Title Page:

Defining the Road Map to a UK National Lung Cancer Screening Programme

Summary

Lung cancer screening (LCS) with low-dose computed tomography (LDCT) was recommended by the United Kingdom National Screening Committee (UK NSC) in September 2022 based on data from trials showing a reduction in lung cancer mortality. These trials provide sufficient evidence to show clinical efficacy, but further work is needed to prove deliverability, in preparation for a national roll-out of the first major targeted screening programme. The United Kingdom (UK) has been world-leading in addressing LCS logistical issues through clinical trials, implementation pilots and the National Health Service England (NHSE) Targeted Lung Health Check Programme (TLHC). This article describes the consensus reached by a multiprofessional group of experts in LCS on the key requirements and priorities for effective implementation of a programme. It summarises the output from a roundtable meeting of clinicians, behavioural scientists, stakeholder organisations and representatives from NHS England, the UKNSC and from the four UK nations. This manuscript serves as an important tool in the ongoing expansion and evolution of an already successful programme, as well as providing a summary of UK expert opinion for consideration by those organising and delivering LCS in other countries.

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1. Introduction

Screening for lung cancer with low dose computed tomography (LDCT) has been shown to reduce disease-specific mortality.[1-4] The largest trial, the National Lung Screening Trial (NLST), showed a reduction in all-cause mortality of 6·7% despite being underpowered for this outcome.[1] An all-cause mortality reduction was not seen in the screening trials in breast and bowel cancer.[5-7] Recent meta-analyses have confirmed both the disease-specific and all-cause mortality benefit when other, also underpowered trials are included.[3,4] These trials provide sufficient evidence to show clinical efficacy, but further work is needed to prove deliverability, in preparation for a national roll out of the first major targeted screening programme. The United Kingdom (UK) has been world-leading in addressing logistical issues through clinical trials, implementation pilots and the National Health Service England (NHSE) Targeted Lung Health Check Programme (TLHC).[8] The NHSE programme has invited approximately 500,000 participants so far, scanning over 120,000 participants and diagnosed over 1,500 lung cancers since 2019 (personal communication).

This paper presents a consensus on the essential elements that should form part of the implementation of a pragmatic and cost-effective screening programme. It has been produced by an expert group comprising clinicians, behavioural scientists, stakeholder organisations and representatives from NHSE and the UK National Screening Committee (UKNSC) with representation from the four UK nations. The Roy Castle Lung Cancer Foundation provided funding for the round table discussions involved in the background work for the paper. Literature for this Review was identified by the authorship as part of this round table and refined through development of this review.

2. Identification of population, invitation, selection

Advertising and questionnaires have been the main method of invitation in many research trials to date, but uptake of those eligible for screening is often low, and such approaches can be highly resource intensive. Trials that have adopted a population approach to recruitment have shown very low participation rates (UKLS, NELSON), and serve to indicate that this should not be employed in the UK. The Lung Screen Uptake Trial[9,10] was designed to maximise uptake using a targeted approach in primary care and found a 53% participation in the "MOT for your lungs". UK pilots in Manchester and Liverpool did not directly measure participation rates but recruited very quickly, again using targeted methods.[11,12] In other non-UK healthcare systems, physician referral has led to high participation rates.[13] Drawing on these examples, the NHSE Targeted Lung Health Check Programme (TLHC) uses primary care data to identify people who have any smoking record, who are then contacted for further risk stratification.[8] This minimises contact with people who are ineligible, thereby reducing cost and potential distress from being contacted about cancer screening. Parallel routes, such as physician or self-referral, could be considered as part of research and innovation.

Risk-related eligibility criteria can be defined by age and smoking status or by using multivariable models. Risk prediction models incorporate additional risk factors such as chronic obstructive pulmonary disease (COPD), including centrilobular emphysema on thoracic imaging,[14] or asbestos exposure and have been shown to identify more people with lung cancer per screen. However, they may select people at greater risk of comorbidity and competing cause of death.[15-20] The fact that models identify more cases of lung cancer than age and smoking criteria, has been confirmed in UK data for those models used in the TLHC[8] (Liverpool Lung Project version 2 (LLP_{v2})[21] and the Prostate, Lung, Colorectal and Ovarian Cancer Screening Trial model (modified 2012) ($PLCO_{m2012}$))[20]. Several new models have been published and it is important that a strategy for testing those that may be better in UK data is developed. Cost-effectiveness estimates, model performance, eligibility thresholds and prediction of benefit from screening are all important in evaluating new models. Machine learning approaches are also in development.[22]

A recent validation study showed that the existing models cannot currently be used directly on primary care data to select the participants, largely due to missing detailed smoking data that they require.[23] Instead, additional data may be sought from people with a history of ever having smoked before the models are applied. It is important that data completeness in primary care records, particularly for smoking status, is comprehensive and contemporaneous, which may require incentivisation but also improved, or more accessible approaches to optimising data completeness and quality. NHS clinicians and IT administrators will need to work together to identify approaches such as structured data entry forms and alerts for critical data entry with each encounter. This will be critical to avoid racial/ethnic disparities that can arise through data bias. Novel methods e.g. using the NHS Health app to encourage people to update their own smoking data and text messages to ask those without a primary care smoking record to reply with their smoking status could also be helpful . Ongoing research seeks to identify those unlikely to benefit from screening and develop newer risk prediction models which can integrate into primary care software.[23]

3. Supporting Equitable Participation in Lung Cancer Screening

It is important to use evidence-based approaches to contact potential screening candidates, and to maximise informed participation in a population where socioeconomic deprivation is common and there is risk of widening existing inequalities.[24] UKLS and other studies have shown that individuals at highest risk are least likely to respond to a lung screening invitation.[25] Common reasons are difficulty accessing services and cancer fear, fatalism and stigma associated with lung cancer and smoking.[26-28] The balance of risks and benefits of lung cancer screening participation is underpinned by the wider social determinants of health, or environmental conditions that impact health outcomes and risks. For example, time and resources required to participate in the lung screening process may be a greater burden for people experiencing socioeconomic deprivation.

Currently, participation rates in the TLHC average around 35%, which is below other established screening programmes, although recent uptake figures have shown some improvement (48% for the past 3 months) (Personal communication, NHS England TLHC team). Data from the SUMMIT Study, Yorkshire Lung Screening Trial and LSUT show uptake rates of 41%, 51% and 53% respectively.[29,30] These data also observed socioeconomic and smoking-related inequalities in participation, as well as inequalities by ethnicity and region seen in screening programmes for other cancer types.[31,32]

Behavioural science principles tell us that behaviour change is influenced by capability, opportunity and motivation.[33] In relation to improving participation, this means improving awareness of lung cancer screening and its availability (capability), enabling easier physical access and support (opportunity), and counteracting deep-seated perceptions of risk-based eligibility and candidacy for lung screening, particularly among people with longstanding smoking histories (motivation).[28,34,35] Each of these components may be targeted through evidence-based methods at multiple levels of intervention (individual and interpersonal, organisational and wider system). Examples might include tailored messaging and a targeted, stepped and low-burden invitation approach, as proposed and tested by the LSUT.[10] These methods should be co-designed and evaluated based on local knowledge, community engagement and evidence from other screening programmes to optimise equitable participation among the eligible population.

This process applies to the whole lung screening pathway from awareness, invitation and eligibility assessment, through to surveillance, participation in subsequent screening rounds and potential decisions about diagnostic work-up or treatment.[36] Shared decision making is important, involving participants and healthcare professions, the latter supporting the often complex cognitive and emotional demands.[37] It is recognised that decision support tools can improve overall knowledge scores, but eligibility, false positive and negative findings, and lung cancer mortality reduction remain poorly presented and misunderstood.[38-40] Thus, LCS programmes need to be organised in a way that supports integration of shared decision making in lung screening.

Existing TLHC pilots have used community outreach in the form of local communications (e.g. local radio, bus-stop and engagement events, community educators or 'champions'). This should be supported by materials adapted to the needs of the local population, and evaluated for acceptability. Charity and third sector support can facilitate this (e.g. Roy Castle Lung Foundation supported events and media activity https://roycastle.org/lung-health-checks/), with patient and public involvement and behavioural scientists key to their evidence-based design and evaluation. Pathway navigators may have an important role in empowering high risk individuals from under-represented communities to access lung screening, integrated smoking cessation and treatment.[41]

4. Lung Health Check

The Lung Health Check (LHC) approach was perceived to be valuable in embodying a holistic, targeted health intervention that combines lung cancer screening with prevention and early detection of other smoking related co-morbidities such as COPD and cardiovascular disease (CVD). Components of the TLHC include an assessment of screening eligibility, based on an individual's lung cancer risk score, an assessment of respiratory symptoms, immediate access to smoking cessation support and measurement of spirometry (although spirometry was paused during the Covid-19 pandemic but has been reintroduced at some sites, but is not mandatory); assessment of cardiovascular risk may also be included.[42]

LHC models that have been developed to address 'barriers' to participation include a 'one-stop-shop' community-based service with immediate access to a mobile CT scanner located in areas of high socio-economic deprivation,[11,43,44] and a targeted, low burden, stepped invitation approach to a hospital based service.[10] In the Yorkshire Lung Screening Trial (YLST) and the SUMMIT study, an initial telephone triage was used to assess risk followed by a community or hospital-based TLHC / LDCT scan for those identified to be at higher risk.[29,44,45] Other variations in service delivery include TLHCs located in the primary care setting, followed by LDCT scans in hospital at a separate appointment[12] or a combination of approaches.[46] Although the optimal approach will continue to evolve following evidence and good practice, the guiding principle is that TLHC services should be accessible and convenient, especially for individuals from underserved communities in whom transport and perception of healthcare models may be particularly misaligned with provision. It is recognised that local TLHC teams are best placed to determine the optimal approach for their area. For those eligible, the TLHC should include a discussion about the benefits and risks of screening prior to undergoing the baseline LDCT scan with attendees and their GP should receive a prompt, electronic copy of the TLHC outcome.

Smoking cessation

It is widely acknowledged that smoking cessation is an essential component of any lung cancer screening programme, alongside interventions to address stigma and perceived candidacy. The UKLS demonstrated that LCS, and in particular receiving an abnormal scan result, increased smoking cessation rates and thus represents a powerful opportunity to maximise cessation.[47] Furthermore, cost effectiveness data show that adding any kind of 'stop smoking' intervention to LCS is very likely to be cost-effective, resulting in further lung cancer deaths averted and life years gained over and above the impact of screening alone.[48-50]

Consideration must be given to how support may be provided and funded, given disparities in TLHC pilots and community 'stop smoking' service provision.[51] The finding that smoking cessation rates are higher in lung cancer screening may suggest that funding should be provided in addition to that for national smoking cessation services. This is a departure from current policy, however, and needs to be underpinned by the robust health economic evaluations that are underway. With regard to models of delivery, smoking cessation should be delivered as an 'opt out' in order to minimise stigmatising individuals, and where possible, as an integrated service for current and recent former smokers. Ideally there should be immediate access to a co-located smoking cessation practitioner who is able to provide a comprehensive package of smoking cessation support. This should include immediate access to nicotine replacement therapies, and inclusion of electronic cigarettes or 'vapes'

should be considered .[52,53] A model which simply suggests onward referral of screening attendees to existing external national services could be ineffective and risks widening health inequalities[53-55]

Spirometry

In contrast, there is ongoing debate about the relative merits of measuring spirometry within a LCS program, especially in asymptomatic participants, where evidence of benefit, particularly on the scale required for screening programme implementation and cost effectiveness, is lacking.[56] Whilst published series to date suggest approximately 10 to 15% of attendees are likely to have undiagnosed symptomatic COPD,[57-59] it is unclear whether routine spirometry withing TLHC measurably improves health for these individuals and hence there are not sufficient grounds to adopt this within a national programme. Further research is however required to better define the role of spirometry within lung cancer screening programmes, and the NHSE TLHC is likely to be well placed to enable such investigation. Spirometry may also be useful in further defining risk of lung cancer as recent screening studies have shown this to be an independent risk factor.[59]

5. Management of Findings and Pathways

Incidental findings are common in CT screening but there are concerns that over-investigation and over-reporting might cause anxiety, lead to harm from unnecessary tests and increase costs. Data from the UK have shown that by using clear guidelines and protocols for the management of incidental findings, those requiring referral to primary care (10%) or hospital services are low[60-62]. NHSE guidelines for referral of incidental findings are largely based on American College of Radiology (ACR) white papers and included in the NHSE Quality Assurance Standard appendix.[63] Principles for cancer referral are also described in the NHSE Standard Protocol.[8] Implicit within these documents is the requirement for a high threshold for referral to primary/secondary care due to either clinically significant and/or urgent findings, and where there is a recognised evidence-based intervention available to benefit patient outcome. A European Consensus Statement on management of incidental findings from low-dose CT screening for lung cancer is expected to be published in 2023. It is critical that the national screening programme develop and promote clear and unambiguous guidelines for clinicians about the threshold for onward referrals. Practice in other screening programmes suggest that variable thresholds are the norm, and this must be avoided.

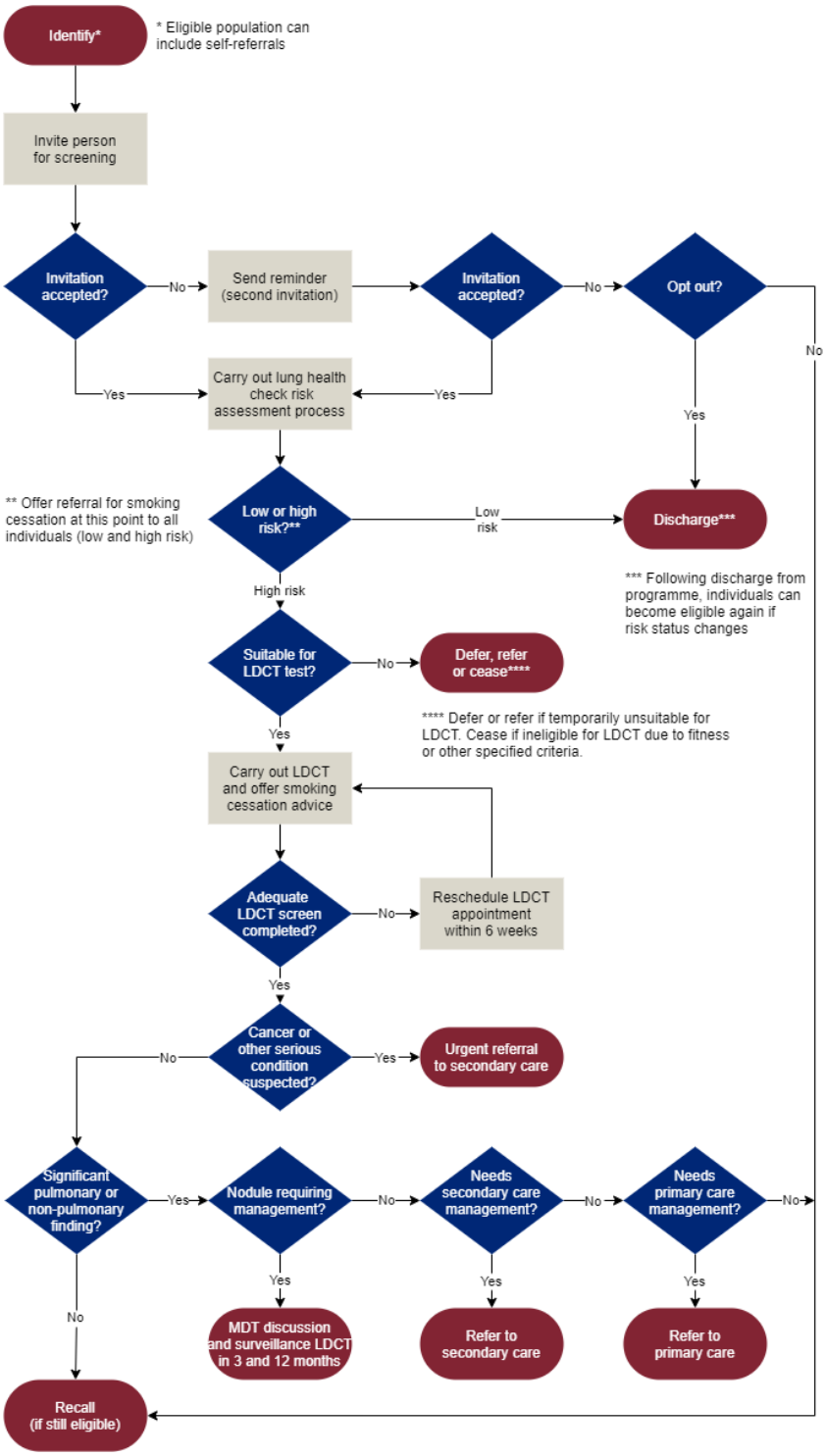
Lung nodule management in most UK screening pilots follow (modified) British Thoracic Society (BTS) guidelines and volumetric analysis should be used wherever possible.[64,65] Updated BTS nodule management guidelines are also planned, which are likely to include guidance for new nodules detected at incident screening rounds. Computer-aided detection (CAD) software can assist nodule detection, perform semi-automated or fully automated volumetric analysis and assess risk of malignancy. Research is needed to compare and validate existing and new systems and assess their impact on nodule management and LDCT reporting times.

LDCT screening also readily detects undiagnosed cardiovascular and respiratory disease, which could be an 'added benefit' of LCS.[42,57,66,67] The evidence is clearer for coronary artery disease where the degree of coronary artery calcification is correlated with clinical outcome.[68-70] However, limited evidence suggests that despite identification of respiratory and cardiovascular disease, changes to patient management in primary care are infrequent.[60] There needs to be more effort to ensure that evidence-based preventive management is offered in primary care facilitated by communication from the screening programme.

It is crucial to ensure that radiology reporting and management of incidental findings by the clinical team are audited regularly and form part of formal screening QA for any programme. In line with the TLHC recommendations and following precedent from other screening programmes using imaging interventions, all radiologists should undertake a training programme, and In addition, must also read a minimum number of screening CT scans on yearly basis. before becoming screening reporters. They should be subjected to regular

appraisal to ensure that their reporting is in line with expected standards. Examples of best practice include screening review meetings, where all incidental findings are assessed by an expert team with shared responsibility to minimise downstream impacts.

Figure 1 NSC Consultation TLHC pathway diagram



Flow chart derived from lung screening pathway development group, for the lung screening chapter of the screening manual of the National Screening Committee, UK (with permission). *** The NHSE Standard Protocol

recommends recall every two years, or for those previously ineligible, GP re-query on the basis of age, lung cancer risk score (e.g. LLP/PLCO), or protocol modifications.[8]

6. Adherence

Adherence to subsequent screening rounds is important to realise the full potential of the programme both for the individual and the population as a whole. Adherence in LCS trials has been high (92-94%).[1,2] In the Manchester UK pilot adherence was 90% at one year,[43] and in YLST it was approximately 80% after a 2-year interval (unpublished). In the US, adherence rates vary greatly but the model of care is also variable and not transferable to the UK. Two systematic reviews and meta-analyses of adherence to screening have shown pooled adherence rates of 37-72%.[71,72] Factors that affect adherence were found to be very similar to those impacting baseline participation. Navigators have been identified as an important way to improve adherence. It is established that either nurse navigators or lay patient navigators improve baseline participation. In one primary network based randomised controlled trial in the US, patient navigators assessed eligibility, undertook shared decision making and addressed concerns and barriers.[73] Participation amongst eligible people was 94% and of all people approached, 31% in the navigator arm and 17% in the control arm had a CT.

Target metrics for adherence are unclear but should be ≤10% attrition per year of screening interval. This may be influenced by screen interval, currently set in the UK at two years for those without significant indeterminate nodules. Shorter screen intervals would require higher total funding, whereas intervals of >2 years are not recommended based on data from NELSON where the final screening round, 2·5 years from the penultimate found a higher proportion of later stage tumours.[74]

7. QA and governance

Quality Assurance (QA) is an essential requirement for all screening programmes. QA provides a mechanism to support very complex programmes in delivering the most benefit and minimising risk of harm. This is achieved by helping providers to meet requirements for safe and effective delivery of screening, facilitate quality improvement and mitigate risk. Screening QA spans the entire screening pathway from identification and invitation of eligible individuals to informing the attendee and relevant health services of the screening result. QA metrics need clear definitions and should focus on those processes in which system failures or errors are most likely to lead to harm. This will help to minimise the burden of data collection and reporting. The framework used by Screening Quality Assurance Service (SQAS) to QA the national cancer screening programmes is set out in Programme Specific Operating Models (PSOM). Screening providers and commissioners are required to have internal processes that ensure effectively managed service quality and describe participation in QA assessments. This should extend to engaging with public and participant stakeholders (e.g. interviews and surveys). SQAS regional teams look at data from the services, compare these with other similar services and undertake QA visits. This ensures compliance with standards, assessment of service quality and support for quality improvement. They also support local providers with advice on quality related matters at commissioner-led programme board meetings and through regular contact with providers. QA will be a mandatory requirement for all sites delivering lung cancer screening. However, to be effective and proportionate, it is vital that this is underpinned by a suitable IT system and QA should link in closely with screening digital transformation programmes. For example, nationally defined data items should be uploaded, and results presented through a single interface using a consistent format across the country. This could include a dashboard providing site specific 'RAG' ratings for each quality standard, with results updated in a timely manner. At present, TLHC sites are asked to return questionnaires to this effect.

Screening standards are used to drive and benchmark screening performance and enable consistent data collection across sites. Quality standards have already been published for the TLHC programme,[63] and reviewed by the Royal College of Radiology (RCR) and British Society of Thoracic Imaging (BSTI).[75] It is recognised that

current standards which focus on TLHC process, are likely to need further development. With the support of the National Screening Committee and Screening Quality Assurance Service, revised standards may include outcome measures such as cancer detection rates, stage distribution, or harms observed from invasive procedures and benign resection. The screening standards should incorporate mechanisms to assess the ongoing clinical effectiveness of the program, including mechanisms to capture recall rates, and to identify and manage discrepancy (i.e. a "live" QA). Current standards mandate prompt risk assessment to scan, and scan to result, each being less than four weeks – this will likely in future need to be expedited. In addition, routine QA of radiologists using an external system should be mandated with expert-validated cases, analogous to that used for over 30 years in the breast cancer screening (BCS) programme (PERFORMS) as part of regular practice.[76] This is currently at the deployment stage in the TLHC (acronym PERFECTS).[77] The quality of healthcare experiences should also be captured through participant-reported outcome measures (PROMs) and participant-reported experience measures (PREMS). Development of modified or additional standards should take advantage of best practice and learning from other screening programmes already in operation. For example, the UKNSC categorises standards for population screening into themes, which include population, coverage, uptake, test, diagnosis/intervention, referral, intervention/treatment, and outcome. In addition, a standardised approach and timeframe (e.g. every three years as in the BCS program) for reviewing and revising standards is required. Criteria of success should be defined and used to compare screening sites, drive precise remedial actions, and allow prioritisation of specific areas for QA.

8. Data and Information technology

IT Systems

UK health data are extensive and largely ahead of other countries. However, for a national cancer screening program, it is vital to aggregate existing healthcare data and LCS data that are identified as a requirement. In 2019 an independent report commissioned by NHSE on screening was very critical of the IT systems for the existing cancer screening programmes, describing them as "..woefully out of date and long due for replacement."[78] It was noted that NHSX had then started the scoping exercise but that it was "…important to progress this work programme at pace, and under close scrutiny." In LCS, as in other programmes, a safe, end-to-end IT solution covering invitation and recall, results communications, and QA is required, including necessary live data returns. A single, national IT system is considered a priority in LCS to provide consistency and standardisation. Although single national systems run the risks that they might not meet the required specification, and could be inflexible, and limit innovation, this can be mitigated through careful design and evaluation, building on the functionality seen in some of the trial IT systems. These systems must be maintained and evolve.

In the TLHC, individual sites are required to collect data but the approach to IT is highly variable. Some are modelled on existing screening infrastructure or use third party solutions, but many employ simple spreadsheets for data collection and disjointed systems for managing other aspects. A major limitation is the ability of many these systems to output data and provide real-time review of performance (e.g. uptake, DNA and recall rates). Furthermore, the lack of a national system means that new sites must develop their own, which is inefficient and leads to further variation.

The initiation of a new programme is an ideal time to develop a system that is fit for purpose, and which is easily adopted by new sites. Whilst separate systems adhering to the same standards may be an alternative, they are a compromise. In this scenario, systems must be able to output data in a format that can be amalgamated at a national level for benchmarking, QA and research.

Technology and artificial intelligence

In recent years, the development of digital radiology tools has been rapid. In LCS, tools in use include computer-aided detection (CAD) of pulmonary nodules and (semi-)automated measurement of nodule volume. These are predominantly third-party solutions that interface with the Picture Archiving and Communications Systems (PACS). It is important that these undergo validation and revalidation on a regular basis. More advanced AI solutions are in development and may be important to improve accuracy of reporting and workflow.[79,80]

AI solutions offer the opportunity to reduce workforce pressures, e.g. obviating the need for double radiologist reading, but it is important that workflow is improved and this will require greater technical capacity, server infrastructure and appropriate backup mechanisms.

9. Workforce

The Health Select Committee report from April 2022 set out the significant workforce challenges faced by today's NHS.[81] National LCS will add to this and therefore careful planning is required to optimise resources. This will mean that design of the programme should always have in mind potential capacity limitations and should deploy technology where this maximises efficiency. Table 1 lists the workforce disciplines involved in lung cancer screening, with comments on likely increased demand and potential solutions.

Table 1: Workforce disciplines in LCS

Discipline	Level of resource increase and comment.	Potential mitigations
Radiology	Marked; estimates provided by RCR/BSTI	AI solutions to improve accuracy and workflow; National or regional pooled reporting platforms; Train and appoint additional thoracic radiologists, trained in screening reading and biopsy
Radiography (diagnostic / reporting / therapeutic)	Marked – likely marked for diagnostic; modest for reporting in the short term; modest for therapeutic	AI solutions to improve flow and potentially allow first or definitive read by radiographer
NM radiology	Modest – mainly PET	More staff with appropriate training
Interventional radiology	Marked – lung biopsy	Latest technology to assist in lung biopsy; Train and appoint additional thoracic radiologists, trained in screening reading and biopsy
Administrative staff	Marked – potentially easy recruitment and training	Good administrative cover likely to improve efficiency of whole program
Nursing staff (screening process)	Modest – need to ensure duties focussed on clinical aspects	Good training in screening activity
Respiratory Medicine	Marked – used in screening review and work up of participants with positive scans (including peripheral lung biopsy)	Use of admin staff to support, automated communications where possible; Guideline driven management; Latest technology in peripheral biopsy funded for selected centres; Train and appoint more respiratory physicians.
Thoracic surgery	Marked – surgery rates are high	More theatre time and ITU beds now; Train and appoint more surgeons for the future
Clinical oncology	Marked – SABR rates higher; likely increase in chemoradiotherapy	Train and appoint more clinical oncologists and therapeutic radiographers; work on better and more efficient pathways (see NOLCP)
Medical oncology	Modest – late stage patients are fit and earlier stage disease requiring adjuvant treatment. With time, fewer late stage patients requiring long term treatment	Train and appoint more specialist nurses to run nurse-led clinics; train and appoint more medical oncologists
Pathology	Modest – longer reporting times for resections and possible frozen sections	Existing shortfall should be addressed; digital pathology
Pathology scientists	Modest – more patients will need full molecular tests	Provision of better equipment including local NGS panels
Smoking Cessation Practitioners	Marked – essential to maximise benefit	Fund SCP and deploy on site or on mobile unit

Primary care	Modest- will help patient engagement and some incidental findings management	Mitigate workload through clear protocols and pathways of care

There was consensus on the importance of an explicit roadmap to developing the workforce capacity for the TLHC, and the need to demonstrate that the creation of such capacity synergistically benefits the wider NHS (e.g. increased clinical and radiology capacity) as a whole.

10. Corporate, Third Sector, Charity, and Participant Engagement

It is important to engage a variety of charitable, third sector and corporate groups and ensure that they are part of the discussions around lung cancer screening. These sectors are often a key source of cancer information for the public and are well known for providing accurate, trustworthy and accessible content. Many charities and third sector organisations already have information about the TLHC programme on their websites and would update this for any national program, with tailored information as required.[82-85] As well as 'standard' descriptive information, charities can also play an important role in addressing misunderstandings and myths around cancer screening. This can be via online content, but they can also create bespoke opportunities to air specific messages through their experts in promoting awareness and in leveraging mainstream and social media. Expertise within these organisations can also be helpful for the development/review of formal programme participant-facing materials. Whether charities are in a position to get involved in more actively raising awareness and promoting engagement with cancer screening opportunities varies. Some charities have considerable experience with local community engagement. However, there is often not the funding in charitable organisations for large scale national campaigns. Instead, charities often put their efforts into influencing Government-funded campaign plans.[86] There has also been industry interest in increasing engagement with lung cancer screening, acknowledging the growing evidence for its effectiveness. It is important to maximise the impacts of relationships with Industry, whilst adhering to the principles surrounding transparent joint working relationships.[87]

Engaging at a more strategic/political level to ensure screening implementation and ongoing optimisation is also an important role of these organisations. They play a key role in influencing national policy and holding Government and other key stakeholders to account, and also in producing reports for politicians and policymakers to highlight the most important areas of focus to improve lung cancer outcomes.[88]

These organisations also undertake insight work across different audiences, including public and health professionals. While this is often led by internal priorities, there can be opportunities to feed questions into this process that may provide rapid feedback on topics relevant to cancer screening programme development and implementation.

Another important role is as funders of academic research. Where this operates on a commissioned basis, there may be opportunities to influence the focus of commissioned research to fit with cancer screening programme development and implementation, but the bulk of research is likely to be investigator-led and highly competitive.

11. Discussion

This article describes the consensus reached by a multiprofessional group of experts in LCS on the key requirements and priorities for effective implementation of a programme (see Table 2). It draws on the considerable experience gained from UK trials, pilots and most recently the NHSE TLHC. In September 2022, the UKNSC recommended LCS be implemented in the four UK countries, initially on the same basis as the TLHC. This manuscript serves as an important tool in the ongoing expansion and evolution of an already successful programme as well as providing a summary of UK expert opinion for consideration by those organising and delivering LCS in other countries. Full implementation in the UK is a major challenge but has to be achieved if the full benefits of LCS are to be realised. It is essential that the UK countries prepare to deliver high quality LCS by complying with the key elements identified here, and in particular addressing capacity limitations and

ensuring a secure funding source equivalent to the other UK screening programmes. There needs to be a clear message to the entire healthcare system about the nature and efficacy of an ongoing LCS programme with explicit information on roles and responsibilities at all levels including Cancer Alliances and Integrated Care Systems.

It is appreciated that the 4 UK nations will implement screening programmes under different branding but it is strongly recommended that each adopt a shared learning principal to achieve comparable standards.

Table 2: Priorities and requirements for implementation of LCS

Priorities	Requirements
Identification and Selection	Methodology to identify ever smokers from GP record. Consider updating the primary care record
Participation and Adherence	Clear guidance on the best methods to encourage equitable participation and adherence
Smoking cessation	Enhanced SC intervention with co-location and opt-out
Managing findings	Guidelines, education and QA of management of nodules, work-up and incidental findings
Add-on health interventions	Clarification of what is included in the screening intervention TLHC and from where the funding is derived
QA and governance	Full participation in QA with clear effective and audited governance
Data and IT	An end to end IT system for LCS; use of the latest technology to minimise workload
Workforce	Identify the workforce needs and plan expansion and improved logistics
Collaboration	Continue to develop effective working relationships between responsible NHS organisations and the third sector, industry and charities
Innovation and Research	Foster innovation by encouraging local initiatives with a mechanism for evaluation. Build research into the LCS programme

Search Strategy and Selection Criteria

The literature was reviewed by the relevant co-authors based on English language articles from journals and book chapters sourced from PubMed. The articles were selected on the basis of whether they addressed a semi-structured questionnaire completed for each theme of the round table discussion in advance of the event as preparation work. Articles were not excluded on the basis of date, but had to include content considered relevant to the forward-looking view of the round table discussion. The reference list was further refined in the development of the manuscripts by all authors.

Acknowledgements

The Roy Castle Lung Cancer Foundation provided funding for the meeting. They had no role in the writing of the manuscript or the decision to publish. The authors would like to acknowledge representatives from the NHS Cancer Programme, NHS England (David Fitzgerald, Dan Cariad and Ciaran Osborne) and Cancer Research UK (Jodie Moffatt) who contributed their expertise during the meeting. Jackie Tebbs (Roy Castle Lung Cancer Foundation) provided administrative support.

Author contributions

All authors contributed to the literature search, study design, discussion, analysis, and interpretation of the relevant literature. EOD, RL, PC and DRB drafted the manuscript. All authors contributed to the written content and editing of the final manuscript and approved the version to be published.

Declaration Of Interests

Richard Lee is funded by the Royal Marsden NIHR BRC, Royal Marsden Cancer charity. RL's institution receives compensation from NHSE for time spent in a secondment role for the lung health check program and as a National Specialty Lead for the National Institute of Health and Care Research. He has received research funding from CRUK, Innovate UK (co-funded by GE Healthcare, Roche and Optellum), SBRI (co-applicant with QURE.AI), RM Partners Cancer Alliance and NIHR (co-applicant in grants with Optellum). He has received honoraria from CRUK.

Stephen Bradley reports being clinical lead for cancer for the Leeds office of the West Yorkshire Integrated Care Board and received funding from Cancer Research UK for doctoral research.

Kate Brain receives funding from Welsh Government via the Health and Care Research Wales-funded Wales Cancer Research Centre (grant no. 517190) and Primary and Emergency Care Research Centre (grant no. 517195).

Mat Callister reports being PI for Leeds Lung health Check and YESS study (funding from Yorkshire Cancer Research).

Yan Chen reports the following COI: Lead for PERFECTS (PERFormance Evaluation for CT Screening): the first national External Quality Assurance scheme for lung cancer imaging assessment funded by NHS England and NHS Improvement. The scheme is used to ensure appropriate interpretation of lung scans.

Anand Devaraj declares a role as Medical Director for Thoracic Radiology at Brainomix

John K Field has received fees from AstraZeneca (Speaker’s Bureau) and advisory boards of Epigenomics; NUCLEIX Ltd. AstraZeneca, iDNA; Grant Support: Janssen Research & Development, LLC.

Sam M Janes declares Paid Advisory Board 2017-2020 for Astra-Zeneca, Bard1 Bioscience, Achilles Therapeutics and Jansen. He has received assistance for travel to meetings from Astra Zeneca (ATS 2018 Takeda WCLC 2019), is grant income lead investigator for GRAIL Inc, GSK and Owlstone, and is a shareholder in Optellum Ltd and BARD1 Lifescience Ltd.

Anne Mackie declares her role on the National Screening Committee

Rachael Murray declares honorarium from Astra Zeneca and has been commissioned by Action on Smoking and Health to produce a report on smoking cessation in targeted lung health checks

Arjun Nair declares grants from Department of Health's NIHR Biomedical Research Centre's funding scheme and GRAIL Inc (Summit study); Consulting fees from Aidence BV, Faculty Science LTD and MSD; Support for attending meetings from Takeda Limited; Advisory Board participation for Aidence BV and Faculty Science Ltd; Leadership roles for the British Society of Thoracic Imaging, British Lung Foundation and NHS England Targeted Lung Health Checks Programme.

Emma O'Dowd reports research funding from Roy castle Lung Cancer Foundation.

Samantha Quaife receives funding from Cancer Research UK (grant no. C50664/A24460), Barts Charity (MRC&U0036) and University College London Hospital NHS Trust (grant no. N/A).

Robert Rintoul reports advisory boards/consultancy for Inivata, Astra-Zeneca, and Olympus Medical;

Research funding support from Owlstone Medical Ltd, Victor Dahdaleh Charitable Foundation, Cancer Research UK, and Asthma and Lung UK.

Richard Booton declares honoraria from Siemens for speaker fees.

David Baldwin declares his role as Clinical Advisor to the UK National Screening Committee, DHSC and honoraria from Astra-Zeneca, MSD, Roche and Bristol Myers Squibb.

Philip Crosbie reports consultancy for Novartis, Everest Detection, Astra Zeneca, and North West eHealth; Stock options for Everest Detection.

The remaining authors declare no conflicts of interests

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