Biosafety Consequence Assessment Modeling at BNL

Subcommittee on Consequence Assessment and Protective Actions

SCAPA

New Orleans, LA

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May 5, 2005

Agenda

- Biological Consequence Assessment at BNL
- Two different problems - biotoxins and infectious agents
- Vectors and pathways - it’s not like chem and bio
- Approach to modeling of biological agents
- Issues for consideration

Biosafety Consequence Assessment at BNL

Biological Hazards at BNL

- Small number of locations
- Limited hazard
  - 2 BSL-2 facilities
  - 1 BSL-3 facility
- A few bio-toxins
- NO infectious agents
- Basically - small fragments of organisms used for research
- Virtually - individual particles in most cases

Biological Emergency Management at BNL

- Well-established in Biosafety world
- Laboratory- and building-level emergency plans
- Fundamentally a “contamination control” response
- Not well established yet in 151.1 space
- Included in BNL hazard survey
- Will be included in EPHAs

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Biological Consequence Assessment at BNL

- Approach and methods under development
- Will depend in part on how Order / Guidance develops
- Hazard-driver for consequence assessment is much lower than for chemical and radioactive materials

Two Different Problems - Biotoxins and Infectious Agents

Biotoxins

- Act much like chemical toxins
  - Exposure occurs and consequence develops in receptor
  - Does not pass on effects to other receptors
- May be able to develop equivalents of PAC and TEL ???
- Need collaboration with “biotoxicoligists”

Infectious Agents

- Act very differently from our traditional hazards
  - Consequence to receptor may grow over time (infection)
  - Consequence may be transmitted to other receptors (index patient effect)
  - Secondary consequence delivery may be very complex (multiple vectors and pathways)
- Our traditional approach to consequence assessment will not work
- Need to define what “consequence assessment” means in this context
- Need to define the role of consequence assessor

Vectors and Pathways - It's Not Like Chem and Bio

Biological Vectors Are Different

- Vectors may include:
  - Human-human contact
  - Insect
  - Animal
  - Water
  - Food
  - Indoor air
  - Outdoor air

Biological Vectors Are Different

- Outdoor air is USUALLY the least important
  - Many biologicals are NOT transported in air
  - Most biologicals become inert quickly in ambient air
  - Other vectors are much more effective in producing exposures
- This may not be the case with some biological warfare agents
  - Engineered specifically to overcome problems with atmospheric vector

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Biological Pathways are Complex

- Multiple pathways often exist
  - Ingestion
  - Skin absorption
  - Inhalation
- Inhalation is often NOT the primary pathway
- More like radiological than chemical
- Can not expect to make the sorts of simplifying assumptions we have for chemicals

Approach to Atmospheric Modeling of Biological Agents

Focus on Decisions

- Atmospheric transport will not usually be the most critical vector of concern, but it MIGHT be important, so …

- The decision:
  - In an atmospheric release of an infectious agent, where can we expect to find index cases
  - We will quickly quarantine the area and test the population in order to control spread by secondary vectors

Decision-Support Needed

- Where are index patients likely to be found?
- What critical receptors are likely to be exposed at levels that may produce infections and trigger secondary vectors
- Critical receptors may be defined differently than we are used to (e.g., a movie theater or a soccer field may be critical receptors)

Modeling Outdoor Airborne Pathway for Infectious Agents

1. For infectious agent of concern: identify colony forming units that represent graded probabilities of infection (e.g., 10,000 units produces a 30% chance of infection)
2. Use standard breathing rate to calculate an exposure that reflects each probability level
3. Estimate concentration of agent in carrier substance
4. Estimate release of agent / carrier to atmosphere

Modeling Outdoor Airborne Pathway for Infectious Agents

5. Predict dispersion of agent / carrier through atmosphere
6. Consider important transport / dispersion effects (e.g., gravitational settling, deposition)
7. Consider time-dependent agent viability during transport
8. Calculate inhalation exposure at each receptor

Modeling Outdoor Airborne Pathway for Infectious Agents

9. Calculate deposition-related exposure at each receptor
10. Convert exposures to probability of infection at each receptor
11. Prepare decision-support products (e.g., maps with probability of infection contours)
12. Deliver and brief decision-support information to decision-makers

Some Issues for Biological Consequence Assessment Modeling

Issues for Consideration

- Toxins vs. infectious agents
- The other, more important vectors - it's still consequence assessment!
- The complexity of multiple pathways
- Bio-specific transport considerations (e.g., viability)
- The Powers Conundrum - population size and the Gaussian Distribution