Principles of Disease Outbreak Investigation

AND

Their Application to Potential Oilfield Toxic Events

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Not Rocket Science

- Nothing new
  - Food animal veterinarians conduct outbreak investigations all the time
- Oilfield toxic event investigations are:
  - Difficult
  - Intensive
  - Time consuming
  - Potential for litigation requires documenting and/or defining everything

If You Want To Go TO Sleep

- Ask every question and record all answers
- Thoroughly examine all sick and record your findings
- Thoroughly examine all deads, test them for every sensible cause and record your findings
- Test everyone with every test that logically fits the disease
- Determine causal associations
- Write a detailed report

Purpose of Outbreak Investigations

- Halt the progress of the outbreak
- Determine the reasons for the outbreak
- Institute corrective measures
- Recommendations to reduce risk of future outbreaks

Accomplish These Goals By W5

- What and how much
- Who
- When
- Where
- Why

Purpose of Outbreak Investigations

For Oilfield Toxic Event Investigations:

- Determine the reasons for the outbreak
  - Oilfield toxic event Y/N
  - If No: what are the reasons?
- This is a problem of causality
  - Extremely difficult to prove causality once an event has occurred

Practical Causality For Oilfield Toxic Events

1. Establish existence of disease
   - Morbidity, mortality, decreased production, etc.
2. Establish existence of cause(s) or risk factors
   - Oilfield toxic event(s)
   - Other risk factors: infectious agents, heredity, management, environment etc.
3. Establish potential causal associations
   - Oilfield toxic event and disease?
   - Other events (risk factors) and disease?

Establish Existence of Disease: What?

- Define the characteristics of disease
- "More is Better"
  - History and records
    - Dates of mortalities, abortions, onset of sickness, etc
    - Reproduction, production data
    - From current, past and future production cycles
  - Examinations and testing
    - Clinical signs, pathology, hematology, serum chemistry, serology, virology, bacteriology, parasitology etc.
    - **Examine all deads, test everyone**
- **Do an excellent job many eyes will be see your work/records/pictures**

Establish Existence of Disease: How Much?

- Develop a precise case definition
- Case definition is used to accurately identify and count the number of diseased
- Quantify amount of disease by comparing the number/proportion diseased to:
  - Historical and/or future records
  - Published baseline data
  - Neighbors with similar management
  - **Examine all sick/dead, test everyone**

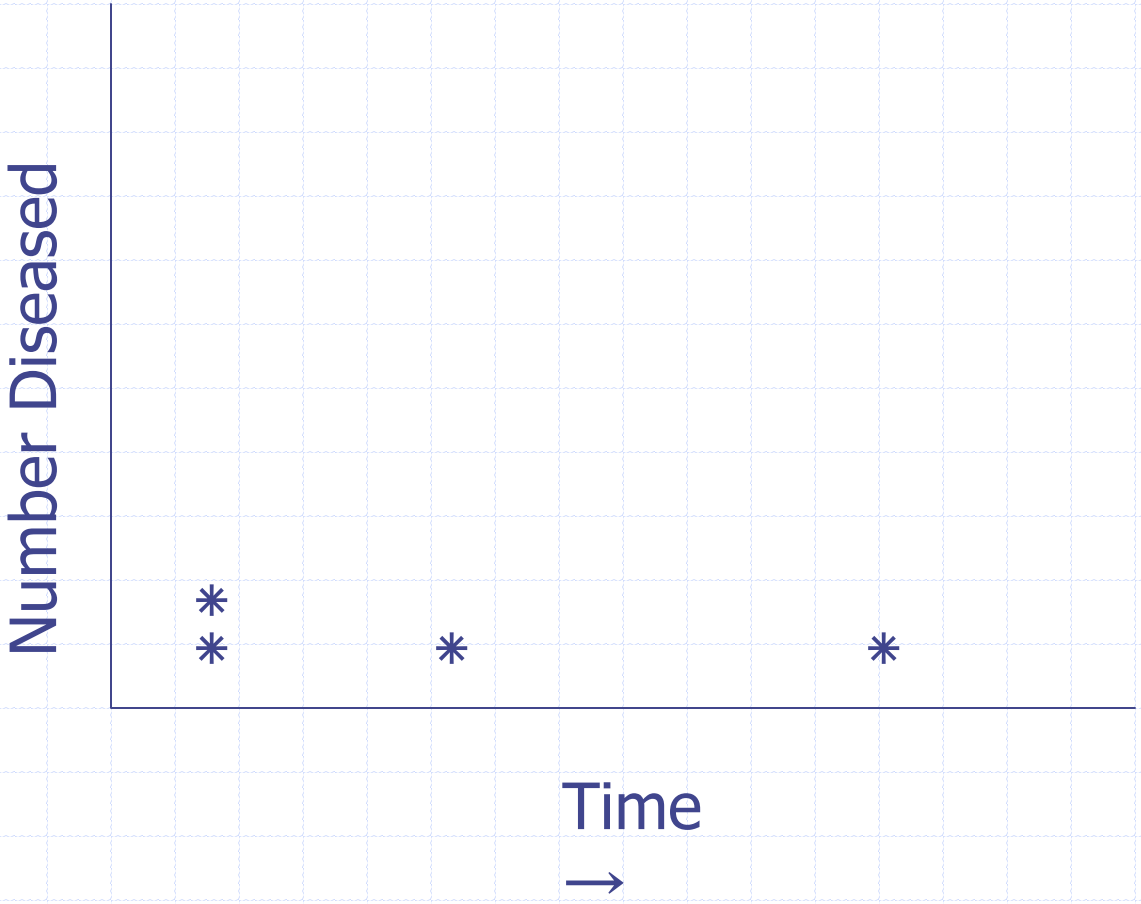
Establish Existence of Disease: Who?

- Characteristics of diseased and non-diseased:
  - Age, breed, sex, color, management group, pasture group, feed, water, stage of gestation, lactation status, vaccination status,treatment history, born on farm etc, etc, etc, etc…….
- For individuals and groups

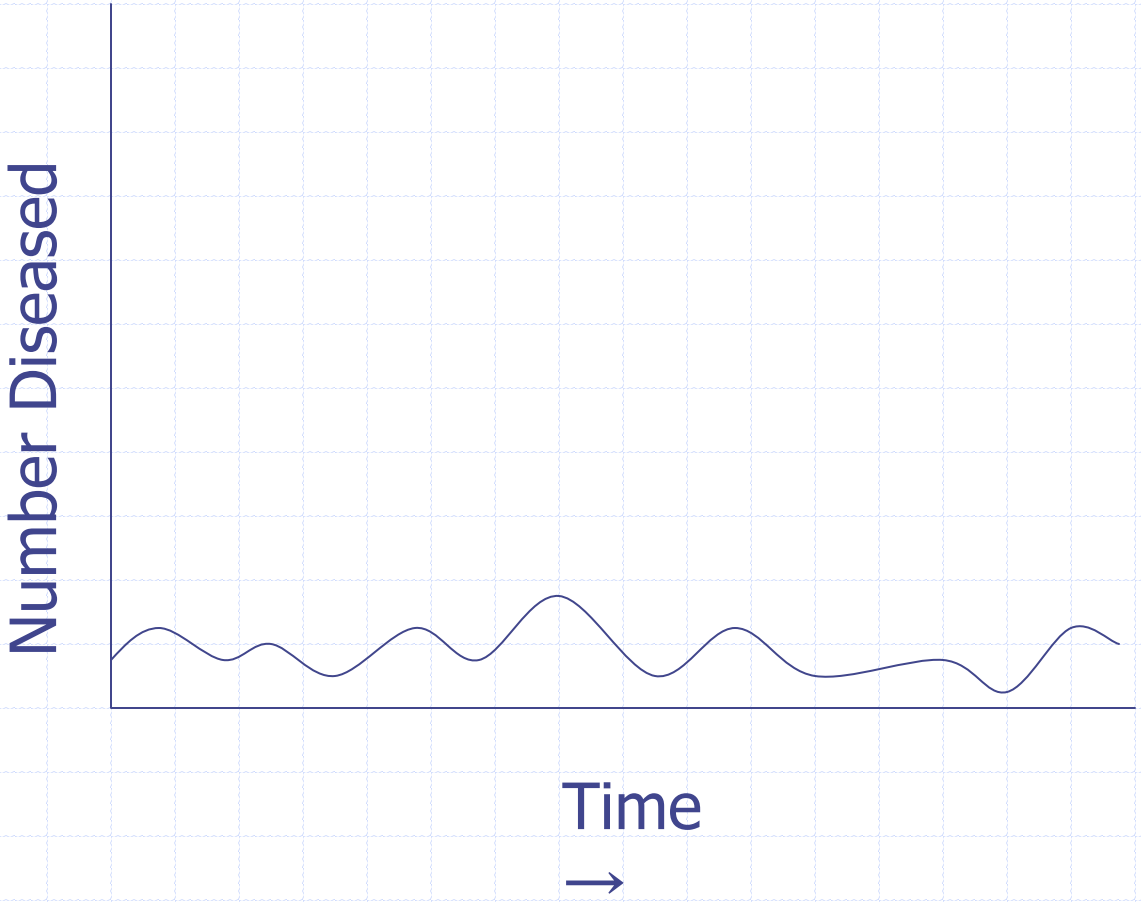
Establish Existence of Disease: When?

- Temporal pattern of disease
  - Record dates of disease onset, death, abortion, decreased feed consumption etc, etc, etc……
- Temporal patterns in other risk factors
  - Pasture change, feed change, introductions etc, etc, etc……..
- Epidemic curve
  - Sporadic
  - Endemic
  - Epidemic: point source vs a propagated agent

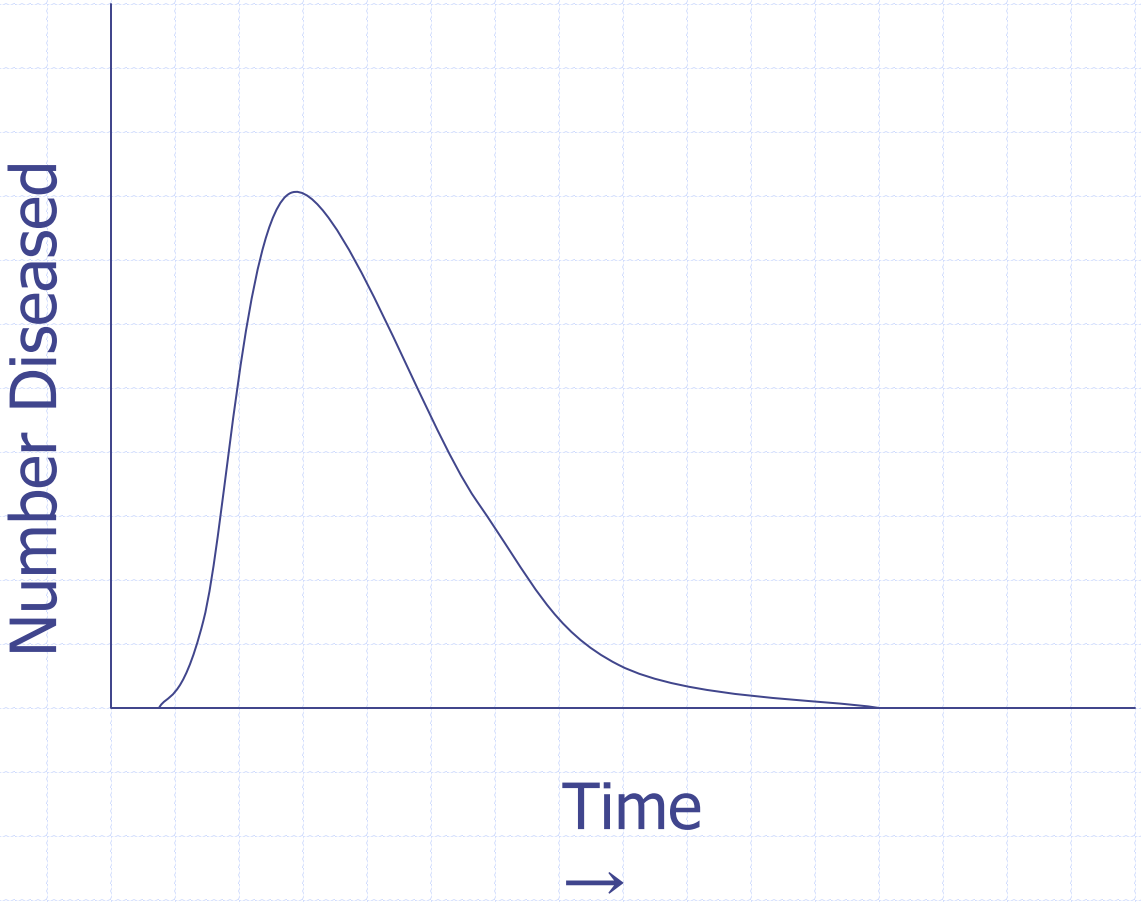
Sporadic



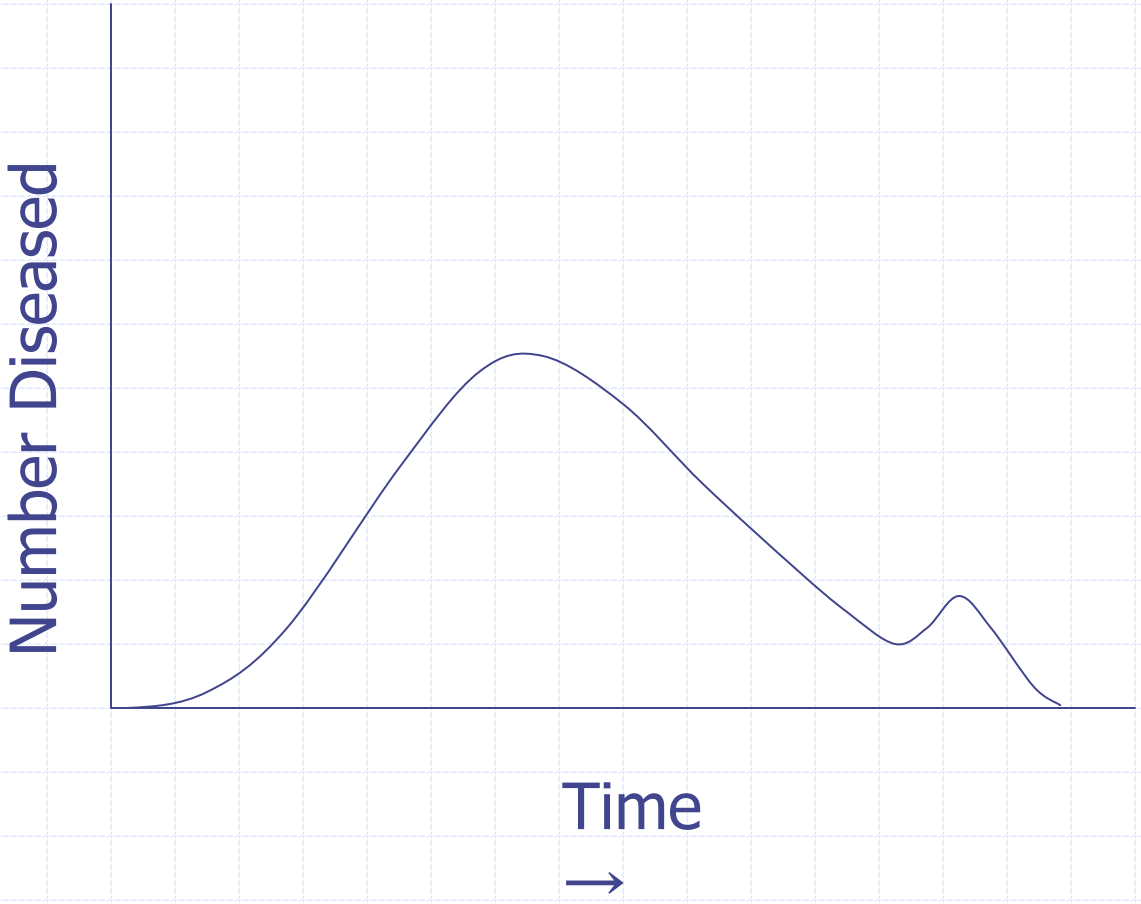
Endemic



Epidemic: Point Source



Epidemic: Propagated



Establish Existence of Disease: Where?

- Spatial pattern of disease
- Drawn maps and locate:
  - Groups
  - Diseased
  - Exposure
- Look for clusters and associations with exposure or other risk factors

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Establish Causality

- Many models of causality
  - Koch's postulates
  - Causal Web
  - Rothman's Component-Causes
  - Hill's criteria
- No single model fits all diseases or outbreaks

Some Practical Criteria To Help Establish Causality

- Is the cause(s) biologically sensible?
- Is there other research/evidence to support the cause(s)?
- Did the cause(s) occur before disease?
- Is there an association between the cause(s) and the disease?
- Is their a dose-response?

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- Is there other research/evidence to support the cause(s)?
- Did the cause(s) occur before disease?
- Is there an association between the cause(s) and the disease?
- Is their a dose-response?
- Technically these criteria do not PROVE causality
- Increase certainty of the cause(s)

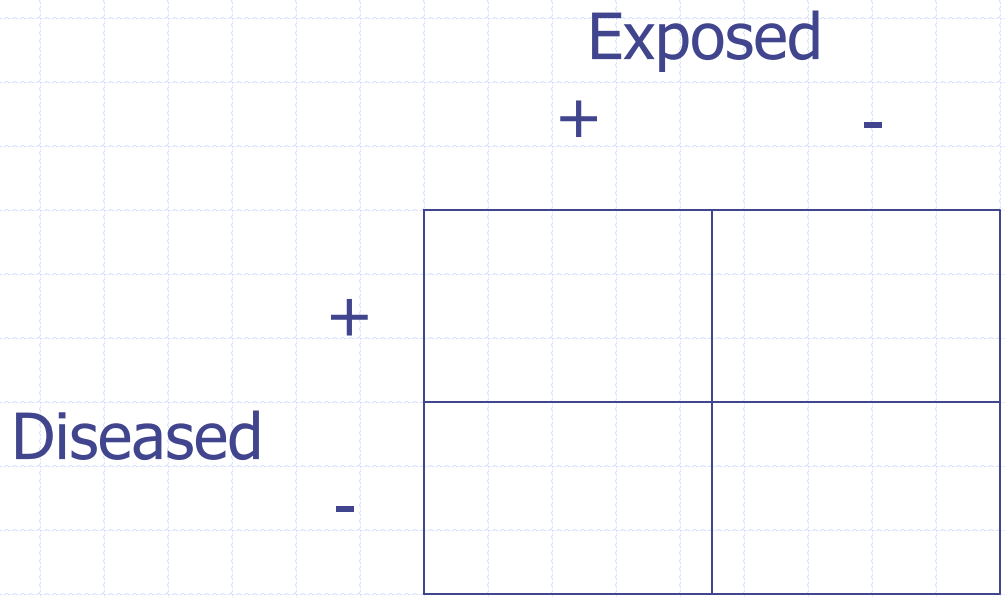
Establishing Associations

1. Smoking Gun
   - Evidence of cause (infectious or toxic agent) found in diseased
2. Statistically Significant Associations
   - Established by comparing groups

Comparisons
Statistical Associations

1. **Diseased versus Non-diseased**
   - Compare the amount of cause (risk factor) present in diseased animals/groups to the amount in non-diseased animals/groups
   - # diseased with cause vs # non-diseased with cause
2. **Exposed versus Non-exposed**
   - Compare the amount of disease found in animals/groups exposed to the cause (risk factor) to the amount in animals/groups non-exposed
   - # exposed with disease vs # non-exposed with disease

Two By Two Tables



Statistical Associations Can Be Demonstrated If:

1. **More** diseased animals with (exposed to) the cause (risk factor) than non-diseased
2. **More** exposed animals with disease than non-exposed

- **Difference** must be statistically significant

Two By Two Tables

Diseased	Exposed +	Exposed -
+	16	0
-	34	50
	50	50

$p < 0.0001$

Statistical Significance Depends On:

1. Magnitude of the difference
   - **How many more** diseased animals with (exposed to) the cause (risk factor) than non-diseased
   - **How many more** exposed animals with disease than non-exposed
2. Number of animals in each group (N)

For Statistical Significance

- A large difference requires small numbers in each group to be significant
- A small difference requires very large numbers in each group to be significant

Two By Two Tables

Diseased	Exposed +	Exposed -
+	16	0
-	34	50
	50	50

$p < 0.0001$

Two By Two Tables

		Exposed +	Exposed -
Dead	+	4	0
	-	46	50
		50	50

$p = 0.06$

Testing:

- For any reason:
  - Hematology, chemistry,serology, bacteriology, virology, parasitology…….
- **Sample all animals in the herd**
  - To make any group comparison the herd must be divided into at least 4 groups
  - Have no idea how great the difference will be until after you get your test results

Example: one herd with two groups of cows. One of the two groups was exposed to H2S. 20 of 116 aborted.

		Exposed +	Exposed -
Aborted	+	18	2
	-	46	50
		64	52

$p = 0.0004$

Example: one herd with two groups of cows. One of the two groups was exposed to H2S. 20 of 116 aborted. Could it be Neospora?

		Exposed +	Exposed -
Seropositive	+	16	13
	-	48	39
		64	52

$p = 0.92$

Example: one herd with two groups of cows. One of the two groups was exposed to H2S. 20 of 116 aborted. Could it be Neospora?

Aborted	Seropositive +	Seropositive -
+	5	15
-	24	72
	29	87

$p = 0.89$

Statistical Significance

- Requires comparisons of groups
- "More is always Better"
- **Test everyone**

What If All Are Exposed

- Difficult to prove causality: No groups
- Smoking gun?
- Compare to:
  - Previous years, neighbors, published data
- Associated temporally or spatially to the exposure?
- Eliminate all other causes
  - Examine and test all deads
  - Test all live animals for all biologically sensible causes
  - Leave no stone unturned

Report

- Detailed
- Comprehensive
  - Include everything
- Very time consuming
  - Charge for your time

Summary

- Establish existence of disease
  - Examine all deads, test all living and dead
  - "More is Better"
- Establish existence of cause(s)
  - Oil field toxic and other causes
- Establish causal associations
  - Smoking gun
  - Statistical associations "More is Better"
- Write the report

Questions?