

Lung Cancer Screening & Occupational Lung Disease

Rural Physicians Workshop Sept 2024

Prof Fraser Brims

Sir Charles Gairdner Hospital & Curtin Medical School

resp-scgh.com.au



institute for
RESPIRATORY HEALTH





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National Lung Cancer Screening Program

The new NLCSP is a screening program using low-dose computed tomography scans to look for lung cancer in high-risk people without any symptoms. It aims to find lung cancer early and reduce deaths from lung cancer. Screening services will begin for eligible people from July 2025.



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5th

Most commonly
diagnosed cancer in
Australia

1st

Leading cause of cancer
death in Australia

24[%]

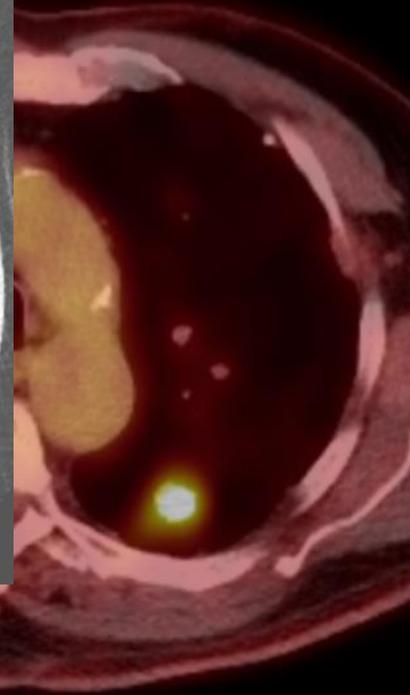
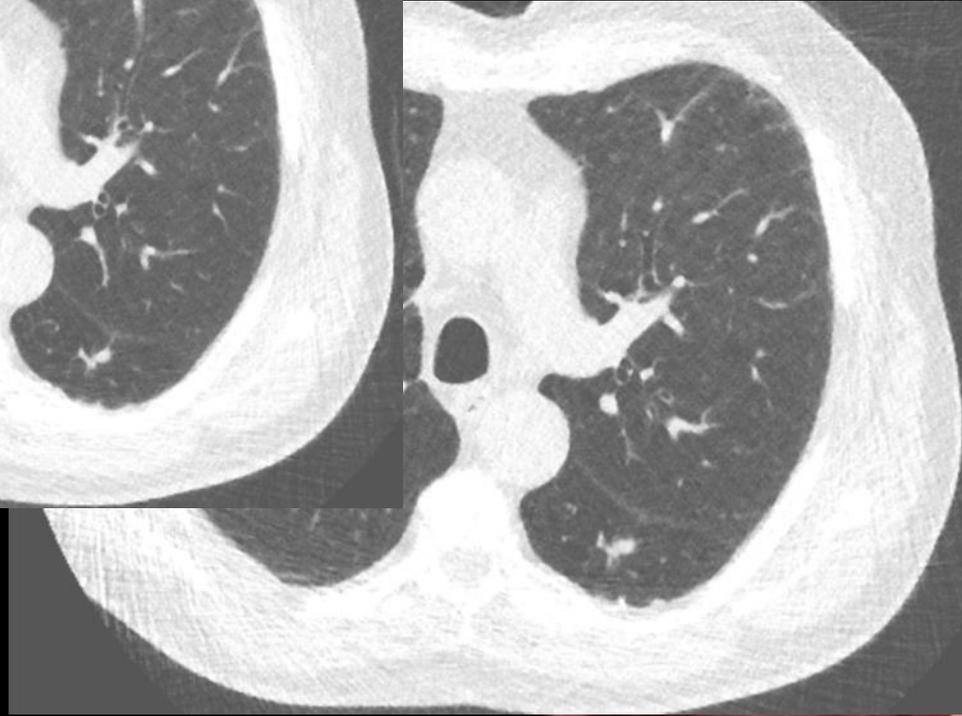
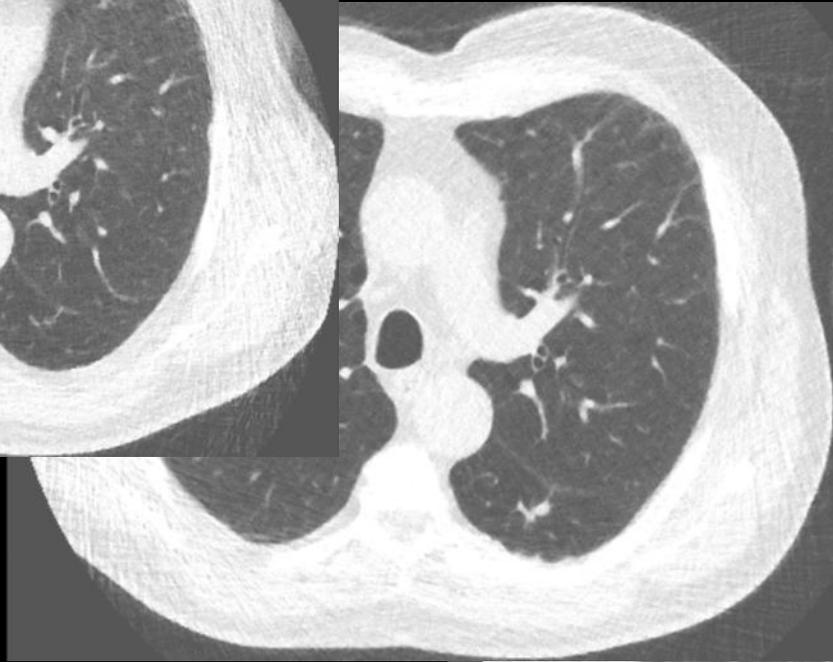
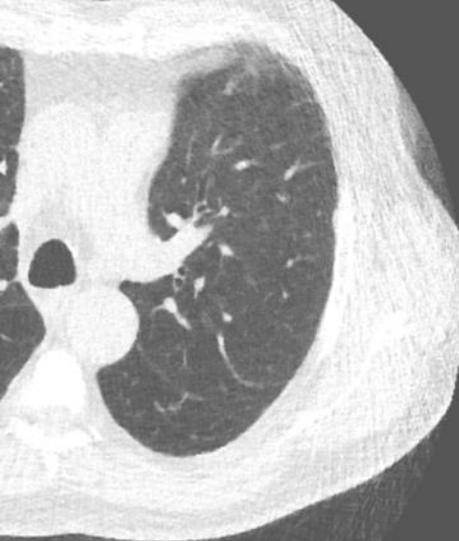
5-year survival



20%

Of lung cancers are in **never smokers**

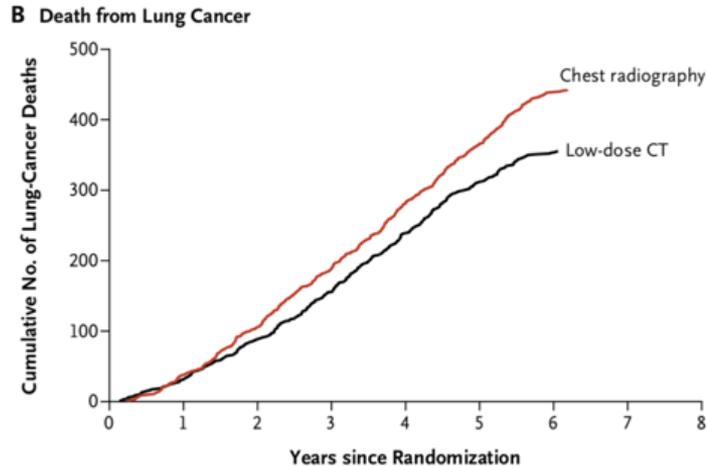
LDCT detection of early lung cancer is effective



Early Detection is effective

National Lung Screen Trial (NLST)

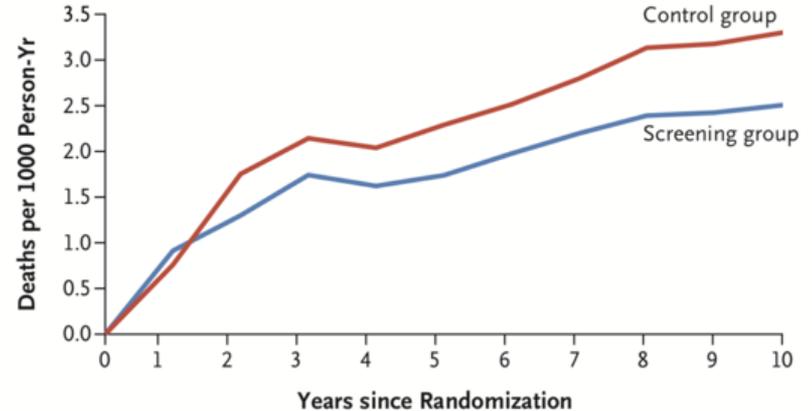
- LDCT screening vs CXR
- ↓ Lung Cancer Specific Mortality **20%**
- ↓ All Cause Mortality (6.7%)
- N = 53,454, 6 years follow-up



NELSON Study

- 10 years follow-up
- N = 15,792 1:1 LDCT vs No screening
- **26% reduction** in lung cancer deaths for men
- **~30% reduction** in lung cancer deaths for women

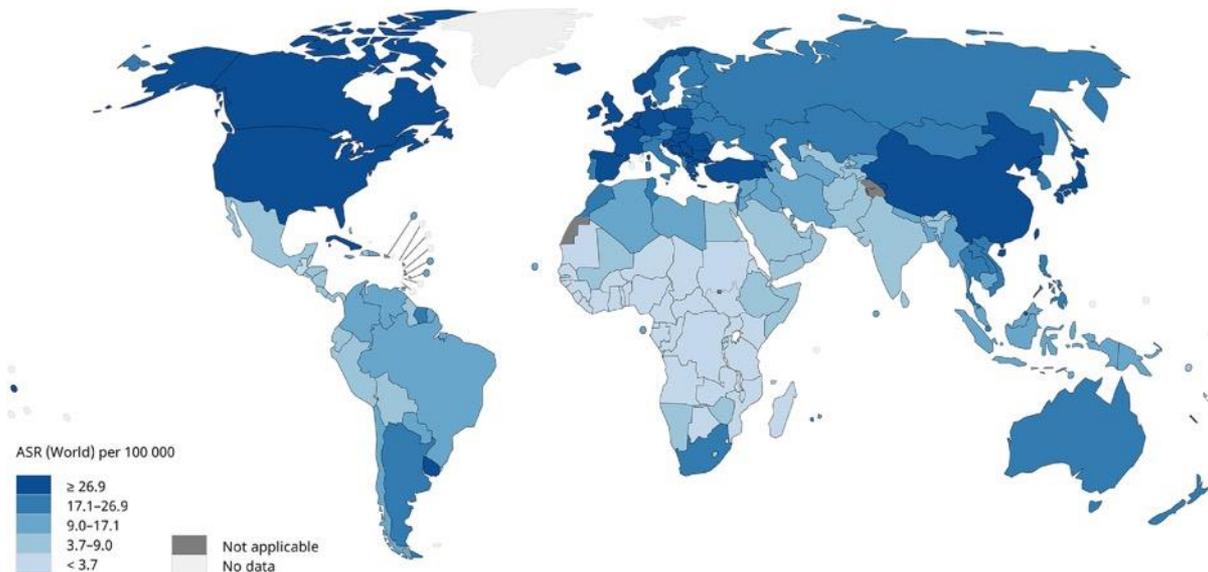
B Lung-Cancer Mortality



LCS around the world (public funding)

- USA
- Canada
- S Korea
- Poland
- Croatia
- Taiwan
- UK
- **Australia**

Estimated age-standardized incidence rates (World) in 2020, lung, both sexes, all ages



12,000

Lives saved with the adoption of LCS in Australia in next 10 years

Targeting High Risk Participants strongly influences outcomes

Targeting High Risk Participants strongly influences outcomes

- **NLST 55-74-30-15**
- **USPSTF₂₀₁₃** – Age 55-80 – 30-15
- **USPSTF₂₀₂₁** – Age 50-80 – 20-15
- **UK** - Age 55-74 - LLP_{v2} ≥5%

LC risk factors

Age

Tobacco smoke

Family Hx

Biofuel exposure

Occupational exposure

COPD

BMI

Social Class

Air pollution



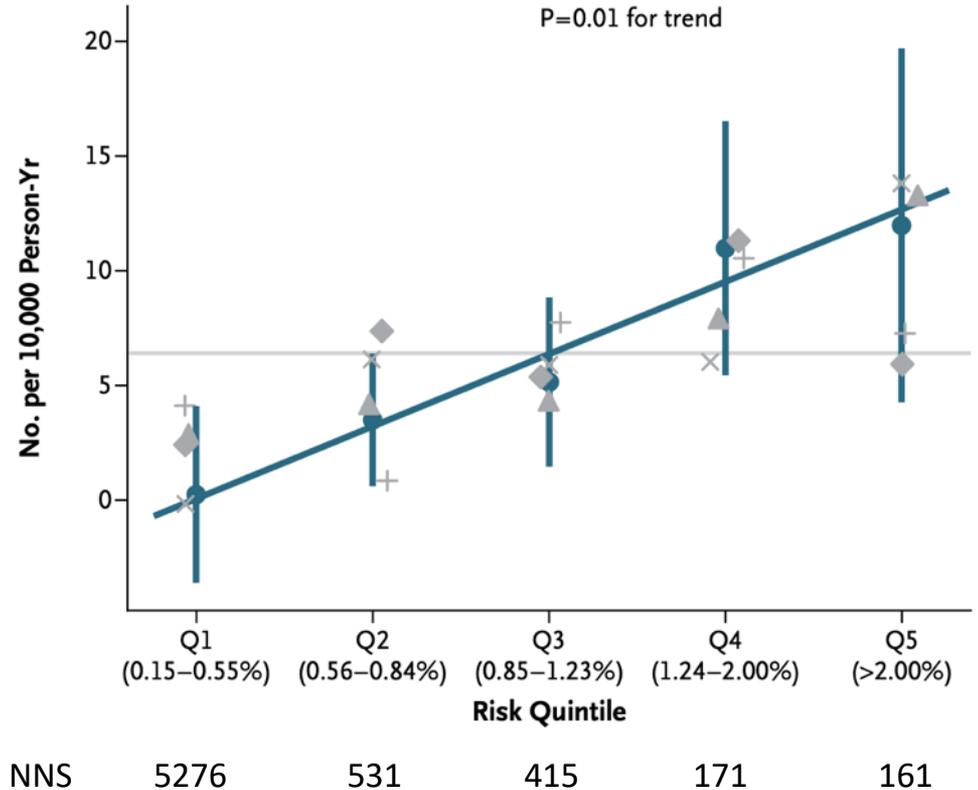
**Even in high-risk
populations, the risk is
heterogeneous**



Heterogeneous risk

- Quintiles of risk from NLST
 - Highest 20%:
 - 33 deaths prevented
- Lowest 20%:
- 1 death prevented

B Lung-Cancer Deaths Prevented by Low-Dose CT



National Lung Cancer Screening Program



Eligibility:

- **50 – 70yrs, >30 pk yrs, <10 yrs quit**
- Bi-annual low dose CT chest

Key role for primary care

- Recruitment via GPs
- Check eligibility
- Shared decision making
- Enroll onto NCSR
- Smoking cessation



Australian Government



PROMOTION & AWARENESS

Healthcare providers

ELIGIBILITY

Aged 50-70 years
old

+

30 pack-year
smoking
history

+

Currently
smoking or quit
in last 10 years

+

No signs or
symptoms
suggestive of
lung cancer

*NOT eligible for
screening?* →

PROMOTION & AWARENESS

Healthcare providers

ELIGIBILITY

Aged 50-70 years old

+

30 pack-year smoking history

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Currently smoking or quit in last 10 years

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No signs or symptoms suggestive of lung cancer

NOT eligible for screening?

PROGRAM ENTRY

Participant Identification & Recruitment

Healthcare providers

Organised Opportunistic Facilitated Self-identify

Eligibility confirmed in general practice or by specialist

Shared Decision-Making

Authorised medical practitioner

Person supported to make decision about screening

Informed choice & consent

Low-dose CT Scan Suitability Assessment

Suitable to undergo low-dose CT scan

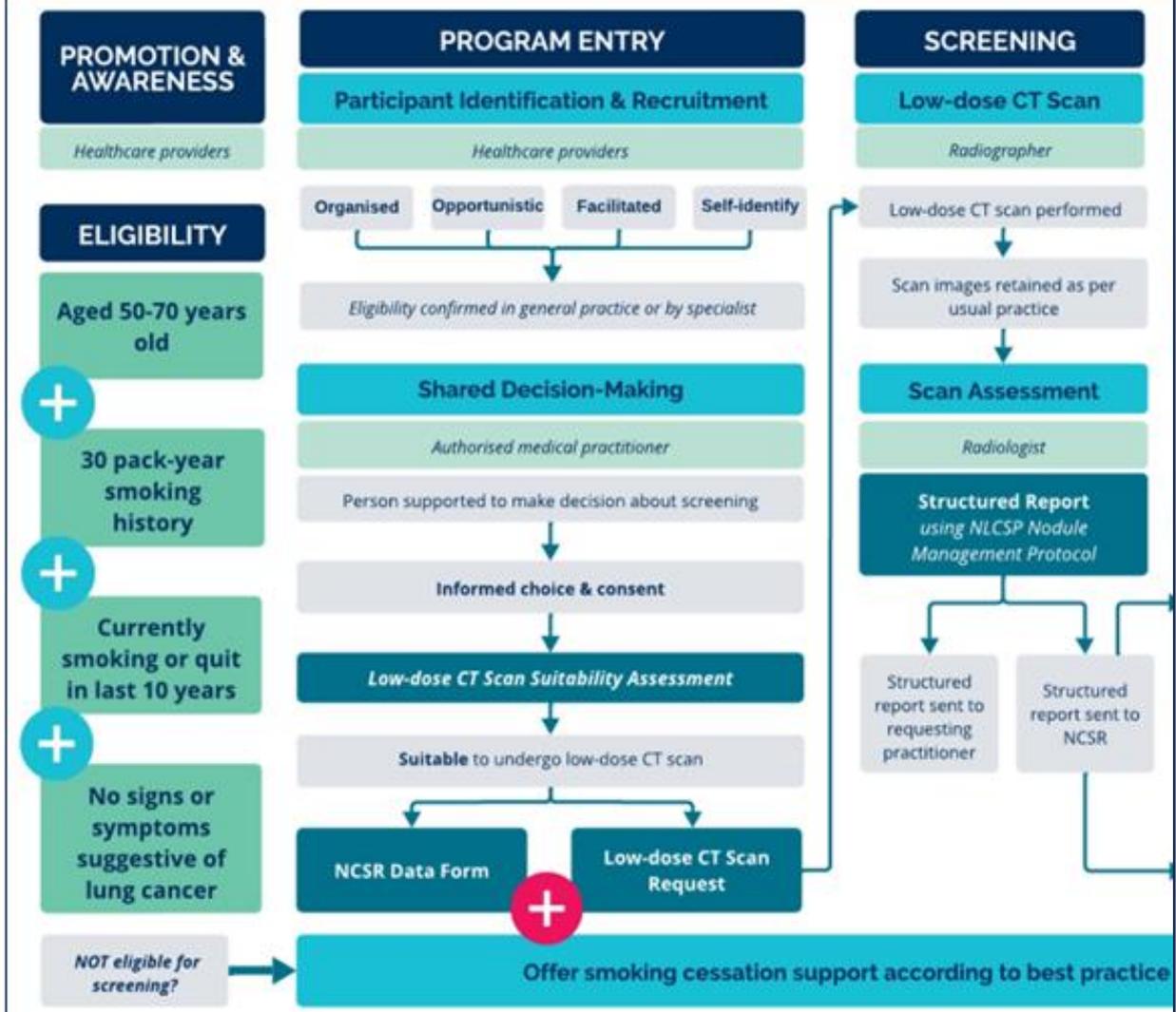
NCSR Data Form

Low-dose CT Scan Request

+

Offer smoking cessation support





PROMOTION & AWARENESS

Healthcare providers

ELIGIBILITY

Aged 50-70 years old



30 pack-year smoking history



Currently smoking or quit in last 10 years



No signs or symptoms suggestive of lung cancer

NOT eligible for screening?

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Suitable to undergo low-dose CT scan

NCSR Data Form

Low-dose CT Scan Request

SCREENING

Low-dose CT Scan

Radiographer

Low-dose CT scan performed

Scan images retained as per usual practice

Scan Assessment

Radiologist

Structured Report using NLCSP Nodule Management Protocol

Structured report sent to requesting practitioner

Structured report sent to NCSR

RESULTS & MANAGEMENT

Very low risk

Return for screening in 24 months

Low risk

Return for screening in 12 months

Low to moderate risk

Return for screening in 6 months

Moderate risk

Return for screening in 3 months

High risk

Refer to respiratory physician linked to lung cancer multidisciplinary team

Very high risk

Additional actionable findings

As appropriate to the specific finding

Results & Reminders

Requesting medical practitioner

NCSR sends results to requesting practitioner (and GP)

Findings with no further action needed

NCSR notifies participant of result

NCSR reminds participant to screen at required interval

Findings with further action needed

NCSR notifies participant to contact GP

GP provides results to participant

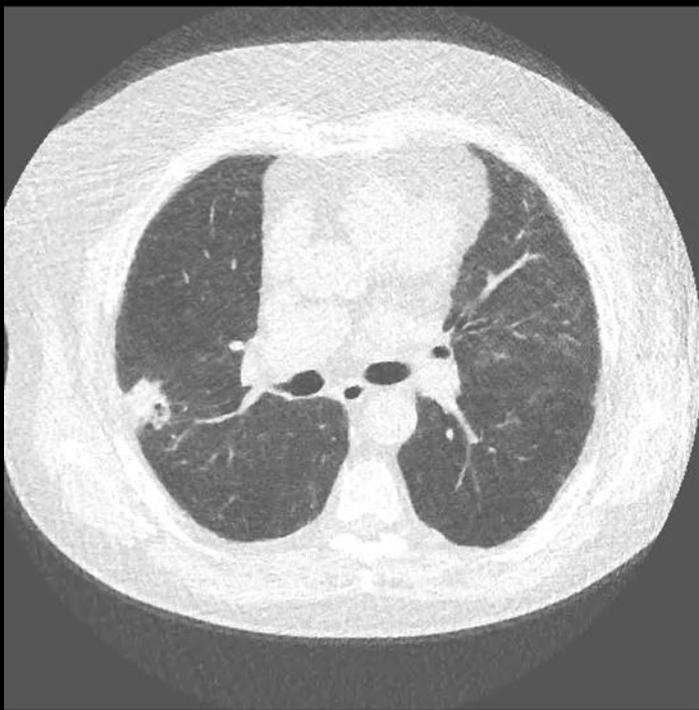
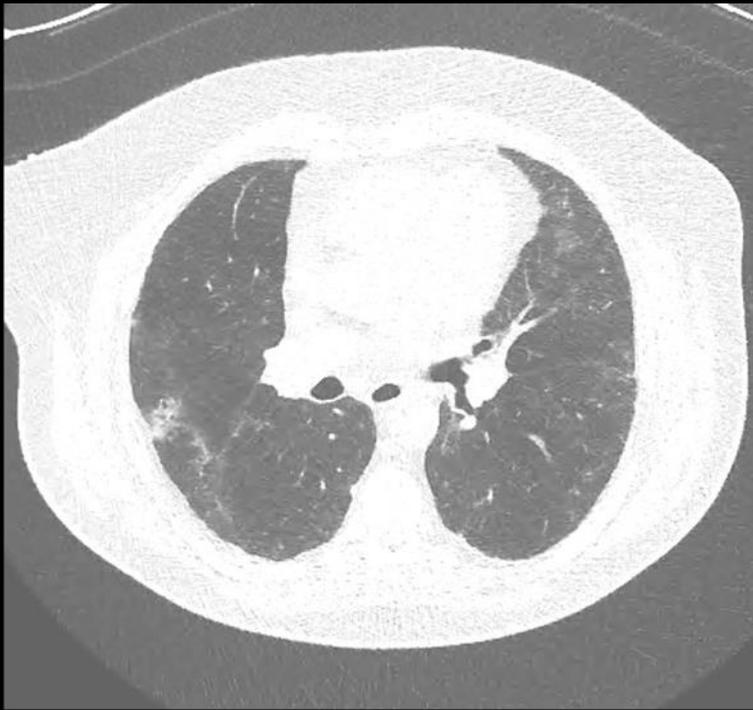
Offer smoking cessation support according to best practice guidelines (ASK, ADVISE, HELP)

Triaging at screening program entry with PanCan nodule risk

	CATEGORY	PROPORTION	ACTION
1	Very low risk [No nodules or <1.5%]	75%	Rescreen 2 years
2	Low risk [≥1.5 to <6%]	14%	Interval LDCT 12 mths
3	Moderate risk [≥6 to <30%]	8%	Interval LDCT 3 mths
4 or 5	High risk or Suspicious for lung cancer [≥30% or radiologist recommendation]	2.8%	Refer to Thoracic Malignancy team

McWilliams A et al. WCLC Sep 2024

PPV 48.7%

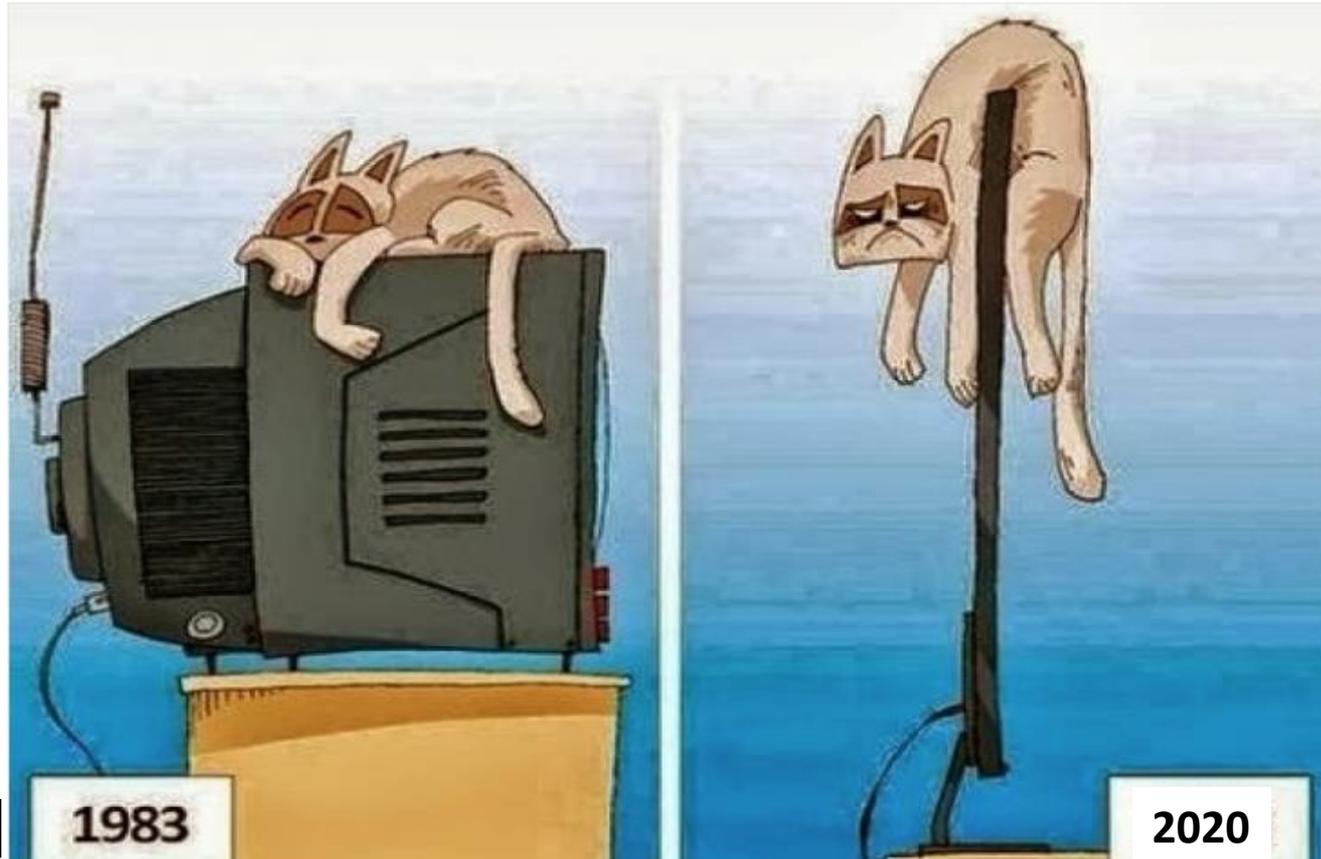


WA response and planning for NLCSP

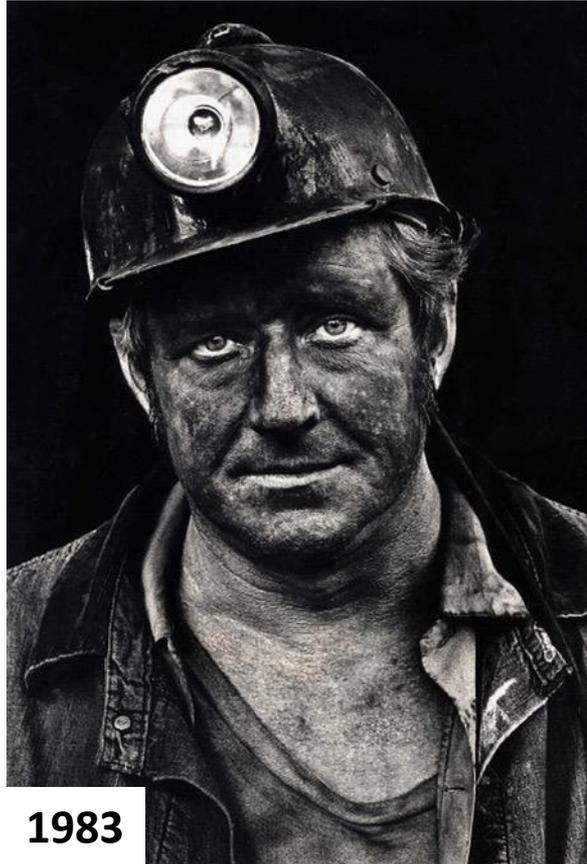
- WA Health – remarkably proactive
- Mobile CT screening trucks to serve rural population(s)
- Utilising fixed CTs (Apex)



Things are changing



Things are changing



1983



2020

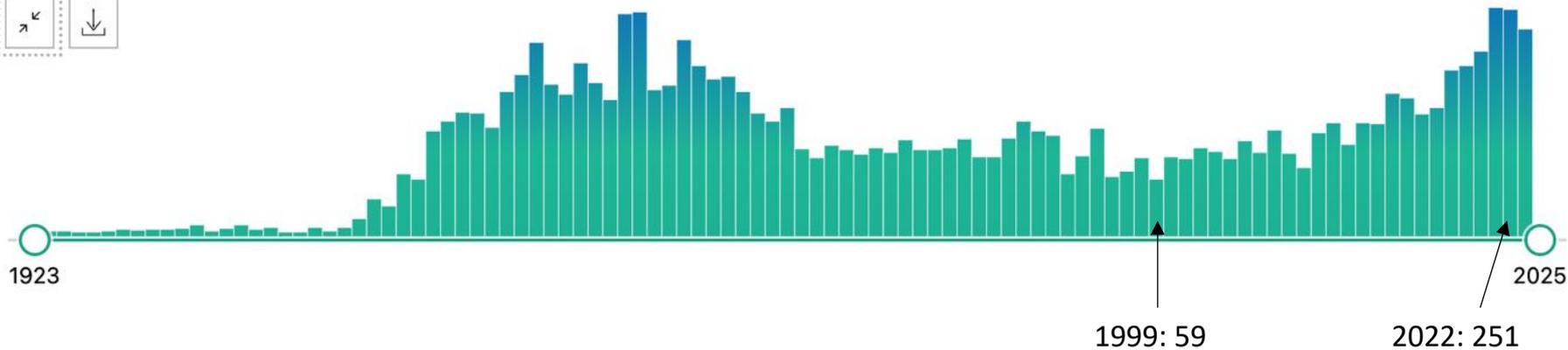


Curtin University



RESULTS BY YEAR

9,723 results



Bad bench tops



Respirable Crystalline Silica (RCS)

- Silica (silicon dioxide) is the most abundant mineral on earth
- Quartz is the most common type of crystalline silica

- Hydrated magnesium silicate



Respirable Crystalline Silica (RCS)

- Silica (silicon dioxide) is the most abundant mineral on earth
- Quartz is the most common type of crystalline silica
- Hydrated magnesium silicate = asbestos

Other exposures (and RCS proportion)

- Granite (~30%)
- Slate (~30%)
- Sandstone (~80%)
- Concrete (~30-70%)
- Marble (~2%)
- Artificial stone (> 90%)



2 Selected occupational interstitial lung diseases, causes and example occupations

Agent	Example occupations
Pneumoconiosis	
Asbestos	Asbestos waste handler, carpenter, construction worker, electrician, mechanic, miner, railway worker, shipyard worker
Coalmine dust	Coalminer
Silica	Benchtop fabricator, ceramics worker, miner, quarry worker, stonemason, sandblaster, tunneller
Talc	Talc miner and miller
Kaolin	Ceramics manufacturer
Hypersensitivity pneumonitis	
Bacteria	Compost worker, farmer, machinist, mushroom worker, swimming pool/spa worker
Fungi	Cheese worker, mushroom worker, tobacco grower, woodworker
Animal proteins	Bird breeder, laboratory worker, textile worker
Low molecular weight chemicals	Dental technician, painter, plastic industry, polyurethane foam worker, yacht manufacturer
Granulomatous lung disease	
Beryllium	Aerospace industry worker, electronics worker, electronics/computer parts recycler
Cobalt	Diamond polisher, grinder operator, industrial tool sharpener
Aluminium	Aircraft industry worker, chemist, metal recycler
Other interstitial disorders	
Indium tin oxide	Manufacture and recycling liquid crystal displays
Acramin (organising pneumonia)	Textile worker
Nylon flock	Textile worker
Mineral oils (lipoid pneumonia)	Mill operator, painter

References: Litow et al;³⁰ Newman Taylor A, Cullinan P, Blanc P, Pickering A, editors. Parkes' occupational lung disorders. 4th ed. Boca Raton: Boca Raton, 2016; Hendrick DJ, Burge PS, Beckett WS, Churg A, editors. Occupational disorders of the lungs: recognition, management and prevention. London: WB Saunders, 2002. ♦



Respirable crystalline silica and silicate dust exposure

No detectable disease



Simple silicosis
(Includes chronic silicosis and silicosis with >10 years since first exposure when not complicated)



Complicated silicosis
(A definition based on imaging when size of nodules >1 cm in diameter (PMF) or change of more than one ILO subcategory within 60 months)



Slowly progressive
(Includes late-stage classical silicosis in which significant emphysema, COPD, and/or traction bronchiectasis is present)

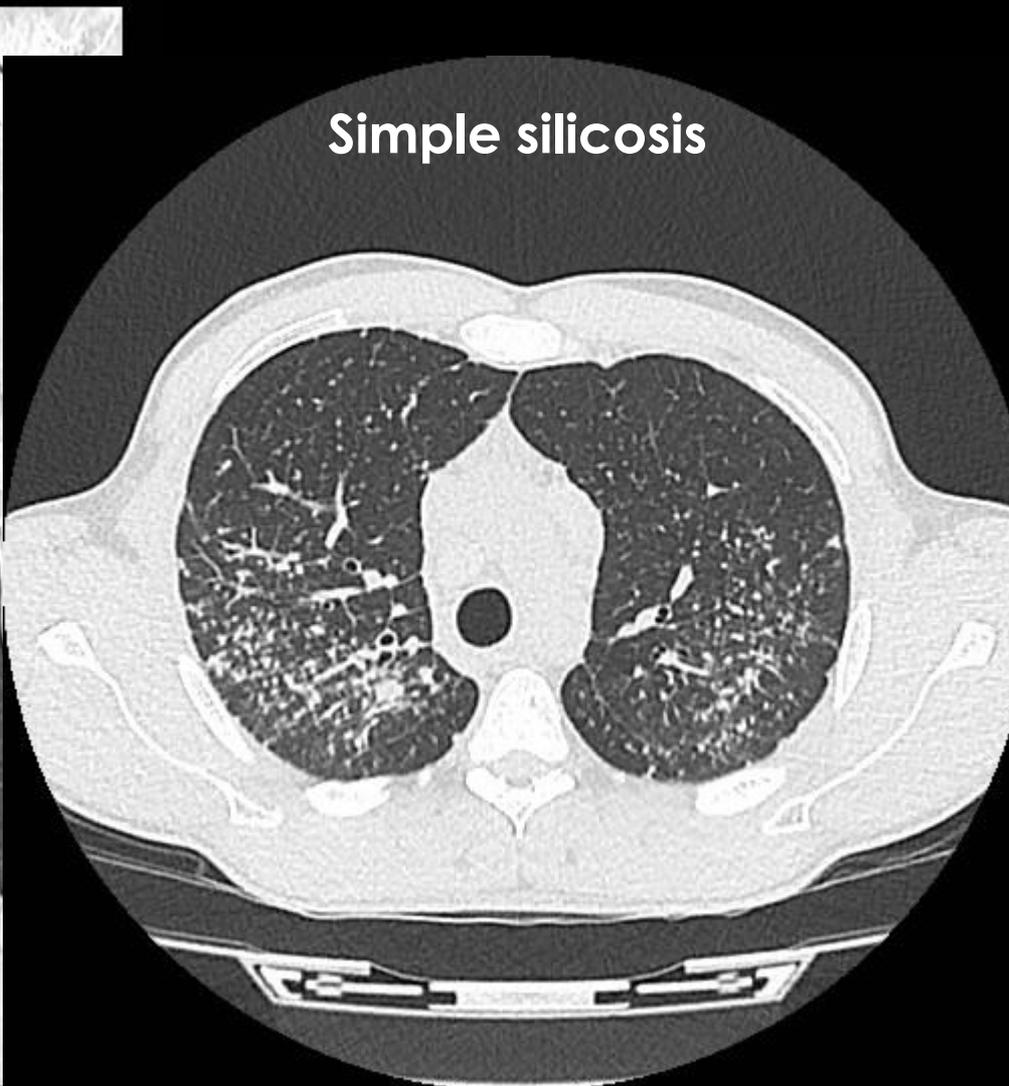
Rapidly progressive
(Includes accelerated silicosis¹ if <10 years since first exposure and FEV1 or FVC declines by >15% from baseline over any period)²

Acute silicosis
(<3 years since first exposure typically with silica induced alveolar proteinosis)

Radiology

Speed of progression

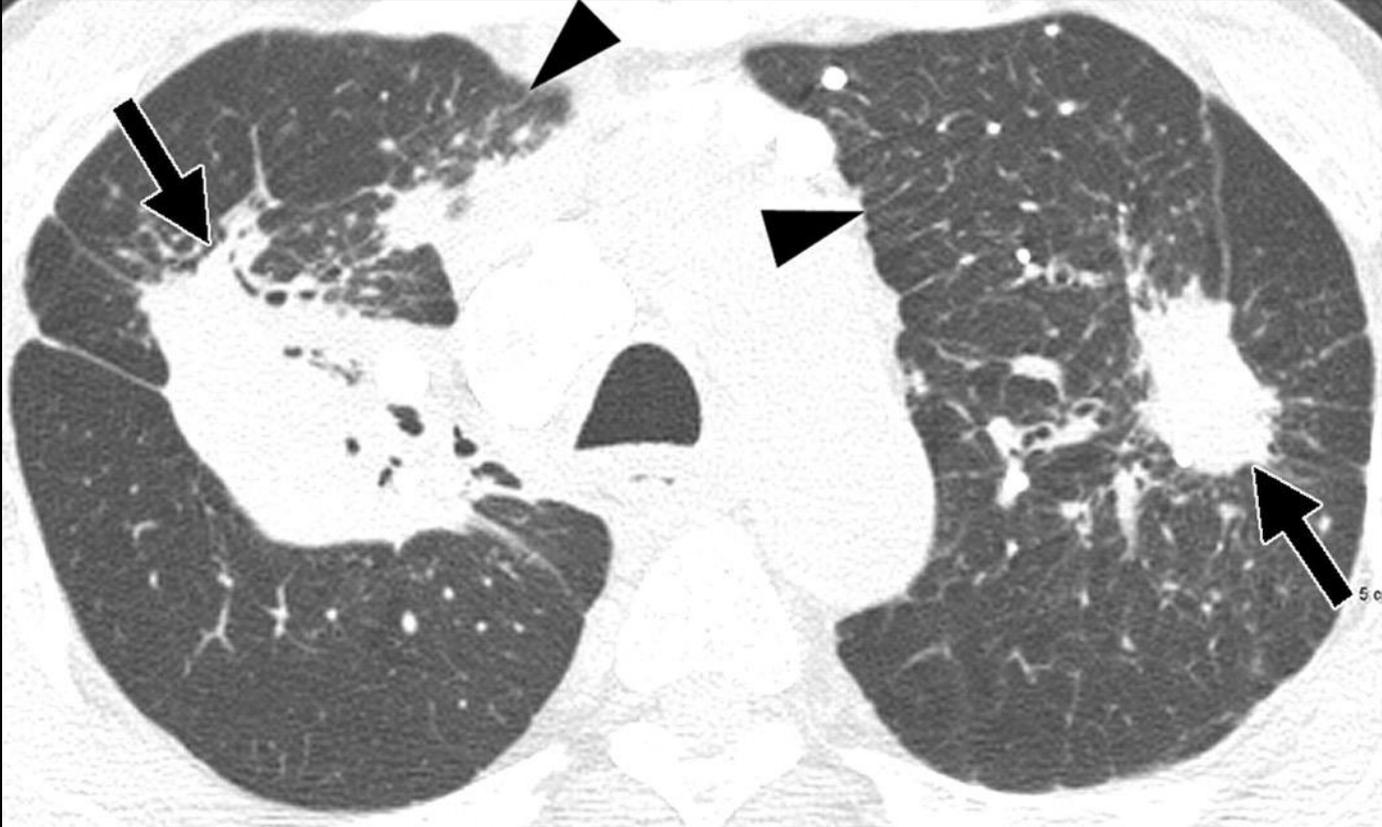




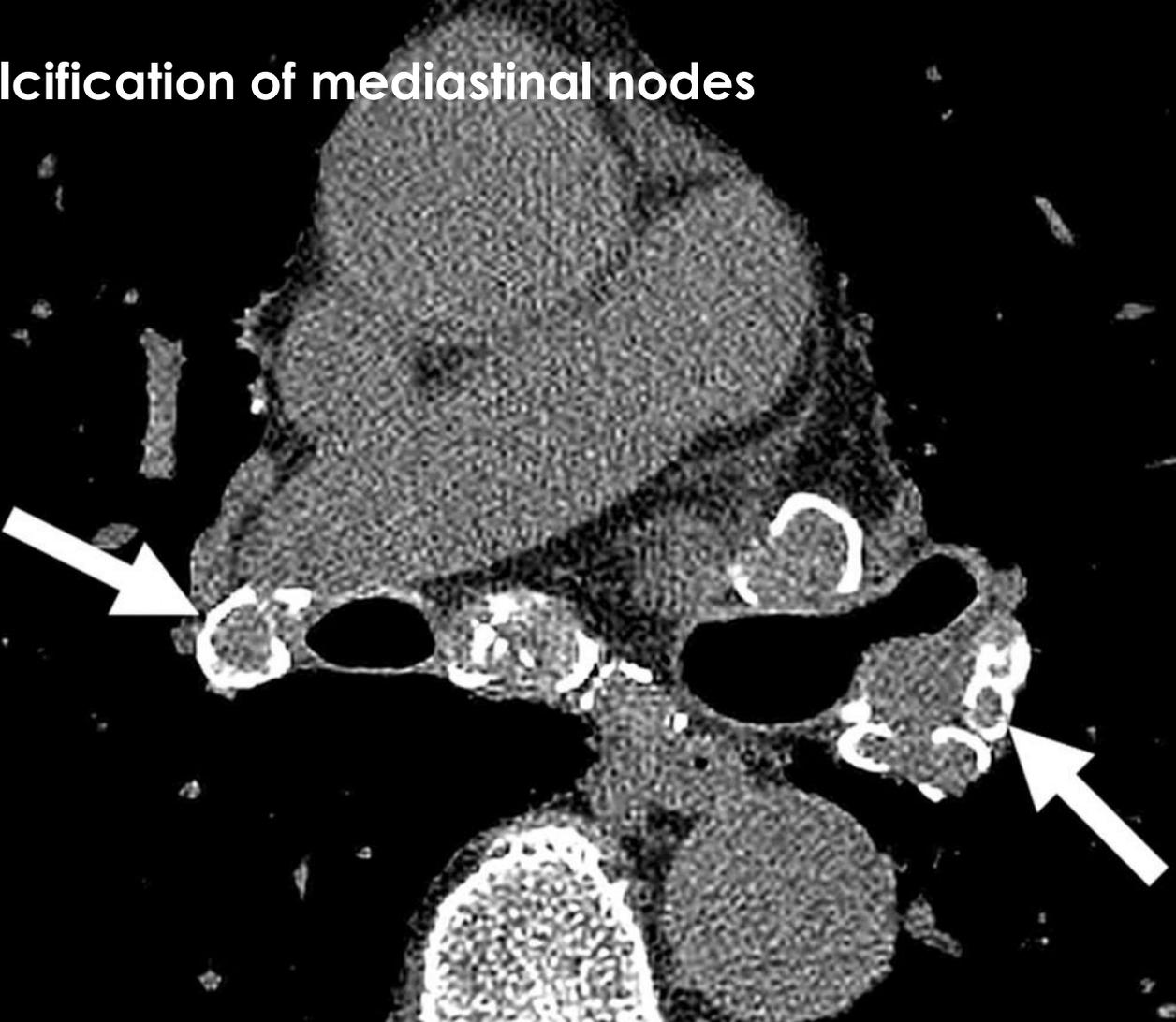
(Becoming) Complicated Silicosis



Progressive Massive Fibrosis

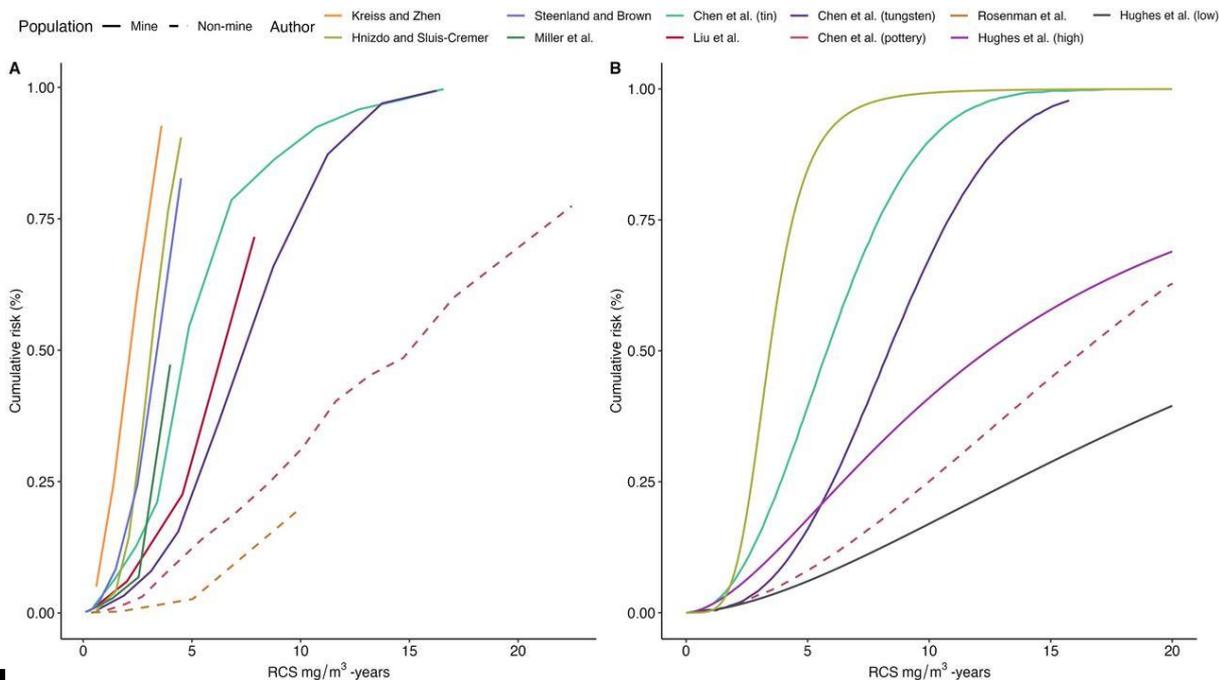


Egg Shell calcification of mediastinal nodes



Relationship between cumulative silica exposure and silicosis: a systematic review and dose-response meta-analysis

Patrick Howlett ¹, Jeffrey Gan,¹ Maia Lesosky,¹ Johanna Feary ^{1,2}



Exposure assessment

1. What proportion of time did you spend doing dry work (without use of water)? (Circle answer)

Never 0%	Rarely 1 to <10%	Sometimes 10 to <25%	Frequently 25 to <50%	Very frequently 50 to <100%	Always 100%
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2. What proportion of time have you spent near someone else doing dry work since starting this job? (circle answer)

Never 0%	Rarely 1 to <10%	Sometimes 10 to <25%	Frequently 25 to <50%	Very frequently 50 to <100%	Always 100%
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Exposure intensity scale



Step 3: Exposure Dose

The exposure dose matrix considers the number of years a person has been in the industry (Step 1) and their likely exposure intensity (Step 2).

DURATION (years in industry)		DURATION			
		< 2	2-4	4-6	> 6
EXPOSURE INTENSITY	LOW	LOW	LOW	MEDIUM	MEDIUM
	MEDIUM	MEDIUM	HIGH	HIGH	HIGH
	HIGH	HIGH	HIGH	HIGH	VERY HIGH
	VERY HIGH				

1. Monash University Centre for Occupational & Environmental Health (MonCOEH) (79); 2. Hoy, Glass (80); 3. WorkSafe Queensland Government (16); 4. Government of South Australia (84)

Clinical

- **Asymptomatic**
- Chronic cough and dyspnoea on exertion
- More common and severe with worsening radiographic abnormalities
- Physical examination: variable
- Lung function: variable
- Association with increased risk of TB
- Autoimmune syndromes (?)

Hoy R. *Occup Environ Med.* 2018; **75**:3-5



Accelerated silicosis

- Associated with high exposure.
- Develops within ~10 years of initial exposure.
- Same radiographic appearance as chronic silicosis
- Increased risk for the later development of PMF
- It is not known why some workers with high-level exposure develop acute silicosis and others develop accelerated silicosis.
- Acute alveolar proteinosis



The world is failing on silicosis

Editorial

www.thelancet.com/respiratory Vol 7 April 2019

- 1995 WHO & ILO campaign to eliminate silicosis by 2030
- India – estimated 11.5m exposed to silica
- China – booming mining industry
- Turkey – sandblasting
- USA – CDC rates – static, but increasing concern

Australia reports on audit of silicosis for stonecutters

World Report

Poorly managed working practices, including poor provision of education to artificial stonecutters, has led to what has been called an epidemic of silicosis. Tony Kirby reports.

www.thelancet.com Vol 393 March 2, 2019

QLD – Workplace Health & Safety inspections

- 552 compliance notices to 138 workplaces
- Screened 799 workers
 - 98 have silicosis
 - 15 of these PMF



Prevalence and risk factors for silicosis among a large cohort of stone benchtop industry workers

Ryan F Hoy ^{1,2}, Christina Dimitriadis,¹ Michael Abramson,³ Deborah C Glass ¹,
StellaMay Gwini ¹, Fiona Hore-Lacy,^{1,2} Javier Jimenez-Martin,¹
Karen Walker-Bone ¹, Malcolm R Sim ¹

117 / 541 (21.5%) exposed SBI workers had silicosis

Prevalence and risk factors for silicosis among a large cohort of stone benchtop industry workers

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Table 4 Relationship between silicosis diagnosis (outcome measure) and respiratory function tests for secondary screening participants

	No silicosis N=297	Confirmed silicosis N=117	No silicosis (ref) versus confirmed silicosis* OR (95% CI)	Simple silicosis N=96	Complicated silicosis N=21	Simple (ref) versus complicated silicosis OR (95% CI)
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All spirometry is within normal limits

Percentage of predicted, mean (SD)	101.9 (13.2)	98.3 (16.0)	0.98 (0.96 to 1.00)	100.6 (14.4)	87.5 (19.2)	0.95 (0.91 to 0.99)
z-score, median (P25, P75)	0.3 (-0.6, 0.8)	0.0 (-0.9, 0.7)	0.79 (0.64 to 0.98)	0.2 (-0.7,0.8)	-1.2 (-2.1,-0.1)	0.52 (0.32 to 0.84)
FEV ₁ /FVC†						
Percentage of predicted, mean (SD)	95.9 (7.8)	94.7 (10.9)	0.98 (0.95 to 1.01)	95.1 (11.1)	92.8 (9.9)	0.99 (0.94 to 1.04)
z-score, median (P25, P75)	-0.4 (-1.1, 0.1)	-0.7 (-1.5,0.3)	0.88 (0.70 to 1.10)	-0.5 (-1.6,0.3)	-1.1 (-1.5,-0.3)	0.88 (0.59 to 1.33)
D _L CO†						
Percentage of predicted, mean (SD)	104.2 (17.9)	94.9 (19.4)	0.98 (0.97 to 0.99)	99.0 (16.3)	76.0 (21.8)	0.92 (0.87 to 0.96)
z-score, median (P25, P75)	0.3 (-0.5, 1.0)	-0.4 (-1.2,0.4)	0.75 (0.62 to 0.93)	-0.3 (-1.0,0.5)	-2.1 (-2.6,-0.4)	0.31 (0.16 to 0.59)

Case finding

- Recommend / consider:
- Annual review
- Spirometry
- CXR (WA – ‘reduced dose HRCT’)



Health monitoring

Guide for crystalline silica



CXR – born c.1910



- Research has shown:-
 - Poor performance c.f. CT for most pathology
- Unchanged *screening* examination since 1910
- Fails in occupational disease because of limits to technology not interpretation

Why not just use CT ?

The ALARP principle



• Background (Aus)	2-3 mSv
• CXR	0.05 mSv
• Contrast CT Chest	3-4 mSv
• PET-CT	15 mSv
• LDCT	<1.5 mSv
• Ultra LDCT	<0.2 mSv
• 7 Hour flight	0.02 mSv



CXR



HRCT

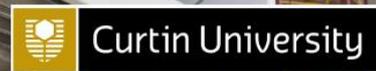


LDCT



WA Silicosis Screening Program (WASSP)

- Prospective cohort study comparing paired CXR and uLDCT in AS-exposed subjects



Health check for silicosis

Have you worked with artificial stone, undertaken stone benchtop grinding or cutting?

Do you need to have a WorkSafe WA health check?

The WA Silicosis Screening Program (WASSP) is offering free WorkSafe WA approved screening.

In addition to meeting all WorkSafe WA screening requirements, this study will compare the accuracy of plain chest x-rays with low dose CT scans in detecting silicosis

WHAT DO YOU NEED TO DO?

To participate in this voluntary study, call the study coordinator who will:

- Tell you more about the study
- See if you are eligible to participate
- Make an appointment for you to have your scans and lung function tests

HOW DO I CONTACT THE STUDY COORDINATOR?

Phone: 1800 512 456, please leave a message with your details and we will contact you.

Email: wassp@curtin.edu.au

Make tomorrow better.

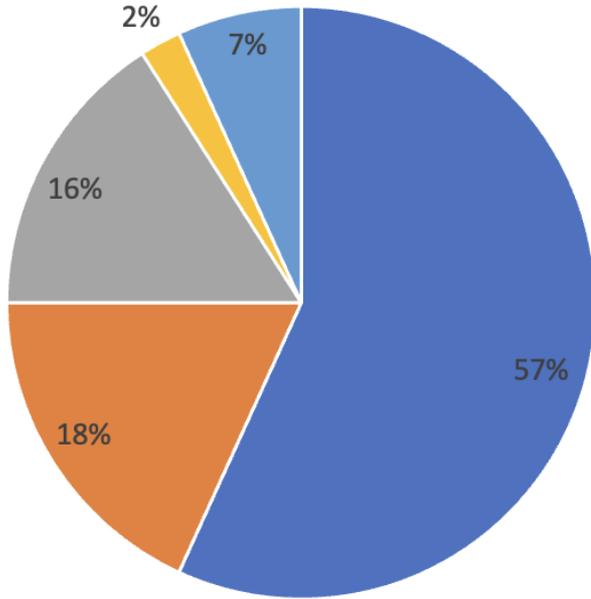
curtin.edu.au

WA Silicosis Screening Program (WASSP)

Male	45 (100)
Age	42.4 (33-47)
Born Australia	20 (44%)
Employee	33 (73%)
Years RCS exposure	12 (3 – 21)
Resp PPE provided	41 (91%)
Current Smoker (inc e-cig)	11 (24%)
Any resp symptom	7 (16%)



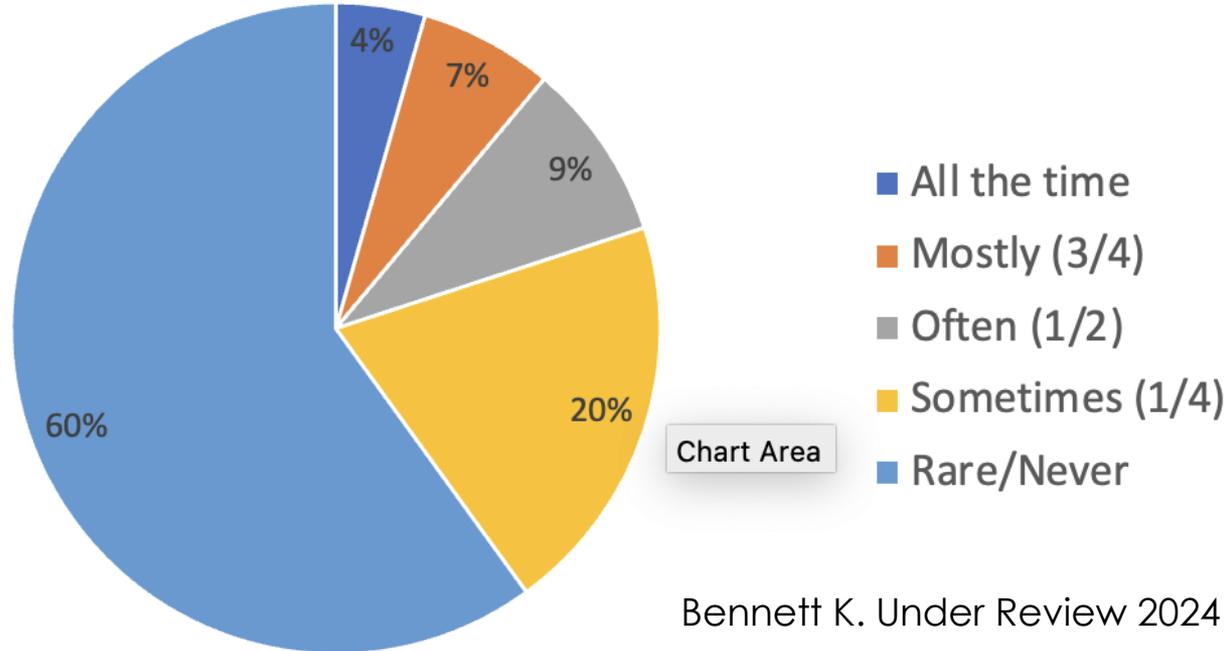
Actually Wearing PPE



Fit tested for RPPE n=16 (36%)
Clean shaven n=22 (49%)

40% don't wear PPE
40% dry cut

How often Dry Cut



WA Silicosis Screening Program (WASSP)

CXR silicosis	3 (6.7)
uLDCT silicosis	7 (15.6)
CXR Sensitivity	0.43 (95% C.I. 0.12, 0.8)
CXR Specificity	0.87 (95% C.I. 0.71, 0.95)



Curtin



Bennett K. Under Review 2024



Management

- **Recognise** – *case finding*
- **Avoidance** – *a ban on artificial stone benchtops*
- **Smoking / vaping cessation**

Management

- Close **surveillance** – *how long for? Annual / biannual ?*
- **Antifibrotics** (?)
- **Psychosocial support**
- **Whole lung lavage** (?)
- **Transplant**

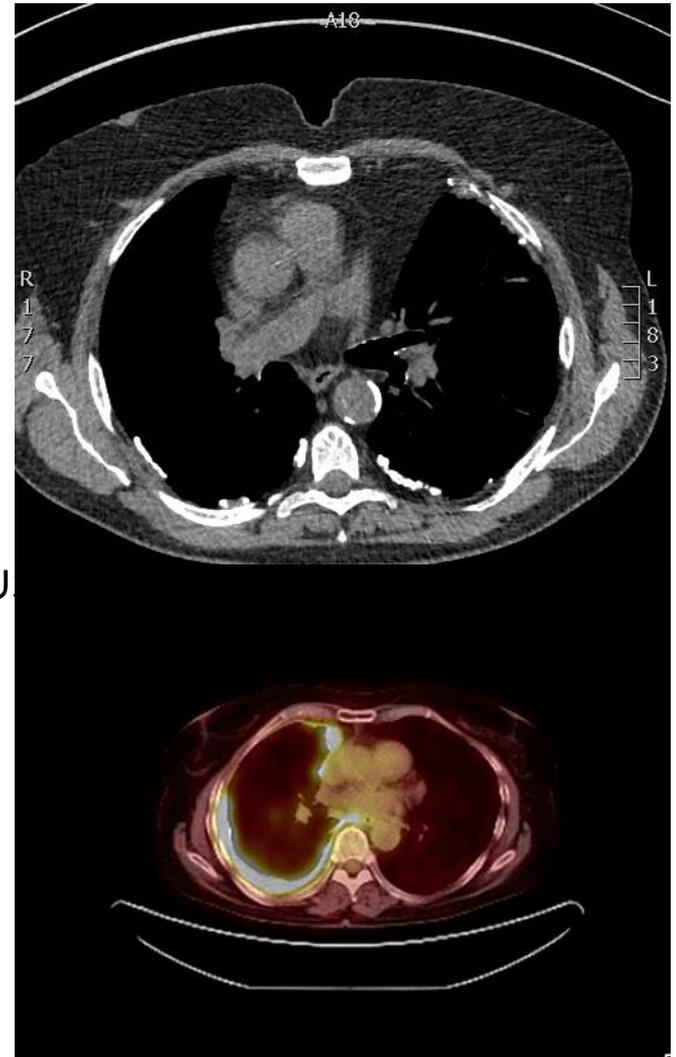




ASBESTOS

Effects on the lung

- “Benign” effects
 - Pleural plaques
 - Rolled atelectasis
 - Diffuse pleural thickening
 - Benign asbestos related pleural effusion
 - Asbestosis
- Malignant
 - Malignant mesothelioma
 - Lung cancer



ASBESTOS

Occupations at risk

Carpenters, joiners, builder

Plumber

Boilermakers

Fitters, turners, machinists

Telecommunications

Mechanic, fitter, panel beaters

Marine engineers

Shipwrights, Waterside workers

Armed services



Asbestos Review Program (ARP)

- **Established 1990**

- Wittenoom workers or families
- **≥ 3 months full time asbestos exposure**
- or pleural plaques present on imaging
- Any smoking status
- No age cut off

- **Imaging**

- Annual CXR until 2012
- **Annual LDCT since 2012**



ARP screening – 10 year data

- 11,834 uLDCT scans on **2,131 individuals**
- Median age **70 years** (IQR 63-75)
- **Male predominant:** 1,819 (85.4%)
- **Ever-smokers:** 1,357 (63.7%)



~1:35 of the ARP population develop lung cancer

- 66 lung cancers were diagnosed in 64 participants
(3.1% of cohort)
- 52.3% asbestosis
- 47.6% emphysema

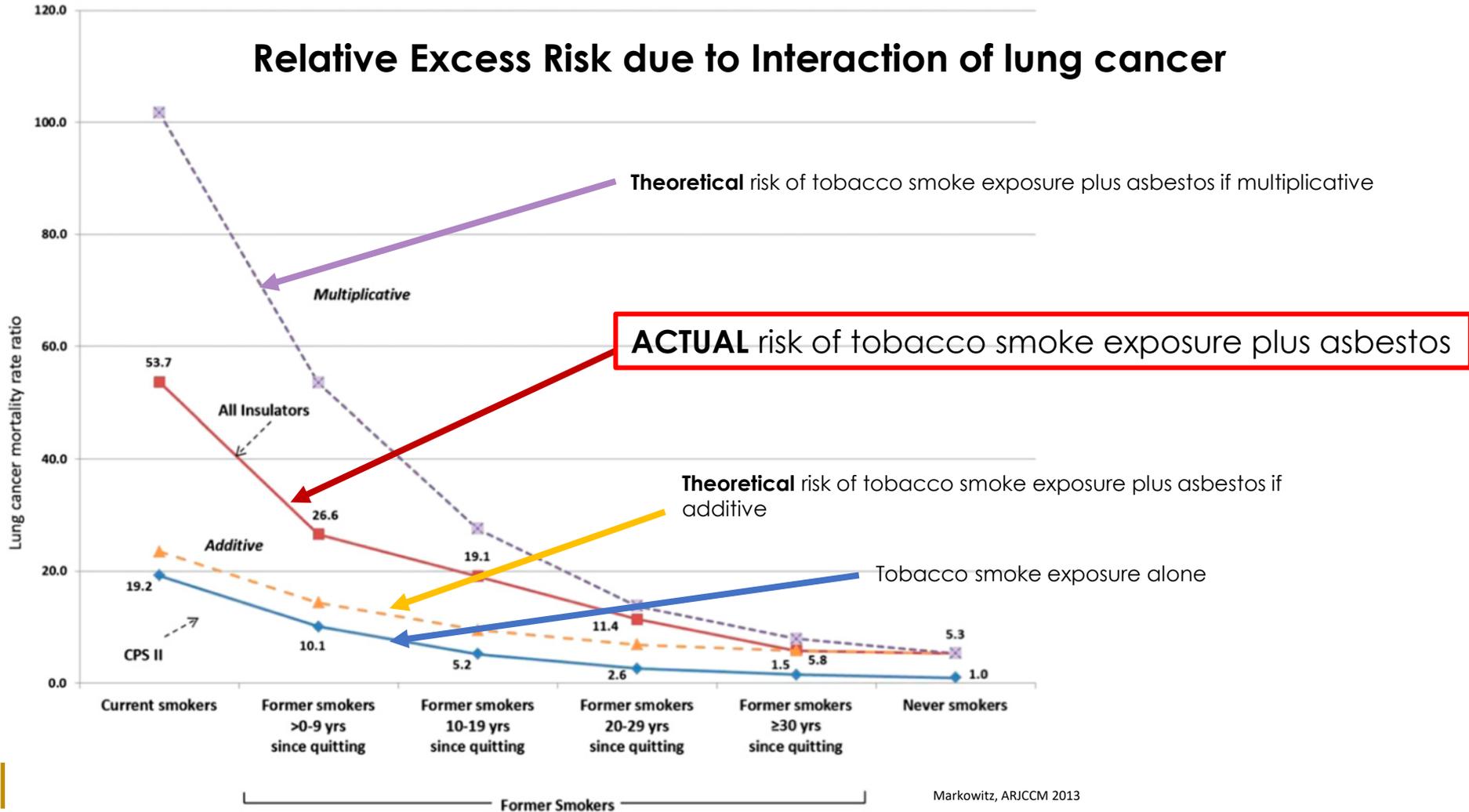


The risk of tobacco & asbestos exposure is more than additive, but less than multiplicative

“Additive Synergism”

“RERI” = Relative Excess Risk due to Interaction

Relative Excess Risk due to Interaction of lung cancer



Asbestos & ARP

- Annual lung health check
- uLDCT, lung function, health questionnaire
- All welcome

Thank you

fraser.brims@curtin.edu.au

fraser.brims@health.wa.gov.au



X @Charlies_Resp

resp-scgh.com.au

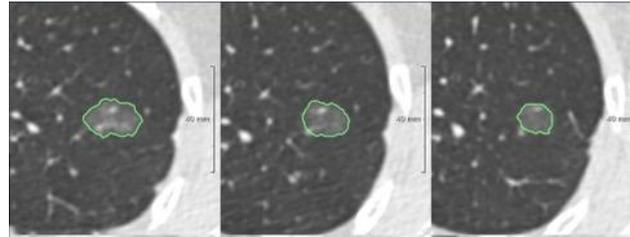


institute for
RESPIRATORY HEALTH

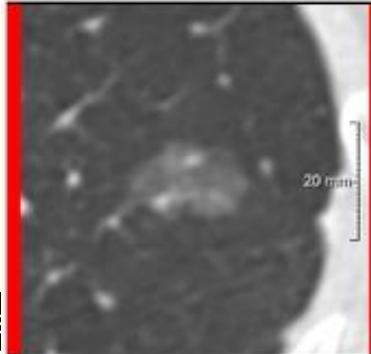


Computer Assisted Detection and AI

Computer assisted detection (CAD) software



	Baseline Dec 10, 2007	Visit 2 Jan 07, 2009	Visit 3 Nov 30, 2009
Finding			
Segment			
Location	Slice 260	Slice 282	Slice 289
Status	New	Old	Old
Result		Growing	Growing
Type	GroundGlassOpacity	GroundGlassOpacity	GroundGlassOpacity
Equivalent Diameter	12.4 mm	15.9 mm	17.0 mm
Mass	308.7 mg	581.6 mg	802.9 mg
Axis long/short	13.6 / 11.2 mm	17.3 / 11.8 mm	21.9 / 14.1 mm
Description			
Malignancy probability	7.99%	13.09%	19.59%



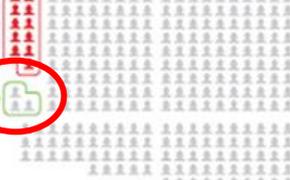
Cautionary tale

Screening for lung cancer can cause significant harm

SCREENED (1000 PEOPLE)

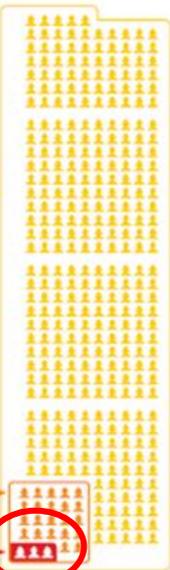
BENEFITS ADDED by Screening

18 PEOPLE DIED from lung cancer in a group of 1000 people who are screened. This was 3 FEWER DEATHS from lung cancer compared to the NOT SCREENED group.



HARMS ADDED by Screening

365 IN 1000 PEOPLE SCREENED experienced a FALSE POSITIVE result.



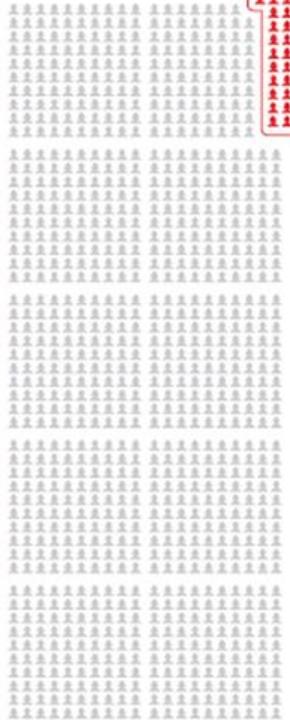
25 of those false positive results led to an INVASIVE PROCEDURE.

3 PEOPLE developed a MAJOR COMPLICATION from the invasive procedure.



NOT SCREENED (1000 PEOPLE)

21 PEOPLE DIED from lung cancer in a group of 1000 people who were not screened. This was 3 ADDITIONAL DEATHS from lung cancer compared to the group that was screened.



Harms from LCS: tales from NLST

- From 1000 screened
 - 365 false positive
 - 25 had an invasive procedure
 - 3 major complication
- 32% of surgery was on a benign lesion, 15.9% of these had a complication

PET use - 1,556 of 14,195 positive screens

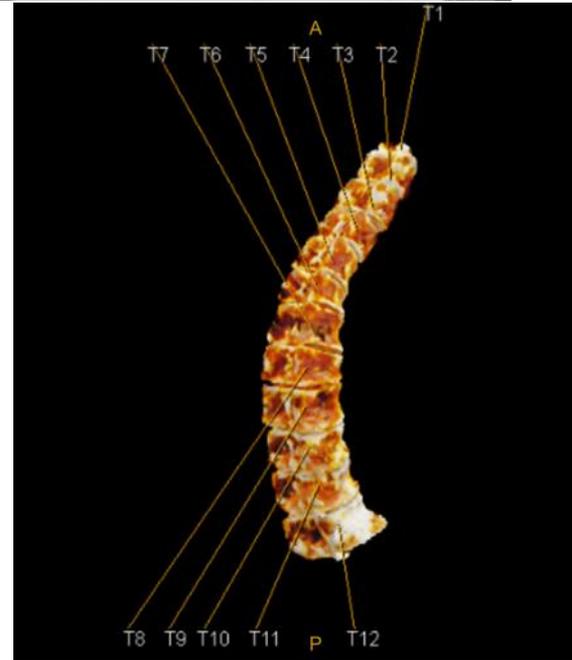
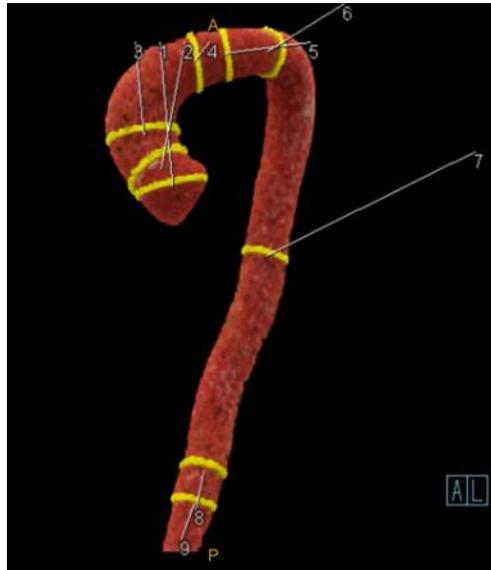
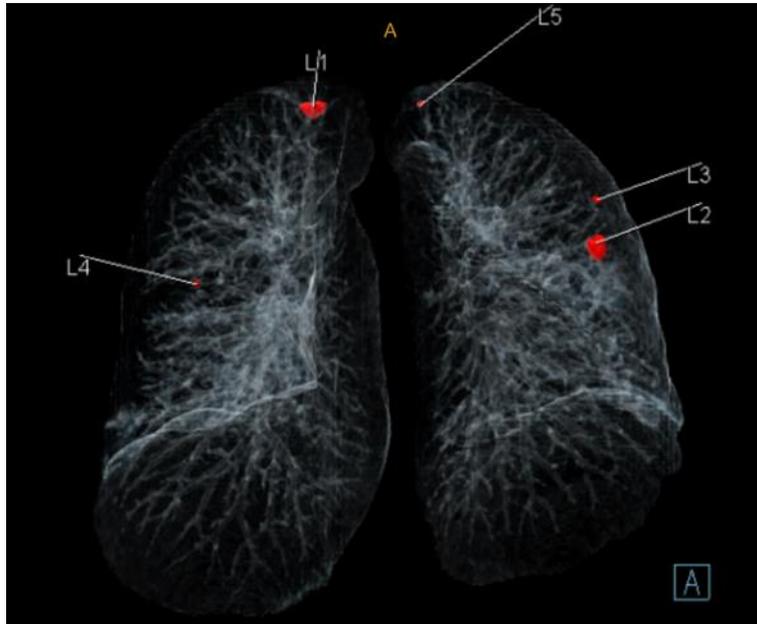
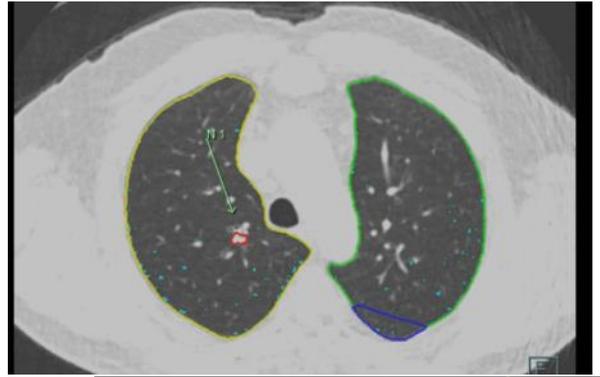
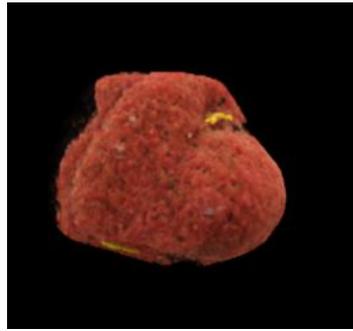
- 21% 'inappropriate'
- 36% had been recommended by a radiologist
- 86% of PETs for <8mm nodule ordered despite no recommendation



LESIONS	Lobe	Volume [mm ³]	Max. 2D Ø [mm]	Max. 3D Ø [mm]	Not for diagnosis *
L1	Right Upper Lobe	737.5	16.6	18.1	
L2	Left Upper Lobe	505.6	15.4	20.5	
L3	Left Upper Lobe	54.1	6.7	6.8	
L4	Right Middle Lobe	31.5	5.7	5.8	
L5	Left Upper Lobe	32.4	4.8	5.4	
Tumor Burden			49.2		

LUNG	LAV950 [%]	LAV950 [%]
Left Upper Lobe	0.4	Right Middle Lobe 0.4
Left Lower Lobe	0.9	Right Lower Lobe 1.0
Right Upper Lobe	0.4	Both Lungs 0.7
Lung Range *	I	

HEART	
Heart volume	1098.5 ml
Total Coronary Calcium Volume	731.9 mm ³
Calcium Range *	IV



Lung-RADS



Consensus based

Lung-RADS for nodules at baseline	Findings	Management
Category 1	Nodules with benign calcification pattern	LDCT 12 mo
Category 2	Solid nodule <6mm	
	Part-solid nodule <6mm total diameter	
	Non-solid nodule <20mm	
Category 3	Solid nodule ≥6mm to <8mm	LDCT 6 mo
	Part-solid nodule ≥6mm total with solid core <6mm	
	Non-solid nodule ≥20mm	
Category 4A	Solid nodule ≥8mm to <15mm	LDCT 3 mo / PET-CT
	Part-solid nodule ≥6mm with solid core ≥6mm to <8mm	
Category 4B	Solid nodule ≥15mm	contrast CT / PET-CT / biopsy
	Part-solid nodule with solid core ≥8mm	