

**DELIVERING INNOVATION THROUGH THE NHS GENOMIC MEDICINE SERVICE**

**Executive summary**

- The UK has been a global leader in genomics over a number of decades and the 100,000 Genomes Project launched in 2012 was a landmark programme being the largest national whole genome sequencing project in a healthcare setting anywhere in the world delivered in conjunction with the NHS.
- In October 2018 NHS England and NHS Improvement launched the NHS Genomic Medicine Service (GMS) building upon both the rich history of genetics in the NHS and the transformation delivered as part of the contribution to the 100,000 Genomics Project. Its aim was to create a world leading service to actively embed genomics into the NHS inclusive of Whole Genome Sequencing (WGS).
- Genomics is being embedded in end to end pathways and there is investment in cutting edge technology as well as working with partners across the genomics eco-system to deliver innovation and transformation. The NHS GMS infrastructure includes (appendix 1):
  - a national genomic laboratory network made up of seven NHS Genomic Laboratory Hubs (GLHs);
  - the National Genomics Test Directory (Test Directory) setting out the testing within the genomic laboratory network covering rare and inherited disorders and cancer, and the full range of testing technologies;
  - national WGS provision and the underpinning data and informatics infrastructure, secured in partnership with Genomics England;
  - an integrated clinical service (built by restructuring existing clinical genetics services);
  - seven NHS GMS Alliances to support equity of access and systematic embedding of genomics in end-to-end clinical pathways and to deliver a range of national and local transformation activity; and
  - an NHS GMS Research Collaborative to provide a forum to coordinate and facilitate high quality genomic research and innovation on a national scale.
- The overarching aims of the NHS GMS are to:
  - enable genomic testing to drive predictive and preventative care, earlier diagnosis and precision treatments with consistent and equitable access across the country;
  - focus on improving quality and reducing variability, setting standards and driving consistency, economies of scale and affordability;
  - drive the embedding of genomics into healthcare and the professional leadership and development of the healthcare workforce;
  - rapidly adopt and integrate cutting edge genomic technologies into the NHS GMS to help improve the diagnosis and treatment of patients; and
  - enable genomic and other phenotypic data collected as part of routine care to be aligned with clinical research, academia, industry and international collaboration to support ongoing innovation from discovery to adoption and a genomically informed learning healthcare system.

- At its core, the NHS GMS carries out over 600,000 genomic tests in England every year for common and rare and inherited disease, pharmacogenomics, and cancer.
- The full range of genomic testing offered by the NHS, including currently over 360 rare and inherited disease clinical indications (covering around 3200 rare diseases) and 203 cancer clinical indications, is outlined in the Test Directory and covers the full repertoire of testing technologies, from single gene testing to WGS. This is reviewed on an annual basis to ensure it reflects the latest developments and innovation and by working with partners including the AAC, horizon scanning ensures that the NHS GMS can respond quickly to new opportunities to advance genomics into healthcare, as demonstrated by the introduction in 2020 of NTRK gene fusion testing for histology independent treatments (HITs).
- Genomic testing is carried out by a national network of seven NHS GLHs (appendix 2), each of which has been funded to invest in cutting-edge sequencing and genomic technology, for example high throughput Illumina NovaSeq machines that enable the delivery of WGS, whole exome sequencing (WES) and large panel testing at scale.
- Seven NHS GMS Alliances have also been established to provide professional leadership and support the mainstreaming and embedding of genomic medicine (appendix 3). This includes a Research Director to develop regional and national networks to support research and development activities. In addition to significant investment in their core infrastructure, the NHS GMS Alliances are funded around £7 million pounds annually to deliver transformation and innovation in pathways in cancer, rare disease and pharmacogenomics, including for example, for Lynch syndrome and supporting the NHS Long Term ambitions for increasing detection of Familial Hypercholesterolemia (FH) (appendix 4).
- Key to ensuring these new products, technologies and genomics advances are rapidly adopted in the NHS, is maximising the synergy between research and healthcare. This is represented through an infinity loop model aligned to an innovation pathway.
- At the heart of the infinity loop is the NHS GMS Research Collaborative, established by NHS England and NHS Improvement with Genomics England and the National Institute for Health Research (NIHR). This is the mechanism to mobilise and embed research, discovery and innovation to advance clinical care for patient and societal benefit through the NHS GMS, as well as supporting end to end innovation in pathways. In addition to the NHS GMS Research Collaborative, there are currently over 920 genomic research projects being delivered utilising embedded research networks across the UK and the NHS GLH infrastructure.
- Through the WGS service, every patient is offered the opportunity to participate in research and for their data to be stored in the National Genomic Research Library (NGRL). To date, 92% of patients who have been offered WGS and who have discussed participating in research gave consent to their data being submitted to the NGRL. We are exploring expanding this offer to non-WGS testing, such as cancer panels and exome sequencing, to enrich the data available to researchers and increase patients benefitting from cutting-edge research.
- The NHS GMS works with a range of partners across industry, academia and the wider genomics ecosystem to deliver benefits to patients in a number of key areas, including:
  - a. implementing cutting edge technology, for example embedding WGS through the NHS GMS and exploring its utility for sequencing newborns, in partnership with Genomics England and Illumina; exploring the use of long-read sequencing with Oxford Nanopore; developing an approach to Polygenic Risk Scores and liquid biopsy testing with GRAIL; while continuing to develop new approaches with Genomics England on cancer technologies and improving the diversity of genomic data (appendix 5).

- b. working with partners to advance research and embed it in the NHS including through the NHS GMS Research Collaborative and supporting the infinity loop model to ensure innovation and research are driving cutting edge benefits for patients in the NHS; and
- c. expanding access to cutting edge genomic testing, for example through work with NICE, NIHR, charities and others on the Test Directory and with Bayer and Roche on implementing NTRK gene fusion testing for HITs in the NHS.

**Board members are asked to:**

- consider how the approach being taken in the NHS Genomics Programme can be used in other areas of the NHS
- suggest opportunities to make connections with emerging AAC products and routes to implementation
- support alignment with work on other AAC products.

**Background:**

**a. Implementing cutting edge innovation products in the NHS with key partners**

1. To deliver the strategic aims of the NHS GMS, working with key partners, there has been significant investment in improvements in the technology infrastructure in the NHS GLHs, which has facilitated a move to delivering the full range of genomic testing from comprehensive DNA and RNA panel testing through to whole exome and WGS to drive efficiency and productivity.

*Delivering a world leading WGS service in the NHS*

2. Working with Illumina as the WGS provider, the NHS is the first national healthcare system in the world to offer WGS as part of routine care. All seven NHS GLHs are offering WGS, with volumes being ramped up and over 10,000 clinical whole genome equivalents (WGE) have been sent for sequencing and over 4,500 WGE reported to clinicians. This has shown an overall diagnostic yield of 35% increasing to nearly 60% in cystic renal disease specifically.
3. Each of the seven NHS GLHs have secured Illumina NovaSeq machines and other Illumina technologies that enable the delivery of more extensive cancer panel testing using cutting edge high throughput technology. Once volumes increase this will also reduce turnaround times to the benefit of patients. Each NHS GLH has access to an Illumina decision support tool to support the interpretation of WGS results.

*Exploring the utility of WGS for sequencing newborns*

4. In the next two to three years, the NHS Newborn Genomes Programme, delivered in partnership between the NHS and Genomics England will explore the potential benefit of using WGS to screen newborn babies as part of our aim to support an earlier diagnosis for patients. This world leading discovery will provide an opportunity to expand screening from the present nine conditions screened for in the UK to many more rare diseases. Key to the delivery of this programme will be continued engagement with stakeholders, including with the NHS, the public, charities, and industry.
5. In addition to the clinical benefit, all babies that receive WGS as part of the programme will, through their parents, have the opportunity to contribute their de-identified genome data to the National Genomic Research Library – enabling research into new diagnostics and treatments to accelerate healthcare.

### *Introducing long read sequencing*

6. Another area of innovation that is being explored is the use of Oxford Nanopore long-read sequencing technology that may provide an improvement in testing for some cancer types, for example brain tumours. The NHS GLHs are working with Genomics England and Oxford Nanopore to pilot the use of the long-read sequencing technology and further deepen our understanding of the end-to-end cancer genomics journey.
7. This is part of a wider programme of work being taken forward with Genomics England, which will also explore the integration of multiple data sources and new technologies in a multi-modal approach to cancer genomic testing. This is with the aim of shortening the time it takes to receive accurate diagnostic results for the over 300,000 people diagnosed with cancer per year and to support clinicians with their patient treatment decisions.

### *Understanding the potential use of polygenic risk scores in the NHS (PRS)*

8. In line with ambitions to accurately detect disease at a much earlier stage and predict chronic disease, another technology being explored is the potential for the use of PRS in the NHS. It is now known that for common diseases there are tens of thousands of places in the genome, each with individually small effects, which combine to generate the genetic component of disease risk. For a particular disease, the combination of these effects is called a PRS.
9. There is a potential to use genomic risk prediction tools, based around PRS, to identify groups of individuals at high risk for specific conditions.

### *Piloting the use of liquid biopsy testing*

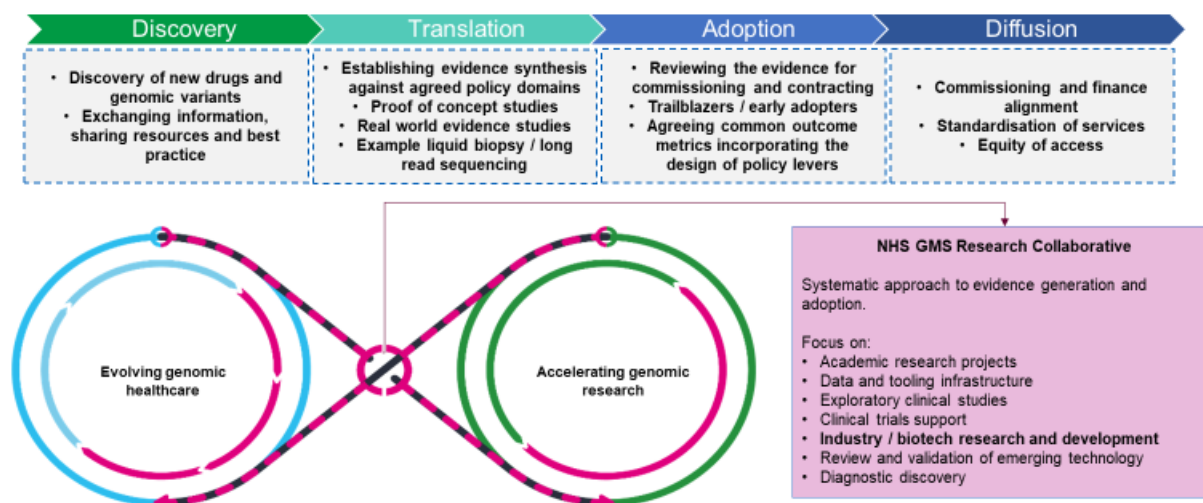
10. Liquid biopsy testing, using blood samples to test the circulating free DNA (cfDNA) for the presence of disease-causing mutations in circulating tumour DNA (ctDNA), is becoming increasingly possible. NHS England announced in November 2020, a collaboration between Grail and the NHS to deliver a world first pilot of the Galleri cfDNA blood test, which can detect early stage cancers through a simple blood test. This will be piloted in around 165,000 patients.
11. Research for patients with signs of cancer has already found that the test can identify cancers that are difficult to diagnose early, such as head and neck, ovarian, pancreatic, oesophageal and some blood cancers. If the NHS programme shows the test also works as expected for people without symptoms it will be rolled out to become routinely available. This would help to deliver the NHS Long Term Plan commitment to increase the proportion of cancers caught early.
12. In addition to this population-based testing, a proposal is currently being developed to perform a service evaluation through the NHS GMS to explore the expansion of use cases for ctDNA to support diagnosis, treatment identification, and onward disease monitoring. Taking this systematic approach to introduction of this new technology will ensure it meets the required standards for a clinical service and is implemented equitably.
13. In addition to supporting NHS Long Term Plan and Genome UK commitments, this also has the potential to support the COVID-19 recovery programme to detect cancer causing mutations without the need to perform invasive surgery, reducing the number of patients who need a tissue and biopsy, and reduce waiting times.
14. NHS England and NHS Improvement have convened a working group which has recommended an evaluation study on the utility of ctDNA starting in stage 3 and stage 4 non-small cell lung cancer patients. The evaluation will measure quality, turnaround time, meeting the required scope of testing, outcome of the testing and cost effectiveness. It is proposed that a mixed testing model is used (both commercial and in-house testing) with a capacity to analyse 140 samples per month across all seven NHS GLHs.

## b. Working with partners to advance research and embed it in the NHS

### Genomics research driving improvements in clinical care

15. Key to ensuring these new products, technologies and genomics advances are rapidly adopted in the NHS, is maximising the synergy between research and healthcare. This is represented through an infinity loop model (figure 1) aligned to an innovation pathway that covers:

- discovery – including new genomic variants and drugs, through exchanging information, sharing resources and best practice;
- translation – through establishing evidence synthesis against agreed policy domains, proof of concept studies; and real world evidence studies. The liquid biopsy example of innovation is a demonstration of this in the NHS GMS;
- adoption – by reviewing the evidence for commissioning and contracting; supporting early adopters; and agreeing common outcome metrics; and
- spread – ensuring commissioning and finance alignment, providing standardised services and ensuring equity of access across the NHS GMS.



**Figure 1 - The infinity loop model of genomic research driving improvements in clinical care.**

### The NHS GMS Research Collaborative

16. At the heart of the infinity of the infinity loop is the NHS GMS Research Collaborative. NHS England and NHS Improvement have worked with Genomics England, the National Institute for Health Research (NIHR) and the NHS to establish the NHS GMS Research Collaborative in February 2021, to maximise the potential of genomic research at a national scale. The NHS GMS Research Collaborative will cement the UK's position as a world leader in genomic research for healthcare, while delivering real, measurable benefits for patients.

17. The purpose of the Collaborative is to:

- work collaboratively with NHS England and NHS Improvement, Genomics England, NIHR, industry, academics, the NHS and other partners to support and enable increasing volumes of high-quality genomic research in the NHS;
- through the Steering Committee, it rapidly evaluates the capacity, capability, and resource, of the NHS GMS to support research and associated delivery activities;
- facilitate and enable access to genomic data and new genomic samples from the NHS GMS to enable this research to be delivered at scale and speed;
- receive and review proposals and creative collaborative bids, support identification of unmet need and respond to emerging technologies;

- explore opportunities to evaluate and implement new and emerging technologies; and
- identify the need and opportunities to support further development of genomic medicine in the NHS.

18. A Steering Committee is co-chaired between NHS England and NHS Improvement (Professor Dame Sue Hill) and Genomics England (Chris Wigley). The membership of the Steering Committee is comprised of representatives from NHS England and NHS Improvement, Genomics England, NHS GLHs, NHS GMS Alliances and NIHR.
19. The role of the Steering Committee is to facilitate access to expert research and advice for early stage research; provides access to the NHS clinical and laboratory infrastructure for approved and funded research; and support communication and dissemination of findings for completed genomic research. The Steering Committee will consider research proposal in areas including (but not limited to) academic research, NHS research, recruitment into clinical trials and studies (including those from industry), biotechnology and industry research, assessment of new technologies, and diagnostic discovery.
20. The Collaborative is receiving and reviewing research proposals to be supported by the NHS GMS, for example, studies looking to;
- utilise WGS data from patients with acute myeloid leukaemia in assessing response and stratification to a new treatment
  - utilise data generated through the fetal exome sequencing service (R21) to investigate potential genomic causes of fetal hydrops
  - identify the molecular origins of early onset immune dysregulation in children through identifying novel causative mutations and explore their pathogenic mechanisms
  - support identification of patients with specific gene fusion mutations for a clinical trial of a precision anti-cancer antibody treatment
21. The Steering Committee are also engaged in ongoing work with external partners, including working with Cancer Research UK relating to the role of genomic testing in support for clinical trials.
22. The NHS GMS Research Collaborative has received a number of requests for early feedback to date, for example for studies to predict mental and physical health outcomes in serious mental illness integrating common measures and genetics and seeking to identify mutations to facilitate patient diagnosis and explore the prevalence of AADC deficiency.
23. In addition to the Steering Committee, an Advisory Forum for the NHS GMS Research Collaborative will be launched in 2022 to bring together steering committee members; Academic Health Science Networks; charities; industry representatives; patient and public representatives; the Office for Life Sciences; the NIHR Bioresource; Medical Research Council; the Wellcome Trust and others.
24. The role of the Advisory Forum will be to agree a strategic direction for genomic research in the NHS, identifying knowledge gaps, areas of unmet need and research priorities for genomic research, and to discuss the merit of technological or analytical strategies to maximise the value of implementation research for the NHS.

### **c. Expanding access to cutting edge genomic testing**

#### *The National Genomic Test Directory*

25. The Test Directory outlines the range of genomic tests that are available as part of the funded NHS clinical service. The Test Directory currently includes genomic tests for 357

rare and inherited disease clinical indications, covering around 3,200 rare diseases, and 203 cancer clinical indications.

26. NHS England and NHS Improvement, supported by a Genomics CRG and Test Evaluation Working Groups, review the Test Directory on an annual basis to keep pace with scientific and technological advances, while delivering value for money for the NHS. In the 2021 application cycle, over 180 applications for updating the Test Directory were received, with over 169 applications supported for adoption (including 16 new rare disease clinical indications and 18 new cancer clinical indications). In addition, 15 rare disease clinical indications were approved to move to WGS and a total of 1,003 gene content changes were made.
27. Through work with NICE, NIHR, charities, industry and other partners, this is supported by a horizon scanning process and fast stream application system to ensure the Test Directory can respond quickly to emerging developments. This process helps to prepare for new drugs and to consider different cancers and rare diseases treated by high cost drugs which could benefit from the different technologies, delivered through the NHS GMS.

#### *Histology Independent Treatments*

28. One example of new testing being introduced in the Test Directory is the introduction of NTRK fusions as an essential target for appropriate cancer clinical indications. This was introduced in Spring 2020, following NICE approval for the first candidate tumour agnostic drugs, larotrectinib and entrectinir and funding from the Cancer Drugs Fund.
29. Genomic testing is being delivered through the NHS GMS. To begin the delivery of *NTRK* testing during the COVID-19 response period, a phased implementation plan was developed to utilise the available testing capacity where it would have the most impact. NTRK testing is now offered by all seven NHS GLHs across the NHS GMS. Each NHS GLH is receiving referrals for *NTRK* gene testing every month and have a positivity rate of around 2%. Work is ongoing in each of the NHS GLHs with partners, for example Bayer, to increase awareness of the tests.
30. In order to learn from the implementation of genomic testing for these *NTRK* gene fusions, a workstream on pathway preparedness for Histology Independent Treatments is coordinated through the AAC. This brings together different AAC partners to work on different elements of the pathway for example patient engagement and horizon scanning to ensure moving forward genomic testing can continue to be implemented quickly when new advancements emerge.

#### *Pharmacogenomics*

31. Genomic testing has the potential to be expanded to other areas such as pharmacogenomics which would support wider ambitions around predictive medicine. For example, through testing already available through the NHS GMS, around 38,000 patients each year that have treatment with fluoropyrimidine-based chemotherapy drugs are able to have a genomic test for variants in the *DPYD* gene to identify whether they have a variant which may increase the risk of an adverse drug reaction, preventing significant and life-threatening toxicity to patients receiving chemotherapy.
32. Looking to the future, work is planned to explore the wider clinical utility of pharmacogenomics and how this can be systematically embedded in the NHS GMS. This aligns with other opportunities to explore new drugs coming to market and builds on the work of the NHS England and NHS Improvement and Genomics England Joint Pharmacogenomics Working Group to explore and evaluate the potential implementation of pharmacogenomic testing in the NHS.

33. It is proposed that a future pharmacogenomics strategy would explore clinical use cases where the introduction of testing is likely to have the largest impact; advances in technologies to inform the testing strategy; workforce implications; evolution of the digital and IT infrastructure; and cost effectiveness, affordability and funding requirements for systematically embedding pharmacogenomic testing.

### **Ensuring the patient voice is embedded in genomics**

34. The patient voice is embedded throughout the NHS GMS infrastructure and all governance, including patient representation in each of the seven NHS GMS Alliances, the Genomics CRG and the Genomics Programme Board. These individuals have a key role in ensuring that the NHS GMS is engaging appropriately with patients, considering their priorities and reflecting their voice in business planning and ultimately the delivery of the NHS GMS.
35. At a national level, the patient voice is brought together through the NHS GMS People and Communities Forum which acts as an advisory group for the NHS GMS including on policy developments, commissioning decisions and communication with patients on genomics. More widely the patient voice is fed into a range of consultations on the delivery of the NHS GMS, for example an ongoing update to the NHS Genomics Service Specification, and representation embedded in the Test Evaluation Working Groups.

### **Developing the workforce**

36. Key to driving innovation is the clinical leadership embedded across the NHS GMS. Each NHS GLH is funded to include a multidisciplinary clinical and scientific leadership infrastructure led by a Medical, Scientific, Operations and Informatics Director, as well as a number of other roles covering cancer, rare and inherited disease, haematological malignancies, bioinformatics, pathology, contract and financing and education and training. These multidisciplinary teams work across the NHS GLHs enable complex genomic information to be discussed across clinical teams.
37. Similarly, in the NHS GMS Alliances, NHS England and NHS improvement have funded over 200 posts to support multi-professional clinical leadership. Each of the NHS GMS Alliances is led by a Clinical Director and their multidisciplinary clinical leadership secures input from a range of professions including clinical leads for different areas such as cancer, nursing, midwifery and allied healthcare professionals, and pharmacy. A dedicated Research Director, in each region supports the national coordination and facilitation of genomic research across the country to embed research and discovery to advance clinical care for patient and societal benefit.
38. This is part of a wider workforce of around 2,000 NHS staff dedicated to the delivery of the NHS GMS; a multi professional workforce that is evolving to meet the demands of a rapidly expanding service.
39. In addition, NHS England and NHS Improvement commissions the Academy of Medical Royal Colleges (AoMRC) to lead a Genomics Professional Partnerships Group, jointly chaired by Professor Helen Stokes-Lampard, Chair of the AoMRC and Professor Dame Sue Hill, Senior Responsible Officer for Genomics in NHS England and NHS Improvement.

#### **Board members are asked to:**

- consider how the approach being taken in the NHS Genomics Programme can be used in other areas of the NHS
- suggest opportunities to make connections with emerging AAC products and routes to implementation; and



- support alignment with work on other AAC products.

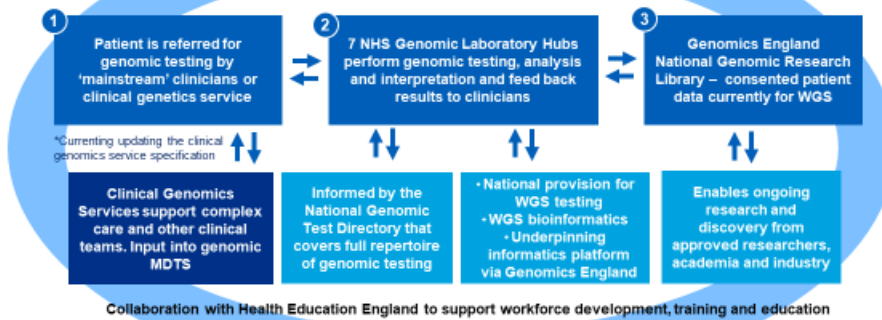
## Appendix 1 – NHS GMS infrastructure

# Building the infrastructure: The NHS Genomic Medicine Service *NHS*

Overarching aim: To enable the NHS to harness the power of genomic technology and scientific advances to improve population health and patient outcomes

NHS England and NHS Improvement: Commissions and funds services and is responsible for national oversight, assurance and direction

7 NHS GMS Alliances to provide multidisciplinary clinical leadership to embed genomic medicine across end-to-end pathways



### Key principles:

- Be clinically and scientifically led
- Have patients and public involved at all levels
- Ensure equity of access for all patients
- Have a standardised model of delivery and commissioning across the country
- Be responsive to innovation and new technologies
- Inform and drive change using data led insights

## Appendix 2 – NHS GLH infrastructure

1. To create the national genomic laboratory service, NHS England and NHS Improvement procured seven NHS GLHs, each responsible for the provision and coordination of genomic testing for a defined area of the country.
2. The seven NHS GLHs are contracted to deliver high quality genomic testing through consolidated state of the art, high throughput, high quality and standardised laboratories working together as part of a national network to deliver the testing defined in the National Genomic Test Directory.
3. One of the key enablers to the successful operation of the national genomic laboratory service is the implementation of a national funding model, supported by clear roles and responsibilities for the provision of, and access to, appropriate testing comprising a:
  - a. Scientific Director
  - b. Clinical Operations Director
  - c. Medical Director
  - d. Data and Informatics Lead
  - e. Bioinformatics Lead
  - f. Contracts and Finance Lead
  - g. Scientific Leads for Rare & Inherited Disease, Cancer Solid Tumours, and Cancer Haematological Malignancy
  - h. Pathology Lead
  - i. Medical Leads for Rare & Inherited Disease, Cancer Solid Tumours and Haematological Malignancy Services
  - j. Education and Training Lead.
4. By working as a network, the NHS GLHs should ensure equitable access to genomic testing across England.

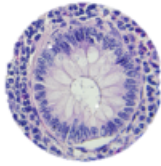
### **Appendix 3 – NHS GMS Alliance infrastructure**

1. An NHS GMS Alliance is defined as a collective of providers working in partnership to support the strategic systematic embedding of genomic medicine for a given population. Each NHS GMS Alliance covers the same geographical area as the seven NHS GLHs.
2. To support implementation, each NHS GMS Alliance is expected to engage with all other NHS providers and organisations across their geography including appropriate and effective engagement with Primary Care Networks, Cancer Alliances, Pathology Networks, Integrated Care Systems, Academic Health Science Networks and academia.
3. The core infrastructure of each NHS GMS Alliance includes:
  - a Clinical Director with responsibility for setting the strategic direction and leading all aspects of the clinical activity;
  - to drive regional and national research collaboration, embed research and discovery and facilitate local research networks;
  - programme and project management support to coordinate the work of the NHS GMS Alliance;
  - communications and PPI expertise that supports communication and engagement activity; and
  - multidisciplinary clinical leadership to secure input from a range of professions including clinical leads for different areas such as cancer, nursing, midwifery and allied healthcare professionals, and pharmacy.
4. It is expected that the clinical leadership will be made up of individuals from across multiple branches of medicine, who are able to demonstrate leadership and/or expertise in genomics, with a track record of delivery of change.
5. Through this leadership team it is expected they will drive transformation activity, including for cancer, through their local and national projects. They will deliver the priority to use genomics to improve health and care productivity, quality and efficiency:
  - access to testing, including supporting the mapping of end-to-end genomic pathways for all clinical indications for rare and inherited disorders and cancer in the Test Directory;
  - delivering national and local transformation projects including for Lynch syndrome, DPYD and pathology;
  - improve access to treatments and interventions based on genomic information, including:
    - targeted treatment where access is based on a genetic or genomic test result e.g. targeted chemotherapy;
    - histology-independent or tumour-agnostic products; a new class of cancer therapies developed for use for tumours that express a genomic alteration, regardless of where in the body the cancer originated; and
    - pharmacogenomic test guided therapy e.g. abacavir and HLA-B\*5701 or fluoropyrimidines and DPYD.
  - identify current testing pathways that are in operation for cancer and ensure that genomic multi-disciplinary team processes are aligned with existing referral and reporting pathways including cancer multidisciplinary teams;
  - identifying a senior workforce development lead to understand the multi-professional workforce needs to embed genomics in a safe and efficient way and establish a workforce development strategy, which should consider cancer workforce needs.
  - supporting research through playing an active role in the NHS GMS Research Collaborative and supporting decision making about research opportunities on behalf of their geography.

### **Appendix 4 – NHS GMS Alliance transformation activity**

1. In 2021/22, NHS England and NHS Improvement commissioned the NHS GMS Alliances to deliver seven national transformation projects. The projects emerged out of a number of business cases, proposed by the NHS GMS Alliances, that either aligned with national priorities such as NHS Long Term Plan commitments or were identified by the majority of the NHS GMS Alliances as areas of local importance. The national transformation projects were then developed and agreed following an evaluation and review process.
2. Summary of NHS GMS Alliance national transformation projects:
  - **Optimising and improving the clinical effectiveness of *DPYD* gene testing for patients with cancer**  
To optimise and standardise the equitable implementation of and access to *DPYD* pharmacogenomic testing, building recommendations for multidisciplinary pathways and data collection, as an exemplar for future pharmacogenomic pathways.
  - **Embedding implementation of Familial Hypercholesterolemia (FH) services in primary care**  
To support the mainstreaming of genomic medicine for FH in primary care, establishing and developing pathways and evidence to support potential amendments to the National Genomic Test Directory.
  - **Delivery of a comprehensive service for the detection of Lynch syndrome**  
For colorectal and endometrial cancer, the NHS GMS Alliances will work with the NHS GLHs to align pathways and processes to drive standardisation, equity of access and clinical benefit for Lynch syndrome testing at a national level.
  - **Improving the identification and treatment of monogenic diabetes**  
To support the National Diabetes Programme through clinical leadership and engagement through senior medical and nursing leadership, to raise the profile of monogenic diabetes, ensure equity of access to genomic testing and support the development of new models of care.
  - **Nursing and Midwifery**  
To enable Nurse Leaders to drive the strategic and systematic integration of genomics across nursing and midwifery practice in the NHS in England.
  - **Pathology Accelerator Programme to support rapid cancer genomic diagnostics**  
To work with laboratories to improve the pathway for preparing and sending cancer samples to the NHS GLH, improving access and turnaround times.
  - **Sudden Cardiac Death**  
To support a national British Heart Foundation pilot scheme, linking directly into the infrastructure of Inherited Cardiovascular Clinics (ICC) to develop and deploy an integrated sudden cardiac death model offering dedicated ICC liaison.
2. Each NHS GMS Alliance has also been funded to deliver a range of regional transformation activities. 26 local transformation projects have been agreed for 2021/22 in a range of areas including informatics, for example to introduce electronic ordering systems; in cancer genomics, to improve diagnosis and management of haem-onc patients with germline susceptibility variants; and in pharmacogenomics, where they are exploring polypharmacy and the effect on an ageing population.
3. In 2022/23 further regional and transformation projects will be funded, with each NHS GMS Alliance again submitting bids for different projects.

## Future projects in partnership with Genomics England



### Cancer 2.0

Proof of concept work to explore the use of long-read sequencing technology in cancer and look at the integration of multiple data sources and new technologies in a multi-modal approach to cancer genomic testing



### Diversity in genomic data

Enriching genomic dataset by sequencing cohorts from diverse backgrounds, engaging with relevant communities, and developing analytics to derive the most value possible from the data



### Sequencing in newborns

Preparatory work and engagement on a research study to sequence genomes of newborns to diagnose and avoid harm from early-onset treatable disease. An NHS steering group led by Sarah-Jane Marsh, Chief Executive of Birmingham Women's and Children's Hospital has been set up to help gather and shape input to the proposals