



# Silica and the “head of the snake” – silica, gold mining and tuberculosis in Southern Africa

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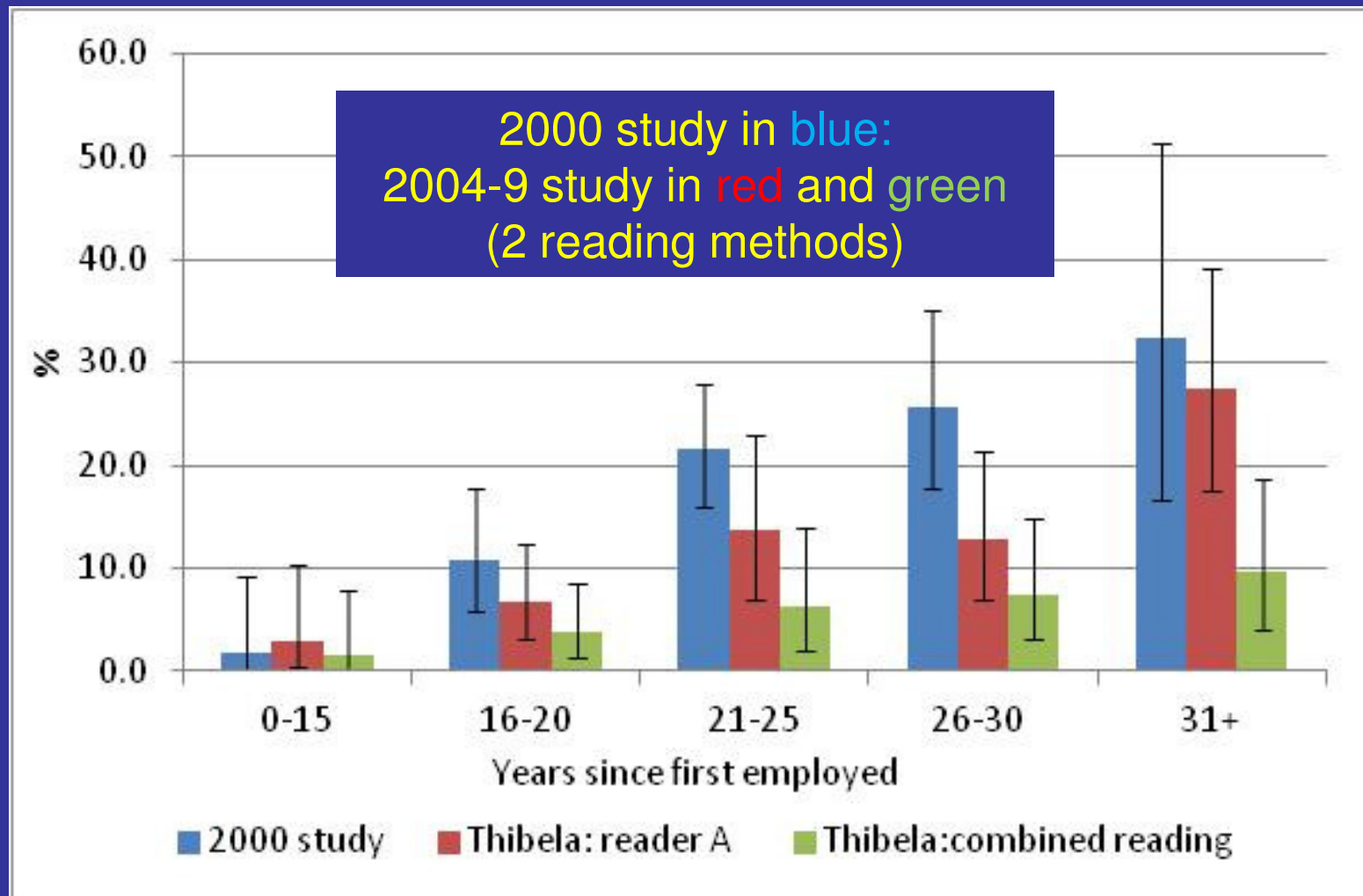


Some background:  
Current epidemiology of silicosis and  
TB in gold miners

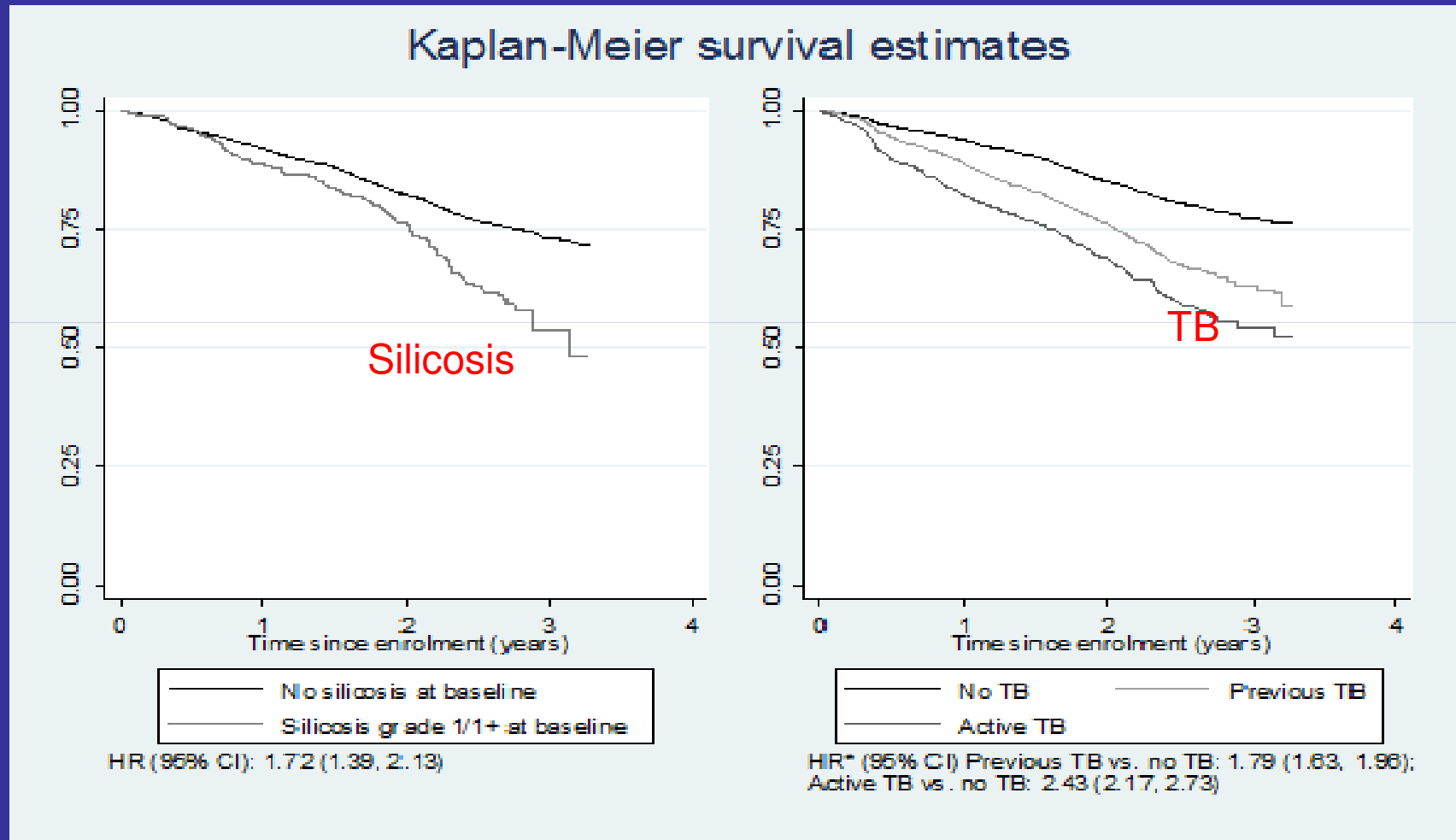
# What is the situation re TB in gold miners?

Measure (study)	
Incidence (Churchyard 2014)	2.4 per 100 p-y (range 1-7) US homeless 0.09 WHO "emergency" 0.25
Recurrence rate of PTB among those with previous TB (Glynn 2010)	HIV+: 19 per 100 p-y HIV- : 7.7 per 100 p-y
Prevalence of latent TB infection (Hanifa 2009)	89%
Proportion drug resistant cases (Calver. 2010, Churchyard 2014)	MDR: 2.5 - 3.6% XDR: 0.2% ?
HIV infection (Corbett 2004, Girdler Brown 2008)	22-27%

# Silicosis? Falling silicosis prevalence among working gold miners



# Externalisation: probability of remaining in workforce over 3 by silicosis or TB



# Miners and their health are back in the news

## 1. South African government

“If TB and HIV are a snake in Southern Africa, the head of the snake is here in South Africa. People come from all over the Southern African Development Community to work in our mines and they export TB and HIV, along with their earnings. If we want to kill a snake, we need to hit it on its head.”

Aaron Motsoaledi, South African Minister of Health, June 2010

## 2. Regional governments

“Improvement of ...standards of ... health and safety in the mining sectors.. is a way of addressing TB..”

*Declaration on Tuberculosis in the Mining Sector* Ministers of the South African Development Community – SADC (15 countries), April 2012.

# Miners and their health are back in the news

## 3. Tort attorneys

3 class actions suits against all the major gold mining companies:

- All 3 for silicosis or silicotuberculosis
- One for tuberculosis *alone* – science contested

## 4. World Bank

- “Elimination” of TB highly cost-effective for the industry
- Includes halving of dust OEL from 0.1 to 0.05 mg/m<sup>3</sup>
- *No cost estimates for dust control measures*

# Miners and their health are back in the news

## 5. Global Fund To Fight AIDS, TB, and Malaria:

- \$ 60m. To be invested into regional TB control programmes to “screen and treat 500 000 miners for TB”

## 6. Recent World Bank/Global Fund/WHO workshop in Cape Town: *Addressing tuberculosis in the Mining Sector in Southern Africa*

- Agenda focused exclusively on service delivery and coordination challenges.
- No mention in agenda of dust nor silicosis



- What is to be done about TB?

1. Screen and treat for TB

2. TB chemoprophylaxis?

5 year chemoprophylaxis trial among 15 000 gold miners showed no sustained reduction in TB incidence after end of prophylaxis

3. Housing

4. Control dust and silicosis

# Preventive algorithm

- To what degree will control of (silica) dust exposure reduce the TB burden?



- Do you need silicosis for the silica-TB effect?



YES

Prevent silicosis to eliminate  
excess TB risk attributable to dust

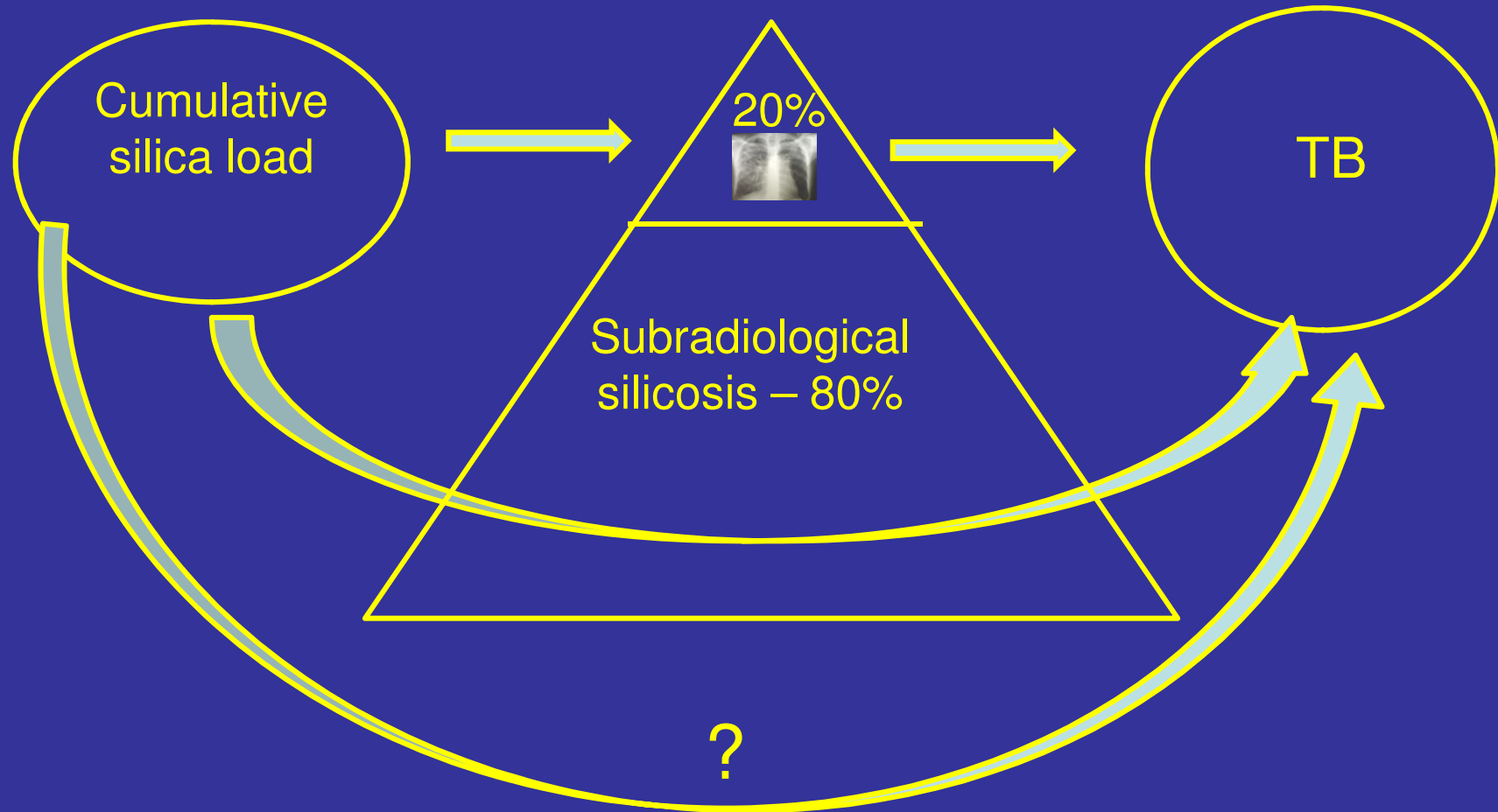
NO



- What is the appropriate silica OEL for TB?

# Multidisciplinary approach – epidemiology, biology and history

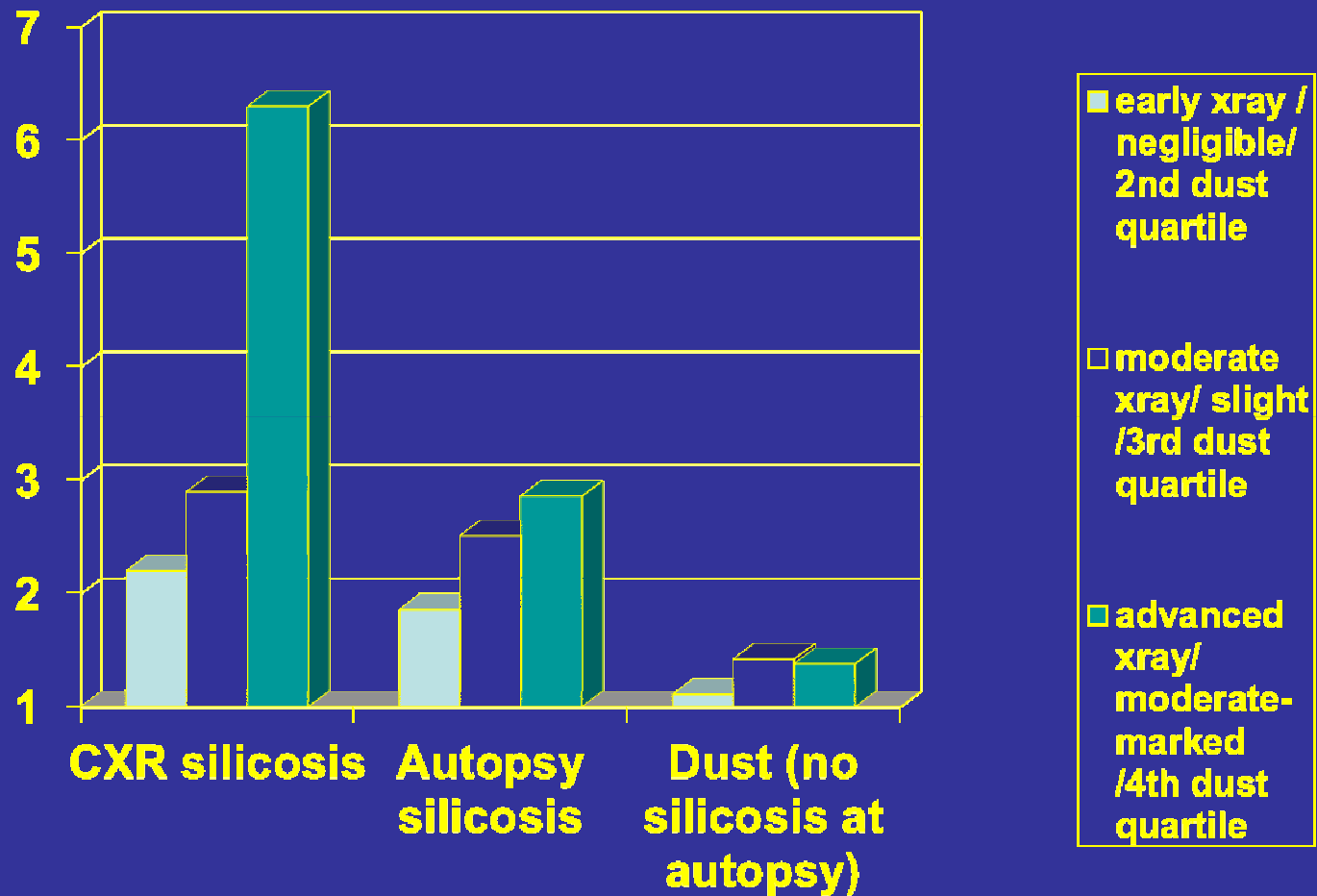
# Pathways from silica to TB



Confounders: Age, mine housing, more intense screening<sup>12</sup>

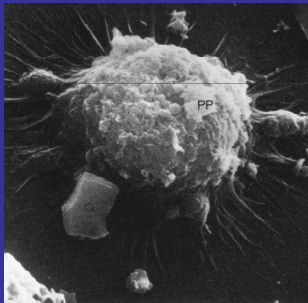
# Epidemiology

TB  
Relative  
Risk



# Biology (in vitro and in vivo)

Lung macrophage  
and silica particle,



Silica Dose

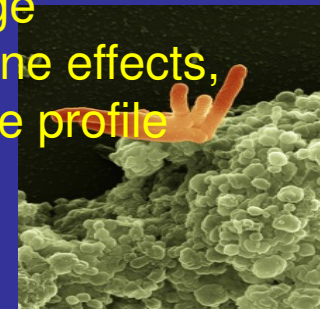
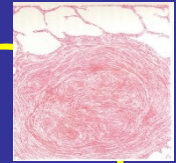
“Toxic”

Macrophage *death*  
(e.g. via lysosomal disruption)

Fibrosis

Proliferation of  
tubercle bacilli

Macrophage  
*alteration*: membrane effects,  
changed cytokine profile



# History – silica-TB relationship

<p>Pre-20<sup>th</sup> C (one disease)</p>	<p>Single entity. “Miners phthisis”, “Miner’s consumption”, etc.</p>
<p>Early 20<sup>th</sup> C.  (2 diseases but close aetiological and pathological relationship)</p>	<ul style="list-style-type: none"> <li>➤ Two diseases recognised – association between them undisputed.</li> <li>➤ South Africa: Silicosis spectrum:             <ol style="list-style-type: none"> <li>1. <i>“Pure” / “simple”-----“Infective”</i></li> <li>2. <i>TB on its own or as late complication of silicosis</i></li> </ol> </li> </ul>
<p>1930 Conference, Johannesburg  (2 distinct diseases for compensatable purposes)</p>	<ul style="list-style-type: none"> <li>➤ Influential in international definition of silicosis.</li> <li>➤ Influenced by SA Chamber of Mines, concerned about retention of labour, relaxation of restrictions on recruitment of labour from outside SA, compensation criteria</li> <li>➤ Distinction between “silicosis a chronic disease, and “active TB” widened.</li> </ul>

# History – silica-TB relationship

1960s-70s (2 distinct diseases)	Silicosis less severe -> “chronic” “simple”, “benign”. TB in decline in West → Focus on TB treatment not dust. → Association fades from view (“textbook twilight”)
1970 -80s (SA) (“Coincidental” diseases)	Excess TB in miners due to: ➤ “High community TB levels” ➤ “More intensive surveillance” → “Not an occupational disease”
1990 – 2000s (association “reconfirmed”)	Industry based research shows silicosis-TB association. HIV supervenes as new alibi for main driver of TB in miners; but interaction of HIV and silicosis effect on TB <i>multiplicative</i> .
21 <sup>st</sup> C.	Litigation. Silica-TB link now coming into judicial view. Causation and tort significance.



# Conclusions

- Since 80% of silicosis is subradiological, epidemiology cannot distinguish effects of silica dust load and subradiological silicosis (Hnizdo 1998 study unrepeatable)
- Need to integrate *in vitro*, *in vivo* and epidemiologic findings. Need to recognise:
  - ❖ Clinical implications: Gold miners at lifelong risk of TB and at high risk of recurrence – “silicised” population
  - ❖ Occupational Health implications: Control of silicosis, e.g. by halving OEL important step, but OEL for TB could be lower → much greater costs of dust control.
  - ❖ Remain aware of inhibition of science by powerful vested interests but also of legitimate fears about jobs and livelihoods.