Assessing Risk During Contamination Incidents

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This presentation

- Defining malicious contamination
- Expertise and agent selection
- Assessing risk in criminology
- Separating ‘actualisers’ vs ‘bluffers’ based on agent selection
- Suggestions for the future?

What is Malicious Contamination?

- Can encompass a variety of different crimes in which a product is adulterated in order to cause some type of harm to another
- Product at any point along the supply chain
- Includes criminal poisoning, product tampering, extortion and food terrorism
- Often difficult to differentiate between these crimes

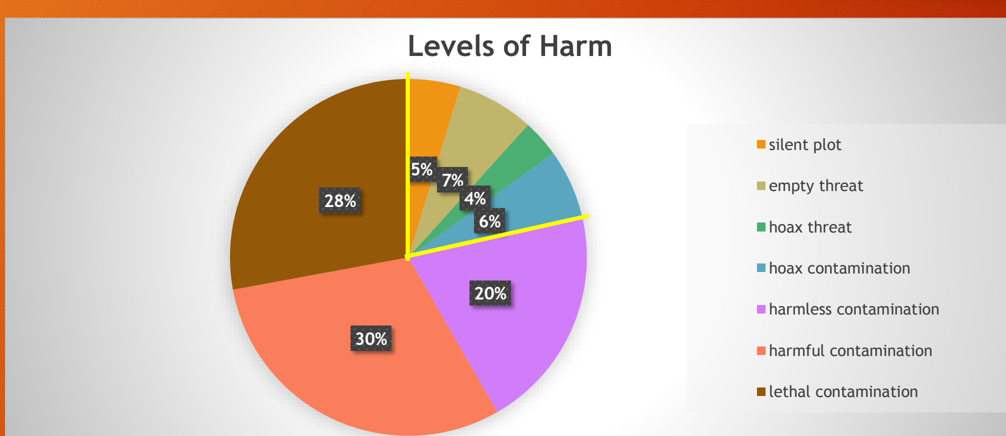
Existing research

- Little is known about poisoners and product tamperers
- Previous research does suggest that those who engage in malicious contamination may have some degree of poison knowledge (e.g. Dalziel, 2009; Trestrail, 2007)
  - Will experts use more 'successful' poisons?
- May be similar to bomb threats, where knowledge is not necessary for a threat but is for an actual actual (Hakkanen, 2006)

The dataset

- The database used consisted of 384 malicious contamination incidents, occurring worldwide, between 1970 and 2011
- Actual attacks, threats and plots all considered in this sample
- Descriptions of incidents were taken from news reports, academic journal articles and official government records
- A content analysis was performed to determine whether selected variables were present or absent in each case

How harmful are these cases?



Agents used

- Agents were divided among four categories:

Chemical agents	Biological agents	Radiological agents	Foreign bodies
• pesticides • heavy metals	• bacteria • toxins • viruses	• plutonium • polonium-210	• glass • needles

Part 1: Agents and expertise

Agent types

Agent	Actual contamination		Claims / threats only		Total uses
	n	% of actual	n	% of claims	n
Chemical	243	74.5%	9	22.5%	252
Biological	22	6.7%	17	42.5%	39
Radiological	8	2.5%	0	0.0%	8
Foreign body	25	7.7%	1	2.5%	26
Unknown	37	11.3%	15	37.5%	52
Total	326*		40*		366*

Specific agents used

- For cases involving actual contamination (n=326), the most common specific agents used were as follows:

Agent	n	%
Rat poison	51	15.6%
Cyanide	28	8.6%
Insecticide / pesticide / herbicide	24	7.4%
Arsenic	23	7.1%
Thallium	22	6.7%
Prescription medication	19	5.8%

Specific agents used

- For cases involving threats / hoaxes (n=40), the most common specific agents used were as follows:

Agent	n	%
‘HIV / AIDS’	7	17.5%
Insecticide / pesticide / herbicide	4	10.0%
Arsenic	2	5.0%
E. coli	2	5.0%
Snake venom; ‘typhoid’; ‘botulism’	1	2.5%

Poison knowledge

- One of the few noted trademarks of such contaminators is the potential to show a high level of interest in poisons
- However, not all cases require specialist knowledge
- Sample was reduced to only cases with known perpetrators (n=269)

Poison knowledge

- In the current sample, several different types of poison knowledge were identified:
  - Professional poison knowledge
  - Personal poison research
  - Military training
- 18.2% of this subsample were found to have some existing poison knowledge
  - Consistent with past estimates (e.g. Trestrail, 2007)

Poison knowledge

- Do experts use different agents than those without any known poison knowledge?
- There were no cases in the subsample of experts making empty threats or claims, and so only actual contamination cases were considered

Agent selection and expertise

	Experts		Non-experts	
	n	%	n	%
Chemical	35	71.4%	164	74.5%
Biological	11	22.4%	23	10.5%
Radiological	2	4.1%	0	0.0%
Foreign body	0	0.0%	10	4.5%
Total	49		220	

	Experts		Non-experts	
	n	%	n	%
Rat poison	1	2.0%	48	21.8%
Cyanide	5	10.2%	19	8.6%
Insecticide / herbicide/ pesticide	1	2.0%	17	7.7%
Arsenic	7	14.3%	14	6.4%
Thallium	7	14.3%	9	4.1%
Prescription drugs	6	12.2%	17	7.7%
Ricin	4	8.2%	2	0.9%
Salmonella (or other bacteria/ bacteria by-product)	7	14.3%	13	5.9%
Total	**49**		**220**	

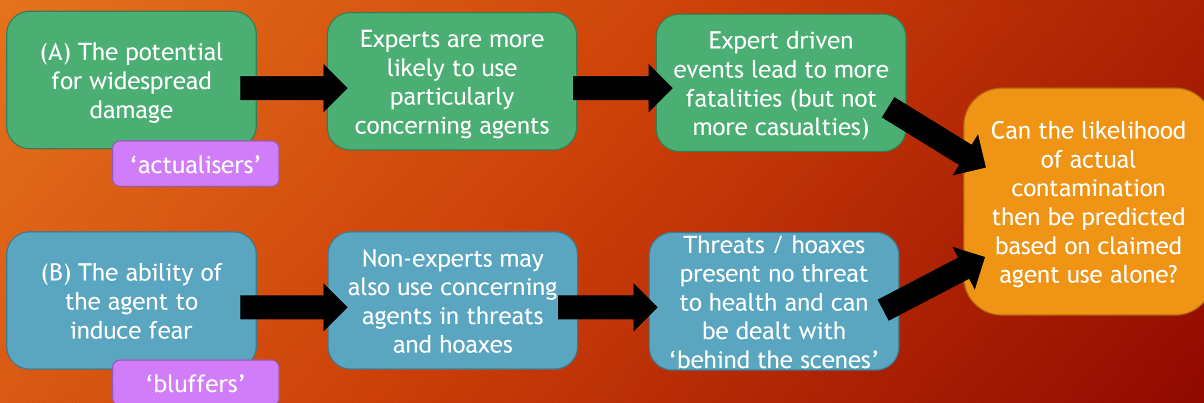
Expertise and harm

	Mean number of victims	Mean number of deaths	Number of cases involving no harm
Experts (n=49)	26.7	11.5	14 (28.6% of expert cases)
Non-experts (n=220)	49.1	7.1	95 (43.2% of non-expert cases)

Agent selection

- Choice of agent based on (1) perpetrator knowledge and (2) goal of the act
- In actual contamination cases, non-experts are most likely to use easily accessible / household poisons
- Experts may use those agents which they have access to / knowledge of (e.g. routine activity theory)
- The most fear-inducing of agents are more likely to be used in threats than actual contaminations
  - BUT could also be used in cases of food terrorism or attacks by experts

Two potential pathways



Part 2: Probability of use of CBRN agents

What is a CBRN agent?

- Particularly concerning contaminants are often shortened to 'CBRN agents'
  - Chemical, biological, radiological and nuclear agents
- Often mentioned in discussions of terrorism
- Focus here on chemical weapons, biological weapons, and radionuclear agents

What is a CBRN agent?

- For this analysis, agents classified as CBRN were:
  - Any toxic chemicals or precursors identified by the OPCW
  - Any bioterrorism agents identified by the CDC
  - Any radiation emitting material

ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS

CDC

CDC Bioterrorism Agents

Category A
Anthrax (*Bacillus anthracis*)
Botulism (*Clostridium botulinum* toxin)
Plague (*Yersinia pestis*)
Smallpox (variola major)
Tularemia (*Francisella tularensis*)
Viral hemorrhagic fevers (filoviruses [e.g., Ebola, Marburg] and arenaviruses [e.g., Lassa, Machupo])
Category B
Brucellosis (*Brucella species*)
Epsilon toxin of Clostridium perfringens
Food safety threats (e.g., *Salmonella species, Escherichia coli O157:H7, Shigella*)
Glanders (*Burkholderia mallei*)
Melioidosis (*Burkholderia pseudomallei*)
Psittacosis (*Chlamydia psittaci*)
Q fever (*Coxiella burnetii*)
Ricin toxin from *Ricinus communis* (castor beans)
Staphylococcal enterotoxin B
Typhus fever (*Rickettsia prowazekii*)
Viral encephalitis (alphaviruses [e.g., Venezuelan equine encephalitis, eastern equine encephalitis, western equine encephalitis])
Water safety threats (e.g., *Vibrio cholerae, Cryptosporidium parvum*)
Category C
Emerging infectious diseases such as Nipah virus and hantavirus

Assessing risk in criminology

- *'One of the best determinants of future criminal behaviour is past criminal behaviour'*

- Most often assess risk by:
  1. Using expert opinion to assess risk
  2. Relying on actuarial models to help determine the risk of future violence / a future attack

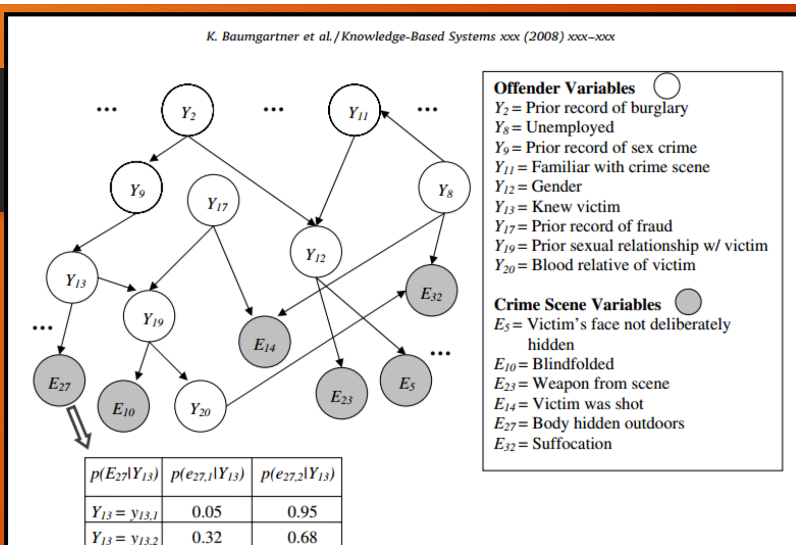
Assessing risk in criminology

- Ezell et al. (2010) argue that there are two reasons against using expert-estimated attack probabilities when consider terrorist attacks, including that:
  1. intelligence data is uncertain and incomplete, making it impossible to come up with accurate probability estimates, and
  2. that probabilities change as terrorists adapt around defensive actions

- There has thus been a push to use data to offer accurate predictions

Assessing risk in criminology

- Criminology and forensic psychology have recently moved from null-hypothesis significance testing towards Bayesian techniques
- This has been used in (for instance) offender profiling, but can also be used to predict future actions from past behaviour
- E.g. Baumgartner et al. (2008) and Zietz et al. (2016)



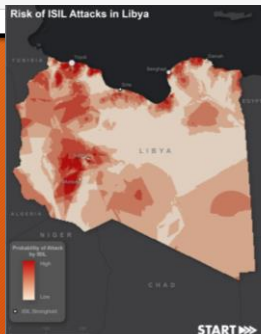
$p(E_{27} \mid Y_{13})$	$p(e_{27,1} \mid Y_{13})$	$p(e_{27,2} \mid Y_{13})$
$Y_{13} = y_{13,1}$	0.05	0.95
$Y_{13} = y_{13,2}$	0.32	0.68

Fig. 6. Slice of the trained BN structure, including one example of a CPT attached to node E_{27}.

- Baumgartner, K., Ferrari, S., & Palermo, G. (2008) 'Constructing Bayesian networks for criminal profiling from limited data.' *Knowledge-Based Systems*, *21*(7), pp.563-572.

$$Pr(A|X) = \frac{Pr(X|A)\,Pr(A)}{Pr(X|A)Pr(A) + Pr(X|A')\,Pr(A')}$$

Pr(X|A)	Chance of ISIL Attack given an Attack Occurs
Pr(A)	Chance of Attack at all (from total potential target population)
Pr(A')	Chance of No Attack at all (from total potential target population)
Pr(X|A')	Chance of ISIL Not Attacking given No Attack Occurs



	ISIL Attacks	Potential Targets	Pr(X|A)	Pr(A)	Pr(A')	Pr(X|A')	Pr(A|X)
Religion	25	2679	0.015547264	0.454222	0.545778	0.984453	1.30%
Infrastructure	14	1032	0.008706468	0.174975	0.825025	0.991294	0.19%
Government	161	696	0.100124378	0.118006	0.881994	0.899876	1.47%
Natural Resources	11	180	0.006840796	0.030519	0.969481	0.993159	0.02%
Public Gathering Areas	81	832	0.050373134	0.141065	0.858935	0.949627	0.86%
Medical	6	479	0.003731343	0.081214	0.918786	0.996269	0.03%
Total	298	5898					
Total Attacks in Iraq/Syria	1608						

- Zietz, D., House, J., & Young, R. (2016) 'ISIL in Libya: A Bayesian Approach to Mapping At-Risk Regions.' START.
- http://www.start.umd.edu/news/isil-libya-bayesian-approach-mapping-risk-regions

Using contact to predict outcomes

- When a threat is issued, the one piece of information that law enforcement have to go on is the contact made by the perpetrator
- From this point, only the cases where contact is made (e.g. to the media, the authorities, or to the targeted company) will be considered (n = 77)
- The specific focus is then on the agent claimed to have been used and whether this can predict the outcome of a specific case

Probability: CBRN agents

Pr(A)	Probability of an actual contamination	.532
Pr(X)	Probability of a CBRN agent being used	.091
Pr(A')	Probability of a no contamination (threat / hoax only)	.468
Pr(X|A)	Probability of a CBRN agent being used given an actual contamination	.073
Pr(X|A')	Probability of a CBRN agent being used given a threat or hoax alone	.111
Pr(A|X)	**Probability of actual contamination given the claimed use of a CBRN agent**	**.428**

Applying a ‘reality test’

- It may be helpful to apply a ‘reality test’ when assessing threats (Tunkel, 2010)
  - Is the threat plausible?
  - Is correct terminology used?
- This may help us filter out cases which are very low risk, or have a low likelihood of resulting a future attack
- Must be assessed on a case-by-case basis, and by those with specific knowledge

Other potential factors

- What other information might we get from a contacting perpetrator?
- Agent → chemical; biological; radiological/nuclear; foreign bodies
- Recipient → targeted company; media; law enforcement
- Product → packaged food/drink; produce; cosmetics; medication; etc.
- Demands → money; behaviour change; attention to a cause
- State of contamination → has happened; will happen
- Point of adulteration → manufacturing; distribution; retail
- Sender → group; individual; unknown

Limitations

- Open source data used only, so some important cases may be missing
  - Unsuccessful cases less likely to be mentioned?
- Easy to tell when someone has poison knowledge based on their profession, but personal poison research slightly harder
- Many threats involve still unknown perpetrators, so we don't know if any of these perpetrators may be experts
- Many different types of crime here; what do we use as priors?

Future research

- Focus on other predictive factors to differentiate between authentic and false threats when contact is made
- Examine specific subsets of malicious contamination incidents
- Collecting more data from alternative sources

Thank you!

- Questions? Suggestions? Please contact:
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