eAppendix 1 – Sample Vignettes

Random Sample of 5 Chemical Incident Vignettes from Study -none of which were judged to be examples of mass psychogenic illness

Operational Title of Incident	Vignette
Gas Leak	Twenty four workers from an industrial estate were taken to 2 hospitals after a leak of ammonia gas from a freezer at a refrigeration plant. One man was feeling nauseous, others were treated for irritation to airways and eyes and at least 2 for difficulty in breathing / chest tightness. Decontamination units were set up at one emergency department (due to miscommunication) but not used, and the major incident plan was not activated. The plant was evacuated (~200 people) and a cordon set up. Twenty fire-fighters in personal protective equipment (PPE) attended. Police began to evacuate nearby houses, but stopped as the leak had stopped. The fire crew reported a 'small' amount of ammonia.
Mixed Chemical Fire	There was a fire involving a skip containing Elastopore H 1246/2, which contains a variety of chemicals. There was a heavy (but relatively small) green / yellow plume of smoke from the fire that persisted for about 30 minutes and dispersed rapidly. The plume was partly over a residential area. The fire service chemical incident unit was alerted. The plant was evacuated but no casualties were reported.
Toxic Spillage	A 20 litre barrel of phosphoric and hydrochloric acid was spilt on the pavement outside a domestic address. It was not known where the drum was from or who owned it. Two policemen approached to investigate and developed red eyes and respiratory irritation. They were given symptomatic treatment and the scene and conveyed to a hospital emergency department. A cordon was established
Noxious Odor	A noxious odor was reported in a flat in a tower block of 110 flats. The odor was also reported in corridors on 3 floors. The ambulance crew were 'overwhelmed' by odor, withdrew with the resident, and requested help from fire brigade. Three members of the ambulance crew were taken to a hospital emergency department with severe headache, difficulty in breathing, chest tightness and cough - they recovered within a few hours. Residents were told to stay indoors and shelter, whilst the building was ventilated. Initially the odor was thought to come from graffiti cleaner or paint; but later the police believed it was from the brewing of illegal drugs
Oil Tank Explosion	There was an explosion of an oil tank due to welding. One man was injured and he was taken to hospital (probably a minor injuries clinic), although his injuries were not believed to be serious. There was a dense plume and businesses on the industrial estate were evacuated and a 200m cordon set up. Residents were told to stay indoors. Police manning the cordon wore Personal Protective Equipment (PPE). The local authority received complaints from residents about the plume. There was a multi-agency response, which included the Environment Agency as 150,000 litres of water was contaminated with oil, which was contained.

eAppendix 2 – Validity and Inter-rater Agreement

Construct Validity

To assess the construct validity of Criteria C, D and E our panel of toxicologists rated an additional ten chemical incidents taken from the published literature. They were not told that these were any different to the other incidents. Of these, five were case reports of episodes of MPI[1-5] and five were case reports of confirmed toxicological poisoning.[6-10] These were presented to the toxicologists in similar anonymised vignette form. All three toxicologists endorsed Criteria C, D and E for all five incidents of MPI incidents taken from the published literature. Thus the Kappa statistic (κ) was 1 (unanimous agreement) for each criteria. Results for the episodes of certain toxicological poisoning taken from the published literature showed complete agreement between all toxicologists for ratings of Criteria D and E (κ statistic= 1), but poor agreement for Criterion C (κ statistic= -0.2; p-value= 0.781) i.e. 'Spread of symptoms is epidemic'.

Inter-rater Agreement

Percentage agreement and the Kappa statistic (κ) were used to assess the level of agreement between the toxicologists' ratings for each of Criteria C, D and E across all incidents for which they produced ratings (i.e. 72 incidents). Percentage agreement was also calculated between pairs of raters, as κ is known to vary depending on the proportion of positive and negative ratings.[11] Two κ statistics were calculated for Criterion E, as the toxicologists rated this Criterion against two separate statements (see 'Definition of Mass Psychogenic Illness' in the Methods section).

The κ statistic result varied between criteria from 0.03 to 0.60 indicating that the level of agreement was between 3% and 60% greater than could be expected by chance (see Table below for details). According to commonly cited guidance on the interpretation of the κ statistic, the result for Criterion C indicates 'fair' agreement, that for Criteria D indicates 'slight' agreement, whilst the 2 components of Criteria E are indicated by 'moderate' and 'fair' agreement.[12] Percentage agreement between pairs of raters is also presented below, demonstrating a high level of agreement for all criteria.

Based on the κ statistic, inter-rater agreement was low for Criterion D and the second component of Criterion E, yet percentage agreement between raters was highest for these criteria. The unduly low κ scores reflect the disproportionate number of positive vs. negative ratings for these criteria (i.e. differing base rates).[11] Overall, our interpretation is that inter-rater agreement for the criteria was reasonable.

References for Appendix 2

1. Jones T, Craig A, Hoy D, Gunter E, Ashley D, Barr D, Brock J, Schaffner W. Mass psychogenic illness attributed to toxic exposure at a high school. New England Journal of Medicine 2000;342:96-100.
2. Selden BS. Adolescent epidemic hysteria presenting as a mass casualty, toxic exposure incident. Ann Emerg Med 1989;18:892-5.
3. Gamino LA, Elkins GR, Hackney KU. Emergency management of mass psychogenic illness. Psychosomatics 1989;30(4):446-9.
4. Bartholomew RE. "Mystery illness" at Melbourne Airport: toxic poisoning or mass hysteria? Medical Journal of Australia 2005;183:564-566.
5. Donnell HD, Bagby JR, Harmon RG, Crellin JR, Chaski HC, Bright MF, M Van Tuinen, Metzger RW. Report of an illness outbreak at the Harry S Truman state office building. American Journal of Epidemiology 1989;129(3):550-558.
6. George G, Cave I, Brock M. Fumes under the bank: report on a chemical incident in a high street bank, Banbury, Oxfordshire. Chemical Hazards and Posions Report 2004;2:9-11.
7. Saunders F. Ammonia release in superstore. Chemical Hazards and Posions Report 2004;2:12-13.
8. McCrea S, Huckle E. Wood pallet yard fire, near Swansea. Chemical Hazards and Poisons Report 2006(6):6-7.
9. Basarab M, Mandal S, Meltzer M, McCrea S, Ruggles R. Carbon monoxide poisoning: lessons in communication and risks to first responders. Chemical Hazards and Poisons Report 2008(12):14-17.
10. Horton DK, Burgess P, Rossiter S, Kaye WE. Secondary contamination of emergency department personnel from o-chlorobenzylidene malononitrile exposure, 2002. Annals of Emergency Medicine 2005;45:655-658.
11. Uebersax JS. Diversity of decision-making models and the measurement of interrater agreement. Psychological Bulletin 1987;101(1):140-146.
12. Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics 1977;33:159-174.

eAppendix 3: Description of 'Highly probable' and 'Probable' Episodes of Mass Psychogenic Illness

	Operational Title of incident	No. of symptomatic individuals	Setting	Odor report?	Symptoms reported	Brief description of incident
Highly probable MPI	*Unknown compound*	3 healthcare workers	Road	No	Eye irritation Throat irritation Mild respiratory symptoms	A truck was involved in an accident in the rain. The truck may have leaked fluid but left the scene. A member of the public involved in the accident did not report any symptoms, but 3 ambulance crew who attended did. They were assessed in hospital emergency department (ED). No chemical was identified, nor was the truck ever located.
	Hospital chemical incident	21 healthcare workers	Hospital	Yes "glue-like", "pear drops"	2 x collapse Dizziness Light-headedness Burning eyes Gritty eyes Sore throat Metallic taste Shortness of breath Feeling 'overcome' Tiredness Lethargy	Staff noticed an odor in a clinical area and became symptomatic. Some attended the ED for assessment - examination was normal and they recovered within 2 hours. There were concerns that the ED had become contaminated so it too was closed for several hours. Over the next few days, several staff reported symptoms attributable to the exposure and there were at least 2 more evacuations following odor reports. Reports of ill-health attributable to an unknown exposure continued for at least one further week. Results of environmental sampling did not identify a cause for the symptoms.
	Lead in water in student residence	1 student + several staff (exact number not known)	College	No	Fatigue Pains Restlessness Headache	A student alleged that he had analysed the tap water from a college building and found lead levels 12 times the recommended maximum. The student complained of symptoms and reported them to his family doctor. 250 staff and students were advised not to drink the water. Some developed headaches that were attributed to lead poisoning. Testing of the water samples showed lead to be below statutory levels.
	CO poisoning	59 children + 2 staff	School bus	Yes	Respiratory symptoms Headache Vomiting	A school bus was involved in 2 suspected mass poisonings in 1 day. The 1st incident occurred when pupils reported an odor and possible smoke on the bus. 5 children were assessed in hospital and found to be clinically well but anxious. An air ambulance assessed a further 25 children at the scene. An hour later the bus was implicated when another group of children developed symptoms. There was a large emergency response including another air ambulance. 11 individuals were assessed in hospital. No toxic cause was identified.
	Possible hydrocarbon contamination	5 adults	Residential property	Yes "sickly sweet" "petrol" "solvent"	Headache Sore throat Nausea	A deposit of an unknown substance was dumped into some surface water. Complaints were received from a nearby household of headache, sore throat, nausea attributed to the deposit. The odor and symptoms stopped once the sludge was removed. The substance was tested and found to be 'benign' and probably the contents of a chemical toilet.

	Mercury Spill	~20 children	School	Yes "nasty"	Headache Tiredness	A thermometer was broken in class. It was not known whether it was made of mercury and no remnants were found, but it was treated as if it had been a mercury spill and the class was evacuated. The children reported symptoms but these did not continue.
Probable MPI	*Orange powder incident*	2 adults + 4 healthcare workers	Hospital	No	Cough Nausea Generally unwell Irritated hands	An unknown orange compound was thrown over a man in the street. He was decontaminated in a hospital ED and treated for superficial burns to his face and hands, but had no other symptoms. In the ED, several staff and patients began to experience symptoms. The orange powder was not identified.
	Phenylacetone exposure	1 adult + 2 healthcare workers	Hospital	Yes "fumes"	Overcome Generally unwell	A woman became ill after mistakenly drinking a substance thought to be either benzylmethyl ketone or gammabutyrolactone. Her conscious level dropped and she was taken to an ED. Her clothes were removed and double bagged, as was the bottle from which the substance had been drunk. 3 others (including a relative and 2 ED staff) developed symptoms as a result of fumes from the woman – this was made worse when she vomited.
	CO poisoning from gas fire	2 adults + 3 children	Residential property	Yes "pepper spray"	Headache Dizziness Other symptoms – not specified in report	A woman became concerned that she and her 3 young children had been poisoned by carbon monoxide from their natural gas fire. They evacuated the apartment and were taken to an ED. No carbon monoxide was detected in the apartment. An upstairs neighbour also reported a smell and became symptomatic.
	Fumes	3 adults	Distributio n centre	No	Headaches Stinging eyes Respiratory symptoms	3 workers developed symptoms after opening a container from the South East Asia. They were taken to the ED but no toxic cause was identified. 9 days earlier there had been an episode when 6 workers developed respiratory symptoms after opening a similar container – associated with a strong chilli odor. On that occasion the symptoms were attributed to chillies having been spilt.
	Fumes on school bus	32 children	School bus	Yes "bad smell" "smoke"	Nausea Headaches Vomiting Generally unwell	Children developed symptoms during and after a school bus journey. Smoke was reported, but this may have been cigarette smoke. The bus driver had not noticed anything unusual and continued on his route with no further problems. 12 children were taken to hospital and later discharged, 20 more were treated at the scene – no toxic cause identified. The bus had been serviced the previous day and was later formally inspected and no problems identified.
	Potassium cyanide	2 police	Police station	Not known	Respiratory symptoms	A 1/2 litre of potassium cyanide was spilt in a police department, although there was no skin contact. 2 police developed symptoms and were taken to hospital ED.
	Smell of ammonia in store	4 adults	Store	Yes "ammonia"	Watery eyes Generally unwell	A smell of ammonia was reported in a store and people became unwell. They were taken to an ED and recovered quickly. Investigation revealed 3-5ppm ammonia levels in the store, but there were puddles near a refrigerator above which higher levels were found (max 50ppm).

	Chlorine release at swimming pool	6-10 adults	School	Not known	Skin irritation Eye irritation	There was a minor release of chlorine at a school swimming pool. Between 6 and 10 adults were believed to have been exposed, although there was uncertainty as to whether or not they reported skin and eye irritation. All were treated at the scene and none went to hospital. The school was evacuated.
	White phosphorus exposure	2 adults	Residential property	Yes "molasses" "chemical"	Burning throat Respiratory symptoms Muscle cramps Shaking Limb weakness Dizziness Collapse with loss of consciousness	Tree surgeons were working on a tree stump when some white smoke or powder was released. They immediately felt burning in the back of their throats and in their chests and muscle cramps, they also reported shaking, limb weakness and two collapsed to the floor (although no loss of consciousness). Neither had any pre-existing health problems. They attributed their symptoms to white phosphorus and self-presented to a hospital emergency department. At assessment they were well but complained of some residual weakness, chest tightness and dizziness and one was slightly hypoxic. They were advised that they were unlikely to have been exposed to phosphorus as their symptoms were not consistent and they were sent home.
	Fumes in store	4 adults	Store	Yes "petrol" "solvent" "styrene"	Headache Eye irritation Nose irritation Nausea	Workers in a store next to a gas station complained of an unpleasant odor and developed headache, eye & nose irritation and nausea. Environmental health officers, the water company and the gas company all investigated but failed to find a source for the odor. The gas station was closed for a week,, and residents / workers advised to drink bottled water. The symptoms resolved within a week, with no source found.
	Armillatox	2 healthcare workers	Hospital	Yes "Jeyes fluid" "phenol"	Headache Dizziness	A suicidal woman drank Armillatox pesticide and attended the local ED. The odor led healthcare workers to develop symptoms when in the vicinity of the closed pesticide bottle and the woman's vomitus.
	CO incident	7 adults	Bus depot	No	Generally unwell	There was a suspected natural gas leak from a boiler in a bus depot. 1 person was taken to hospital and found to have a carboxyhaemoglobin level of 4.4%. 4 further people became symptomatic and attended the ED and 2 more were treated at the scene. Carboxyhaemoglobin levels of <3% were recorded (3% in a smoker). Environmental sampling was unable to establish a cause.
	Potential CO poisoning	4 healthcare workers	Health check bus	Not known	Headaches Black nasal residue	Workers on a stationary health check bus became symptomatic with headaches and a black residue when they blew their noses. They attended a hospital emergency department and were found to have carboxyhaemoglobin levels of <2%. The bus and its generator were inspected, but despite environmental sampling no cause was established.

eTable 1: Inter-rater Agreement for Mass Psychogenic Illness Criteria C, D & E

Criterion[1]		Raters	% Agreement between raters	Mean % agreement	κ statistic
C	Spread of symptoms is epidemic	R_1 & R_2	69%	66%	0.30
		R_2 & R_3	56%		
		R_1 & R_3	73%		
D	Symptoms are attributed by affected individuals to a threatening external agent	R_1 & R_2	88%	89%	0.02
		R_2 & R_3	93%		
		R_1 & R_3	85%		
E	Symptoms are not compatible with the exposure identified	R_1 & R_2	83%	80%	0.60
		R_2 & R_3	81%		
		R_1 & R_3	77%		
E	Symptoms are not compatible with another environmental exposure that could reasonably have been present at the time or shortly before onset of symptoms	R_1 & R_2	100%	96%	0.03
		R_2 & R_3	96%		
		R_1 & R_3	93%		

[1]For 72 incidents that fulfilled criteria A and B;
R_1= Rater 1; R_2= Rater 2; R_3= Rater 3

eAppendix 4 - Restricted Analysis

All associations were re-tested by restricting the analysis to include only the 116 incidents for which there was evidence that symptoms had been reported (i.e. where Criteria A had been met). The results of this analysis showed that odor remained predictive of MPI (aOR 3.3, 95% CI 1.3–8.0), as did incidents occurring in a healthcare facility (aOR 5.4, 95% CI 1.3-22.6) but not at schools. Of the health response variables that had previously been associated with MPI, only the activation of a hospital major incident plan remained so (see Table below).

eTable 2: Associations with Mass Psychogenic Illness - analysis restricted to incidents in which people experienced symptoms

n=116 incidents		Adjusted MH[a] Odds Ratio[b] (95% CI)	Chi^2 test
Incident at school/ college		2.78 (0.70-11.04)	2.3
Incident at healthcare facility		5.38 (1.28-22.59)	6.7
Odor	Smoke odor	3.26 (1.33-7.99)	6.7
	No odor		
	Other odor		
Attendance of police		0.68 (0.24-1.92)	0.5
Attendance of fire service		0.42 (0.14-1.26)	2.6
Attendance of ambulance		0.35 (0.12-1.03)	4.0
Evacuation occurred		0.55 (0.19-1.54)	1.3
Decontamination of public		0.25 (0.03-21.3)	1.9
Decontamination of staff		1.92 (0.17-22.12)	0.3
Hospital ED[c] physician aware		2.14 (0.78-5.90)	2.3
No. casualties presenting to hospital ED[c]	0 persons	1.21 (0.47-3.13)	0.2
	1-10 persons		
	>10 persons		
Hospital major incident plan activated		7.30 (1.05-50.95)	5.53

[a] MH= Mantel-Haenzsel; [b] Adjusted for whether the incident was a fire; [c] ED= emergency department