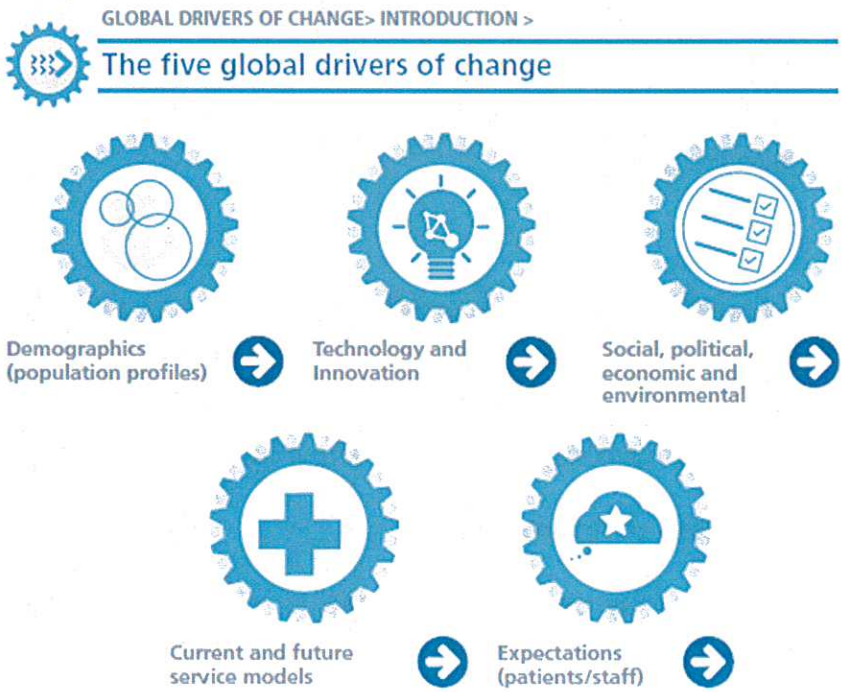
Health Education England

Call for evidence

What are the workforce challenges for cancer services beyond 2021, and what should we do to address them?

The Cancer Workforce Plan Phase 1: Delivering the cancer strategy to 2021 necessarily focusses on immediate steps to secure and increase supply in some key areas to ensure delivery of the Five Year Forward View objectives by 2021. Our ability to understand and respond to cancer is continually changing, therefore we are developing a longer-term strategy that looks at the workforce needs beyond 2021. The longer-term strategy will take the forecast needs of the future population/people affected by cancer as its starting point, build upon HEE's *Framework 15* and be published in the summer of 2018.

In our Strategic Framework, Framework 15 (published in 2014) we identified five key drivers of change:



The call for evidence

As part of Phase 2 of the Cancer Workforce Plan, we are making **this call for evidence** from all interested parties on the five drivers of change and how they are likely to impact on the forecast demand for health care for people affected by cancer over the next ten to fifteen years, to enable us to consider the likely workforce implications against a consistent set of planning assumptions.

What counts as evidence?

To help provide the information we need to help us plan for the future we are inviting the following types of evidence:

- Research (quantitative and qualitative) about the impact of change on cancer services into the future and where possible how this will impact the healthcare workforce
- National and local surveys or collated group feedback
- Examples/case studies from the UK and from the international healthcare community are welcome

Please do not include any of the following:

- Promotional material
- Patient identifiable information or information which does not have the explicit consent of the individual(s) involved (example case studies of patient experience in published material already in the public domain can be submitted)
- Newspaper articles, other than where the source information is not available in its original form elsewhere

Where the information is confidential/commercially sensitive or not in the public domain please highlight this on the feedback form.

Submission

Written evidence should be submitted to cancerstrategy@hee.nhs.uk.including in the subject line of the email '*Cancer Strategy call for evidence documents*' and [Your Name or Organisation], attaching the source documents if possible. Please submit by **Friday 26th January 2018**, although we will endeavour to review any submissions after that date *(if for any reason there is likely to be a delay in your submission, please let us know so we can try to take account of this)*

Data Protection and Freedom of Information

The information you send us may be made available to wider partners, referred to in future published workforce returns or other reports and may be stored on our internal evidence database.

Any information contained in your response may be subject to publication or disclosure if requested under the Freedom of Information Act 2000. By providing personal information for this review it is understood that you consent to its disclosure and publication. If this is not the case, you should limit any personal information provided or remove it completely. If you want the information in your response to be kept within HEE's executive processes, you should make this clear in your submission, although we cannot guarantee to be able to do this.

FORM FOR SUBMISSION OF EVIDENCE

For each of the five questions below, please highlight what form the evidence takes, for example is it published research, surveys etc. (please describe each element of evidence provided, citing page numbers/relevant sections where possible).

1) What are the main DRIVERS OF CHANGE for CANCER services over the next ten to fifteen years?

Please use the five main categories identified in Framework 15 – but feel free to add sub- categories as appropriate to your evidence.

1a. Demographics (population profiles) and Epidemiology:

The increase in the numbers of cancers being diagnosed and treated is highlighted in CRUK documents, including 'Testing times to come'. The volume of assessments of prognostic and predictive markers (to determine and monitor the effectiveness of medical and surgical treatments) will inevitably increase.

According to new figures from the Office for National Statistics, 303,135 people were diagnosed with cancer in England in 2016 – an increase of 3,212 people compared to the 2015 statistics. As was the case for cancer overall, blood cancers were slightly more common in men than women. As the numbers of cancers diagnosed increases, survivorship increases, with an associated increase in long term monitoring.

Pathology disciplines support the diagnosis, care and monitoring of all patients with cancer, and direct care is provided by haemato-oncologists. Haematologists are predicted to see a significant increase in their oncology work due to the increase in the numbers of cancers. The workload of all disciplines in pathology is increasing with the increase in the population that has been diagnosed with cancer.

1b. Technology & Innovation:

Technology will have a significant impact on all disciplines in the future including developments in genomics, epigenetic, mass spectrometry, proteomics, informatics, and digital pathology.

Pathologists welcome the introduction of new technology and are at the forefront of developing and implementing it. Pathologists have an outstanding track record of the innovation and in the adoption and implementation of new technology. Examples include:

- Liquid based cytology was introduced across cytopathology for cervical cancer screening, which entailed whole profession adoption of new technology and retraining of all staff involved in both processing and the interpretation of samples.
- Laboratory information system adoption and instituting electronic ordering and communication systems crossing primary and secondary care
- Microbiology and virology transformation through adoption of nuclei acid based diagnosis
- Mass spectroscopy based microbiology profiling for rapid diagnosis
- Drug level monitoring related to new agents coming in to practice
- Integration of profiles integrating haematology and clinical biochemistry tests into single analyser repertories and the transformation of departments into 'blood sciences' laboratories supporting multiple clinical pathology disciplines
- Single integrated haematopathology diagnosis incorporating cross discipline integration of data and the technological developments to not only make the diagnosis using morphological, molecular, flow cytometric and genetic data, but also to bring these elements together into a single report that is electronic
- HPV screening by molecular methods has been implemented in cervical screening, now in place and being used for primary screening in several centres.

- Faecal immunochemical testing for improving uptake of screening in colon cancer includes the introduction of a new test into clinical biochemistry

Flexible adoption of new techniques is routine in laboratories, responding to clinical needs and new therapies. Introduction of new tests or methods involves training and extensive quality control, validation and monitoring. Every innovation is subject to the requirements of external accreditation within a quality management environment. Such continuing innovation passes largely unnoticed (and often unfunded), by those outside of the pathology community.

Targeted therapy in cancer has required more detailed diagnosis and the introduction of new tests across haematology, immunology, histopathology, cytopathology, neuropathology, paediatric pathology, genetics and molecular pathology; more treatment lines also require repeated investigation to inform treatment choice in a patient pathway; and accompanying newer platforms for diagnostics (genomic, proteomics), which need people with skills in tissue samples, preparation, designing investigative pathways, processing tests and reporting.

The introduction of widespread genomic testing of the general population will increase the need for long-term monitoring of the higher risk individuals to look for early signs of pre-symptomatic disease. As with all screening programs the implications are an increase in workload for pathologists. An impression has been given that genomics will decrease the need for current pathology practices, particularly in histopathology or haematology. The converse is true. As an example, the increase in bilateral mastectomies in patients identified as carriers of the BRCA breast cancer genes. The mastectomy specimens require pathological examination to identify pre-symptomatic cancer and enable appropriate treatment.

Examples of such increases in workload for a 'single' sample include the expansion of melanoma histopathology to incorporate BRAF molecular testing, the extension of breast cancer diagnosis to include receptor status and FISH testing, the molecular profiling of lymphomas.

Clinical innovation. Changes in non-therapeutic approaches in clinical pathways also have an impact on pathology. A specific example of the impact of a change in practice on the workload in pathology is the implementation of multiple prostatic core biopsy in urological practice, which increased 8 fold the associated workload in histopathology.

Research For blood cancers as well as a range of other cancers, there are increasing opportunities for improving outcomes of patients through research. Pathologists, especially haematologists and histopathologists are key to cancer research. It is of pivotal importance that assessment of novel drug cellular and transplant therapies are accelerated through continued investment in National Institute for Health Research (NIHR) supported trials infrastructures as well as innovative trials models supported by NIHR such as Trials Acceleration Programme (TAP) and IMPACT. Now that drugs with such promise are available – in addition to transformative genomics – it is vital patients see them. The pace of development of novel therapies requires substantially increased levels of investment from Government and blood cancer charities, as well as the pathology workforce to support trials. There is evidence of a decrease in the job plan provision of protected time for research, and an audit of this is appended (attachment A). The Survey of Medical Clinical Academic Staffing levels, carried out by the Medical Schools Council, primarily covers the decline in clinical academic staffing levels. This also reports a decline in researchers in pathology.

Digital pathology has many potential benefits for the workforce including more flexibility in working, the possibility of more flexible service delivery, a more comfortable working environment and more possibilities to retain staff post retirement who may be attracted to it. (see Williams B, Bottoms D, Treanor D Future-proofing pathology: the case for clinical adoption of digital pathology Journal of Clinical Pathology 2017. doi: 10.1136/jclinpath-2017-204644).

However uptake and adoption of digital pathology is slow with relatively low rates of uptake, and very low use for primary diagnosis (see survey at: Williams BJ, Lee J, Oien KA, Treanor, D. Digital pathology access and usage in the UK: results from a national survey on behalf of the National Cancer Research Institute's

CM-Path initiative Journal of Clinical Pathology 2018. doi:10.1136/jclinpath-2017-204808). Given the difficulties accessing capital investment in pathology, more investment to enable the uptake of digital pathology is needed.

The digital pathology industry predicted efficiency gains for implementation of digitised whole slide scanning in histopathology are stated to be in the region of 10% (CEO Philips UK), but this involves whole system redesign and substantial investment.

Augmented/Artificial intelligence

Algorithms are already used widely in pathology to support interpretation of data, examples include in clinical biochemistry for the support of the identification of gender and age related abnormal renal function. Digital pathology opens the possibility of using augmented intelligence (AI) as an aide to pathologists practice, by rapid focus on abnormalities, performance of repetitive tasks such as counting nuclei, and increasing the reproducibility or quantifiability of our diagnoses. Pathologists welcome the advent of this new technology and are already key to developing and implementing it. It will help efficiency in the long term, by about 10% as above, but it is not a short or medium term solution to the current workforce shortages.

However the RCPath has been concerned that an impression has been given that the role of a professional pathologist could be replaced by AI, which would remove any need to address the workforce issues. HEE should be aware of the following:

- While AI has the potential to be a useful technology, there is an unrealistic expectation that it may reduce the need for professional pathologists;

- Experience in radiology has supported this – despite a 20-year head start in the use of digital imaging, widespread use of AI to interpret images has unfortunately not yet been seen. Scepticism about the impact of computer aided diagnosis in radiology has been voiced (Fenton JJ. Is it time to stop paying for computer-aided mammography? JAMA Intern Med. 2015 Nov 1;175(11):1837–1838.);

- Development of AI algorithms takes time, and they must be shown to be accurate across datasets and institutions. AI algorithms often require carefully formulated problems and strictly controlled datasets to ensure accuracy, and often struggle in real world situations with variation and uncertainty where humans excel;

- Regulatory issues also add to the time taken for algorithms to go from initial promise to clinical use (only a handful of image analysis algorithms, for very simple tasks, have been approved to date, and even fewer are useful in clinical practice);

- As a result, algorithm development is a long process that can be as long as the drug development pipeline – 10 years or more – with considerable uncertainty whether the algorithms will be clinically useful in the short term;

- HEE should be aware that, typically, only 60% of a histopathologist's role is reporting cases, and only 60% of that time (i.e. 36% overall) is looking at glass slides. (Randell R, Ruddle RA, Quirke P, Thomas RG, Treanor D (2012) Working at the microscope: analysis of the activities involved in diagnostic pathology. Histopathology. 2012;60(3):504-510. doi: 10.1111/j.1365-2559.2011.04090.x. Epub 2011 Dec 16);

- A system that assists with glass slide review is welcome, but would not take away the higher level tasks we perform such as integration of diverse information and application of clinical knowledge. These tasks – which require scientific and clinical qualifications and postgraduate training – are not likely to be replaced by computers in any reasonable timeframe, and physicians are amongst the least replaceable jobs with computers (Ranked 15 of 702 least likely to be computerisable. Frey

CB, Osborne MA. The future of employment: how susceptible are jobs to computerisation? Technological Forecasting and Social Change. 2017;114:254–280.);

- Similarly even if a theoretical system could replace that part of our role which is looking at images (5-10% is a more reasonable estimate for a theoretical AI system based on the proportion of a typical pathologists workload that is routine pattern recognition), this would not even begin to compensate for the increase in demand for histopathologists over the coming decades;

- In fact, the need for pathologists to be involved as subject matter experts in the deployment and development of these new technologies will require additional pathologist resource. For pathologists to train and supervise a new generation of pathologists who understand digital imaging and informatics to deliver high quality integrated reports for patients will also require additional pathologist resource.

Diagnostic digital pathology refers to the use of whole slide imaging to create a digital image that can be used for diagnosis, education and research and will facilitate the development of pathology networks and the introduction of image analysis to assist pathologists in their work.

Digital pathology is a facilitating technology that would assist in the roll out of algorithms for diagnostic use. The current phase of digital funding/implementation will probably take at least 3-5 years, and even that will not cover all work in all histopathology laboratories. We should look to ensure that as AI algorithms are developed, they could be implemented across all digital platforms.

The RCPath produced a 'Diagnostic digital pathology strategy', August 2017, authored by Professor Tim Helliwell. In addition, Dr Darren Treanor, Consultant Histopathologist at Leeds, has been appointed RCPath Clinical Lead for Diagnostic Digital Pathology to take this initiative forward. The work will initially relate to histopathology, cytopathology, veterinary pathology, paediatric and perinatal pathology and neuropathology. This does not preclude other specialist areas taking this forward in the future. The research should incorporate objective evaluation of AI/deep learning as a route to better diagnosis.

For Haematologists, fully automated reporting appears to be remote and, due to complexity, AI is unlikely to replace work on some tissues. Currently work is being done to obtain 100k genome project samples, although the issues are significant with high degree of selectivity of cases to get tumour of sufficient purity. The question being asked is whether AI will know what to disregard.

The use of AI to interpret and integrate a Specialist Integrated Haematological Malignancy Diagnostic Services (SIHMDS) haemato-oncology report is also remote. There is currently no system or team which can digitise all the components that require morphology. Integrating the multiple aspects of marrow investigation is a distant dream.

1c. Social, political, economic and environmental:

International perspectives. Accurate comparative data for the incidence of cancer and outcomes for patients with cancers should be useful indicators of the burden of cancer and the quality of health care. The International Collaboration for Cancer Reporting (ICCR) seeks to deliver accurate classification. AI/deep learning could be applied to ICCR datasets to derive optimal classification and stratification of outcomes.

1d. Current and future service models:

Current service models and the proposals in the Carter report are being developed through the NHSI Pathology Optimisation Delivery project. This model is largely based on blood sciences data, and it is not predicted to reduce the need for increased pathology staff to support cancer diagnosis, care and monitoring. In September 2017, NHS Improvement set out plans to create 29 **pathology networks** across England, each covering populations of 1.5 million to 2 million, in a bid to save £200m by 2020-21. The networks will use the "hub and spoke" model, where the hub will be the lead provider and process complex and high volume tests, while the spokes will provide more routine hospital laboratory services. Indeed the

wholesale reconfiguration of services across large geographic areas has the potential to lead to difficulty retaining existing highly skilled and senior scientific and medical staff. Examples exist of the need for turnaround in pathology services adversely affected by reconfiguration plans which were over-simplistic regarding the complexities of pathology provision, over-optimistic with regard to financial rewards and rolled out with unrealistic timescales. The resulting impacts on patient care and on costs are considerable.

A model where workforce mix and practices work well includes Advanced Practitioner roles. In May 2017 following a successful pilot, the RCPath and Institute of Biomedical Science (IBMS) announced in May 2017 an opportunity for biomedical scientists (BMSs) in histopathological reporting. This represents a major and significant new role for biomedical scientists who complete the rigorous training programme. There are case studies in the RCPath *Bulletin*, January 2015, number 169, for the Advanced Practitioner grade.

BMSs who successfully complete the programme work alongside medically qualified pathologists as part of an integrated reporting team and will be able to dissect, independently report and present cases, such as cancer, at multi-disciplinary team meetings in either gynaecological pathology or gastrointestinal and dermatological pathology. They will also play an integral part in teaching and clinical audit as part of an overall service improvement strategy.

Further information about the Advanced Specialist Diploma in Histopathology Reporting is available: https://www.rcpath.org/trainees/examinations/bms-examinations-histopathology.html

Genomics is expected to transform cancer care including: **100,000 Genomes Project**, **Whole Genome Sequencing** (WGS) service and the NHS England-led laboratory reconfiguration.

Integration will be required across diagnostic platforms currently often seen as separate i.e. genetics and proteomics and tools, like Immunohistochemistry, in tissue assessment.

Haematology consultant posts are increasingly hard to fill and District General Hospital labs are frequently relying on agency staff to cover the service. Proposed laboratory networks cause concerns about recruitment and retention of staff.

The National Cancer Strategy acknowledges the need for adequate numbers of chemotherapy trained nurses, as well as nurse prescribers/nurse practitioners and oncology pharmacists. It also includes the suggestion that chemotherapy is delivered closer to home e.g. in remote or mobile locations.

Whilst microbiologists do not contribute directly to the diagnosis of cancer, they make a substantial and essential contribution to the care of patients with cancer. Patients who have chemotherapy and/or radiotherapy as part of their cancer treatment frequently become immuno-compromised and are susceptible to infectious episodes which are often severe and life-threatening with a range of opportunistic pathogens e. g bacteria, viruses and fungi. Given the speed with which such infections can take hold, as part of a comprehensive package of care for these patients, investment in more specific and innovative molecular diagnostic tests will contribute towards a more rapid and accurate diagnosis of these infections.

In addition, microbiologists work in Multidisciplinary teams (MDT) in various clinical areas. They have crucial clinical liaison and face to face interactions with oncologists, haematologists, paediatricians, and critical care physicians. This MDT approach in advising clinicians on the optimal management of cancer patients with infections in relation to diagnosis, treatment options and monitoring (e.g. response to treatment, antibiotic levels) is essential to achieving the best outcomes for these patients. Investment in the development of new antimicrobial agents (antibiotics, antivirals and antifungals) can also extend the various therapeutic options in the management of these opportunistic infections.

Clinical Biochemistry tests contribute both directly and indirectly to cancer detection and management. This involvement may be direct and examples include specific tumour marker tests: CEA, AFP, CA125, CA19.9 and CA15.3. These may be involved in screening, diagnosis and follow up of patients with certain cancers. The involvement may also be indirect as any increased activity in cancer burden (incidence, activity, new treatment pathways) will be associated with increased use of biochemistry tests monitoring

the response of liver, kidney, bone, pancreas, thyroid, prostate and other organs to progress on cancer pathways.

It is likely therefore that both direct and indirect effects will kick in when either an increase in incidence is observed (expected as the population ages) or when screening, case finding or management becomes more active as a result of increasing incidence, policy change or new guidelines.

1e. Expectations (of patients / staff):

The data on expectations (patients/staff) are less objective but, given the regular communications we have with the active RCPath Lay Governance Group and our Lay Trustees ,we can reasonably surmise that this will not lessen. There has been an increase in complexity of patients' healthcare with significantly more co-morbidities despite the incredible advances in medicine and simultaneously, the public have a higher expectation of the medical treatments that are on offer.

There are current discussions around how clinical trials can be best supported to deliver on the goal of 50% of patients being offered involvement in a trial. There is a tension between more centralised organisation, approval and funding for trials (within networks) and the distributed delivery of research nursing support and medical support in hospitals and GP practices close to patients. The excess care costs of running trials include a significant element of additional laboratory testing. The funding and staff for this needs to be considered in planning capacity.

Following a parliamentary debate on blood cancer, the All Party Parliamentary Group on Blood Cancer (APPGBC) launched their first report on 17 January 2018. The Group's report 'The 'Hidden' Cancer – The need to improve blood cancer care' concluded that the government's 2015 Cancer Strategy is not doing enough to support blood cancer patients. It also recommended that GPs should immediately request a blood test for anyone presenting with one or more symptoms of blood cancer.

One point raised by several of those giving evidence for the APPG in Autumn 2017 was that Haematology often gets under-represented in much that the Department of Health produces in relation to NHS Cancer Strategy.

As well as proposing more frequent blood testing, the Group identified an urgent need for better education and training for doctors and medical students to help them spot blood cancer.

The report also recommended:

- continued government investment in blood cancer research and clinical trials
- better joined up working between primary and secondary health services, and between oncology and haematology teams.

As well as working in the laboratory, haematologists are at the interface between the laboratory and the clinicians. For example they work with other clinicians to provide a Trust-wide seamless transfusion service, manage bleeding, and manage thromboprophylaxis.

Patients in the main are grateful for and believe in the NHS, but the standard of (diagnostic) care offered needs to be world-leading to deliver the clinical outcomes the public expect to be comparable with the best in the world.

2) What EVIDENCE is there on how the drivers identified in Section 1 are likely to IMPACT ON THE FORECAST DEMAND for healthcare in cancer over the next ten to fifteen years? Please rate the likelihood of each impact on a 5-point scale where *1 = very unlikely* to *5 = very likely;* use *0* if the likely impact is *unknown*.

DRIVER of change	Sub - category	EVIDENCE (citation / link)	IMPACT on demand	LIKELIHOOD of impact 0 (unknown), 1 (very unlikely) – 5 (very likely)
a. Demographics and Epidemiology		i) CRUK 'Testing times to come' ii) Trials Acceleration Programme (TAP) iii) IMPACT iv) Office for National Statistics	**5**	**5**

b. Technology and Innovation		i) Williams B, Bottoms D, Treanor D Future-proofing pathology: the case for clinical adoption of digital pathology Journal of Clinical Pathology 2017. doi: 10.1136/jclinpath-2017-204644). ii) Williams BJ, Lee J, Oien KA, Treanor, D. Digital pathology access and usage in the UK: results from a national survey on behalf of the National Cancer Research Institute's CM-Path initiative Journal of Clinical Pathology 2018. doi:10.1136/jclinpath-2017-204808. iii) Fenton JJ. Is it time to stop paying for computer-aided mammography? JAMA Intern Med. 2015 Nov 1;175(11):1837–1838. iv) Randell R, Ruddle RA, Quirke P, Thomas RG, Treanor D (2012) Working at the microscope: analysis of the activities involved in diagnostic pathology. Histopathology. 2012;60(3):504-510. doi: 10.1111/j.1365-2559.2011.04090.x. Epub 2011 Dec 16. v) Frey CB, Osborne MA. The future of employment: how susceptible are jobs to computerisation? Technological Forecasting and Social Change. 2017;114:254–280. vi) http://www.virtualpathology.leeds.ac.uk/ vii) Ellis IO et al. Pathology reporting of breast disease in surgical excision specimens incorporating the dataset for histological reporting of breast cancer. https://www.rcpath.org/resourceLibrary/g148-breastdataset-hires-jun16-pdf.html viii) RCPath workforce survey of histopathology departments in the UK Workforce Survey - Clinical Demand report	**5**	**4**

c. Social, political, economic and environmental		International Collaboration for Cancer Reporting		
d. Service models – current and future		i) Carter report ii) The RCPath *Bulletin*, January 2015, number 169, case studies for Advanced Practitioner grade. iii) NHS Improvement plans 29 **pathology networks** in England. iv) 100,000 Genomes Project v) Whole Genome Sequencing vi) National Cancer Strategy		
e. Expectations – patients / staff		All Party Parliamentary Group on Blood Cancer report 'The 'Hidden' Cancer – The need to improve blood cancer care'		

3) What are the potential IMPLICATIONS FOR THE WORKFORCE of these changes (please cross reference to the previous sections) and where in the health and care pathway are they most likely to impact *(e.g. prevention / diagnosis / treatment / living with and beyond cancer / palliative care)*?

Driver of change	Implication for workforce	Pathway impact
a. Demographics and Epidemiology	CRUK 'Testing times to come' Trials Acceleration Programme (TAP) IMPACT Office for National Statistics	Diagnosis Treatment Living with and beyond cancer
b. Technology and Innovation	i) Williams B, Bottoms D, Treanor D Future-proofing pathology: the case for clinical adoption of digital pathology Journal of Clinical Pathology 2017. doi: 10.1136/jclinpath-2017-204644). ii) Williams BJ, Lee J, Oien KA, Treanor, D. Digital pathology access and usage in the UK: results from a national survey on behalf of the National Cancer Research Institute's CM-Path initiative Journal of Clinical Pathology 2018. doi:10.1136/jclinpath-2017-204808. iii) Fenton JJ. Is it time to stop paying for computer-aided mammography? JAMA Intern Med. 2015 Nov 1;175(11):1837–1838. iv) Randell R, Ruddle RA, Quirke P, Thomas RG, Treanor D (2012) Working at the microscope: analysis of the activities involved in diagnostic pathology. Histopathology. 2012;60(3):504-510. doi: 10.1111/j.1365-2559.2011.04090.x. Epub 2011 Dec 16. v) Frey CB, Osborne MA. The future of employment: how susceptible are jobs to computerisation? Technological Forecasting and Social Change. 2017;114:254–280. vi) http://www.virtualpathology.leeds.ac.uk/	Diagnosis Treatment
c. Social, political, economic and environmental	International Collaboration for Cancer Reporting	Diagnosis Treatment

d. **Service models – current and future**	i) Carter report ii) The RCPath *Bulletin*, January 2015, number 169, case studies for Advanced Practitioner grade. iii) All Party Parliamentary Group on Blood Cancer report 'The 'Hidden' Cancer – The need to improve blood cancer care' iv) 100,000 Genomes Project v) Whole Genome Sequencing vi) National Cancer Strategy	Diagnosis Treatment Living with and beyond cancer
e. **Expectations – patients / staff**	All Party Parliamentary Group on Blood Cancer report 'The 'Hidden' Cancer – The need to improve blood cancer care'	Diagnosis Treatment

4) What WORKFORCE TRANSFORMATION OPPORTUNITIES should we explore to ensure we have the workforce with the right skills, numbers and behaviours to meet patient and population needs?

Please use the workforce transformation categories below if this helps, and indicate which of the drivers of change each opportunity could address.

4a. **Upskilling (of existing staff):**
Interventions that increase the depth or scope of a person's role by extending their skills and responsibilities to enable them to practice at the top of their license; may include extending practice across traditional professional and / or organisational boundaries.

Additional training capacity, medical, Biomedical Scientists and Healthcare Scientists.
Potentially Programmed Activities in haematology.
Additional training schools where needed, including funded trainer time.
Training schools for reporting / certificates for independent reporting.
Advanced practitioners reporting and modularising high volume tests.
Retraining cervical cytology screeners and certificating them for reporting e.g. cervical biopsies.
Continuing professional development expansion in collaboration with RCPath for molecular therapies, genomic medicine and areas of rapid development.

4b. **New Roles:**
The creation of an additional health and care role to meet a defined workforce requirement – usually warranting a new job title, a bespoke education and training requirement, a career framework and national recognition by clinical / professional / regulatory governing bodies.

Extension of training of new proven roles in pathology, such as advanced practitioners and clinical scientists.

4c. **New Ways of Working:**
Interventions to develop an integrated workforce culture that breaks down traditional system barriers to enable delivery of person-centred care.

Joining up alternative programmes e.g. NHSI networks, Getting It Right First Time (GIRFT), Genomics/Genetics, HPV screening, faecal immunochemical test for haemoglobin (FIT).
IT support including networking, LIMS interconnectivity, digitisation.
Improving links to Cancer alliances.

4d. **Leadership**
Interventions that support individuals, organisations and / or systems to develop leadership capability – these might be targeted at individual behaviours and skills or organisational development through partnerships.

Support for a new cohort of the Leadership Programme in Pathology, which provided QI and leadership skills training

4e. **Supply (of staff):**
Interventions to increase the number and / or availability of current and future workforce with appropriate skills and capabilities.

Ways of helping people stay in service, including flexible models e.g. examine retire and return patterns.

The RCPath has an extensive portfolio of public and professional engagement to help promote pathology as a profession (see RCPath website).

Examining retirement patterns and looking at ways of retaining pathologists within the workforce, including using flexible work patterns and specialist networks.

5) If you have any other comments to add which you think will be helpful please add them here:

[Please limit this section to no more than 500 words]

The prospect of worsening of the acute workforce shortages in pathology is of huge concern. Urgent action is required to support the current workforce and grow capacity for the future.

The RCPath recommends that the pathology specialties are included on the shortage occupation list by the Migration Advisory Committee. Having pathology specialties appear on this list would assist overseas qualified pathologists get a visa to work in the UK.

Please submit your contact details here:

Name: Mrs Avril Wayte / Miss Fiona Addiscott

Contact email: avril.wayte@rcpath.org / Fiona.addiscott@rcpath.org

If you are responding on behalf of an organisation please state your:

Organisation: The Royal College of Pathologists

Organisational role: Assistant Registrar / Workforce Planning Manager

Type of organisation (please circle):

charity/non-profit; professional body; NHS arms length body; NHS service provider; NHS commissioner; independent provider; other (please state) .....

Thank you very much for taking part in our Call for Evidence

Please send your response to cancerstrategy@hee.nhs.uk including in the subject line of the email '*Cancer Strategy call for evidence documents*' and [Your Name or Organisation], attaching any source documents where possible.

The Royal College of Pathologists
Pathology: the science behind the cure

Attachment A

Analysis of an audit of research in

Job Descriptions submitted for review

January 2018

1. Introduction

A Survey of Medical Clinical Academic Staffing levels has been carried out by the Medical Schools Council which primarily covers the decline in clinical academic staffing levels, particularly at Reader / Senior Lecturer level.

A prospective audit has been carried out into the proportion of job descriptions reviewed and endorsed between 1st January – 29th September 2017 that contain a provision for research.

2. Analysis of findings

All employing bodies in England were considered - the total number was 148.

The majority of posts were at Consultant level, with a few academic posts.

The number of job descriptions that were audited totalled 226.
See Appendix A for the number of job descriptions reviewed by specialty.

- 90 job descriptions do not mention research in their job plans however they have included it in the standard wording under the heading of CPD/audit/revalidation and governance.
- 64 job descriptions detail a specific number of SPA's within the job plan for research included, with CPD/audit/revalidation and governance.
- 34 job descriptions had no job plan included within JD.
- 38 employing bodies did not involve us in either JD review/endorsement, AAC assessor or both or have not sent a JD for review this year.

Interestingly there were a small number of employing bodies that state a specific number of SPAs specifically for research, these are listed alphabetically below:

• Great Ormond Street	1 SPA for Consultant Paediatric Haematologist
• Kings College	0.25 SPA for Consultant Immunologist, 0.50 SPA for Consultant Haematologist and 0.50 SPA for Consultant Cellular Pathologist
• Lewisham & Greenwich	1 SPA for Consultant Haematologist
• Mid Essex	1 SPA for Consultant Cellular Pathologist
• Newcastle	0.60 SPA for Consultant Microbiologist and 0.60 SPA for Consultant Virologist
• North Middlesex	0.50 SPA Consultant Haematologist

• North West Anglia	0.50 SPA for Consultant Microbiologist
• Royal Brompton	3.5 SPAs for Consultant Microbiologist
• Royal Marsden	0.375 SPA for Consultant Haematologist
• South Warwickshire	50% NHS work and 50% BRC funded Consultant Cellular Pathologist
• St George's	1 SPA for Consultant Cellular Pathologist and 0.50 SPA for Consultant Paediatric Haematologist
• University College London	50% BRC funded Consultant Gynaecological Cellular Pathologist
• University Hospital Leicester	45% of job is research (Clinical Associate Professor / Hon Con)

3. Summary of findings

Of the 226 job descriptions that were audited in 2017:-

- 40% had no allocation of research in the job plan however mentioned research in the standard wording under the heading of CPD/audit/revalidation and governance.
- 28% detailed a specific number of SPA's within the job plan for research included, with CPD/audit/revalidation and governance.
- 15% were from employing bodies that had no job plan included within the job description.
- 17% were from employing bodies that chose not to involve the College in both JD review and/or AAC assessor request or had not submitted a JD for review.

4. Conclusion

It is surprising that so few employing bodies give adequate time for research considering the amount of demand for research in areas that relate to pathology.

A couple of examples are: The poo transplants for gut bacteria
https://www.channel4.com/news/poo-transplants-for-gut-bacteria-being-researched-for-wider-nhs-use
and the gene tests for prostate cancer
http://www.telegraph.co.uk/news/2018/01/10/100-gene-tests-could-identify-men-three-times-chance-deadly/

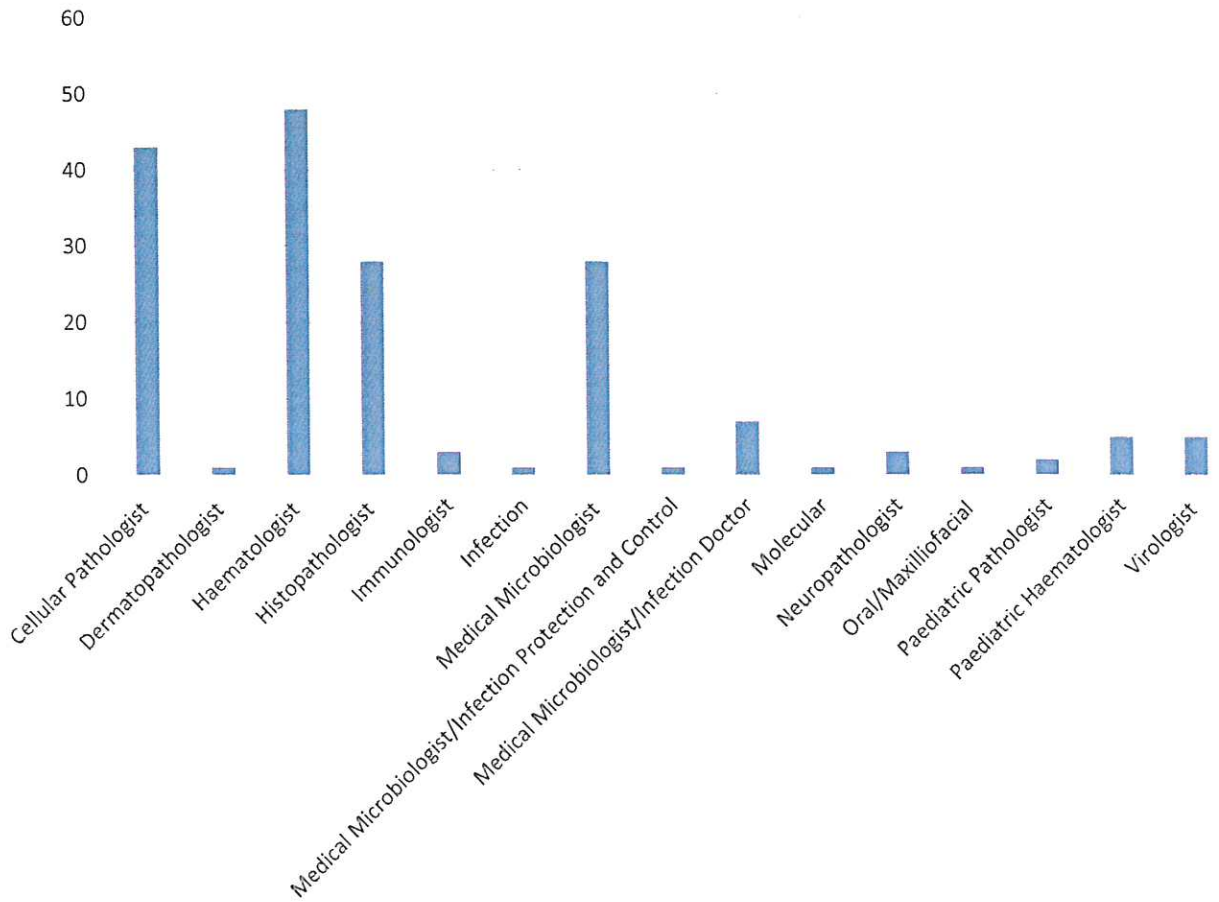
Miss Reshma Patel, Workforce Coordinator

Appendix A

Table of results containing the number of Job Descriptions reviewed per specialty

Cellular Pathologist	43
Clinical Biochemist	11
Dermatopathologist	1
Haematologist	48
Histopathologist	28
Immunologist	3
Infection	1
Medical Microbiologist	28
Medical Microbiologist / Infection Protection and Control	1
Medical Microbiologist / Infection Doctor	7
Molecular	1
Neuropathologist	3
Oral / Maxilliofacial	1
Paediatric Pathologist	2
Paediatric Haematologist	5
Virologist	5
Other	38

Graph of Job Descriptions per specialty



VIEWPOINT

Unintended Consequences of Machine Learning in Medicine

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Over the past decade, machine learning techniques have made substantial advances in many domains. In health care, global interest in the potential of machine learning has increased; for example, a deep learning algorithm has shown high accuracy in detecting diabetic retinopathy.[1] There have been suggestions that machine learning will drive changes in health care within a few years, specifically in medical disciplines that require more accurate prognostic models (eg, oncology) and those based on pattern recognition (eg, radiology and pathology).

However, comparative studies on the effectiveness of machine learning–based decision support systems (ML-DSS) in medicine are lacking, especially regarding the effects on health outcomes. Moreover, the introduction of new technologies in health care has not always been straightforward or without unintended and adverse effects.[2] In this Viewpoint we consider the potential unintended consequences that may result from the application of ML-DSS in clinical practice.

Reducing the Skills of Physicians

A major issue related to incorporation of ML-DSS in medicine could be overreliance on the capabilities of automation. Although the phenomenon of overreliance on technology could be tempting to users in the short term for the convenience and efficiency of automated aids, in the long term these tools can lead to the related phenomenon of deskilling[3] (ie, the reduction of the level of skill required to complete a task when some or all components of the task are partly automated, and which may cause serious disruptions of performance or inefficiencies whenever technology fails or breaks down). This process can affect physicians' ability to derive informed opinions on the basis of detectable signs, symptoms, and available data.

For example, in a study of 50 mammogram readers, there was a 14% decrease in diagnostic sensitivity when more discriminating readers were presented with challenging images marked by computer-aided detection.[4] Another study of 30 internal medicine residents showed that the residents exhibited a decrease in diagnostic accuracy (from 57% to 48%) when electrocardiograms were annotated with inaccurate computer-aided diagnoses.[5] Further research is needed to better understand whether the overreliance on ML-DSS that could outperform or perform as well as human observers could also cause a subtle loss of self-confidence and affect the willingness of a physician to provide a definitive interpretation or diagnosis.

Focus on Text and the Demise of Context

Machine learning technologies also can lead to focusing more on what can be rendered as text (ie, data) at the expense of other elements that are more difficult or impossible to easily describe. Relying on ML-DSS requires considering digital data as reliable and complete representations of the phenomena that these data are supposed to render in a discrete and trustworthy form. This may be a problem when the clinical context is not represented, particularly if physicians lose awareness of the existence of clinical elements that are not included in the clinical record.

Such lack of information may lead to partial or misleading interpretations of ML-DSS diagnostics and therapeutic or prognostic outputs. It also could lead to reduced interest in and decreased ability to perform holistic evaluations of patients, with loss of valuable and irreducible aspects of the human experience such as psychological, relational, social, and organizational issues. These factors may not be incorporated into any ML-DSS because of their qualitative and complex nature, yet are fundamental to individualized care beyond diagnostic and therapeutic categories.

An example in which context mattered and lack of its inclusion resulted in a technically valid but misleading machine learning prognostic model was the use of mortality risk prediction to make decisions about whether to provide treatment on an inpatient or outpatient basis for 14 199 patients with pneumonia.[6] In that setting, an ML-DSS suggested considering patients with pneumonia and asthma to be at a lower risk of death from pneumonia than patients with pneumonia but without asthma. This indication surprised the researchers involved, who nevertheless ruled out that asthma could be a protective factor in patients with pneumonia. However, machine learning models do not apply explicit rules to the data they are provided, but rather identify subtle patterns within those data.

There were 2 causes for the algorithm being correct, but producing a counterintuitive and dangerous output. First, at the hospitals hosting this study, patients with a history of asthma who presented with pneumonia were usually admitted directly to intensive care units to prevent complications; this led to patients with pneumonia and asthma having better outcomes than patients diagnosed with pneumonia and without a history of asthma, with an approximately 50% mortality risk reduction (with mortality rates of 5.4% vs 11.3%, respectively). Second, this contextual information could not be included in the ML-DSS, and thus the algorithm "correctly misinterpreted" the presence of asthma as a protective variable. Failing to include difficult to represent factors into medical decision making may lead to other similar contextual errors, and overreliance on ML-DSS may enhance the odds of the occurrence of these types of errors when contextual factors cannot be easily integrated.

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Intrinsic Uncertainty in Medicine

Machine learning-based decision support systems bind empirical data to categorical interpretation. Potential unintended consequences arising from this approach may be related to the formalization into a decision model of the mapping between the physical signs that a physician can evaluate and their "right" class as identified by observers. In medical practice, observers often do not agree with each other about diagnostic findings and outcome evaluation. This observer variability is related not only to interpretive deficiencies, but also to an intrinsic ambiguity in the observed phenomena.[7]

However, the intrinsic uncertainty of medical observations and interpretations that are part of input to "optimize" machine learning models is not usually considered. As a result, the extent that reliability and accuracy of machine learning performance is affected by observer variability can be underrated; this has been shown to negatively affect the performance of the most common machine learning models. For example, interobserver variability in the identification and enumeration of fluorescently stained circulating tumor cells was observed to undermine the performance of ML-DSS supporting this classification task.[8]

Users and designers of ML-DSS need to be aware of the inevitable intrinsic uncertainties that are deeply embedded in medical science. Further research should be aimed at developing and validating machine learning algorithms that can adapt to input data reflecting the nature of medical information, rather than at imposing an idea of data accuracy and completeness that do not fit patient records and medical registries, for which data quality is far from optimal.

The Need to Open the Machine Learning Black Box

A further issue involves the nature of machine learning algorithms, which are often referred to as "black box models," whereby the rationale for the outputs generated is inscrutable not only by physicians but also by the engineers who develop them. The preceding case about management of patients with pneumonia[6] is a relevant example. In that setting, different machine learning models for risk prediction were evaluated to choose the most accurate one. The identification of the intensive care acting as a confounder could be considered in virtue of the model that had its classification rules explicit; however, the other models did not permit such post hoc analysis.

Because purely accuracy-driven performance metrics are now pushing toward more opaque models like artificial neural networks, as in the study of referable diabetic retinopathy,[1] similar subtle shortcomings of ML-DSS may be difficult or impossible to prevent or detect. To alleviate the tension between accuracy and interpretability, research is being conducted to have ML-DSS automatically provide explanations, and to offer physicians rich interactive visualization tools to explore the implications of potential exposure variables. Despite the utility of these technology improvements, their availability will not relieve physicians from acquiring stronger skills in assessing the value of machine learning-based aids in practice.

Conclusions

It is likely that machine learning applications will soon transform some sectors of health care in ways that may be valuable but may have unintended consequences. Use of ML-DSS could create problems in contemporary medicine and lead to misuse. The quality of any ML-DSS and subsequent regulatory decisions about its adoption should not be grounded only in performance metrics, but rather should be subject to proof of clinically important improvements in relevant outcomes compared with usual care, along with the satisfaction of patients and physicians.

A prudent attitude toward research on unintended consequences could help reduce the odds of negative consequences. Moreover, if such consequences occur despite these efforts, research could help manage and reduce the related effects of these consequences.

ARTICLE INFORMATION

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