

**DETERMINING OCCUPATIONAL
CAUSATION OF COCCIDIOIDOMYCOSIS
– TWO CASE STUDIES**

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THE CAUSATION QUESTION

In an endemic area, when a worker generates soil dust, or is a bystander to soil dust generated by others, and becomes infected, the usual question is:

**Was the infection due to the work or
or due to spores blown onto the site
from elsewhere?**

TWO SETTINGS

- 1. There are multiple cases among a group of individuals who did the same job or worked in the same area in the same time frame.**
- 2. There is an individual case with no coworkers or no information available about the health status of coworkers.**

MULTIPLE CASES

- **The standard approach for determining work-relatedness is to compare the group incidence rate to the population incidence rate in the general area.**
- **A related approach is considering the probability of observing the number of cases given the background risk.**

THE SINGLE CASE

- **Soil dust exposure measurements while performing job tasks may be available. Monitoring data for the ambient dust level (mostly soil) in the general region should be available.**
- **Soil dust exposure is treated as a surrogate for potential exposure to Cocci spores.**
- **One compares the cumulative soil dust exposure on the job versus off the job.**

MULTIPLE CASES – THE OILY WASH

- **In 2008 near the town of McKittrick in Kern County, CA, a highway overpass along State Route 33 was widened. Soil was excavated in the wash (called Oily Wash) below to create new footings.**
- **Water was not available for dust prevention for the first three days when most excavation took place.**
- **Respirators were not worn. The cab window of an excavator was kept open to aid in communication.**

MULTIPLE CASES – THE OILY WASH

Among 10 crew members who worked less than eight days in a two calendar week period, **7/10 developed severe Cocci pneumonia.**

MULTIPLE CASES – THE OILY WASH

- **In 2008, the reported incidence rate in Kern County was 102 per 10^5 population, corresponding to a background risk of .00102.**
- **To be conservative, I assumed the background risk was 10-fold higher at .0102.**
- **The two-week risk was .000394, because:**

$$1 - (1 - .000394)^{26} = .0102$$

MULTIPLE CASES – THE OILY WASH

The binomial probability that among $n = 10$ persons, 7 or more are infected due to the background risk $p = .000394$ is less than one in a billion billion. There was no overt strong dust source nearby. It is safe to conclude the infections were due to airborne spores generated on the work site.

$$\Pr[k \geq 7 | n = 10] = \sum_{k=7}^{10} \binom{10}{k} (.000394)^k (0.999606)^{10-k} = 1.77 \times 10^{-22}$$

SOME INTERESTING FACTS

- **The workers were from non-endemic Northern California. The contracting agency knew about the Cocci risk, but did not inform the contractor.**
- **The contract specified using water for dust prevention. The contracting agency allowed the work to proceed without water use.**
- **The contracting agency refused the contractor's request to buy its water, available at a nearby pump station, due to a drought proclamation.**

MULTIPLE CASES – THE OILY WASH

- **The contracting agency contended the cases were not work-related. An independent medical legal examiner ruled the cases were work-related.**
- **The seven infected persons sued the contracting agency for damages and negligence. A jury ruled in their favor and awarded \$12 million. The verdict was upheld on appeal.**

ONE CASE – McKITTRICK OIL FIELD

- **In 2016, an African-American man from Alabama was hired on contract to operate heavy equipment and do laborer tasks on the McKittrick Oil Field in Kern County, CA.**
- **He arrived healthy on April 26 and went home with severe Cocci pneumonia on May 27.**
- **Information about the health status of coworkers was not available.**

ONE CASE – McKITTRICK OIL FIELD

- On May 5, the man went to an emergency room with initial symptoms. Up to midnight on May 4, he had been in Kern County for 228 hours and on the oil field for 48 hours.**
- The man described his tasks as very dusty. From May 2 to 4, he pulverized dry soil with an open-cab skid steer. He said he was “engulfed” in a dust cloud.**
- He was not provided a respirator. On May 3, he found a dust mask in a tool shed and wore it thereafter. He was not fit tested. It is not known if the dust mask was NIOSH-approved.**

ONE CASE – McKITTRICK OIL FIELD

- **Summary respirable dust exposure data for construction jobs show an average of 1,480 $\mu\text{g}/\text{m}^3$ for heavy equipment operators and 4,760 $\mu\text{g}/\text{m}^3$ for laborers.**
- **I estimated the man operated heavy equipment (e.g., the skid steer) 90% of the time and did laborer tasks (e.g., manual shoveling) 10% of the time.**
- **I estimated that his exposure level was reduced by 70% when he wore the dust mask.**

ONE CASE – McKITTRICK OIL FIELD

Accounting for (i) the hours spent as a heavy equipment operator and as a laborer, (ii) the average exposure intensity as a heavy equipment operator and as a laborer, and (iii) dust mask use for two days, I estimated the man's cumulative occupational respirable soil dust exposure to be:

66,500 $\mu\text{g-hr}/\text{m}^3$

ONE CASE – McKITTRICK OIL FIELD

- **The California Air Resources Board website indicates the average PM_{2.5} dust exposure level in Ken County in 2016 was 15.9 $\mu\text{g}/\text{m}^3$.**
- **I assumed this exposure level when the man was in his hotel room, where he spent most of his time.**
- **For 228 hours of ambient air exposure, the man's estimated cumulative ambient respirable soil dust exposure was:**

3,600 $\mu\text{g}\text{-hr}/\text{m}^3$

ONE CASE – MCKITTRICK OIL FIELD

- **I adjusted the work-related dust exposure value by subtracting off 48 hours of ambient exposure, and adjusted the ambient dust exposure value for 16 hours of respirator use.**
- **The final ratio of cumulative occupational soil dust exposure to cumulative ambient soil dust exposure was at least **19:1**.**
- **It is more likely than not his infection was due to airborne spores generated on the work site. An independent medical legal examiner agreed.**

SOIL DUST AS A SURROGATE

- **Other than in a laboratory environment, Cocci spore exposure will be accompanied by soil dust exposure.**
- **The idea that everyone in an endemic region is subject to a relatively low background infection risk is consistent with ongoing exposure to a relatively low spore concentration and to a relatively low soil dust concentration in ambient air.**

SOIL DUST AS A SURROGATE

There is no reason that the spore count concentration (# per m³) must always be in proportion to the soil dust mass concentration (mg per m³), but it is a conservative assumption in favor of non-occupational exposure.

WHY IS IT CONSERVATIVE?

- **Because if spores are emitted into air on a work site, the spore concentration per mg/m³ of soil dust will be greatest on the site and decrease with distance away from the work site.**
- **As the spores and soil particles disperse away from the emission point, the soil dust concentration falls off less rapidly than the spore concentration, because the soil cover is always emitting more soil particles into the air.**

EXPOSURE REDUCTION MEASURES

- **If soil is to be disturbed, keep the soil wet if feasible.**
- **On heavy equipment like an excavator or front-end loader, use a positive-pressure enclosed cab supplied with HEPA-filtered air.**
- **Stay upwind of the dust generating work if feasible.**
- **Wash off equipment and change clothes before leaving the work site.**
- **Use respiratory protection, a Type N95 FFR at a minimum, but preferably a PAPR with HEPA filter.**

RESPIRATORY PROTECTION

It is thought it takes just one Cocci spore to infect a person. If that is true, infection risk adheres to a one-hit model:

$$R = 1 - \exp(-D)$$

where D = the expected # spores received

RESPIRATORY PROTECTION

- **If a respirator allows fractional penetration P , it reduces the expected dose received to $P \times D$, and reduces infection risk according to:**

$$R = 1 - \exp(-P \times D)$$

- **For a type N95 FFR, the assumed $P = 0.1$**
- **For a high quality PAPR, the assumed $P = .001$.**

AN EXAMPLE

- For $R = 0.7$ with no respirator use (per the Oily Wash project), the expected dose $D = 1.2$.
- For a N95 FFR with $P = 0.1$, the infection risk $R = 0.11$ (or **11%**).
- For a PAPR with $P = .001$, the infection risk $R = .0012$ (or **0.12%**).

Some Questions

- **Are work-related Cocci pneumonias more severe because the dose of spores received is higher?**
- **Is it feasible to use water spray to knock down airborne respirable particles on construction sites?**
- **Is it feasible to promote preventive measures via requirements attached to public agency permits?**