



Silicotuberculosis: A Dangerous Intersection of Two Diseases

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TB Controller, Orange County

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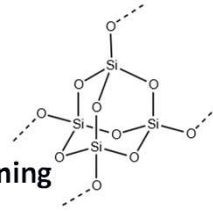
Why Do TB Staff Need to Know about Silicosis?

- **Silicosis is a risk factor for TB disease**
- **Radiographic appearance of silicosis can be very similar to TB**, so these patients may be referred to your clinic as suspects
- Many recent silicosis cases are **young workers from TB-endemic countries**; this means if you are not seeing silicotuberculosis yet, you will see it
- Important to recognize the disease, so appropriate referral can be made if TB ruled out (often misdiagnosed)

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Silica

- **Respirable crystalline silicon dioxide (SiO_2)**
 - Quartz = 10% of earth's crust
- **Rock, concrete, masonry, silica sand**
- **Drilling, cutting, sandblasting, demolition, mining**



NIOSH No. 1996-112.

Slide courtesy of Kristin J. Cummings, MD, MPH
Chief, Occupational Health Branch, CDPH

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Respirable Crystalline Silica (RCS)

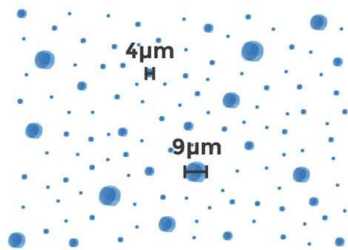
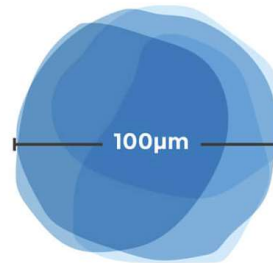
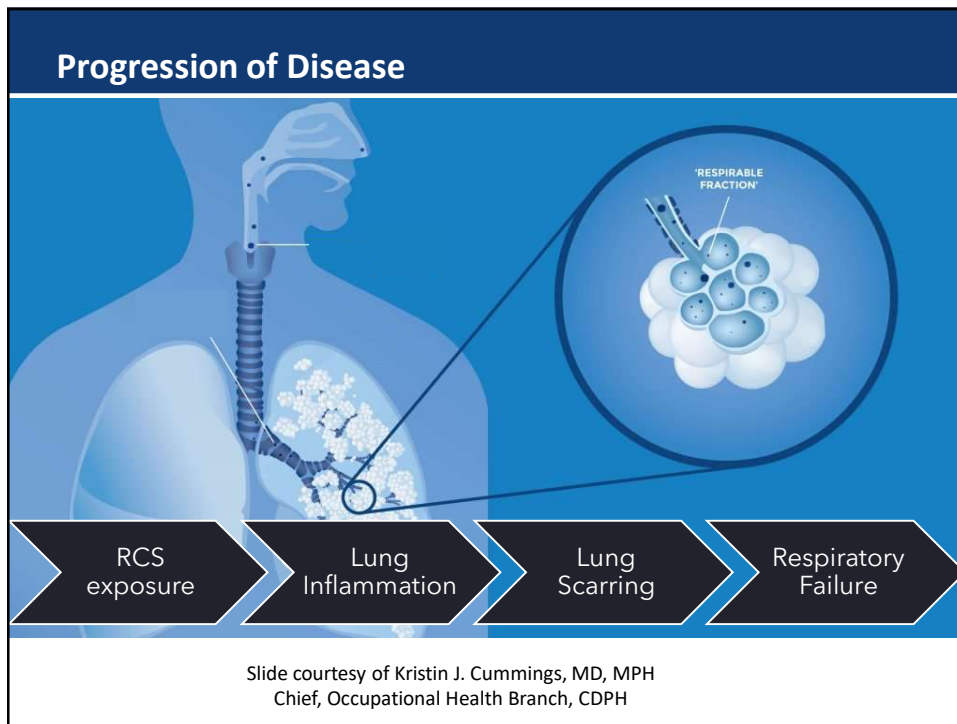


Table Salt



Slide courtesy of Kristin J. Cummings, MD, MPH
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Health Effects of Silica

- **Silicosis**
 - Chronic = after 10+ years, lower concentrations
 - Accelerated = after 5-10 years, higher concentrations
 - Acute = after weeks to years, highest concentrations
- **Mycobacterial, fungal infections**
- **Lung cancer, COPD**
- **Autoimmune disease**
- **Chronic kidney disease**

The slide includes two images: a microscopic view of lung tissue showing silicotic nodules (left) and a chest X-ray showing lung opacities (right).

Slide courtesy of Kristin J. Cummings, MD, MPH
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A New Look, A New Disease



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Countertop Material and Silica Content

<5% silica	~45% silica	
Marble	Granite	Engineered Stone (Quartz*)

Slide courtesy of Kristin J. Cummings, MD, MPH
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*Quartz is a naturally occurring mineral, not a rock. Engineered stone is a composite made of crushed stone that is bound together by an adhesive to form a solid surface

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History of Silicosis and Engineered Stone

- **1975** - Marcello Toncelli (Breton founder) patents *vibrocompression under vacuum*, mixture of fragmented stone or silica dust with polyester resin binder (styrene monomer, anhydrides) to create manufactured stone
- **1987** – **Caesarstone**, Kibbutz Sdot Yam, Israel; by 2012, 25 cases diagnosed, first case seen in 1997; [Kramer et al, *Chest* 2012; 142(2) : 419-424]
- **1990** – **Cosentino**, Ameria, Spain; 2010 – first reported cases with 17 years exposure [Martinez et al, *Arch Bronconeumol* 2010; 426(2): 97-100]
- **2012**: Italian researchers identify 7 cases among 29 workers
- **More companies manufacture stone**; currently about 30 companies throughout the world

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History of Silicosis and Engineered Stone (cont)

- **2014**: Texas Dept of Public Health reports a case in a fabricator with 10 years exposure; first case in North America [MMWR, 2015; 64 (5): 129-130]
- **2019**: CDPH identifies first cases in CA, describing 18 cases with two fatalities [MMWR 2019; 68 (38): 813-818]
- **2022**: Australian researchers publish on 579 cases identified [Occup. Environ. Med 2022; 79(9): 647-648] and estimate that up to 100,000 workers may develop silicosis as a result of exposure
- **2023**: Fazio et al publish about cases in CA [JAMA Intern Med 2023; 183 (9): 991-998]
- **Dec 2023**: Australia bans the importation and use of artificial stone

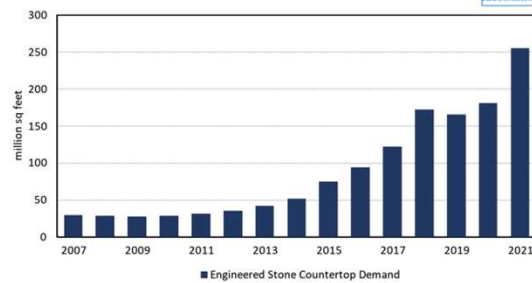
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Engineered Stone

How popular is engineered stone?



Engineered Stone Countertop Demand, 2007 – 2021 (million square feet)

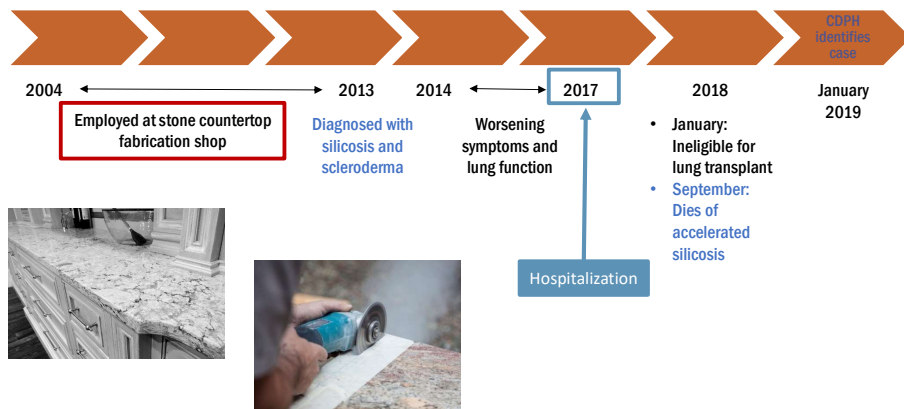


Source: <https://www.freedoniagroup.com/industry-study/engineered-stone-countertops-4395.htm>

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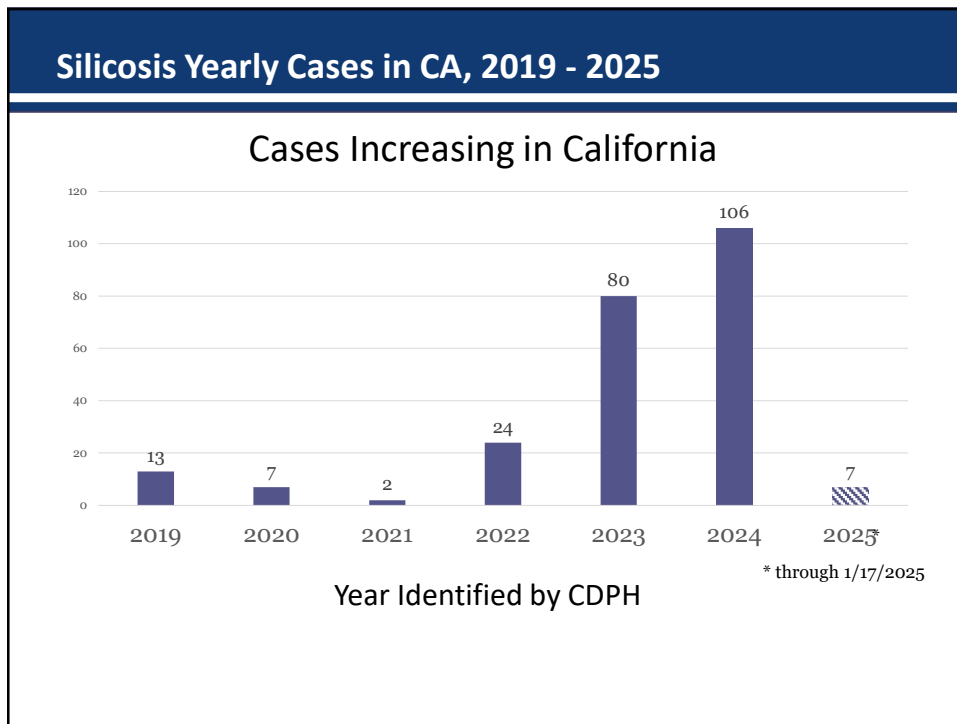
History of Countertop Associated Silicosis in CA

Index California Case

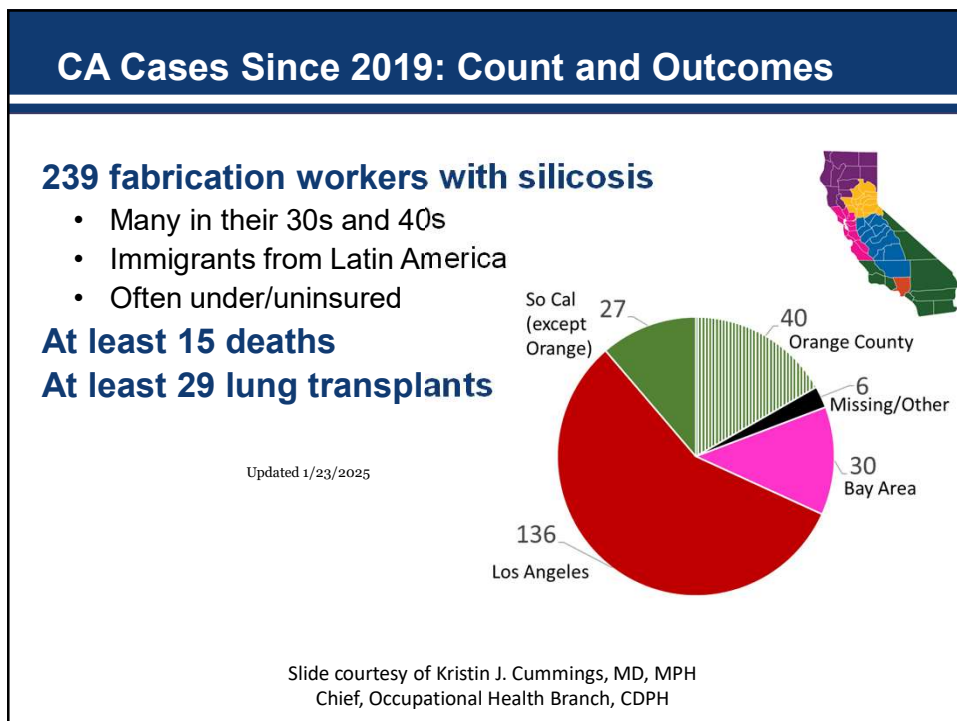


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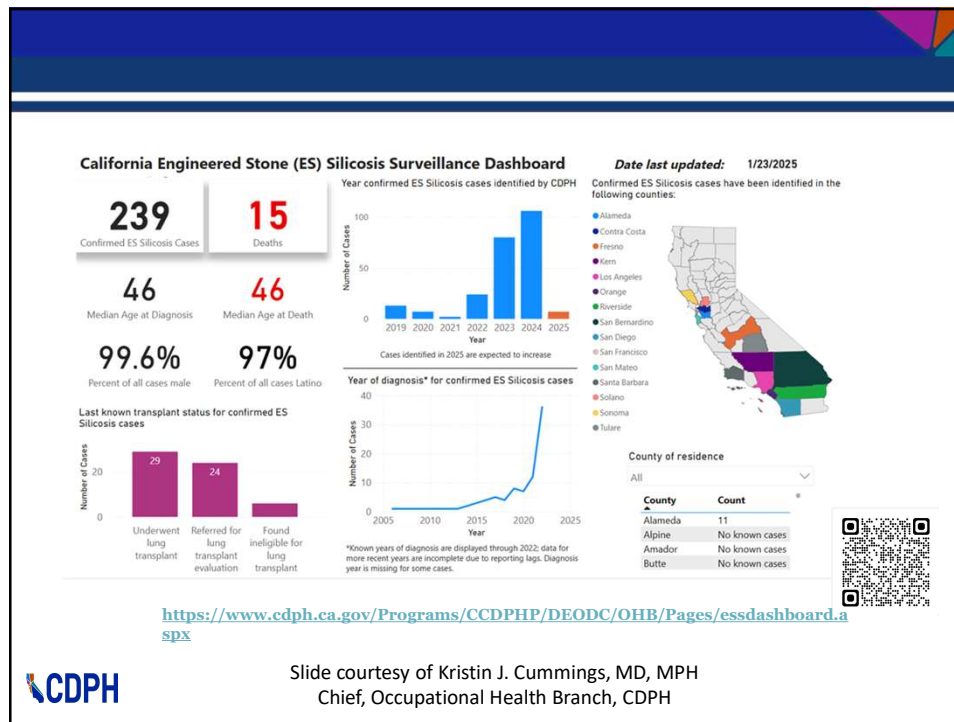
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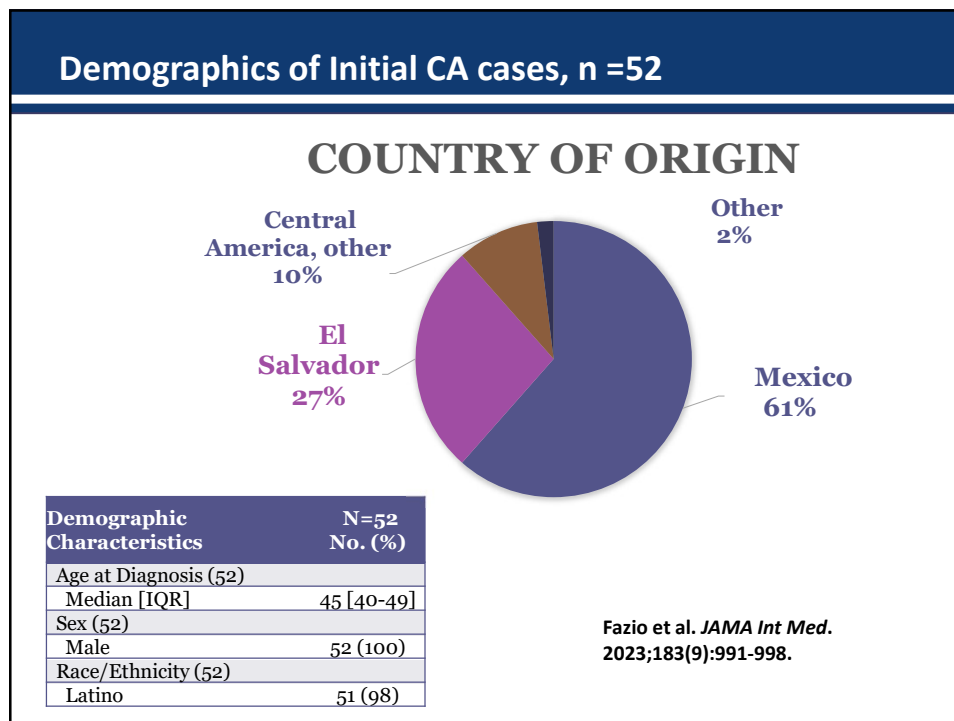
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Occupational History

- Occupational history is key to suspicion for silicosis:
 - Ask specifically about working with countertops
 - Duration of work
 - Ask about specific tasks in work, use of water suppression and use of respiratory protection

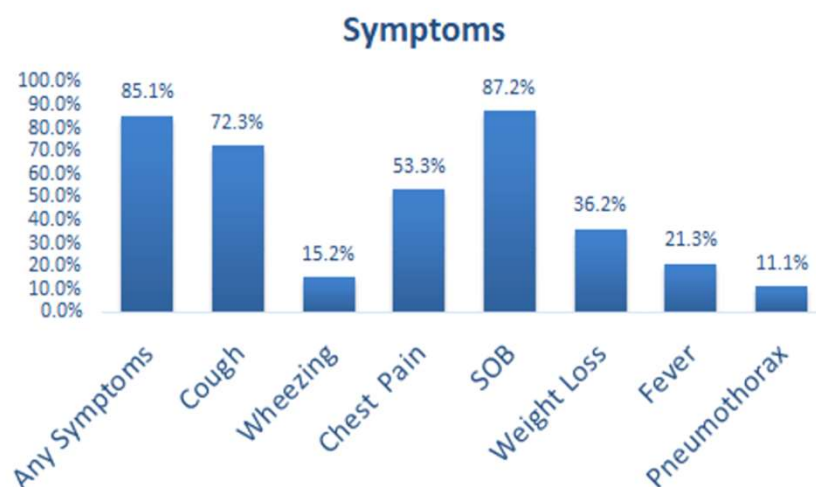
Occupational History	No. (%)
Years of Work in Countertop Industry (51) Median [IQR]	15 [10 – 20]
Continued Working after Diagnosis (52)	25 (48)
Water Suppression Methods (51)	23 (45)
Respirator Use (47)	
Sometimes	35 (74)
Always	12 (26)
Number of Employees in Workshop (35)	
Less than 10	17 (49)
10-50	17 (49)
Greater than 50	1 (2)



Fazio et al. *JAMA Int Med.* 2023;183(9):991-998.

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Symptoms at Diagnosis



Fazio et al. *JAMA Int Med.* 2023;183(9):991-998.

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Radiographic Appearance of Silicosis

- Multiple, bilateral small (1-10 mm, typically 2-6 mm) round opacities uniformly distributed with predominance in upper and mid zones of lungs, sparing apices and bases (“angel wings”)
- Progressive Massive Fibrosis (PMF): larger masses, round to ovoid, may be unilateral or bilateral, upper and mid lung zones, typically do not cavitate
- Adenopathy: may be present bilaterally, may have rim calcification
- Pleural abnormalities: uncommon on CXR
- CT more sensitive in picking up mild disease

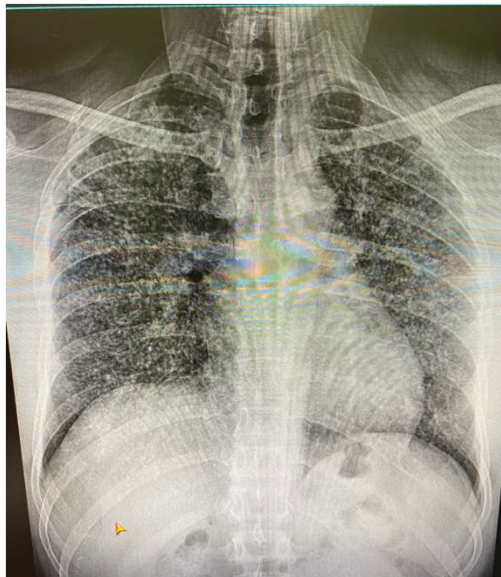
R. Ehrlich et al, Eur Respir Rev 2-24; 33:204168

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Miliary-Appearing Silicosis

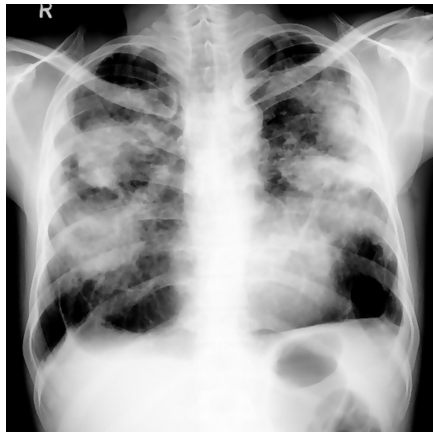
Differentiating miliary TB vs silicosis:

- Miliary TB: **sick** (weight loss, fevers, NS, other abnormalities)
- Miliary silicosis: may have cough, *may* require oxygen, but unlikely to be really sick (no fevers, NS, weight loss or other signs of miliary TB)



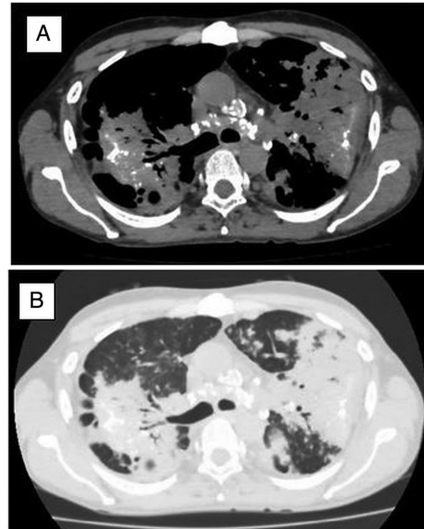
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Progressive Massive Fibrosis (PMF)



Kamal Gera et al. BMJ Case Reports 2014;2014:bcr-2014-206376

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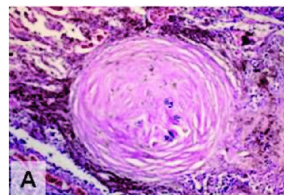
BMJ Case Reports

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Pathology of Silicosis

- Silicosis nodules have unique appearance pathologically: central acellular zone of whorled collagen fibers and narrow peripheral margin of dust-laden macrophages; silica particles, if seen, are weakly birefringent
- Presence of granulomatous response is not normally a characteristic of silicosis; **presence of granulomas should trigger workup for other conditions**
- PMF is conglomeration of silicotic nodules to form a mass at least 1 cm in size; **ischemic cavitation can occur in these larger masses**

R. Ehrlich et al, Eur
Respir Rev 2-24;
33:204168



T. Brüning; International
Archives of Occupational
and Environmental Health ·
January 2011

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Pathogenesis of Silicotuberculosis

- Silica particles are inhaled and phagocytosed by alveolar macrophages
- Promotes pro-inflammatory pathways, disturbing the balance between apoptosis and necrosis, **promoting the release of viable *M. tuberculosis* bacteria**
- Downregulation of Toll-like receptors (TLRs) important in responding to bacterial infections; **impaired response if challenged with TB**, even after exposure ceases
- **Risk of TB in silicosis has been estimated to be 4-6 times than in non-silicosis**, and risk increases with very early disease
 - Risk increases with increasing exposure level
 - Risk highest with radiological silicosis
 - Risk persists after exposure cessation

R. Ehrlich et al, Eur Respir Rev 2-24; 33:204168
P. Jamshidi et al. Pulmonology 2023; 2:50

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Silicotuberculosis Treatment and Outcomes

- Compared to TB patients without silicosis, those with silicosis have:
 - Poorer treatment outcomes
 - Higher relapse rate after standard therapy; prolongation for therapy (8 months) reduces risk of relapse
 - More severe post-TB lung disease
- Prolonged treatment recommended by some; study in Hong Kong in 1991 found that 8 months therapy instead of 6 months lowered relapse rate from 22% to 7%

R. Ehrlich et al, Eur Respir Rev 2-24; 33:204168
P. Jamshidi et al. Pulmonology 2023; 2:50

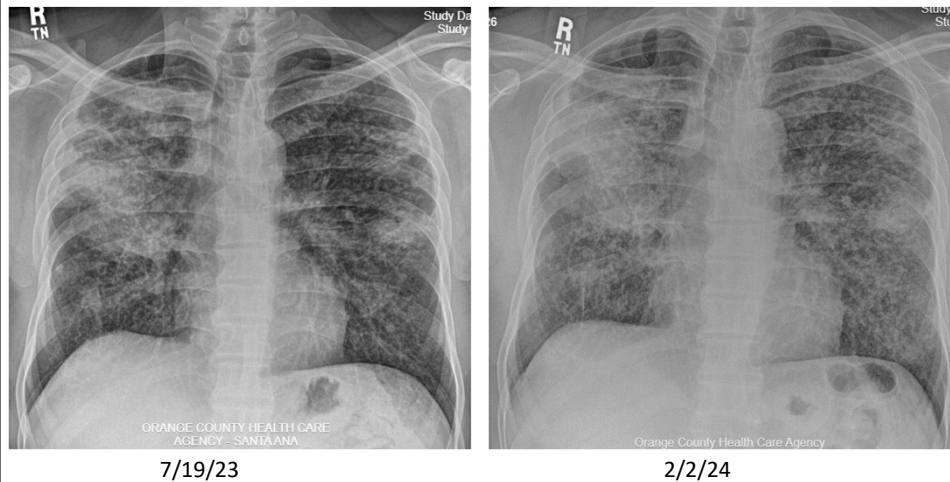
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Silicosis: OC TB Control Experience

- First became aware of issue in July 2023 when CDPH put out alert about silicosis and our first case of silicotuberculosis identified
- A retrospective review identified 3 other cases seen since Aug 2021 who likely had silicosis (one had *M. kansasii* infection); all ruled out for TB
- Since July 2023, we have had 5 confirmed silicotuberculosis patients, and have two additional suspects on Rx currently pending classification (cultures negative, but awaiting clinical classification)
- In all cases, cultures converted relatively quickly, but little to no symptomatic or radiographic improvement

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Case #1: Silicotuberculosis, Initial and End of Rx Film



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Case #2: Silicotuberculosis End of TB Rx

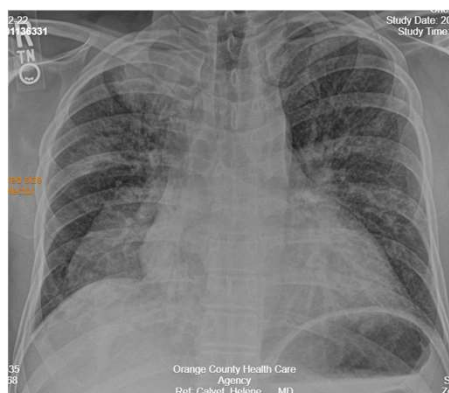


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Case #3: Silicotuberculosis Initial and 3 Month CXR



11/20/24

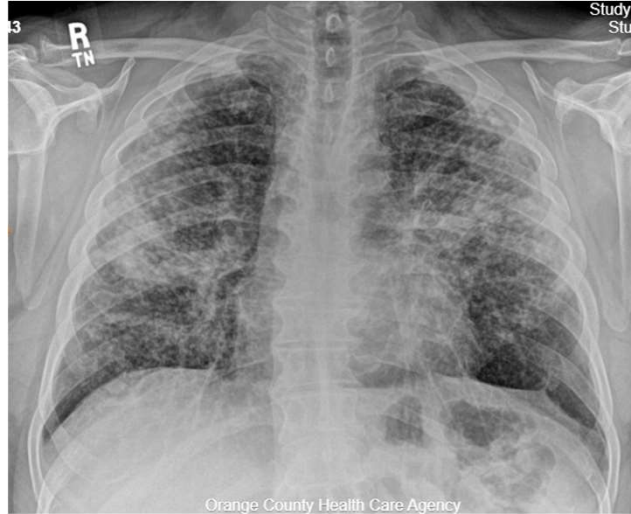


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Contact to Case #2

- Worked with marble countertops x 15 years; no respiratory protection during work until just recently
- Co-worker of prior case
- Very mild cough, no weight loss, F/C/NS
- O₂ sat nl at rest; did not desat with walking
- Sputum negative x 3, IGRA negative x 2 (0/0)

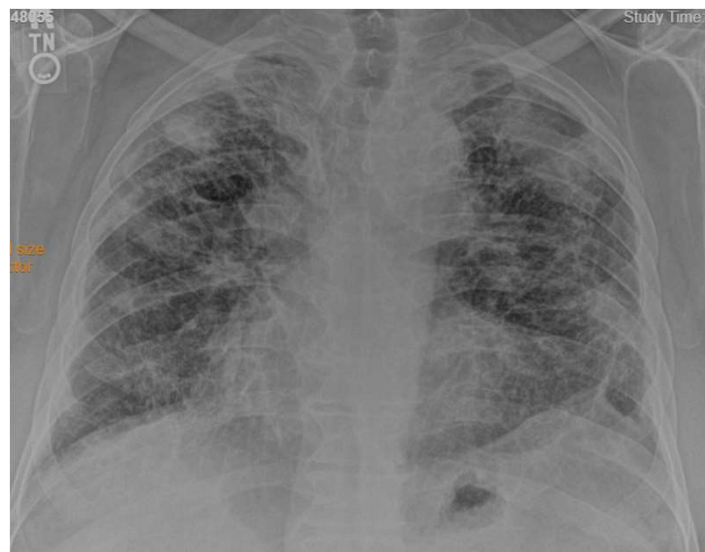


12/1/23

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Advanced Silicosis with +IGRA

R/O TB disease,
treat for LTBI
before they go
for transplant!



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Silicosis Medical Surveillance Exam: Required Components

- Baseline and periodic exams every 3 years or more frequently if recommended by the HCP
- Clinical and occupational history and physical exam
- Imaging: Chest imaging with B-reading
- Pulmonary function testing: spirometry at a minimum
- TB screening (only at baseline exam)
- Any other test recommended by the HCP



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Conclusions

- Patients with silicosis are at increased risk of TB disease, and the vast majority of recent silicosis cases are from TB endemic countries, so we will likely see much more silicotuberculosis in the near future
- Patients with silicotuberculosis do more poorly than TB patients without silicosis, and have a higher risk of relapse so may need longer therapy
- In our experience, little clinical or radiographic improvement seen in TB patients with advanced silicosis
- Important to be familiar with epidemiologic, clinical and radiographic presentation of silicosis, and refer for further silicosis work-up if at risk and TB w/u is negative
 - Think silicosis in young foreign-born workers who look like they have TB, but are not sick!

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Acknowledgements

- CDPH Occupational Health Branch: Dr. Kristin Cummings, Chief, and Dr. Alya Khan
- Olive View Medical Center: Dr. Jane Fazio
- UCSF: Dr. Sheipali Gandhi and Dr. Bob Harrison
- Lestonnac Free Clinic: Ed Gerber, Executive Director

Thanks for your attention; any questions?

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