



## Position Statement: Lung Cancer Screening using Low-Dose Computed Tomography

**Lung cancer** is one of the leading causes of death globally.<sup>1</sup> In Australia, lung cancer is the most common cause of cancer-related mortality for Australian men and women. In 2011, there were 8,114 deaths caused by the disease.<sup>2,3</sup> Smoking is the largest single cause of lung cancer, accounting for 90% of all cases in males and 65% of all cases in females.<sup>4,5</sup>

**There is some evidence** to support annual screening for people at high risk of lung cancer using low-dose computed tomography (LDCT). Individuals at high risk are adults aged 55 to 80 years who have a smoking history of at least 30 pack-years<sup>i</sup> and currently smoke or have quit within the past 15 years.<sup>6</sup> However, there are a number of unresolved issues that need further consideration.

**Unresolved issues** include a high false positive rate of screening with the risk of attendant harms from subsequent investigation; variability in follow up protocols for a positive test; uncertainty regarding the target population and screening interval; uncertainty regarding cost-effectiveness; and the issue of screening versus smoking cessation measures.<sup>7,8,9,10</sup> Further studies are currently underway.

**The Population Based Screening Framework** provides guidance for decision makers when considering potential population based screening programs in Australia.<sup>11</sup> The framework identifies the need for a strong evidence base on the safety, reproducibility and accuracy of screening tests and the efficacy of treatment. It also includes the requirement that screening programs offer more benefit than harm to the target population. Using these criteria, there is insufficient evidence at this stage to support the benefits of population-based screening for lung cancer using LDCT.

**Primary prevention** is the most important strategy for reducing the burden of lung cancer. Lung cancer screening is not an alternative to smoking cessation. Efforts should continue to focus on preventing smoking uptake, encouraging smoking cessation and minimising exposure to second hand tobacco smoke.<sup>6,13</sup> Even smoking occasionally increases the risk of lung cancer.<sup>12</sup>

**General practitioners** and health care providers play an important role in managing people who have or may have lung cancer. The symptoms of lung cancer can be non-specific and mimic those of other conditions. Potential signs and symptoms include: a new or changed cough; coughing up blood (haemoptysis); persistent chest infection; chest pain and/or shoulder pain; shortness of breath; hoarse voice; and weight loss or loss of appetite. More information on lung cancer can be found at the [Cancer Australia website](#), including [investigating symptoms of lung cancer: a guide for GPs](#). For a more detailed review of evidence refer to Appendix A.

**On the basis of the current evidence and in line with the *Population Based Screening Framework*, the Standing Committee on Screening does not support an Australian lung cancer screening program, either for the general population or for high risk populations. The Standing Committee on Screening will continue to evaluate and advise on emerging evidence on lung cancer screening.**

<sup>i</sup> Pack-years are calculated by multiplying the average number of packs of cigarettes smoked per day by the number of years a person has smoked.

## Appendix A – Supporting Evidence

### General messages

- There are two main types of lung cancer – small cell carcinoma and non-small cell carcinoma.
  - Small cell carcinoma accounts for approximately 12% of diagnosed lung cancers. It is the most aggressive form of lung cancer and tends to spread quickly through the body. Surgery is often ineffective and chemotherapy and radiotherapy are required.
  - Non-small cell carcinoma is more prevalent, accounting for 60% of all lung cancers. This type of lung cancer grows more slowly than small cell carcinoma and typically exhibits better survival outcomes. Some non-small cell carcinomas are confined to the lung and can be removed surgically, however those that have spread to other parts of the body will require more aggressive treatment.
- The prognosis for lung cancer diagnosis is poor in comparison with other commonly diagnosed cancers. This is attributable to cases typically being diagnosed at more advanced stages and the aggressive nature of some lung cancers.
- In Australia, between 2006 and 2010, the relative five-year survival rate for people diagnosed with lung cancer was 14.1%.<sup>13</sup>

### Current diagnostic methods

- Current diagnostic techniques for the detection of lung cancer in Australia typically begin with a non-invasive test, such as a chest x-ray or LDCT scan, which may identify a pulmonary nodule or lung mass.
- The diagnosis must be confirmed using more invasive procedures, including needle biopsies and bronchoscopies.

### Research on the effects of lung cancer screening

- Annual screening with chest x-ray does not reduce lung cancer mortality compared with usual medical care.<sup>14</sup>
- The National Lung Screening Trial (NLST) was a randomised controlled trial conducted in the United States, involving 53,454 current and former heavy smokers aged 55 to 74 years. The study, which was published in 2011, found a 20% reduction in mortality from lung cancer with annual screening with LDCT compared to those screened with chest radiography across three screening rounds, and a 6.7% reduction in all-cause mortality in the LDCT screened group.<sup>15</sup>
- In response to the results of the NLST and subsequent modelled analysis, the U.S. Preventive Services Task Force published a statement in December 2013, recommending annual screening for people at high risk of lung cancer using LDCT. Individuals at high risk are adults aged 55 to 80 years who have a smoking history of at least 30 pack-years and currently smoke or have quit within the past 15 years.<sup>6</sup> The U.S. Preventive Services Task Force recommendation states that chest x-ray has not shown adequate sensitivity or specificity as a screening test.
- Other smaller LDCT screening trials are underway in Europe and the United Kingdom.<sup>16,17,18</sup> The results of these trials will be pooled to increase the generalisability of the findings.<sup>27</sup> It is anticipated that these data will be available in the future.<sup>16,17,18,27</sup>
- Currently, there is minimal evidence on the benefits and harms of lung cancer screening within the Australian health care setting. The Queensland Lung Cancer Screening Study investigating the feasibility of LDCT screening in Australia has published initial findings showing that the magnitude of benefit and harm is consistent with the NLST trial. However, these findings are limited by the small sample size of the local study.<sup>19,20</sup>

## Cost Effectiveness

- Cost effectiveness of LDCT screening varies between studies and has been predominantly analysed in U.S. context.
- Researchers in Australia are currently investigating effectiveness and economic viability. It is anticipated that these data will be finalised by the end of 2015.<sup>19</sup> However, an early analysis of the cost-effectiveness of LDCT screening in Australia found screening was likely to be expensive.<sup>21</sup>
- LDCT screening as performed in the NLST was estimated to cost \$81,000 per quality-adjusted life-year (QALY) gained. The equivalent incremental cost-effectiveness ratio (ICERs) was \$52,000 per life year gained. However, the study noted modest changes in assumptions would significantly alter the figure and the ICER varied widely in the subgroup and sensitivity analysis.<sup>22</sup>
- An earlier U.S. study estimated that annual screening of current and former smokers aged 50-74 with a minimum 20-pack years of smoking cost \$126,000-\$169,000 per quality-adjusted life-year gained; screening individuals with a minimum of 40 pack-years cost \$110,000-\$166,000 per quality-adjusted life-year gained.<sup>23</sup>
- In Canada, annual screening of individuals with a 30 pack-year smoking history, aged between 55 and 74 years, saved 51,000 QALYs and had an incremental cost-effectiveness ratio of CaD\$52,000 per QALY compared with no screening. Annual screening of individuals with a 20-pack year smoking history had an incremental cost-effectiveness ratio of CaD\$62,000 per QALY, whereas screening individuals with a 40 pack-year smoking history resulted in an incremental cost-effectiveness ratio of CaD\$43,000 per QALY. In addition, a smoking cessation program improved the incremental cost-effectiveness ratio to CaD\$24,000 per QALY.<sup>24</sup>
- In comparison, for BreastScreen Australia, the current policy of screening eligible women aged 40+ who participate, while specifically targeting women aged 50–69 years, yielded a cost-effectiveness estimate of \$38,302 per life year gained (LYG) and \$23,713 per LYG over a period of 20 and 40 years, respectively.<sup>25</sup>
- Based on modelling, Australia's National Bowel Screening program is expected to reduce mortality from bowel cancer by 15-25% resulting in 300-500 fewer deaths from colorectal cancer per year, or 3600-6000 life-years saved. The undiscounted cost per LYG of screening is estimated to be \$25,000-\$41,667.<sup>26</sup>

## Potential benefits of screening with LDCT

- The NLST found a 20% reduction in lung cancer mortality for a high risk population and a significant reduction in all-cause mortality.<sup>15</sup>
- European trials of LDCT screening are underway. The trial results will be pooled to increase the generalisability of the findings that will be useful in the future.<sup>27</sup>
- Recent data from the NELSON trial in Europe show that using volumetric analysis of nodules and introducing an early (three month) follow up CT for nodules of indeterminate size decreased the false positive rate. The mortality results from the NELSON trial however, will be available in the future.<sup>28</sup>
- There is ongoing research on risk prediction tools and use of biomarkers, to better target people for LDCT screening, which may improve both the sensitivity and the positive predictive value, and hence reduce the harms of screening.<sup>29</sup>

## Potential harms of screening with LDCT

- LDCT has a high false positive rate (96.4% in the NLST), leading to a high rate of follow-up investigation, potentially including invasive procedures to confirm the diagnosis, with potential for additional harms where cancer is not present.<sup>15</sup> The radiation dose of LDCT is ten times higher than chest radiography. Using data from the NLST, it is estimated that one cancer death per 2,500 people screened could be attributed to radiation exposure.<sup>8</sup>
- The effect of LDCT screening on quality of life is yet to be determined, although there is some emerging evidence on this issue.<sup>30,31</sup> There is potential for harm as a result of anxiety associated

with positive test results (both true and false positives), false negative results, health system and personal costs and disease overdiagnosis.

- There is limited data on the overdiagnosis rate for LDCT lung cancer screening (estimated at 18.5% (95% CI: 5.4%-30.6%) using NLST data).<sup>32</sup> Studies on screening with chest radiographs estimated an overdiagnosis rate of 25%.
- There is no evidence that smoking cessation is affected by LDCT screening (specifically no evidence that smokers are falsely reassured by screening), however, screening potentially diverts scarce health dollars from tobacco control measures.<sup>23</sup>

## References

---

- <sup>1</sup> International Agency for Research on Cancer (2012). *GLOBOCAN 2012: estimated cancer incidence, mortality and prevalence worldwide in 2012 – Lung cancer fact sheet*. Accessed 12/05/14. [http://globocan.iarc.fr/Pages/fact\\_sheets\\_cancer.aspx?cancer=lung](http://globocan.iarc.fr/Pages/fact_sheets_cancer.aspx?cancer=lung)
- <sup>2</sup> Australian Institute of Health and Welfare (2014). *Australian Cancer Incidence and Mortality (ACIM) books: Lung cancer*. Canberra: AIHW. <http://www.aihw.gov.au/acim-books>
- <sup>3</sup> Australian Institute of Health and Welfare (2013). *Lung Cancer*. Accessed 12/05/14. <http://www.aihw.gov.au/cancer/lung/>
- <sup>4</sup> Australian Institute of Health and Welfare and Cancer Australia (2011). 'Lung cancer in Australia: an overview.' *Cancer series no. 64. Cat. no. CAN 58*. Canberra: AIHW.
- <sup>5</sup> Ridolfo, B & Stevenson, C. (2001). 'The quantification of drug-caused mortality and morbidity in Australia, 1998'. *Drug statistics series no. 7. Cat. no. PHE 29*. Canberra: AIHW.
- <sup>6</sup> Moyer, VA. (2014). 'U.S. Preventive Services Task Force. Screening for lung cancer: U.S. Preventive Services Task Force recommendation statement.' *Ann Intern Med*, 160(5):330-8.
- <sup>7</sup> ABIM Foundation. (2014). *Choosing Wisely*. Accessed 1/09/15. <http://consumerhealthchoices.org/catalog/ct-scans-find-lung-cancer-smokers-chestats/>
- <sup>8</sup> Bach, P., Mirkin, J., Oliver, T., Azzoli, C., Berry, D., Brawley, O., Byers, T., Colditz, G., Gould, M., Jett, J., Sabichi, A., Smith-Bindman, R., Wood, D., Qaseem, A., Detterbeck, F. (2012). 'Benefits and Harms of CT Screening for Lung Cancer.'. *JAMA*: 307(22): 2418-29.
- <sup>9</sup> Canadian Partnership Against Cancer, Lung Screening Expert Panel. (2011). 'Lung Cancer Screening Expert Panel: Summary of Existing and New Evidence.' Toronto: Canadian Partnership Against Cancer: 2011.
- <sup>10</sup> Vansteenkiste, J., Doooms, C., Mascaux, C., Nackaerts, K. (2012). 'Screening and early detection of lung cancer'. *Annals of Oncology* 23: 320-327.
- <sup>11</sup> Australian Population Health Development Principal Committee – Screening Subcommittee. (2008) *Population Based Screening Framework*. AHMAC. Accessed 12/05/14. [cancerscreening.gov.au](http://cancerscreening.gov.au)
- <sup>12</sup> Centres for Disease Control and Prevention. (2014). 'What are the risk factors for lung cancer?' Accessed 1/09/15. [http://www.cdc.gov/cancer/lung/basic\\_info/risk\\_factors.htm](http://www.cdc.gov/cancer/lung/basic_info/risk_factors.htm)
- <sup>13</sup> Australian Institute of Health and Welfare. (2012). 'Cancer survival and prevalence in Australia: period estimates from 1982 to 2010.' *Cancer series no. 69. Cat. No. CAN 65*. Canberra: AIHW.
- <sup>14</sup> Oken, MM., Hocking, WG., Kvale, PM., Andriole, GL., Buys, SS., Church, TR., et al. (2011). 'Screening by Chest Radiograph and Lung Cancer Mortality', *JAMA*, 306(17): 1865-1873.
- <sup>15</sup> National Lung Screening Trial Research Team, Aberle, DR., Adams, AM., Berg, CD., et al. (2011). 'Reduced lung-cancer mortality with low-dose computed tomographic screening.' *N Engl J Med*. 365(5): 395-409.
- <sup>16</sup> Infante, M., Cavuto, S., Lutman, P.R., et al. (2009). 'A randomized study of lung cancer screening with spiral computed tomography: three year results from the DANTE trial', *Am J Respir Crit Care Med.*, 180:445-53.
- <sup>17</sup> van Iersel, CA., de Koning, HJ., Draisma, G., Mali, WP., Scholten, ET., Nackaerts, K., Prokop, M., Habbema, JD., Oudkerk, M., van Klaveren, RJ. (2007). 'Risk-based selection from the general population in a screening trial: selection criteria, recruitment and power for the Dutch-Belgian randomised lung cancer multi-slice CT screening trial (NELSON)', *Int J Cancer*, 120(4):868.
- <sup>18</sup> Pedersen, JH., Ashraf, H., Dirksen, A., Bach, K., Hansen, H., Toennesen, P., Thorsen, H., Brodersen, J., Skov, BG., Døssing, M., Mortensen, J., Richter, K., Clementsen, P., Seersholm, N. (2009). 'The Danish randomized lung cancer CT screening trial-overall design and results of the prevalence round', *J Thorac Oncol*. 4(5):608.

- 
- <sup>19</sup> Marshall, HM., Bowman, RV., Crossin, J., et al. (2013). 'Queensland Lung Cancer Screening Study: rationale, design and methods.' *Intern Med J.* 43(2):174-82.
- <sup>20</sup> Marshall, HM., Bowman, RV., Ayres, J., Crossin, J., Lau, M., Slaughter, RE., Redmond, S., Passmore, L., McCaul, E., Courtney, D., Leong, SC., Windsor, M., Zimmerman, PV., Yang, IA., Fong, KM. (2015). 'Low-dose CT screening using the NLST protocol appears feasible in the Australian health setting', *Eur Respir J.* 45(1): 1734-1737. doi: 10.1183/09031936.00208714
- <sup>21</sup> Manser, R., Dalton, A., Carter, R., Byrnes, G., Elwood, M., Campbell, DA. (2005) 'Cost-effectiveness analysis of screening for lung cancer with low dose spiral CT (computed tomography) in the Australian setting.' *Lung Cancer*, 48(2):171-85.
- <sup>22</sup> Black, WC., Gareen, IF., Soneji, SS., Sicks, JD., Keller, EB., Aberle, DR., Naeim, A., Church, TR., Silvestri, GA., Gorelick, J., and Gatsonis, C. (2014). 'Cost-Effectiveness of CT Screening in the National Lung Screening Trial.' *The New England Journal of Medicine*, 371(19): 1793-1801
- <sup>23</sup> McMahan, PM., Kong, CY., Bouzan, C., Weinstein, MC., Cipriano, LE., Tramontano AC., Johnson, BE., Weeks, JC., and Gazelle, GS. (2011). 'Cost-Effectiveness of CT Screening for Lung Cancer in the U.S.', *J Thorac Oncol.* 6(11): 1841-1848. doi: 10.1097/JTO.0b013e31822e59b3
- <sup>24</sup> Goffin, JR., Flanagan, WM., Miller, AB., Fitzgerald, NR., Memon, S., Wolfson, MC., and Evans, WK. (2015). 'Cost-effectiveness of Lung Cancer Screening in Canada.' *JAMA Oncol.* Published online July 30, 2015. doi:10.1001/jamaoncol.2015.2472
- <sup>25</sup> Department of Health and Ageing. (2009). *BreastScreen Australia Evaluation: Economic Evaluation and Modelling Study.* Commonwealth of Australia.
- <sup>26</sup> Pignone, MP., Flitcroft, KL., Howard, K., Trevena, LJ., Salkeld, GP., and St John, DJB. (2011). 'Costs and cost-effectiveness of full implementation of biennial faecal occult blood test screening program for bowel cancer in Australia.' *MJA*, 194(4): 180-185.
- <sup>27</sup> Heuvelmans, MA., Vliegthart, R., and Oudker, M. (2015). 'Contributions of the European Trials (European Randomised Screening Group) in Computed Tomography Lung Cancer Screening. *J Thorac Imaging*, 30(2): 101-107.
- <sup>28</sup> Ru Zhao Y, Xie X, de Koning HJ et al. (2011). 'NELSON lung cancer screening study'. *Cancer Imaging*, 3 (11): 79-84.
- <sup>29</sup> Tammemägi, MC., Katki, HA., Hocking, WG., Church, TR., Caporaso, N., Kvale, PA., Chaturvedi, AK., Silvestri, GA., Riley, TL., Commins, J., and Berg, CD., (2013). 'Selection Criteria for Lung-Cancer Screening.' *N Engl J Med*, 368: 728-736.
- <sup>30</sup> van den Bergh, KA., Essink-Bot, ML., Borsboom, GJ., Scholten, E., van Klaveren, RJ., and de Koning, HJ. (2011). 'Long-term effects of lung cancer computed tomography screening on health-related quality of life: the NELSON trial', *Eur Respir J*, 38: 154-61.
- <sup>31</sup> Gareen, IF., Duan, F., Greco, EM., et al. (2014). 'Impact of lung cancer screening results on participant health-related quality of life and state anxiety in the National Lung Screening Trial.' *Cancer*. doi: 10.1002/cncr.28833. [Epub ahead of print]
- <sup>32</sup> Patz, EF Jr., Pinsky, P., Gatsonis, C., et al. (2014). 'Overdiagnosis in low-dose computed tomography screening for lung cancer.' *JAMA Intern Med.* 174(2): 269-74.