools closed down or merged and also began to recruit aggressively from overseas because they could not afford to deliver the increasingly costly undergraduate programmes at the price UK students felt willing to pay. By 2030 there were clear signs of a medical workforce that was no-longer world-class. At the same time, the signs of compressed morbidity became clear – with the general population living longer, older and healthier. This led to reduced finance pressures on the health service.

Scenario 3 (expansion of morbidity, high resource environment)

During the second decade of the twenty-first century, the UK government again increased investment in life sciences and biotechnologies. Investments were made in public and private healthcare, and the nation was gripped by a spirit of investment in innovative bio-technologies – with the hope of reaping rich rewards from the growing demand by the wealthy, aging, populations of the world.

However, the increase in science investment did not stem the expansion of morbidities among the older English population. People in their 70s and upward grew both older and sicker, many of those in this age band developed co-morbidities (e.g. dementia, cardiac problems, diabetes, stroke and cancer) that put increased pressure on health and social care services. The greater prevalence of sick, elderly, vocal patients put pressure on the government to do more for this demographic group, but demand started to outstrip the service that our national health system could deliver.

The next few years saw NHS organisations and clinicians follow the government's lead in scientific investment; there was a rise in entrepreneurial activities including new start-ups and spin-off business from trusts and universities. The success of scientific ventures encouraged further investment in science and medical education and training – in the hope to continue and expand the successful recent progress in creating wealth for the UK economy.

However, in the general population, smoking, alcohol and fast-food diets were still popular, and the trend appeared to be changing toward an increase in these drivers of poor health. The free thinking clinical fraternity and the general public – who were both internet-savvy and health conscious – became more and more aware and vocal in their support of the need for change as the health system was seen as not being able to cope with the increasing needs of the nation. This increased pressure to improve the overall state of the nation's health confirmed the importance of earlier creation of a department of public health.

The UK economy continued to grow with the rewards from biotech research success. Roles for super-specialists developed in the medical system because the advancement of science required, and rewarded, those with very specific skills. Careers in research or academia were viewed very positively by young doctors. In the early 2020s the breakthroughs in biotech and some areas of medicine saw the UK established as one of the top contenders for research. Other nations aspired to our high quality clinical research and training. Medicine and the bio-sciences were seen as attractive and secure careers. The UK attracted the brightest and best of international students.

The increased inability of the health service to provide all the care required by the elderly led to the public demanding answers to the increasing, and vocal, suffering of this segment of the population. From 2030 there was a re-focus on cost-effective interventions to contain increasing costs. Towards the end of the second decade of the twenty-first century there was a significant swing in public opinion and old statutes were overturned to bring about the legal right to euthanasia – in certain strict circumstances.

By contrast, most the health service configuration became aligned towards pain management and curbing illness in the elderly – due to an inability to provide comprehensive curative care. However, there were green shoots showing in some areas where past investment was rewarded with new treatments. Debate about UK priorities in the electronic media resulted in most of the population reacting against the seemingly unlimited increase in demand for health services. Voters were unwilling to continue to fund care to the elderly through taxation. There was also pressure for insurance-based funding for healthcare, and charging for some procedures. The government tried to tackle the problem with population-wide interventions. This approach resonated with the view of voters because it looked to be better value for money.

In the 2030s the population still enjoyed a high relative GDP. Despite public health initiatives many segments of the population still indulged in an unhealthy lifestyle. The medical system advanced, but still contended with the health issues resulting from damaging lifestyle choices. The public perception was that quality of life had improved slightly since the 2010s, but had not taken major steps forward.

Scenario 4 (expansion of morbidity, low resource environment)

From the second decade of the twenty-first century and onwards the UK economy worsened resulting in lower spending on healthcare as a proportion of GDP. Investment in health services, health education and life sciences innovation were insufficient to meet the nation's needs and desires. The internet-savvy general population were very much aware that both healthcare provision and research and training in the medical specialities were no longer in the premier league.

Pressure on medical education budgets meant lower quality training, higher fees, and a scrabble for international students by the UK universities. There were also fewer clinical academics and those that were in place were those it seemed should have retired long ago – but they were keen to keep their jobs since the compulsory retirement age had been abolished in 2011 and their pensions had been degraded.

Big pharmaceutical companies that have previously found the UK a conducive place to do business followed the skills and took their research and development investment and their clinical trials elsewhere in the world – where research and innovation were more highly valued and resourced – resulting in some job losses and some loss of income for the country.

Meanwhile, as the health sector declined in significance. Doctors looked further afield for innovations, bringing innovations from overseas to the UK in an attempt to improve the quality of healthcare – with limited success. The age distribution of the English population continued to shift towards a bigger proportion of the old. The old tended to have chronic illnesses for longer – so-called expansion of morbidity – with a resulting rise in co-morbidities. The working population became increasingly unwilling to fund expensive, complex care for the expanding proportion of older, sicker people. There was pressure via internet debate and social networking to move to an insurance-based healthcare system to ease the weight on the younger population's shoulders. At the same time, and partly for the same reasons, the lobby for assisted suicide grew in strength and it was legalised sooner than many people expected.

As healthcare funding decreased but demand increased there was ever-growing pressure on health and social care services, which had to be reconfigured towards Soviet-style basic services, coupled with more emphasis on self-care and care in the community. Debates on 'sensible' prioritisation were a recurring media theme.

The medical profession suffered from what they called the 'Russia syndrome', with pay, status and morale all becoming lower as public perceptions of its ability to enhance health declined. Young people either aspired to careers other than medicine or those with the vocation left to study medicine elsewhere, in a largely English-speaking educational world.

Globally, from 2020, healthcare became a knowledge business. Better-off patients increasingly chose to travel abroad to purchase high-quality healthcare leaving the poor to basic services in terms of range and quality. The NHS became a reactive organisation, resourced to only manage symptoms, not causes. The better-off were able to pay for the newest, technology-enabled treatments; only the more affordable innovations (where proven to reduce costs elsewhere in the system) were funded by the NHS. Many people accessed health services via the internet, often buying consultations and treatments online from overseas providers, which raised some issues of quality and safety. Online engagement with the NHS increased but not significantly since it could not deliver cutting-edge provision.

Towards 2030 there was a boost to the economy with above-trend growth. By 2040 the UK health sector was starting to 'turn the corner' with gradual improvements, but recovery was slow due to 20 years of low investment.

Our thanks to all the medical workshop attendees:

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Mike Medas

Miles Scott

Sir Neil Douglas

Professor Paul Padfield

Professor Peter Kopelman

Dr Simon Plint

Dr Tim Yates

Dr Tom Foley

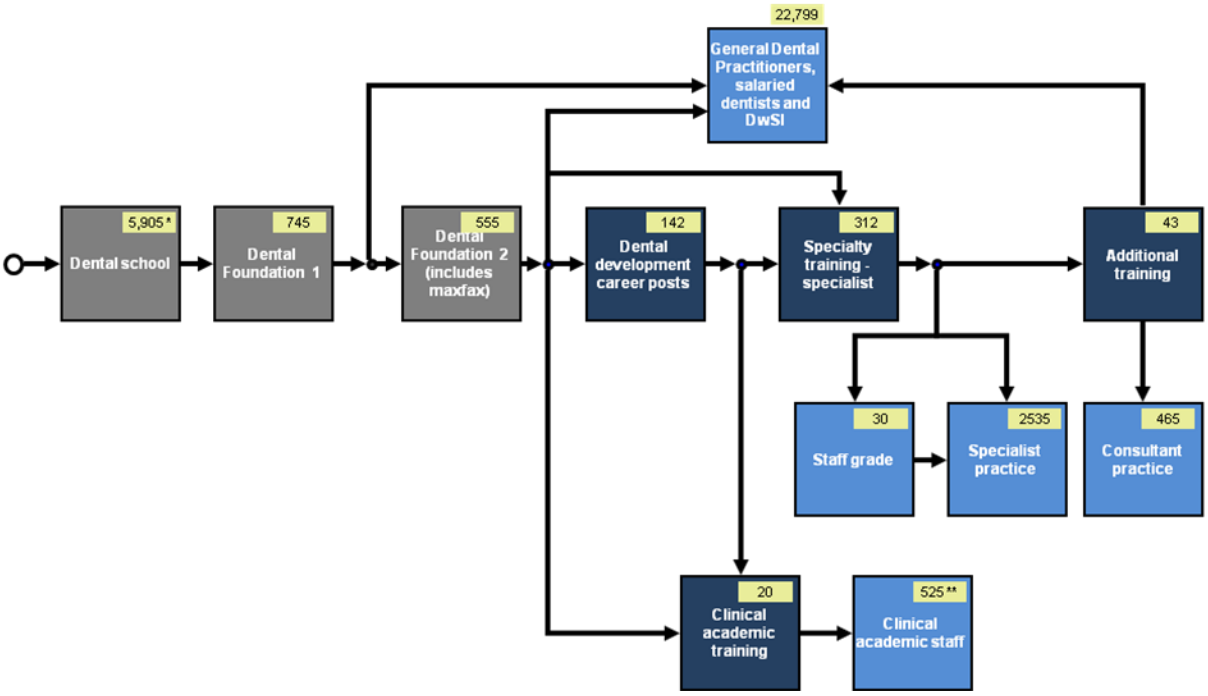
Professor Wendy Reid

Will Seligman

9 APPENDIX F

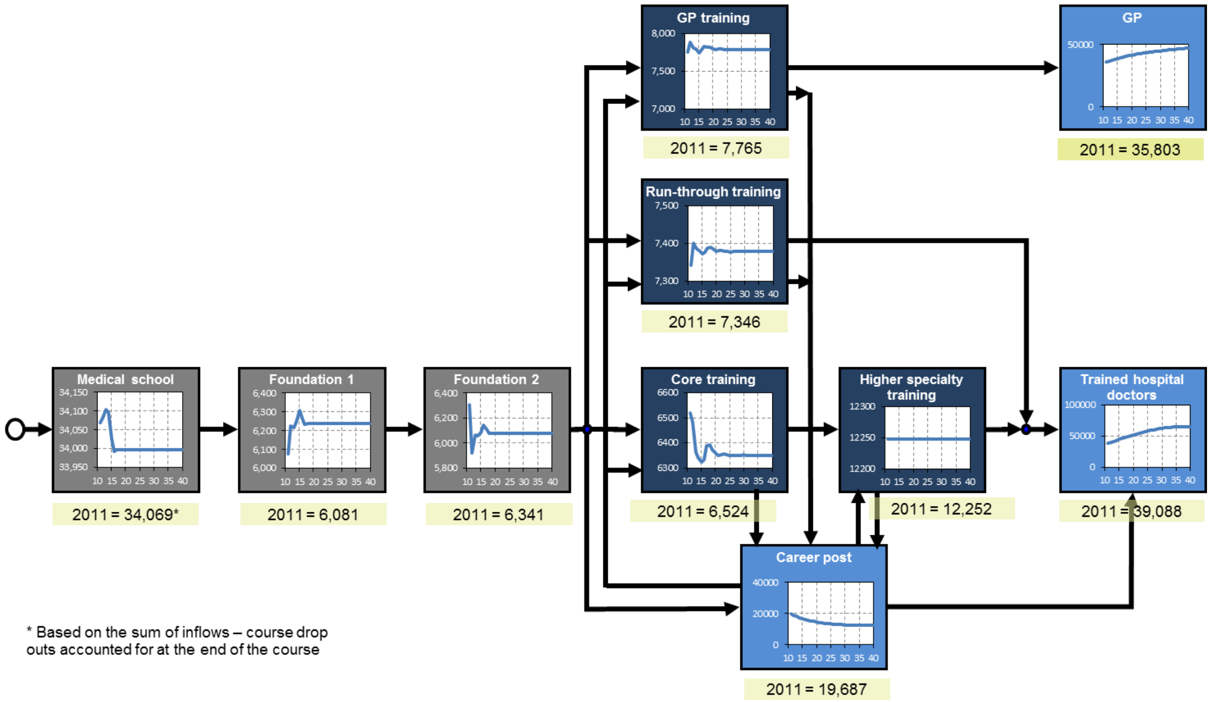
9.1 Overviews of the medical and dental supply models

Figure 29: Overview of the dental supply model showing 2010 stock levels.



Sources: see figure 4

Figure 30: Overview of the medical supply model showing 2011 stock levels.



Sources: see figure 4

10 APPENDIX G

10.1 Examples of key assumptions made in the CfWI demand and supply models

Demand is measured by utilisation

It is assumed that utilisation is a reasonable proxy for demand for services, so for example the demand for GPs is measured by the number of visits people make. In fact, utilisation is a function of demand, need, and supply. For example, demand could exceed utilisation, where people are not able to access or afford care.

Utilisation is independent of supply

Changes in supply, such as cost or ease of access, are assumed not to impact supply. In fact, an increase in supply can have a direct influence, for example through overprovision (supplier-induced demand).

Geographical distribution of health professionals is not modelled

This means that even if demand appears to be matched by supply, there may be geographical areas of under- or oversupply.

Specialties are not modelled individually

The workforce being modelled includes all medical specialties and clinical academics, but does not treat them individually. Future reviews of individual specialties will enable the CfWI to gradually refine the model.

Professions outside of health and social care have no impact on the workforce

It is assumed that changes in other professions, for example wages, do not influence health and social care workforce recruitment and retention.

No pre-existing unmet demand

Given the difficulty of quantifying need and demand, the starting point is that there is no unmet demand at a national level. However, there may be unmet demand at lower levels, for example geographical regions or individual professions.

Each additional health professional produces the same outputs

It is assumed that each additional health professional produces the same amount of activity, whereas increasing workforce numbers typically results in diminishing returns.

Linear change over time

It is assumed that changes in retirement age, participation rate, and demand factors including skill mix, technology and policy happen linearly over the time period being modelled.

No shortage of applicants for medical school

It is assumed that whatever the state of medical education or the health system, there will always be a surplus of applicants for medical school, and all undergraduate places will be filled.

Career decisions are not modelled

The behaviour of trainees in response to the state of the system is not modelled, for example, deciding to specialise as a GP rather than as a hospital doctor according to the number of places available or the difficulty of getting a job. In practice, both are likely to influence behaviour.

11 APPENDIX H

11.1 The top 10 high-impact variables in the medical supply model that rely on low or medium data-quality, the data sources, and the assumptions made

	Top 10 high-impact, low-data quality-variables in the medical supply model	Impact rating	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption
1	GP participation rate	> 5%	M	Health and Social Care Information Centre (HSCIC) GP census 2011, FTE and headcount data for GP Providers, Other/Salaried and Retainers.	Participation rate by age and gender	Participation rate calculated by gender and in age bands of one year. Average participation by women of 79.5%, average participation by men of 93.9% in 2011. The average participation rate changes each year due to the changing ratio of genders and ages.
2	GP attrition rate	3-5%	M	HSCIC GP census 2008 to 2011, headcount for GP providers, other/salaried GPs, and GP retainers by age and gender. The attrition rate accounts for retirements (those 49 and older) and early leavers (those 48 and younger).	CfWI continue past trends due to lack of specific evidence	Historical data (2008 to 2011) is used to build a picture of the likelihood of a GP leaving the workforce, by age and gender. For example, 13% of 60 year old men leave, and 14% of 65 year old men leave. 19% of 60 year old women trained hospital doctors leave, and 22% of 65 year old women leave. We assume that 4% of trained hospital doctors below the age of 49 leave each year.

	Top 10 high-impact, low-data quality-variables in the medical supply model	Impact rating	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption
3	Trained hospital doctor (consultant) attrition rate	1-3%	M	HSCIC medical census 2008 to 2011, headcount for trained hospital doctors by age and gender. HSCIC monthly workforce statistics turnover Provisional Statistics for March 2011 – March 2012. Net trained hospital doctor leavers. The attrition rate accounts for retirements (those 54 and older) and early leavers (those 53 and younger).	CfWI continue past trends due to lack of specific evidence	Historical data (2008 to 2011) is used to build a picture of the likelihood of a trained hospital doctor leaving the workforce, by age and gender. For example, 15% of 60 year old men leave, and 44% of 65 year old men leave. 22% of 60 year old women trained hospital doctors leave, and 33% of 65 year old women trained hospital doctors leave. We assume that 2% of trained hospital doctors below the age of 54 leave each year; this is calibrated using the turnover data.
4	Trained hospital doctor participation rate	> 5%	High	HSCIC medical census 2011, FTE and headcount data by age, grade and gender	Participation rate by age and gender	Participation rate calculated by gender and in age bands of one year. Average participation by women of 90.5%, average participation by men of 96.4% in 2011. The average participation rate changes each year due to the changing ratio of genders and ages.
5	Annual GP re-joiners	1 -3%	M	No specific data available to CfWI	CfWI estimate used due to lack of evidence	289 men and 289 women per year (assumed)

	Top 10 high-impact, low-data quality-variables in the medical supply model	Impact rating	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption
6	Percentage who complete Core training and seek a career post or other training	0-1%	L	No specific data was available to the CfWI at the time of modelling	CfWI estimate used due to lack of evidence	10% (assumed)
7	Percentage who complete training and then leave the system	0-1%	L	Assumption; no specific data was available to the CfWI at the time of modelling	CfWI estimate used due to lack of evidence	5%
8	Annual medical school intake from outside of the country	0-1%	VH	Higher Education Funding Council for England (HEFCE)	n/a	493 students per year from 2011
9	Annual intake into GP training from career posts	0-1%	L	No specific data was available to the CfWI at the time of modelling	CfWI estimate used due to lack of evidence	Estimated at 100 men and 100 women per year
10	Annual intake into run-through training from outside England, age profile	0-1%	M	No specific data was available to the CfWI at the time of modelling; GP ST1 age profile was used instead (GMC data, 2010)	CfWI estimate used due to lack of evidence	Table available

12 APPENDIX I

12.1 Dental supply: full list of baseline assumptions

12.1.1 Dental school

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption	Recommendation
Annual dental school intake from England	VH	Dental Schools Council 2010 autumn term intake data	Dental Programme Board	1297 overall autumn 1230 home fees and 67 other fees	
Annual dental school intake from England, gender balance	VH	Dental Schools Council 2010 autumn term intake data	Dental Programme Board	Men: 539 / Women: 758 = 1297 overall autumn	
Annual dental school intake from England, age profile	VH	Age profile is from UCAS. Accepted applicants by age band and gender to Pre-Clinical Dentistry (Years : 2007 -2011)	Dental Programme Board	Gender Women % Men % 2007 57.4 42.6 2008 59.0 41.0 2009 58.8 41.2 2010 57.6 42.4 2011 57.7 42.3 Average 58.1 41.9	

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption	Recommendation
Annual dental school intake from outside of country	VH	Dental Schools Council	Dental Programme Board	79 students, 2010 autumn term intake data	
Annual dental school intake from outside of country, gender balance	VH	Dental Schools Council	Dental Programme Board	Men: 31 and Women: 48 = 79 overall – 2010 autumn term intake data	
Annual dental school intake from outside of country, age profile	n/a	No specific data was available to the CfWI at the time of modelling	n/a	n/a	Data to be collected on the annual dental school intake from outside of country broken down by age profile. Data to be collected by Dental Schools Council
Percentage of dental school intake that drop out	M	Unverified analysis by Dental Schools Council	Chief Dental Officer	10% per year	
Percentage of students who complete dental school and leave system	n/a	No specific data was available to the CfWI at the time of modelling	0% was queried but no alternative evidence was provided	0%	Data to be collected on the number of students who complete dental school and leave system each year, broken down by gender and age

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption	Recommendation
Time spent in dental school by length of time to complete course	H	GMC data (2010/11)	Chief Dental Officer	GMC data from MSC which indicates approximately 11% intercalate. 4 years =10% 5 years =83% 6 years =6% 7 years = 1%	

12.1.2 Dental Foundation 1 (DF1)

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption	Recommendation
Annual DF1 intake from English dental schools	M	From dental school intake data	Chief Dental Officer	1297 – 10% =1167.3	
Annual DF1 intake from outside English system	M	Chief Dental Officer		100 with non-EU nationality	

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption	Recommendation
Annual DF1 intake from outside English system age profile	n/a	Data from The Committee of Postgraduate Dental Deans and Directors (COPDenD), no breakdown for age profiles by gender provided	n/a	n/a	Data to be collected with a breakdown for age profiles. To be collected by The Committee of Postgraduate Dental Deans and Directors (COPDenD)
DF1 initial 'stock'	H	DF1 training numbers data from COPDenD, which is for both genders. (August 2011 data). Note needed to assume that 2011 value equal to 2010	Dental Programme Board	Men + Women = 781	
DF1 initial 'stock', age profile	n/a	No specific data was available to the CfWI at the time of modelling	n/a	n/a	Data to be collected with a breakdown for age profiles. To be collected by The Committee of Postgraduate Dental Deans and Directors (COPDenD)
Percentage of the trainees that start DF1 who drop out	H	UKFPO annual report 2011 gives 2.5% minus 0.70% that fail and re-sit	Chief Dental Officer	1.8%	
Percentage of the trainees that start DF1 who pass and then leave the	VH	UKFPO annual report, table 16	Chief Dental Officer	1.1%	

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption	Recommendation
system					
Percentage of the trainees that start DF1 who fail and then re-sit and pass	H	Assumption provided by Chief Dental Officer	Chief Dental Officer	1%	

12.1.3 Dental Foundation 2 (DF2)

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption	Recommendation
Annual DF2 intake from English system	M	Calculated from F1 'stock' (see previous table)	Chief Dental Officer		
Annual DF2 intake from outside English system	M	No assumption	Chief Dental Officer	Assume no entries at DF2	

Model element/ variable	Data confidenc e rating	Source of data/ assumption	Validation	Data/ assumption	Recommendation
Annual DF2 intake from outside English system age profile	M	No assumption	Chief Dental Officer	Assume no entries at D F2	
DF2 initial 'stock'	H	The Committee of Postgraduate Dental Deans and Directors (COPDenD)	Dental Programme Board	555	
DF2 initial 'stock' age profile	n/a	No specific data was available to the CfWI at the time of modelling	n/a	n/a	Data to be collected with a breakdown for age profiles. To be collected by The Committee of Postgraduate Dental Deans and Directors (COPDenD),
Percentage of the trainees that start DF2 who drop out	H	Assumption provided by Chief Dental Officer	Chief Dental Officer	0% per year	
Percentage of the trainees that start DF2 who pass and then leave the system	H	Assumption provided by Chief Dental Officer	Chief Dental Officer	1% per year	

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption	Recommendation
Percentage of the trainees that start DF2 who fail and then re-sit and pass	H	Assumption provided by Chief Dental Officer	Chief Dental Officer	1% per year	

12.1.4 Career Development Post workforce

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption	Recommendation
Dental Development Career Post (DDCP) initial 'stock'	H	Data from COPDenD, no breakdown for age profiles by gender. April 2011 data.	Dental Programme Board	142	Data to be collected with a breakdown for age profiles by gender. To be collected by The Committee of Postgraduate Dental Deans and Directors (COPDenD)
Annual DDCP re-joiners	M	No specific data was available to the CfWI at the time of modelling	Chief Dental Officer	0%	Data to be collected for annual DDCP re-joiners. To be collected by The Committee of Postgraduate Dental Deans and Directors (COPDenD)
Percentage of the trainees that start DDCP who drop out	M	No specific data was available to the CfWI at the time of modelling	Chief Dental Officer	0%	Data from The Committee of Postgraduate Dental Deans and Directors (COPDenD), to be collected for trainees that start DDCP and numbers that drop

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption	Recommendation
					out each year
Percentage of the trainees that start DDCP who pass and then leave the system	M	Assumption provided by Chief Dental Officer	Chief Dental Officer	2% per year	
Percentage of the trainees that start DF2 who fail and then re-sit and pass	M	Assumption provided by Chief Dental Officer	Chief Dental Officer	5%	

12.1.5 General Dental Practice (GDP) training

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption	Recommendation
Initial 'stock' of General Dental Practitioners and	VH	NHS IC 2010/2011	Dental Programme Board	Set at 90% of the non specialist workforce: 22,799 Breakdown for age bands by gender	

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption	Recommendation
Salaried Dentists					
Annual inflow of General Dental Practitioners and Salaried Dentists from outside the English system	M	CfWI estimate based on the 'Sheffield model' data. The model was created for the report: Modelling the Dental Workforce Supply in England by Professor Peter Robinson, Ms Alison Patrick and Professor Tim Newton	Chief Dental Officer	223 FTE May need to increase to convert from FTE to headcount	Data to be collected on General Dental Practitioners and Salaried Dentists starting from outside English system
Annual intake into GDP training from outside England, age profile	M	GMC data, 2010	Chief Dental Officer	UK age profile used as proxy, see below	Data to be collected on General Dental Practitioners and Salaried Dentists starting from outside English system broken down by age profile
Annual General Dental Practitioner and Salaried Dentist re-joiners	M	CfWI estimate based on the Sheffield model data	Chief Dental Officer	Based on Sheffield model 2.23% of total workforce: careers break returners and other returners (14/05/2012). Total: 508	Data to be collected on General Dental Practitioners and Salaried Dentists re-joiners

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption	Recommendation
				Overseas re-joiners: 330	
Initial consultants in GDP training	n/a	No specific data was available to the CfWI at the time of modelling	n/a	0%	Data to be collected on the numbers of consultants that transfer into GDP
Percentage who complete GDP training and leave the system	M	Sheffield model	Chief Dental Officer	5% per year	
Time to complete consultant to GDP conversion training	M	Assumption provided by Chief Dental Officer	Chief Dental Officer	1.5 years	
Percentage desired GDP training posts filled	M	Assumption provided by Chief Dental Officer	Chief Dental Officer	100%	
Annual career post start GDP training	M	Assumption provided by Chief Dental Officer	Chief Dental Officer	100 % men and women	

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption	Recommendation
Initial consultant to GDP training, age profile	n/a	No specific data was available to the CfWI at the time of modelling	n/a	n/a	Data to be collected on the number of consultants that transfer into GDP training broken down by age profile
Annual GDP training intake from outside of English system, age profile	n/a	No specific data was available to the CfWI at the time of modelling	n/a	n/a	Data to be collected on the annual GDP training intake from outside of English system breakdown by age profile
Consultant to GDP participation rate	M	Assumption provided by Chief Dental Officer	Chief Dental Officer	100%	
GDP training participation rate	M	Assumption provided by Chief Dental Officer	Chief Dental Officer	100%	
Initial GDP training 'stock', age profile	H	NHS Pensions data	Dental Programme Board	Please see NHS Pensions data Data available on request from the CfWI	
Percentage of suitable DF2 students who select GDP training if training places	M		Chief Dental Officer	80% of students that complete DF2 stay in the system continue to GDP	

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption	Recommendation
unlimited					

12.1.6 Specialist training

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption	Recommendation
Annual intake to specialist training from outside of English system	M	No specific data was available to the CfWI at the time of modelling	Chief Dental Officer	0%	Data to be collected on students joining specialist training from outside of English system, broken down by age and gender
Specialty training length including delay percentage			Chief Dental Officer	Specialist 42% take 3 years 14% take 4 years 41% take 5 years 2% take 6 years Consultant 95% take 3 years 5% take 4 years	

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption	Recommendation
Specialist training attrition rate, students that leave dental system	M	Sheffield model and Chief Dental Officer The Sheffield model was created for the report: Modelling the Dental Workforce Supply in England by Professor Peter Robinson, Ms Alison Patrick and Professor Tim Newton	Chief Dental Officer	0.5% per year	Data to be collected on students leaving specialist training and leaving the dental system
Specialty training attrition rate seeking training or career post	M	Sheffield model and Chief Dental Officer The model was created for the report: Modelling the Dental Workforce Supply in England by Professor Peter Robinson, Ms Alison Patrick and Professor Tim Newton	Chief Dental Officer	0.5% per year	
Initial specialist training	M	COPDenD/Deanery monitoring data	Chief Dental Officer	Initial estimate of specialist training trainees is 312 which includes Men and Women. Feb 2011 data	

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption	Recommendation
				(141 will do additional training)	
Percentage complete speciality training and leave system	M	Sheffield model and Chief Dental Officer The model was created for the report: Modelling the Dental Workforce Supply in England by Professor Peter Robinson, Ms Alison Patrick and Professor Tim Newton	Chief Dental Officer	1.5% per year	
Percentage of specialist training students that will do additional training	M	Chief Dental Officer and CfWI	Chief Dental Officer	Initial assumption 96% of students will do specialist training without additional training; 4% will do specialist training that is followed by additional training Assumed based on current population of training (24.6% in training that will	

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption	Recommendation
				go on to additional training) NB All overseas in English subscript	
Percentage of students who complete specialist training and stay In system continue to consultant training	M	Chief Dental Officer and CfWI	Chief Dental Officer	Initially assume that all the people that completed the specialty training required for a consultant role continue to consultant training	
Percentage of students who complete specialist training and stay in system continue to GDP	M		Chief Dental Officer	0.5% per year	
Percentage of students who complete specialist training and stay in system continue to staff grade	M		Chief Dental Officer	1.2% per year	

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption	Recommendation
Percentage of students who complete specialist training and stay in system continue to specialist practise	M		Chief Dental Officer	94.4% per year	

12.1.7 Additional training

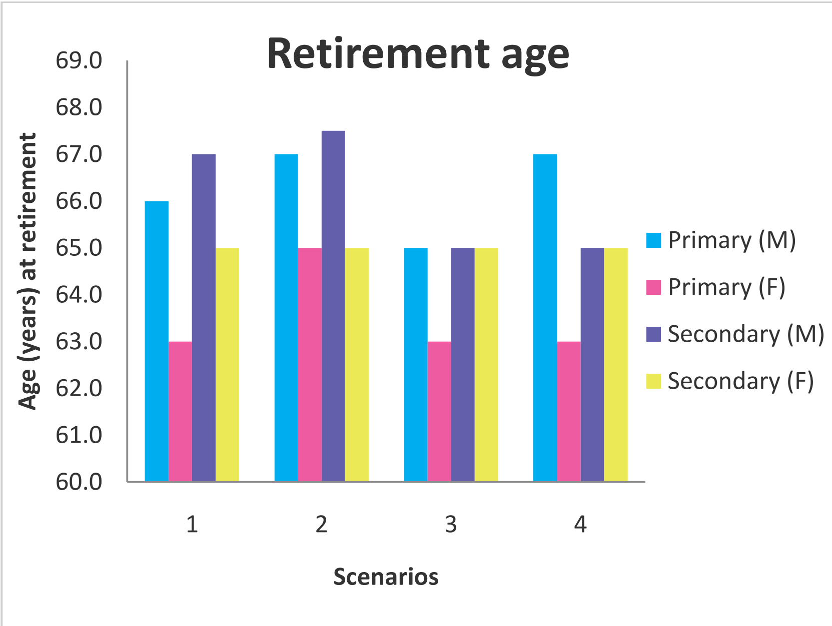
Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption	Recommendation
Initial 'stock' in additional training	VH	COPDenD/Deanery monitoring data	Dental Programme Board	43	
Annual joiners into additional training from specialist practice	M	CfWI	Chief Dental Officer	25 people per year	
Annual additional training re-joiners	M		Chief Dental Officer	0% per year	

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption	Recommendation
Percentage of the trainees that start additional training who drop out	M		Chief Dental Officer	1% per year	
Percentage of the trainees that start additional training who pass and then leave the system	M		Chief Dental Officer	5% per year	
Percentage of the trainees that start additional training who fail and then re-sit and pass	M		Chief Dental Officer	0% per year	
Percentage who complete additional training and start consultant practice	M		Chief Dental Officer	100% per year	
Percentage who complete additional training and then leave the system	M	No known data source	Assumption from Chief Dental Officer	Estimated at 5% per year	

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption	Recommendation
Annual additional training intake from outside of country	M		Chief Dental Officer	0% per year	
Additional training length including delay percentage	M		Chief Dental Officer	49% take 2 yrs 51% take 4 yrs	
Additional training holders who start GDP practice annually	M		Chief Dental Officer	0% per year	

12.2 Dental supply: scenario assumptions

The dental Delphi panel was asked to judge at what age dentists would retire in 2040, on average, in each of the four future scenarios. The following graph shows their collective judgment, which was then used in the supply model.



12.3 Dental demand: scenario assumptions

Multipliers of demand for primary care in 2040	Demographic multiplier	Need multiplier	Service multiplier	Multiplier to account for changing participation (men)	Multiplier to account for changing participation (women)	Sources of data/ assumptions
Demand 'baseline'	1.23	1.00	1.00	1.00	1.00	As listed above
Scenario 1	1.23	1.15	0.86	1.15	1.07	Delphi panel judgment
Scenario 2	1.23	1.05	0.90	1.01	1.16	
Scenario 3	1.23	1.00	0.90	1.22	1.25	
Scenario 4	1.23	1.00	1.10	1.03	1.20	

Multipliers of demand for secondary care in 2040	Demographic multiplier	Need multiplier	Service multiplier	Multiplier to account for changing participation (men)	Multiplier to account for changing participation (women)	Sources of data/ assumptions
Demand 'baseline'	1.21	1.00	1.00	1.00	1.00	As listed above
Scenario 1	1.21	1.10	0.95	1.08	1.34	Delphi panel judgment
Scenario 2	1.21	1.00	1.03	1.08	1.34	
Scenario 3	1.21	1.00	1.03	1.22	1.43	
Scenario 4	1.21	1.08	1.02	1.08	1.34	

Multipliers of demand for secondary care in 2040	Demographic multiplier	Need multiplier	Service multiplier	Multiplier to account for changing participation (men)	Multiplier to account for changing participation (women)	Sources of data/ assumptions
Demand 'baseline'	1.23	1.00	1.00	1.00	1.00	As listed above
Scenario 1	1.23	1.10	0.95	1.08	1.34	Delphi panel judgment
Scenario 2	1.23	1.05	1.02	1.08	1.34	
Scenario 3	1.23	1.00	1.02	1.22	1.43	
Scenario 4	1.23	1.00	1.01	1.08	1.34	

13 APPENDIX J

13.1 Medical supply: full list of baseline assumptions

13.1.1 Medical school

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption
Annual medical school intake from England	Very high	HEFCE medical and dental return November 2006-2011	n/a	5884 home fees students per year from 2011
Gender balance of annual medical school intake from England	VH	HEFCE	n/a	53.6% women (2011 data, down from c. 60% in 2003)
Annual medical school intake from England, age profile	VH	As at May 2012, BMA professional records data of 5000 students at English medical schools (including international students) expecting to graduate in 2016 or 2017 (by age and gender)	n/a	Approximately 80% of entrants are aged 19-20, with the remainder in their twenties except 2% who are older. The age profiles of men and women medical school entrants are similar.
Annual medical school intake from outside of country	VH	HEFCE	n/a	493 students per year from 2011
Gender balance of annual medical school intake from outside of country	VH	HEFCE	n/a	59% women (2011, stable since 2003)
Annual medical school intake from outside of country, age profile	L	No specific data was available to the CfWI at the time of modelling	CfWI estimate used due to lack of evidence	Same as English students
Percentage of medical school intake that drop out	M	Medical Schools Council assumption	Historical data from HEFCE suggests a higher drop-out rate of c.9%	5%
Percentage of students who complete medical school and leave system	N	No specific data was available to the CfWI at the time of modelling	0% was queried by SP/SG but no alternative evidence was provided	0%
Time spent in medical school by length of time to complete course	H	GMC snapshot of student numbers by year of study for English medical schools (2010/11)	n/a	13.4% take 4 years (graduate entry) 40.1% take 5 years

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption
				46.5% take 6 years (intercalations and other delays)
Graduates from medical school	VH	Calculated from intake	Simon Peck, Department of Health WDAT team	Reflects drop-outs and length of time to complete course Number of graduates by year shows a spike around 2015 due to historical fluctuations in intake

13.1.2 Foundation 1 (F1)

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption
Annual F1 intake from English medical schools	n/a	Calculated from medical school 'stock' (see previous table)	n/a	
Annual F1 intake from outside English system	M	UK Foundation Programme Office (UKFPO) annual report 2011 UK summary (November 2011). Note that this data covers the whole of the UK; England-specific data has not been published therefore we have used the UK data as a proxy	n/a	136 trainees per year, or 2.2% ["The data show that the majority (97.7%) of F1 doctors qualified at a UK medical school. Of the remaining appointees, 0.9% qualified at an EEA medical school (excluding the UK) and the remaining 1.3% qualified from a non-EEA medical school."]
Annual F1 intake from outside English system, age profile	H	No specific data for F1s from outside of English system therefore use English age profile as a proxy. HSCIC medical census 2011, headcount data by age and gender for F1 doctors	CfWI estimate used due to lack of evidence	English F1 age profiles used as a proxy.
F1 maximum training places	n/a	UKFPO	n/a	6114
Foundation 1 initial 'stock'	H	UKFPO	n/a	6217, which is the maximum training places plus a small oversubscription informally reported by the FPO [AW to check source]

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption
Foundation 1 initial 'stock', age profile	H	HSCIC medical census 2011, headcount data by age and gender for F1 doctors	n/a	Split by gender. Over 90 per cent of men F1s are below 30 years old, the majority are 24 (34 %). Over 90 per cent of women F1s are below 30 years old, the majority are 24 (31 %).
Percentage of the trainees that start F1 who drop out	VH	UKFPO	n/a	1.8%
Percentage of the trainees that start F1 who pass and then leave the system	VH	UKFPO annual report, table 16	n/a	1.1%
Percentage of the trainees that start F1 who fail and then re-sit and pass	VH	UKFPO annual report, table 30	n/a	0.7%

13.1.3 Foundation 2 (F2)

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption
Annual F2 intake from English system	n/a	Calculated from F1 'stock' (see previous table)	n/a	
Annual F2 intake from outside English system	L	No specific data was available to the CfWI at the time of modelling	CfWI estimate used due to lack of evidence	Zero (assumed)
Annual F2 intake from outside English system, age profile	M	No specific data for F2s from outside of English system therefore use English age profile as a proxy. HSCIC medical census 2011, headcount data by age and gender for F2 doctors	CfWI estimate used due to lack of evidence	English F2 age profiles used as a proxy
F2 maximum training places	n/a	n/a	n/a	Unrestricted (governed by flow in from F1)
Foundation 2 initial 'stock'	H	UKFPO, informal	n/a	6314 (6114 from F1 + 200 assumed new entrants at F2

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption
				including locally-funded trainees)
Foundation 2 initial 'stock', age profile	H	HSCIC medical census 2011, headcount data by age and gender for F2 doctors	n/a	Split by gender. Over 90 per cent of men F2s are below 32 years old, the majority are 25 (33 %). Over 90 per cent of women F2s are below 31 years old, the majority are 25 (32 %).
Percentage of the trainees that start F2 who drop out	VH	UKFPO	n/a	2.5% (calculated by subtracting the percentage of UK F2s who repeat (1%) from the total number who do not complete the year (3.5%))
Percentage of the trainees that start F2 who pass and then leave the system	VH	UKFPO annual report and CfWI analysis	Simon Peck, WDAT	5% (assumed, based on UKFPO annual report table18). Note that 17% appear to leave the UK after F2, but we adjusted this figure to reflect the fact that the majority must return in order to maintain the current and historical fill-rates of core and specialty training.
Percentage of the trainees that start F2 who fail and then re-sit and pass	VH	UKFPO	n/a	1.06%

13.1.4 GP training

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption
Annual intake into GP training from the English Foundation Programme	n/a	Calculated by model from flows into training	n/a	
Annual intake into GP training from outside England	L	No specific data was available to the CfWI at the time of modelling	CfWI estimate used due to lack of evidence	100 (assumed)
Annual intake into GP training from outside England, age profile	M	GMC data, 2010	CfWI estimate used due to lack of evidence	UK age profile used as proxy, see below

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption
Annual intake into GP training from career posts	L	No specific data was available to the CfWI at the time of modelling	CfWI estimate used due to lack of evidence	Estimated at 100 men and 100 women per year
GP training posts (target)	H	Department of Health survey of deaneries, summer 2012 (unpublished)	n/a	8489 (the number of posts that were available in 2012)
GP training posts filled (%)	L	All training places are filled, but only if there are trainees available to fill them	Potential trainees are split between GP, run-through and Core training using the current ratio of trainees per year. If there are sufficient trainees all training posts will be filled.	100%
GP training initial 'stock'	H	Department of Health survey of deaneries, summer 2012 (unpublished)	n/a	7765 (of which 62% are assumed to be women, based on 2011 HSCIC medical census registrar data)
GP training initial 'stock', age profile by gender	VH	GMC data, 2010	n/a	Table available on request. Median age is 26, over 90% are in the age range 25-40)
Length of GP training and 'delays'	M	Informal conversations with postgraduate deans and the RCGP, and CfWI judgement	n/a	25% (assumed) of GP trainees take up to six months longer than the standard three years, due to failure of exams and other reasons. This assumption was represented by setting the men delay at 7.5% for one year of the course, and women delay at 15% for one year of the course.
GP training attrition rate (leave the system)	M	Assumption; no specific data was available to the CfWI at the time of modelling	Postgraduate deans approached were unable to supply data	1%
GP training attrition rate (leave GP training to seek a career post or other training)	L	Assumption; no specific data was available to the CfWI at the time of modelling	Postgraduate deans approached were unable to supply data	1%
Percentage who complete training and then leave the system	L	Assumption; no specific data was available to the CfWI at the time of modelling	CfWI estimate used due to lack of evidence	5%

13.1.5 Core training

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption
Annual intake into Core training from the English Foundation Programme	n/a	Calculated by model from flows into training	n/a	
Annual intake into Core training from outside England	L	No specific data was available to the CfWI at the time of modelling	CfWI estimate used due to lack of evidence	50 men, 50 women
Annual intake into Core training from outside England, age profile	L	No specific data was available to the CfWI at the time of modelling; GP ST1 age profile was used instead (GMC data, 2010)	CfWI estimate used due to lack of evidence	Table available
Annual intake into Core training from career posts	L	No specific data was available to the CfWI at the time of modelling	CfWI estimate used due to lack of evidence	100 men, 100 women
Core training posts (target)	H	Department of Health survey of deaneries, summer 2011 (unpublished)	n/a	7255 (number of available posts in summer 2011)
Core training posts filled (%)	M	All training places are filled, but only if there are trainees available to fill them	Potential trainees are split between GP, run-through and Core training using the current ratio of trainees per year. If there are sufficient trainees all training posts will be filled.	100%
Core training initial 'stock'	H	Department of Health survey of deaneries, summer 2011 (unpublished)	n/a	6,524. We have assumed half are men and half are women
Core training initial 'stock', age profile by gender	H	No specific data available for age of core trainees therefore use the age of those exiting F2 to represent the age of those entering Core training.	CfWI estimate used due to lack of evidence	No specific data so age of those exiting F2 is used as a proxy.
Length of Core training and 'delays'	H	All-England stock-take returns, Department of Health, April 2011, numbers of trainees on two- and three-year training programmes.	n/a	79% take two years 21% take three years* *Three-year Core training is for core psychiatry and acute care common stem.
Core training attrition rate (leave the system)	M	No specific data was available to the CfWI at the time of modelling	CfWI estimate used due to lack of evidence	1% (assumed)

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption
Core training attrition rate (leave Core training to seek a career post or other training)	M	No specific data was available to the CfWI at the time of modelling	CfWI estimate used due to lack of evidence	1% (assumed)
Percentage who complete training and leave the system	L	No specific data was available to the CfWI at the time of modelling	CfWI estimate used due to lack of evidence	5% (assumed)
Percentage who complete Core training and seek a career post or other training)	L	No specific data was available to the CfWI at the time of modelling	CfWI estimate used due to lack of evidence	10% (assumed)

13.1.6 Run-through training

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption
Annual intake into run-through training from the English Foundation Programme	n/a	Calculated by model from flows into training	n/a	Approximately 1,000 new trainees per year. The model only fills posts if there is a flow into the posts from within the model.
Annual intake into run-through training from outside England	L	No specific data available to CfWI	CfWI estimate used due to lack of evidence	75 men, 75 women
Annual intake into run-through training from outside England, age profile	M	No specific data was available to the CfWI at the time of modelling; GP ST1 age profile was used instead (GMC data, 2010)	CfWI estimate used due to lack of evidence	Table available
Annual intake into run-through training from career posts	L	No specific data was available to the CfWI at the time of modelling	CfWI estimate used due to lack of evidence	75 men, 75 women
Run-through training posts (target)	H	Department of Health survey of deaneries, summer 2011 (unpublished)	n/a	7,626 (number of available posts in summer 2011)
Run-through training posts filled (%)	H	All training places are filled, but only if there are trainees available to fill them	Potential trainees are split between GP, run-through and Core training using the current ratio of trainees per year. If there are sufficient trainees all training posts will be filled.	100%

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption
Run-through training initial 'stock'	H	All-England stock-take returns, Department of Health, summer 2011	n/a	7,346 (number of trainees in 2011) we have assumed half are men and half women
Run-through training initial 'stock', age profile by gender	H	No specific data was available to the CfWI at the time of modelling; GP ST1 age profile data was used as a proxy, but adjusted to reflect the longer duration of run-through training (GMC data, 2010)	CfWI estimate used due to lack of evidence	Table available
Length of run-through training and 'delays'	H	Minimum length of training as defined by the training curricular 'Delays' to completion of training as advised by Royal Colleges All-England stock-take returns, Department of Health, April 2011, numbers of trainees by training programme.	Medical royal colleges provided estimates of the faction of trainees that take longer than the minimum length of training.	The minimum length of training, average delays and number of posts was used to calculate the absolute number of trainees expected to complete training by year, for a cohort of trainees. The range was 5 to 13 years for run-through training. The majority of trainees are expected to take eight or seven years (32 and 21 per cent respectively.
Run-through training attrition rate (leave the system)	L	No specific data was available to the CfWI at the time of modelling	CfWI estimate used due to lack of evidence	1% (assumed)
Run-through training attrition rate (leave run-through training to seek a career post or other training)	L	No specific data was available to the CfWI at the time of modelling	CfWI estimate used due to lack of evidence	1% (assumed)
Percentage who complete training and leave the system	L	No specific data was available to the CfWI at the time of modelling	CfWI estimate used due to lack of evidence	2% (assumed)

13.1.7 Higher specialty training

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption
Annual intake into higher specialty training from the English Core training programme	n/a	Calculated by model from flows into training	n/a	

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption
Annual intake into higher specialty training from outside England	n/a	No specific data available to CfWI	CfWI estimate used due to lack of evidence	Zero (assumed)
Annual intake into higher specialty training from outside England, age profile	n/a	No specific data available to CfWI	CfWI estimate used due to lack of evidence	n/a as zero assumed
Annual intake into higher specialty training from career posts (having previously completely Core training)	M	No specific data available to CfWI	CfWI estimate used due to lack of evidence	50 women, 50 men (assumed)
Higher specialty training posts (target)	H	Department of Health survey of deaneries, summer 2011 (unpublished)	n/a	12,251 (number of available posts in summer 2011)
Higher specialty training posts filled (%)	M	All training places are filled, but only if there are trainees available to fill them	Fill rate is dependent on the flow from Core training.	100%
Higher specialty training initial 'stock'	H	Department of Health survey of deaneries, summer 2011 (unpublished)	n/a	12,251(number of available posts in summer 2011)
Higher specialty training initial 'stock', age profile by gender	H	No specific data available for age of current core trainees.	CfWI estimate used due to lack of evidence	We have used the age profile of those finishing Core training for ST3, and increased the age profile by one year for each subsequent ST year.
Length of higher specialty training and 'delays'	H	Minimum length of training as defined by the training curricular 'Delays' to completion of training as advised by Royal Colleges All-England stock-take returns, Department of Health, April 2011, numbers of trainees by training programme.	Medical royal colleges provided estimates of the faction of trainees that take longer than the minimum length of training.	The minimum length of training, average delays and number of posts was used to calculate the absolute number of trainees expected to complete training by year, for a cohort of trainees. The range was three to 11 years for higher specialty training. Over 90 per cent of trainees are expected to take between three and seven years, with the majority taking six years (30 percent).
Higher specialty training attrition rate (leave the system)	M	No specific data was available to the CfWI at the time of modelling	CfWI estimate used due to lack of evidence	0.5% (assumed)

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption
Higher specialty training attrition rate (leave higher specialty training to seek a career post or other training)	M	No specific data was available to the CfWI at the time of modelling	CfWI estimate used due to lack of evidence	0.5% (assumed)
Percentage who complete training and leave the system	L	No specific data was available to the CfWI at the time of modelling	CfWI estimate used due to lack of evidence	2% (assumed)

13.1.8 Trained hospital doctor (consultant) workforce

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption
Annual career post holders with CESR who become trained hospital doctors (trained hospital doctors)	M	No specific data available to CfWI	CfWI estimate used due to lack of evidence	Assumed to be zero
Annual trained hospital doctor intake from outside of English system	L	No specific data available to CfWI	CfWI estimate used due to lack of evidence	Assumed to be zero
Annual trained hospital doctor intake from outside of English system, age profile	H	No specific data available to CfWI, age profile of trained hospital doctor workforce used	CfWI estimate used due to lack of evidence	Assumed to be the same as trained hospital doctor workforce age profile
Annual trained hospital doctor re-joiners	M	HSCIC monthly workforce statistics turnover Provisional Statistics for March 2011 – March 2012. Net trained hospital doctor joiners.	n/a	543, assumed to be split equally between men and women. We know the total number of trained hospital doctors that started in the NHS during the year from March 2011 to March 2012. We calibrate the model using this number. The number of re-joiners and new CCT-holders is equal to the total number of new trained hospital doctors.
Annual trained hospital doctor re-joiners, age profile	H	No specific data available to CfWI, age profile of trained hospital doctor workforce used.	CfWI estimate used due to lack of evidence	Assumed to be the same as trained hospital doctor workforce age profile
Trained hospital doctor attrition rate	M	HSCIC medical census 2008 to 2011, headcount for trained hospital doctors by age and gender.	CfWI continue past trends due to lack of specific evidence	Historical data (2008 to 2011) is used to build a picture of the likelihood of a trained hospital doctor leaving the workforce, by

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption
		HSCIC monthly workforce statistics turnover Provisional Statistics for March 2011 – March 2012. Net trained hospital doctor leavers. The attrition rate accounts for retirements (those 54 and older) and early leavers (those 53 and younger).		age and gender. For example, 15% of 60 year old men leave, and 44% of 65 year old men leave. 22% of 60 year old women trained hospital doctors leave and 33% of 65 year old women trained hospital doctors leave. We assume that 2% of trained hospital doctors below the age of 54 leave each year; this is calibrated using the turnover data.
Trained hospital doctor participation rate	High	HSCIC medical census 2011, FTE and headcount data by age, grade and gender	Participation rate by age and gender	Participation rate calculated by gender and in age bands of one year. Average participation by women of 90.5%, average participation by men of 96.4% in 2011. The average participation rate changes each year due to the changing ratio of genders and ages.
Initial trained hospital doctor 'stock'	VH	HSCIC medical census 2011, headcount for trained hospital doctors	n/a	26,725 men, 12,363 women
Initial trained hospital doctor 'stock', age profile	VH	HSCIC medical census 2011, headcount data by age and gender for trained hospital doctors	n/a	Separate age profiles used for men and women. The largest age group for men trained hospital doctors is 45 years old (4.6%), and for women trained hospital doctors 42 years old (5.5%).

13.1.9 General practice workforce

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption
Annual inflow of GPs from outside of English system	n/a	No specific data available to CfWI	CfWI estimate used due to lack of evidence	Assumed to be zero
Annual re-joiners to GP	M	No specific data available to CfWI	CfWI estimate used due to lack of evidence	289 men and 289 women per year (assumed)
Annual flow of trained hospital doctors to GP conversion training	L	No specific data available to CfWI	CfWI estimate used due to lack of evidence	Assumed to be zero
GP attrition rate	M	HSCIC GP census 2008 to 2011, headcount for GP providers, other/salaried GPs, and GP retainers by age and gender. The attrition rate accounts for retirements (those 49 and older) and early leavers (those 48 and younger).	CfWI continue past trends due to lack of specific evidence	Historical data (2008 to 2011) is used to build a picture of the likelihood of a GP leaving the workforce, by age and gender. For example, 13% of 60 year old men leave, and 14% of 65 year old men leave. 19% of 60 year old women trained hospital doctors leave and 22% of 65 year old women leave. We assume that 4% of trained hospital doctors below the age of 49 leave each year.
GP participation rate	M	HSCIC GP census 2011, FTE and headcount data for GP Providers, Other/Salaried and Retainers.	Participation rate by age and gender	Participation rate calculated by gender and in age bands of one year. Average participation by women of 79.5%, average participation by men of 93.9% in 2011. The average participation rate changes each year due to the changing ratio of genders and ages.
Initial 'stock' of GPs	H	HSCIC GP census 2011, headcount for trained hospital doctors by age and gender.	n/a	19,359 men, 16,444 women

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption
Initial 'stock' of GPs, age profile	H	HSCIC GP census 2011, headcount by age and gender for GP providers, other/salaried GPs, and GP retainers.	n/a	Age profile represents that of the current English GPs
Age profile of GP re-joiners	M	No specific data available to CfWI	CfWI estimate used due to lack of evidence	Assume the same age profile as the GP workforce

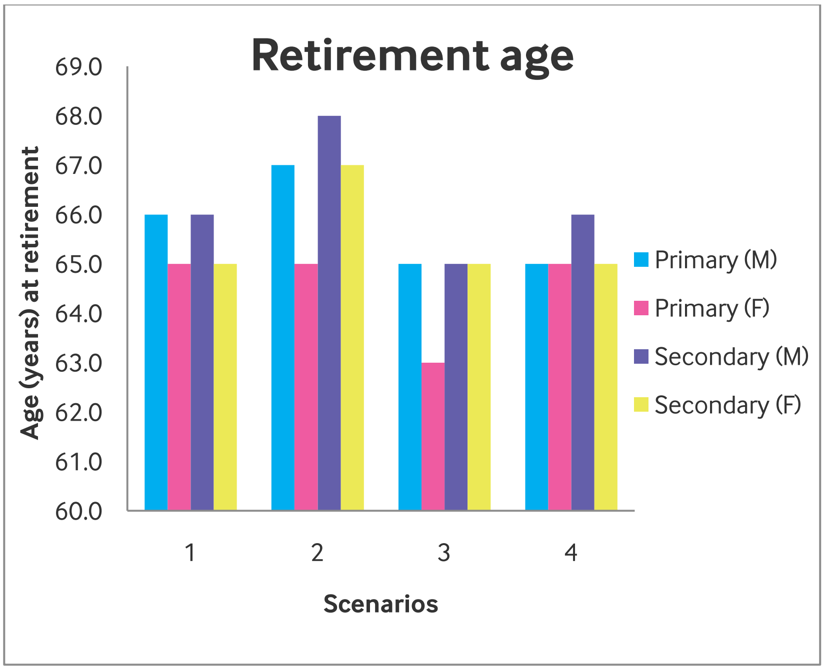
13.1.10 Career post doctor workforce

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption
Annual intake into career post from F2 and non-completed training	n/a	Calculated by model from flows into training	n/a	
Initial 'stock' of career post holders without CESR	M	HSCIC medical census 2011, headcount for Associate Specialists, Specialty Doctors, Staff Grades, Senior House Officers, Hospital Practitioners and Other Staff (medical).	Some Staff and Associate Specialist (SAS) grade doctors may have a CESR. The initial assumption is zero due to lack of evidence.	8,653 men, 10,034 women
Initial 'stock' of career post holders without CESR, age profile	L	HSCIC medical census 2011, headcount by age and gender for Associate Specialists, Specialty Doctors, Staff Grades, Senior House Officers, Hospital Practitioners and Other Staff (medical).	n/a	90% of men are in the 30 to 63 age bracket 90% of women are in the 24 to 58 age bracket
Career post participation rate		HSCIC medical census 2011, headcount and FTE by gender for Associate Specialists, Specialty Doctors, Staff Grades, Senior House Officers, Hospital Practitioners and Other Staff (medical).	Participation rate by age and gender	Participation rate calculated by gender and in age bands of one year. Average participation by women of 77.5%, average participation by men of 92.1% in 2011. The average participation rate changes each year due to the changing ratio of genders and ages.
Career post holders without CESR, re-joiners and those coming from outside the English system	L	No specific data available to CfWI HSCIC monthly workforce statistics turnover Provisional Statistics for March 2011 – March 2012. Other	CfWI estimate used due to lack of evidence	600 men, 400 women per year.

Model element/ variable	Data confidence rating	Source of data/ assumption	Validation	Data/ assumption
		medical staff.		
Career post holders without CESR, re-joiners and those coming from outside the English system, age profile	L	No specific data available to CfWI HSCIC medical census 2011, headcount by age and gender for Associate Specialists, Specialty Doctors, Staff Grades, Senior House Officers, Hospital Practitioners and Other Staff (medical).	CfWI estimate used due to lack of evidence	Assume same as the career post age profile
Attrition from career post grades	L	HSCIC GP census 2008 to 2011, headcount by age and gender for Associate Specialists, Specialty Doctors, Staff Grades, Senior House Officers, Hospital Practitioners and Other Staff (medical).	CfWI estimate used due to lack of evidence	Historical data (2008 to 2011) is used to build a picture of the likelihood of a career post doctor leaving the workforce, by age and gender. We assume that 5% of career posts below the age of 45 leave each year.
Career posts without CESR that gain CESR	L	No specific data; assumption required	CfWI estimate used due to lack of evidence	1% per year (assumed)
Initial 'stock' of career post holders who have completed Core training	L	No specific data; assumption required	CfWI estimate used due to lack of evidence	1,000 (assumed) 54% women as per the average for career posts
Initial 'stock' of career post holders with CESR	L	No specific data; assumption required	CfWI estimate used due to lack of evidence	Zero (assumed). We let the number build from flows within the model

13.2 Medical supply: scenario assumptions

The medical Delphi panel was asked to judge at what age doctors would retire in 2040, on average, in each of the four future scenarios. The following graph shows their collective judgment, which was then used in the supply model.



13.3 Medical demand: data sources, baseline assumptions and scenario assumptions

We calculated increasing demand for medical care due to demographic growth using projections of the English population and weightings for medical services requirement by age and gender. The relative demand from people in a particular age band and gender is calculated for the whole population, and summed for each future year to give an estimate of the overall future health service demand by year.

The baseline growth of the English population uses the 2010-based principal population projection for the England that assumes:

- a long-term average completed family size of 1.85 children per woman
- life expectancy at birth in 2035 of 83.6 years for men and 87.2 years for women, with constant rates of mortality improvement assumed thereafter
- long-term annual net migration to the UK of +172,500 per year.

The baseline weightings for health service use were calculated for both primary and secondary care. Secondary care weightings used HSCIC (2012) outpatient attendances data by age and gender. Primary care weightings used PCT revenue allocation weightings (DH, 2011) by age and gender. The average demand from secondary and primary care estimates is used to give the year on year per cent growth in demand.

Office for National Statistics (2011) *Table A3-4, Principal projection - England population single year of age, 2010-based*. [online] Available at: http://www.ons.gov.uk/ons/rel/npp/national-population-projections/2010-based-projections/index.html [Accessed March 2012]

NHS Health and Social Care Information Centre (2012) *Hospital Episode Statistics for England. Main specialty by age group for all outpatient attendances: All, 2010-11*. [online] Available at: http://www.hesonline.nhs.uk/Ease/servlet/ContentServer?siteID=1937&categoryID=893 [Accessed May 2012]

Department of Health (2011) *Exposition book 2011-2012, Table 6: 2011-12 primary medical services component, Age-gender weights*. [online] Available at: http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_124949 [Accessed May 2012]

The following tables show the assumptions used regarding the multipliers of demand for primary and secondary care in 2040, both in the 'baseline' and scenario cases:

Multipliers of demand for primary care in 2040	Demographic multiplier	Need multiplier	Service multiplier	Multiplier to account for changing participation (men)	Multiplier to account for changing participation (women)	Sources of data/ assumptions
Demand 'baseline'	1.33	1.00	1.00	1.00	1.00	As listed above
Scenario 1	1.33	1.25	1.17	1.12	1.08	Delphi panel judgment
Scenario 2	1.33	1.20	1.02	1.06	1.03	
Scenario 3	1.33	1.30	1.18	1.12	1.08	
Scenario 4	1.33	1.30	1.06	1.12	1.01	

Multipliers of demand for secondary care in 2040	Demographic multiplier	Need multiplier	Service multiplier	Multiplier to account for changing participation (men)	Multiplier to account for changing participation (women)	Sources of data/ assumptions
Demand 'baseline'	1.27	1.00	1.00	1.00	1.00	As listed above
Scenario 1	1.27	1.20	1.14	1.13	1.13	Delphi panel judgment
Scenario 2	1.27	1.10	1.02	1.07	1.08	
Scenario 3	1.27	1.25	1.15	1.07	1.13	
Scenario 4	1.27	1.25	1.08	1.13	1.13	

14 APPENDIX K

14.1 Overview of medical model testing

The CfWI adopted a robust, formal approach to testing the medical model. The purposes of model testing were:

- to ensure that the model design had been transformed into a simulation model with sufficient accuracy
- to ensure that the simulation model was sufficiently accurate for the required purpose.

The CfWI developed a test specification based on the model documentation. The test specification detailed all the tests to be carried out on the model, and included tests of the model structure, formulation and behaviour. The test specification ensured that the testing was carried out methodically, and that all areas of the model were tested.

The testing was carried out by a CfWI modeller who was independent of the simulation development process. The results of the testing were captured in a spreadsheet. The spreadsheet identified when and by whom the test was carried out. The outcome of each test was also logged in the spreadsheet. If the test resulted in a fail, then the fault was corrected by the model developer. The test was then re-run by the model tester to ensure that it had been corrected, and also that the correction had had no wider implications on the model. The model tester also had the freedom to carry out additional tests on the simulation model, and these were also captured in the testing results spreadsheet.

In addition to the tests identified in the test specification, the CfWI also carried out the following analyses:

- comparing the results of the model with previous simulation models that represented the medical workforce
- reviewing the projections produced by the model for each stage of the training and workforce pipeline, along with the associated assumptions, with relevant stakeholders
- testing the sensitivity of the model outputs to the input data.

As a result of changes in the way data is reported, it was not possible to compare the fit between historical data and simulation output. However, this will be carried out as future data is made available.

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