Implementation Planning for Lung Cancer Screening: Five Major Challenges.

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In this issue, the review article by van der Aalst et al (ref), focuses on our current understanding of lung cancer computed tomography (CT) screening. It outlines key unanswered questions and briefly addresses the issue of screening implementation. The article adds to at least seven national and international statements providing recommendations on CT lung cancer screening.

To date there are no recommendations on how to implement a lung cancer CT screening programme within a national health service model. Clearly lung cancer screening implementation will be different from breast or colon screening because of our ability to more precisely define the risk of lung cancer and therefore inclusion criteria will be more than just age and sex. The US Preventive Services Task Force recommended similar inclusion criteria to the National Lung Screening Trial (NLST) and most other US recommendations follow suit with only the National Comprehensive Cancer Network including risk factors other than smoking and age [2]. The UK Lung Screen trial used the LLP_{v2} risk model and demonstrated that high risk individuals could be recruited with 2.1% lung cancer detection after a single screen, equivalent to 3 annual screens in NLST [3]. The $PLCO_{m2012}$ risk model was tested on the NLST data and demonstrated that >12% more cancers would have been identified using this model [4] .

The pragmatic use of risk prediction models has not been evaluated in the lung cancer screening setting. One issue may be the availability of sufficient accurate data with which to populate the model. This will include accurate and up to date data on smoking status, as the most influential risk factor. Possible ways to acquire data are through primary care, or at a national level through invitation letters to all individuals within a specified age band. Data completeness is an issue with the former and participation an issue with the latter (due to language or educational barriers and the fact that many high-risk people will be in the more socioeconomically deprived groups where participation is lower [5]). Innovative uses of technology and messaging services on which the population could update their risk data may be an option, but the older population in the lung cancer screening setting may, not embrace this technology and a more tailored, personalised approach may be necessary. Obtaining risk data on individual patients presents our first major challenge.

A second major challenge, not dealt with in the paper by van der Aalst (Ref 1), is participation. If lung cancer screening is to make a significant impact on the mortality from lung cancer, sufficient numbers of the population at risk of lung cancer will need to participate. There is good evidence that this will be lower than for breast cancer and bowel cancer because lung cancer is over-represented in the more deprived socioecomomic groups, where participation rates in health interventions such as smoking cessation [6] and screening [7] is known to be low. Methods to increase engagement with this group need to be developed to increase the overall efficacy of screening.

A third major challenge is the availability of CT scanners and the pressure on radiological services. Most of the CT equipment in the UK is located in busy secondary care institutions. Suitable access to CT scanners needs to be determined, including whether mobile CT scanners would be more appropriate to engage the hard to reach community, which opens the question of the investment required to set up

this infrastructure.

The health service community have not to date quantified the additional radiological services required to report annual and follow up CT scans as part of a national screening programme, but clearly some addition to the radiology workforce will be required. Innovative approaches may need to be considered, such as whether screening CT images could be read by radiographers [8] or specialist trained clinical scientists, working under a Lead Radiologist, possibly in national CT reading centers. Training and accreditation requirements for CT screen readers will have to be considered, including in the use of volumetric analysis of lung nodules as has been used in European Lung Cancer Screening Trials [3, 9, 10]. A national repository of CT lung cancer screening images could play an important role in this process. Ongoing quality assurance programmes evaluating readers' false positive and false negative rates will also need to be developed. Finally, effort needs to be devoted to making the process of CT reporting and the communication of CT results as efficient as possible. For example standardised reporting templates, rapid access to historical imaging, and seamless integration with radiology information systems will all have a role to play in achieving this.

The fourth major challenge, as discussed by van der Aalst et al (ref 1), is how to undertake integrated smoking cessation with lung cancer screening. If an annual scan is the preferred way forward, there will be a unique opportunity to regularly update patient smoking records and, if accepted, provide the necessary interventions. The current review shows that this has not been resolved.

All of the current CT screening programmes have identified 'significant other findings', at varying percentages, which should be considered as an added potential benefit to the patient for participating in the screening programme. However, we are not yet in a position to fully utilise the CT image data to diagnose coronary heart disease and COPD, which when combined kill a larger number of individuals than lung cancer alone. This is our fifth major challenge and needs to be the focus of future demonstration projects.

These issues need addressing urgently, if we are to achieve the potential further control of lung cancer via early detection [11].

[Reference 1 will be van der Aalst et al.]

1. Aberle DR, Berg CD, Black WC, Church TR, Fagerstrom RM, Galen B, Gareen IF, Gatsonis C, Goldin J, Gohagan JK, et al: **The National Lung Screening Trial: overview and study design.** *Radiology* 2011, **258:**243-253.
2. **Clinical Practice Guidelines in Oncology: Lung Cancer Screening V.2 2016** [https://www.nccn.org/professionals/physician_gls/pdf/lung_screening.pdf]
3. Field JK, Duffy SW, Baldwin DR, Brain KE, Devaraj A, Eisen T, Green BA, Holemans JA, Kavanagh T, Kerr KM, et al: **The UK Lung Cancer Screening Trial: a pilot randomised controlled trial of low-dose**

computed tomography screening for the early detection of lung cancer. *Health Technol Assess* 2016, **20:**1-146.
4. Tammemagi MC, Katki HA, Hocking WG, Church TR, Caporaso N, Kvale PA, Chaturvedi AK, Silvestri GA, Riley TL, Commins J, Berg CD: **Selection criteria for lung-cancer screening.** *N Engl J Med* 2013, **368:**728-736.
5. Bryan L, Westmaas L, Alcaraz K, Jemal A: **Cigarette smoking and cancer screening underutilization by state: BRFSS 2010.** *Nicotine Tob Res* 2014, **16:**1183-1189.
6. Murray RL, Bauld L, Hackshaw LE, McNeill A: **Improving access to smoking cessation services for disadvantaged groups: a systematic review.** *J Public Health (Oxf)* 2009, **31:**258-277.
7. Sutton S, Wardle J, Taylor T, McCaffery K, Williamson S, Edwards R, Cuzick J, Hart A, Northover J, Atkin W: **Predictors of attendance in the United Kingdom flexible sigmoidoscopy screening trial.** *J Med Screen* 2000, **7:**99-104.
8. Nair A, Baldwin DR, Field JK, Hansell DM, Devaraj A: **Measurement methods and algorithms for the management of solid nodules.** *J Thorac Imaging* 2012, **27:**230-239.
9. Horeweg N, van Rosmalen J, Heuvelmans MA, van der Aalst CM, Vliegenthart R, Scholten ET, ten Haaf K, Nackaerts K, Lammers JW, Weenink C, et al: **Lung cancer probability in patients with CT-detected pulmonary nodules: a prespecified analysis of data from the NELSON trial of low-dose CT screening.** *Lancet Oncol* 2014, **15:**1332-1341.
10. Baldwin DR, Callister ME, Guideline Development G: **The British Thoracic Society guidelines on the investigation and management of pulmonary nodules.** *Thorax* 2015, **70:**794-798.
11. Field JK: **Perspective: The screening imperative.** *Nature* 2014, **513:**S7.