Criminal Poisoning and Product Tampering:

Toward an operational definition of malicious contamination.

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Abstract

'Malicious contamination' encompasses multiple crimes which have received little previous academic attention, including poisoning and product tampering. While these acts may seem easy to distinguish, there are many areas of overlap, and so before these crimes and those who commit them can be understood clear definitions must be introduced. The presence or absence of 14 behavioural variables is proposed as a way of distinguishing product tamperings from poisonings, with the empirical definition then tested on 384 malicious contamination incidents. The operational definition successfully distinguishes 92.7% of the cases and allows for a comparison of the differences between poisoning and tampering.

Keywords: poisoning, product tampering, malicious contamination, food security

INTRODUCTION

As long as it has been understood that chemical and biological compounds can cause illness these agents have been used to intentionally cause harm, and yet relatively little is known about poisoning crimes, representing only a small proportion of all homicides (e.g. Shepherd and Ferslew 2009). However, when poison is used to harm others, motivations range from the political to the personal. Similarly, while single victims known to the offender are common, poisons are also used against multiple victims in mass homicide, and in complex hoaxes aimed at extortion. Although little research has been carried out on these crimes, the two forms of malicious contamination which have attracted the most attention are homicide by poisoning and product tampering.

Shepherd and Ferslew (2009) found that homicidal poisonings in the US occurred at a rate of 0.26 per million people per year over a seven year period, and that victims were more likely to be infants and the elderly. Studies conducted on homicidal poisonings in Japan and the US have found that the gender of the perpetrator is related to the gender of the victim and that the perpetrator is likely to be someone previously known to the victim (Westveer et al. 2004; Zaitsu 2010). A 30 year sample of poisoning cases in the US concluded that homicidal poisoning is “an intimate type of crime, occurring most often in family or domestic settings” (Adelson 1987:249).

With the exception of the above studies on poisoning homicides, the crime of poisoning has received little previous attention in the criminological literature. The few studies published in criminology have emphasised historical narratives and gender differences (e.g. Nagy 2014), with little attention given to poisoning as a contemporary form of violence. Poisonings may be mentioned in the context of broad studies of homicide (Farrell et al. 2011; Fox and Levin 1998; Gurian 2009; Myers et al. 2005), although the focus is rarely on their forms and few studies use empirical analysis.

Product tampering is a much more recent crime, thought to have peaked in the mid-1980s (Rosette 1992). Motives have been listed as the disguise of a separate case of homicide, financial gain, publicity, and “random sociopathic acts” (Logan 1993:923). While threats are more common than authentic cases of product tampering, these too may still cause considerable economic damage to a targeted company (Logan 1993).

Poisoning crimes are commonly thought to be expressive attacks, occurring as an emotional act with no other goal but to harm the targeted victim (Shepherd and Ferslew 2009). Expressive aggression, which can also be referred to as hostile, affective, impulsive, or reactive aggression, is generally defined as aggression which is unplanned and driven by anger (Anderson and Bushman 2002), is caused by high levels of autonomic arousal, and serves the evolutionary purpose of protection from physical threats (Meloy 2006). Indeed, attacks against romantic partners (Fitness 2001) and within the workplace (Aquino et al. 2001) have often been found to be motivated by revenge. However, Zaitsu (2010) argues that both instrumental and expressive aggression can be observed in poisoning cases. In cases of instrumental aggression the intent to harm the victim still exists, although this is considered secondary to achieving an external goal, such as financial gain (Bushman and Anderson 2001). Instrumental aggression is seen as being methodical, deliberate and goal-driven (Kockler et al. 2006), and physiological arousal is minimal or non-existent (Stanford et al. 2003), with the evolutionary goal of securing resources (Meloy 2006). Similarly to poisonings, different motivations appear to exist in product tampering, such as extortion of money from the targeted company, or to exact financial loss on a company because of grievances, whether personal (e.g. firings) or related to political activism. Therefore, a bimodal distribution of aggression where types of aggression are expressed dimensionally rather than categorically (e.g. McEllistrem 2004; Meloy 2006) may be more appropriate here, with poisonings and product tamperings straddling both of these aggressive domains.

On first examination it may seem clear how product tampering is to be distinguished from criminal poisoning. However, when the range of malicious contamination crimes is examined, it becomes obvious that the boundaries between different forms of criminal action are much more difficult to define, and that crimes vary as to how typical they are of their class. Previous works have emphasised the importance of clear definitions in criminology, and how definitional issues can seriously impede the study of crime (e.g. Ball and Curry 1995; Hagan 2006). This paper therefore takes a large sample of actual contamination crimes, to propose and test the behavioural indicators which can be used to differentiate product tampering from other forms of malicious contamination. Once this operational definition is in place, the data are used to examine the characteristics of product tampering crimes and their perpetrators, and how they differ from crimes of poisoning.

Defining the Sample of Malicious Contamination Crimes

Poisons have been defined as “chemical substances that act on human beings, including medical supplies (e.g., hypnotics) and non-medical supplies (e.g., thallium)” (Zaitsu 2010:505). However, this simple definition omits other commonly used agents, such as bacteria and viruses. In addition, this definition only considers whether each agent acts on humans, not the strength of this effect or whether it is considered to be positive or negative, both of which are important in understanding what constitutes a crime.

In their study of homicidal poisonings, Shepherd and Ferslew (2009) used the ICD-10 definition of poisoning (WHO 2010; see section T15-T98), which includes a more thorough list of agents, such as drugs, pesticides, corrosive substances, and gases and vapours, among others. While these agents are those most commonly associated with poisoning acts, physical agents may also be found in contaminated items. Foreign objects can be defined as “any unwanted food product, even if it originated from the food product itself (e.g. bone in meat; fruit stones)” (Graves et al. 1998:21). These foreign bodies can be potentially hazardous (e.g. sharp fragments of bone or glass), unsanitary (e.g. dead animal remains) or largely innocuous (e.g. chewing gum). For the current study, only items which (a) were not meant to be part of the product and (b) were placed in the product *intentionally* are considered foreign bodies, thus eliminating cases of accidental contamination with items like bones and fruit stones.

The United States Federal Anti-Tampering Act (FATA) of 1983 defines tampering with consumer products as the “reckless disregard for the risk that another person will be placed in danger of death or bodily injury” or the “intent to cause serious injury to the business of any person” when the individual “taints any consumer product or renders materially false or misleading the labelling of, or container for, a consumer product, if such consumer product affects interstate or foreign commerce” (FATA 1983:§1365). Under this legislation, both threats and conspiracies to tamper with consumer products are also considered to be criminal acts (FATA 1983). While similar legislation exists for the UK in the form of the Food Safety Act of 1990, this law offers no explicit definition of product tampering.

The starting point for this analysis is to stipulate the greater sample of crimes from which our definitions can be developed, and collect together accounts of actual crimes that have taken place in the past. The FATA definition allows for ‘reckless disregard’ which could include those who alter the structure of the product for their own, typically financial, gain. For the FATA definition, it does not matter whether there is actual criminal intent or incompetence. This would include, for example, allowing potentially harmful ingredients in a product to increase profits. For the purposes of this analysis we are limiting the sample to those who have a deliberate intent to harm, whether that harm is to physical wellbeing or to a company’s business. The first and most obvious criteria must therefore be that a) the act was a deliberate attempt to cause physical, psychological, or financial harm to another person, persons, or organisation, and that b) the act involved the use of or threatened use of some form of contaminant.

In line with the FATA definition we include not only cases where actual poisons are administered but also hoaxes, which could include products adulterated with non toxic substances, as well as ‘bluffing hoaxes’ where claims are made regarding contaminations which have not taken place. The agent which was used, or claimed to have been used was recorded in the database, along with whether the incident turned out to involve an actual adulteration of a product, or a simple hoax. The outcome of the incident in terms of the number of injuries or deaths was also recorded.

Finally, the FATA definition states that the act must have some effect on ‘interstate or foreign commerce’ and that the substance must be poisonous (FATA 1983:§1365). Since these criteria may be incompatible with the inclusion of crimes involving threats and hoaxes we have not used these to restrict our data sample.

A list of cases was first collected for this sample from keyword searches of news databases and from previous research studies. Information for each case was collected from government sources, academic journal articles, and news reports. While international and regional newspapers were used, the most common source for these cases were national newspapers from the US and UK.

The final sample for this analysis consisted of 384 incidents of malicious contamination occurring between 1970 and 2011. Figure 1 shows the frequency of cases per year in the final sample and Table 1 shows their geographical location.

[Figure 1 and Table 1 about here]

Once sources were collected, a number of relevant behavioural variables were identified and a content analysis was performed, with each variable being coded as ‘present’ or ‘absent’ for each individual case. In order to account for missing data, additional ‘unknown’ categories were included throughout (e.g. unknown agent used, unknown point of adulteration, unknown attack location, etc.).

A wide range of apparent motives were identified across the sample and cases were coded as to whether they were directed toward; political activism (n=74), extortion (n=50), other financial gain (n=52), attention/notoriety (n=21), revenge (n=64), homicide concealment (n=5), and theft (n=8). These categories will be explained in more detail later in the paper.

Having selected a sample of 384 incidents which fulfil the inclusion criteria, we now turn to the characteristics of the crime itself, the variables that were coded and the measure we propose to use to define an act of product tampering and distinguish it from an act of poisoning.

Offence Characteristics

The first stage in constructing an empirically derived definition is to content analyse the accounts of the crimes and establish a coding scheme that records salient characteristics of the offences. From these characteristics we then developed hypotheses about which variables might be indicative of product tampering and which could be considered more indicative of poisoning offences. Other variables are recorded, but left without prediction, and tested against the definitional categories later in the paper.

The product contaminated. According to the FATA definition, product tampering involves the tainting of a 'consumer product'. Our first set of offence characteristic variables were therefore designed to record the type of product that was contaminated, or stated to have been contaminated. The content analysis first recorded the class of product that was contaminated. Across the sample, a range of products were found to have been poisoned. First there are products that one literally consumes; i.e. items of food or drink (n=121)[3]. However, along with mainstream food items, cases of contamination were also found to affect baby food (n=11), pet food (n=4), and non-food products such as medicines (n=26) and cosmetics (n=8). All of these routes to harm involve products that may be purchased from a retail outlet. However, the sample also includes cases where a contaminant was added to meals or drinks (n=155), both in restaurants and in the home, and to open access foodstuffs such as crops (n=4) or water supplies (n=19) which are destined to be consumed at a later stage in the supply chain. This brings the first difficulty with the definition of a

[3] The numbers given in brackets in this section indicate the frequency of occurrence across the whole sample.

‘product’, and the blurring of the boundary between what constitutes product tampering as opposed to poisoning.

Attacks which occur within a restaurant or similar establishments could be considered product tamperings as the customer is expected to pay for their meal. However, while food or drink in a restaurant setting could be considered consumer products, these goods are not subject to the same protective barriers as similar items purchased within a retail setting. If we took the definition of a consumer product to be something that is for sale, then the contamination of crops, livestock and open water would also count as product tampering, since they are items which are generally bought and sold. Due to the lack of critical control points, agriculture and fresh produce are particularly vulnerable to contamination going unnoticed (WHO 2008). However, such ‘open access’ items may be used or consumed without actually being sold, in which case they would not be considered consumer products. In this case then, it would be difficult to differentiate between the contamination of crops for personal use by a farmer from those for consumer distribution, even though only the latter would be considered a ‘product’. In addition, the same could be said in regards to public water sources, such as rivers and lakes. In such instances, the definition of an open water source as a product may be based on the existence of some form of water treatment procedure, as well as the distribution of water to paying consumers. However, it has also been noted that many water treatment facilities, such as dams and reservoirs, are often easily accessible by the general public (Gleick 2006), and as such are not protected by the same types of barriers shared by many other commercial products.

It is acknowledged that illegal products may also be contaminated for some of the same reasons that legal goods are contaminated, such as to obtain money for other illegal activities. For example, illegal drugs used both for therapeutic (i.e. counterfeit drugs; see Henney et al. 1999; Kao et al. 2009) and recreational purposes (e.g. Caulkins 2007; King 1997) have been known to be adulterated with potentially dangerous substances. While the contamination of illicit goods is in need of further study, the scope of the current analysis is limited to consumer products which travel through the traditional supply chain.

In order to propose some objective measures that relate to the products contaminated, we hypothesised that two overarching variables would function to differentiate crimes. First we distinguish the location in which the contaminated product was acquired by the victim. We took the two most clear cut locations as definitional indicators, with contaminated products obtained from a *retail outlet* (n=108) as most indicative of product tampering, and contaminated products administered in *the home* (n=70) as most indicative of poisoning. No specific hypotheses were attached to other locations such as restaurants (n=37), prisons (n=10) and hospitals (n=14).

The second issue for defining product tampering might be whether or not the product is packaged. This would seem to make intuitive sense in that it rules out restaurant and home based meals as instances of product tampering, as it would the poisoning of crops, livestock or water supplies. However, we are left with unpackaged consumables such a fresh fruit, which have no packaging and yet are consumer goods sold in shops. If one accepts poisonings to be more expressively aggressive acts, and that such crimes are generally spontaneous in nature, it is more likely that a perpetrator would choose an item to which they have immediate and unrestricted access, such as those considered to be open consumables or open access products.

For the purposes of this analysis we therefore decided to create a super-ordinate classification of the different product types and that *packaged consumables* (n=131) would be considered indicative of product tampering, and that the other categories, *open consumables* (n=166) and *open access* (n=23) would be variables that would be more associated with a case of poisoning.

The intended victim. As noted in relation to contamination of open access products, to define product tampering may require us to look at the potential distribution of the products, i.e. who was intended to consume them eventually. For this reason we identified and coded who the intended victim was, in terms of who would be physically harmed should the product be consumed (or otherwise used for its intended purpose). As well as coding for the specific type of victim, it was deemed important to distinguish between the targeting type. Victims could therefore be specific named individuals, individuals who were chosen because of their occupational role or what they represent (e.g. military personnel), or unspecified, i.e. the targeting is left open to whoever happens to consume the product. Finally, there may have been no intended victim, for example in hoaxes, where no genuine contamination has taken place. As previously mentioned, research has suggested that in traditional poisoning crimes, the victim is likely to be previously acquainted with the perpetrator, and thus selected specifically based on their identity, rather than on their occupation or their consumer habits (Adelson 1987; Zaitsu 2010). We therefore used these variables such that cases where there was *no intended victim* (n=47), or victims were *unspecified* (n=130) were taken to be more associated with product tampering, whilst a *specified* (named) victim (n=180) was taken to be more likely to reflect a poisoning. Furthermore, cases where there was an *existing personal relationship* (n=129) between the perpetrator and the victim (where known) were taken to be further indicative of a poisoning rather than a tampering crime. No specific hypotheses were made concerning victims selected by occupational role (n=29).

The Point of Adulteration (PoA). According to the analysis so far, it seems reasonable to take the contamination of a meal (an *open consumable*), which is given to a relative or other acquaintance (a *specified victim, existing personal relationship*) in the *home* as being a case of poisoning rather than product tampering. If we also added the fact that the meal was adulterated in the home, this might make the case an even clearer example of poisoning rather than product tampering. Similarly, the most clear cut point of adulteration for an incident to be a case of product tampering would be at the manufacturing, distribution or retail stage, where the contaminated product had the opportunity to reach unspecified victims.

For this reason we decided to define not just where the product was obtained by the victim, but also the stage at which the contamination itself took place, being either *in the supply chain* (i.e. in production, distribution or retail; n=49) *or post supply chain* (e.g. in the home; n=138). Thus, it can be hypothesised that a product that is contaminated in the home, without being returned to the distribution chain, would not be considered a case of product tampering. An example would be the contamination of over-the-counter medication by a spouse wanting to harm their partner, or possibly some gift item, such as candy or chocolates, which may have been delivered by a vindictive neighbour. In these cases, although a packaged consumable is altered, it is in the home and given directly to a known, specified person and therefore appears more like a poisoning than a product tampering. In order to help clarify the close and specified nature of poisonings we included a variable which indicated whether the tainted product was *given directly* (n=82) to the victim.

However, whilst the distinction between adulterations in supply chain vs. post supply chain may constitute the 'prototypical' cases, here again we discovered some interesting anomalies which present problems for a clear cut definition. First, there are several cases (n=7) in which the perpetrator falsely claims that the alteration occurred before the product reached the home, with the supposed victim having committed the act themselves. These cases appear to meet the criteria of packaged consumables, although the product was contaminated in the home and does not re-enter the supply chain. While in these cases there may be no intended victim, the company targeted could still experience the same damage to reputation as would occur in a case with authentic contamination while in the supply chain. Another variant occurs when a contaminated item is sent directly to the targeted company (n=20). The act generally occurs in conjunction with an extortion demand, and so the company may still be at a loss, even though the item has not re-entered the distribution chain. These cases seem more like tampering, albeit hoaxes, and so we thought it important to include a variable that indicates whether a crime involves a *commercial target* (n=85), and whether the perpetrator/s *communicate with that target* (n=77). These inclusions will further help distinguish product tamperings from poisonings.

The 14 indicator variables discussed here, which are proposed to distinguish product tampering from poisoning are summarised in Table 2.

Data coding. Each of the 384 cases was coded according to all of the offence characteristic variables, the apparent motivations, the contaminant and the eventual lethality of the incident. Further variables were included in the database to record information about the perpetrators' background (where known). Finally, an inter-rater reliability assessment conducted on 15% of the data (n=58) revealed a significant kappa value (κ=.783; p<.001), which, according to Landis and Koch (1977), can be considered to be in the 'substantial' range (.61-.80) and very near to the 'almost perfect' range (.81-1.00).

[Table 2 about here]

Mapping Sentence

Taking the variables described above, it is possible to combine them in the form of a mapping sentence, shown in Figure 2. A mapping sentence can be defined as a "combination of formal and informal language", with the formal elements being represented by 'facets' (shown in brackets) and the informal elements (the connecting language) being the aspects of secondary focus (Borg and Shye 1995:50). In other words, a mapping sentence is a qualitative statement which can help identify factors of primary importance in defining a concept, as well as provide a framework for testing how variables may interact with one another. The mapping sentence is a tool associated with Facet Theory (Guttman 1971; Guttman and Greenbaum 1998). The facets of the mapping sentence each contain a mutually exclusive list of 'elements'. The elements from each facet can then be selected independently of one another in order to create a statement, which can also be referred to as a *structuple*. Thus, reading through the mapping sentence, taking one element from each facet gives a statement of a hypothetical case which can be deemed more or less indicative of a product tampering as compared to a poisoning[4].

[Figure 2 about here]

The mapping sentence in Figure 2 was created in order to combine the variables hypothesised to distinguish product tampering from poisoning. Since we have already specified which elements of each facet are to be indicative of poisoning and tampering there are two combinations of elements (i.e. structuples) which would define the most clear cut cases of poisoning and tampering. Following one pathway through the mapping sentence we can see that the most prototypical product tampering would be: "A crime which aims to cause harm to another through the use (or threat) of a contaminant introduced while *in the supply chain* to a *packaged consumable* which is *not given* directly to *no or unspecified* victims who are *unknown* to the offender via a *retail outlet* and which involves a *commercial company* with whom the perpetrator makes *contact*". Likewise, the most prototypical poisoning incident can be hypothesised to be, "a crime which aims to cause harm to another through the use (or threat) of a contaminant introduced *post supply chain* to an *open consumable or open access product* which is *given* directly to *specified* victim/s who are *known* to the offender in a *home environment* and which does not involve a *commercial company* or any *contact* with one".

Although the mapping sentence gives us the characteristics of the most prototypical cases that we might find in the data set, it also shows that there are many more combinations of elements (structuples) that are theoretically available in the data and which might represent more or less typical instances of either poisoning or product tampering. For this reason the 'common range'

[4] There are a small number of combinations that are not theoretically possible.

shown at the end of the mapping sentence is taken as a continuum from tampering to poisoning rather than a clean cut categorisation of one crime or another. The task for the current paper is now to investigate the frequency with which the cases in our sample conform to the prototypes and to devise a measurement scheme that can be used to create a 'cut off point' for converting this continuum into a workable categorical definition.

AN EMPIRICAL DISTINCTION

Once the appropriate indicator variables were identified, overall scores were determined for each case based on the total number of poisoning and tampering indicators that each case contained. The number of poisoning indicators was subtracted from the number of tampering indicators to obtain a total score ranging theoretically from -7 (complete poisoning) to +7 (complete tampering). For example, if a case involved all seven of the poisoning variables mentioned previously (a score of 7) and none of the seven tampering variables (a score of 0), the cumulative score would be 0 – 7, or -7. If on the other hand a perpetrator contaminated an item at the retail point which was then found in a supermarket, and directed the attack at a large number of unspecified individuals, (3 tampering indicators), but the product was an open consumable (1 poisoning indicator), the score would be 3 - 1 = 2. For the entire dataset, the mean of these scores was -0.43, with a standard deviation of 3.45, and range from -6 to +6. No case on either side was found to have a score of +/- 7.

The data were then split at the zero point for indicator scores, with positive scores being considered tamperings (41.1% of scores; n=158), and negative scores being poisonings (51.6% of scores; n=198). Cases with an overall score of zero were considered to be indeterminate and were not included with either of the categories above, although these accounted for only 7.3% of the dataset (n=28). The complete distribution of poisoning and tampering indicator scores can be seen in Figure 3.

[Figure 3 about here]

Figure 4 shows the distribution of joint poisoning and tampering scores for each case, with tampering scores on the x-axis and poisoning scores on the y-axis. In total, 44.3% of cases (n=170) had a tampering score of zero but a poisoning score of at least one, while the opposite was true in 28.4% (n=109) of cases. Of the 384 cases represented in Figure 4, only a small proportion (0.52%, n=2) were relatively high in both scores, with multiple poisoning and multiple tampering variables found in these cases, both of which were identified as poisonings. In addition, the fact that many cases were assigned overall scores around the zero mark lends more support to the fact that a clear and finite distinction between these cases may not exist. Nonetheless, in order to describe tampering as a distinct criminal act, criminologists need a workable empirical definition. The following section applies the proposed definition to the cases in the current database, in order to examine the characteristics of product tamperings as compared to poisonings.

[Figure 4 about here]

A COMPARISON OF POISONING AND PRODUCT TAMPERING

Perpetrators and Victims

Based on the scale scores described above, all cases were classified as being either a poisoning or tampering incident, or indeterminate, where the scale score was zero. The 28 indeterminate cases were excluded from further analysis, leaving a sample of 356 cases, or 92.7% of the original data. Of the 356 cases in the new sample, 104 (29.2%) were unsolved and we therefore have no information about the offender/s responsible. Of the remaining 252 cases, 182 (72.2%) were carried out by lone offenders whose identity was known to authorities, and of these, most were clearly identifiable as poisonings (n=124) with a smaller number of product tamperings (n=58). There were 42 cases in the new sample where more than one person was involved in a personally motivated offence. In these non political crimes, a similar proportion of the poisoning cases (11.6%) and the tampering cases (12%) were attributable to teams rather than lone offenders.

Non-directional Pearson Chi-square tests were performed on a number of the background and offence descriptor variables which were coded in the database in order to explore further the potential differences between poisoning and product tampering. Bonferroni corrections were used throughout.

Poisoners. The Westveer et al. (2004) study of homicidal poisonings in the US has provided one of the most detailed sources of information concerning poisoner demographics to date. In their study, it was found that men were more often the perpetrators of homicidal poisonings, and that victims were equally divided by sex. However, the victims of female perpetrators were most often male. In Zaitsu's (2010) sample of Japanese homicidal poisoners, 46% of perpetrators were men and 54% were women. Neither of these studies find perpetrator gender remarkably skewed in either direction.

In the present study, where poisoners are working alone, 49.6% (n=60) of the cases were carried out by men and 50.4% (n=61) by women (when perpetrator gender was known). This finding is therefore comparable to previous studies, which lends support to the validity of our definition for poisoning cases. It should be noted however, that only 45.2% of poisonings by lone, known offenders were lethal attacks, compared with 100% in Westveer et al.'s (2004) study. Furthermore, demographic information was not known in many cases in the current sample, and so interpretation of results should be made with caution. Finally, it must also be noted that the two datasets overlap, although the sample covered by Westveer et al. (2004) accounted for less than 2% of the current sample.

For poisonings carried out by lone individuals, both male and female perpetrators fell within a very similar age range (14-60 for female perpetrators; 17-57 for male perpetrators). The age range of the victims was also similar (8 months-60 years for women; 5-82 years for men), although the victims of female perpetrators were younger overall. For single perpetrators and single victims, when victim gender was known, men targeted 43.8% male victims and 56.2% female victims, while women targeted more men (73.9% of cases) than women (26.1%). Women were also much more likely to attack a family member (78.7%) than men (43.3%). Men more often had some existing knowledge of poisonous substances than women (35.0% to 14.8%, respectively). Lethality was roughly equal between the genders, with a slightly higher percentage of lethal cases being observed when the perpetrator was female (47.5% compared to 43.3%).

Product tamperers. In 57.6% (n=91) of incidents of product tampering the offender was either unknown or their identity was unreported at the point of data collection. For those offenders who were known and acting alone, the majority (78.9%; n=45) were male, with only 21.1% (n=12) identified as female. Tamperers were also found to be slightly older than poisoners, with ages ranging from 20-78 years old. When tampering cases have unknown victims (71.5% n=113), this may be either because they were not reported, or the cases were hoaxes or threats, with corporations as the main target. Further, many tampering crimes tend to be random in regards to victim selection and so we would not expect to find any pattern in the age or sex of the victims. However, there may be exceptions in the case of some specific products, such as baby food, in which the targeted consumer belongs to one specific group. While such cases are particularly emotive (Cremin 2001), baby food was targeted in only 2.9% (n=11) of all cases in this entire sample.

Taking just those cases that involved a single offender whose identify is known (n=182), 24.2% of poisonings were committed by an offender with some sort of existing poison knowledge, compared with only 12.1% of tamperings (see Table 3). Both professional and personal poison knowledge were found to be more prevalent among poisoners than tamperers, although none of these relationships were found to be statistically significant with Bonferroni corrections. This may reflect the fact that poisoning more often aims to cause actual harm, while tampering may only require a threat, or the perception that contamination has occurred (Cremin 2001; Logan 1993). In many cases of product tampering, one only needs to know what constitutes a poisonous substance, but not how to obtain it, handle it or what dose would be required to cause harm. Indeed, perpetrators with poison knowledge were found more frequently in product tampering cases with actual contamination (21.5%), as opposed to only 10.5% among non-contaminations, although this was not found to be statistically significant (χ^2=1.259, df=1, p=.372, Fisher's Exact p used).

Only 27 (7.6%) of the cases identified as a poisoning or a product tampering involved victims targeted in terms of their occupational role, and this was more prevalent in poisonings (n=23) than in tamperings (n=4; χ^2=10.347, df=1, p=.001), which is still statistically significant given Bonferroni corrections.

Terrorist or other political actors were responsible for 40 crimes in the data set, but only 28 of these cases were clearly classified as poisoning or product tampering. Of these 28, 14 were classified as poisoning and 14 as product tampering. Although these acts of contamination formed a greater proportion of tampering cases than poisoning cases the difference is not statistically significant (X^2 = 2.634, df=1, p=.105). In the past, poisoning has often been used in warfare or assassination, and political activism has been a common motive in product tampering. The potential for the food chain to be hijacked in order to commit a large-scale act of terrorism should not be underestimated.

[Table 3 about here]

Motivations

In coding the 384 crimes for analysis in the original sample, each case was coded as to whether the motivation was judged to be political activism, extortion, other financial gain, attention/notoriety, revenge, homicide concealment, or theft. The motives were coded as separate variables and so it is possible for a crime to have more than one motivation. For example, in 1983, Florida high school student Montgomery Todd Meeks was convicted of plotting to murder his father with ricin. The defence team in his trial claimed that the plot stemmed from Meeks witnessing his father abusing his mother, however it was also found that Meeks stood to inherit hundreds of thousands of dollars, as well as his father's business, on his death (Carus 2002). This case would therefore be considered to be motivated by both revenge and 'other financial gain'.

Table 4 shows the percentage of the 356 clear cut poisoning or tampering cases judged to be associated with each of the seven motives. The results in Table 4 show that the most common motivation among poisoners was revenge, and that this is more frequent in poisoning than in product tampering crimes (χ^2=11.682, df=1, p=.001). For product tampering crimes, the most frequent motivation was extortion, again much more prevalent here than in poisonings, where no such crimes were reported (χ^2=71.206, df=1, p<.001). Both of these findings were statistically significant.

[Table 4 about here]

As for other motives that showed a statistically significant difference between crime types, non-extortion monetary gain was found to be a motive in more cases of poisoning (19.7%) than tampering (6.3%; χ^2=13.230, df=1, p<.001), however, attention/notoriety was a more common motive among product tamperers (10.1% compared to 2.0%; χ^2=10.891, df=1, p=.001). Monetary gain in the form of insurance claims motivated a number of cases of spousal homicide, and the desire to attract publicity motivated several product tamperers.

Political activism was a motive in 18.2% or the poisonings compared with 13.9% of the tampering cases (χ^2=1.168, df=1, p=.280) showing that both crimes were as likely to be used by those with a terrorist or extremist cause. There were too few cases of theft and homicide concealment for statistical analysis, but both were more frequently associated with product tampering than poisoning. Similarly, although there were only seven cases of those falsely claiming to have been victims, six of these were found among the poisoning cases.

Agents

Table 5 shows the percentage and frequency of the combined actual and claimed use of each type of contaminant for the 356 cases that could be classified as poisoning or product tampering. The results show three statistically significant findings. Chemical agents were used, or claimed to have been used, more often in cases of poisoning, comprising just over three-quarters of all such cases (χ^2=12.405, df=1, p<.001). However, biological agents were more prevalent in cases of tampering than poisoning (χ^2=9.580, df=1, p=.002). It is possible that biological agents may *sound* more threatening than chemical agents, and so may be used more in threats. Indeed, it was found that biological agents were used in 5.7% of actual contaminations, but 30.6% of threats and claims in this sample.

Where publicity is the objective in financially or politically motivated tampering cases, causing serious harm to consumers may be unnecessary in order to meet the perpetrator's specific goals (Logan 1993). In these cases, less serious contaminants such as foreign bodies (James 2005) may be sufficient. In the current sample, foreign bodies were found to be statistically significantly more common among tamperings (13.3%) than poisonings (2.0%; χ^2=17.097, df=1, p<.001). Finally, while radiological agents were used more frequently among poisonings, there were few cases in total, and the results were not statistically significant.

For the 356 cases that could be categorised, only seven poisoning cases had no real contamination present, while 32 product tampering cases turned out to be hoaxes or false claims. Examination of the agents that perpetrators were actually able to get hold of during acts of genuine contamination shows that chemical agents are used most frequently in both poisonings (75.8% of cases) and product tamperings (58.2% of cases).

[Table 5 about here]

Locations

The location where the contaminated product was acquired by the victims has already been noted for its importance with the inclusion of 'retail' and 'home' points as variables indicative of tampering and poisoning respectively. However, no hypotheses were made regarding the other locations mentioned. While attacks in restaurants accounted for a larger percentage of tampering cases, this was not found to be statistically significant, and hospital attacks were also found in a similar percentage of cases for both poisonings and tamperings (see Table 6). Contaminated products administered in prisons were found in poisoning cases alone, however this was not statistically significant with Bonferroni corrections (χ^2=5.698, df=1, p=.019). Finally, a statistically significant relationship was found in cases where a contaminated product was sent directly to the manufacturing company, with these cases occurring more frequently among product tamperings (χ^2=16.533, df=1, p<.001).

[Table 6 about here]

Outcomes

Our definition of poisoning contained the variables 'existing personal relationship' and 'administered in the home', and their occurrence indicates physical proximity between perpetrators and victims. It is therefore possible that poisoning cases would be more likely to be deadly than tamperings, as the one-to-one delivery may make consumption of the product more likely. On the other hand, poisonings deaths may be fewer in number, because they may be more specified in victim selection. This can be summarised as a 'lethality-bandwidth', based on the concept of a 'disease-bandwidth', whereby the wider the scope for an attack to reach a large segment of the population, the more people will be affected (Khan et al. 2001; WHO 2008). Meanwhile, the potential to harm specific individuals increases as the point of contamination nears the point of consumption (WHO 2008). Poisoning cases were more likely to use harmful substances, and for there to be casualties as a result (42.9% for poisonings; 16.5% for tamperings). In this sample there were no cases of poisoning threats and a very small number of hoaxes. This may be due to the lack of reporting in these cases, or the inability of such innocuous acts to help the perpetrator achieve their goals.

In comparison to poisoning cases in which 42.9% were lethal, only 10.8% of tamperings resulted in at least one fatality, which was found to be a significant difference when applying a Mann-Whitney U test (U=10610, p<.001, two-tailed). The most frequent form of tampering was those where a potentially harmful contaminant was used but no injuries were reported (31.0%), followed by those resulting in harm but no fatalities (16.5%) and empty threats in which no item was adulterated (16.5%). This reinforces the conclusion that tamperings are often based on external goals, such as extortion or attention to a cause, since only a minority of cases in this sample resulted in any casualties.

There were a small number of cases in the sample (n=10) in which the perpetrator attempted or took their own life following the contamination incident. All of the attempted (n=3) and completed (n=7) suicides occurred among the poisoning cases, with no known cases of a tamperer taking their own life. Again, these results are not unexpected if we take into consideration that tampering is most often committed for instrumental goals, such as extortion or notoriety whereas poisoning was more highly associated with revenge. In addition, all acts involving suicide were lethal attacks in which the victim and perpetrator had an existing relationship. However, while the majority of murder-suicides have been reportedly committed by men (Friedman et al. 2005; Malphurs and Cohen 2005), six of these ten cases were perpetrated by women. One example is the 2007 case of Johanna Vera, who poisoned her two sons with rat poison-laced juice before drinking the juice herself in an attempted murder-suicide. The incident was reportedly caused by the breakup of Vera's relationship with her sons' father, and medical intervention was able to save the lives of Vera and both of her children.

DISCUSSION

This paper set out to examine the crime of malicious contamination and establish an empirical definition which would distinguish product tampering from poisoning. Drawing on the relevant literature and existing definitions, 14 variables were chosen with which to create an empirical measurement scale to differentiate between these crimes. Using a broad international sample of 384 contamination incidents the definitions were tested against the crime characteristics of past cases.

The results show that in 'real world' cases crimes do not fit easily into simple labels, and that none of the actual cases fitted exactly the 'stereotypical' profile of a poisoning or a product tampering. In reality, these crimes fall along a continuum of how typically they represent either a poisoning or a product tampering template. Nevertheless, in order to study these crimes and their perpetrators, criminologists require some kind of definition to classify these acts. The current paper has therefore proposed an operational definition which allowed 92.7% of the cases to be identified as product tamperings or poisonings. Using this definition we were then able to characterise the qualities that distinguish between these crimes with statistical significance, including motive, agent type, and perpetrator characteristics.

As with previous studies of homicidal poisoners (e.g. Westveer et al. 2004; Zaitsu 2010) the cases of poisoning in the current sample, when committed by known single actors, were roughly equally divided between male and female perpetrators, whose ages fell within a similarly broad range. Female poisoners in the current sample were more likely to attack male victims and family members than their male counterparts. Both male and female poisoners were equally likely to commit a lethal attack. In contrast, in cases of product tampering, where a lone operating perpetrator was apprehended, just under 80% were found to be male. Victims targeted by occupational role were relatively infrequent in our sample but were more often found among poisoning crimes.

Although not statistically significant, there was a trend towards more poisoners than tamperers being found to have some kind of specialist knowledge of poisonous substances, either by virtue of their occupation or because of specific research they have done in order to commit the crime. This makes intuitive sense, since in the current sample 38.0% of the tampering crimes were hoaxes that required only the threat of harm, and 72.8% resulted in no injuries, compared to the poisonings which almost always appear to have intended serious harm, whether or not the perpetrator eventually succeeded. Poisoners therefore not only require a genuinely harmful agent, but ideally some knowledge of how to use it. The higher lethality of poisonings can not only be accounted for by intent, but potentially also because of the higher frequency of personal relationships between poisoners and their victims. It is possible that a poisoning incident would be more likely to result in death due to the increased certainty that the victim will consume the tainted product, as per the lethality-bandwidth. Indeed, attacks occurring in the home or at the level of food service have been found to involve the highest number of casualties (Dalziel 2009; WHO 2008). However, this is difficult to confirm from the literature, as many past studies of poisoning focus on ‘successful’ homicidal poisonings only, without the consideration of non-lethal cases (Adelson 1987; Shepherd and Ferslew 2009; Westveer et al. 2004; Zaitsu 2010).

In practical terms, many cases of product tampering will come to the attention of law enforcement when the company whose product has been targeted, or some other agency such as the media, is notified by the perpetrator. However, these approaches only happen in 43.7% of the tampering cases studied in this sample, and are only necessary for those offenders whose aim is extortion or publicity, whether for personal notoriety or political leverage (Logan 1993). The threat of contamination can be enough to damage a company’s reputation and is fuelled by the public’s ability to recall cases like the 1982 Chicago Tylenol murders, or more recently in the UK, the 2011 deaths of several elderly patients in Stepping Hill hospital in Stockport, as a result of saline solution filled with insulin. These high profile lethal cases are much easier to recall than cases in which a company was extorted with no real victims, especially considering that many hoax cases are deliberately kept out of the public domain (Cremin 2001).

Despite the number of hoaxes found among product tampering cases there are still a number of cases where damage is done to consumers without any prior warning. A sizable minority of around 25% of tampering crimes involved genuinely and dangerously tainted products which did result in casualties or fatalities. It is therefore important that law enforcement take these threats seriously, with one in ten cases of product tampering in the current sample resulting in at least one fatality.

Analysis of the agents used or claimed to have been used to contaminate products showed that chemical agents were more prevalent in cases of poisoning than tampering, while tampering cases were more associated with both foreign bodies and biological agents. Considering only the genuine adulterations, chemical agents were the most frequently obtained agents for both poisoning and product tampering. This analysis shows the most desired agents for the perpetrators of malicious contamination crimes, whether they were able to acquire these agents or not. However, it is important that future research establishes the likelihood of actual contamination based on the claimed use of certain agents (Kilbane 2015). Not only should we have a better understanding of which contaminants are accessed by which types of offender, but it would be of practical importance for law enforcement to be able to predict the potential lethality of such claims.

Two locations where the contaminated product was acquired by the victim were already embedded in the definitions of product tampering and poisoning in this paper; ‘home’ for the cases of poisoning, and ‘retail outlet’ for the cases of product tampering. The small number of contaminations found in prisons were all found to be poisonings, while restaurants and hospitals were the locations for as many poisoning cases as cases of product tampering. However, as there was a small number of cases occurring in these three locations, more data are needed in order to draw any conclusions.

In terms of motivation, poisonings are most frequently carried out for revenge while product tampering crimes are most often motivated by extortion. For product tampering there was a trend towards more frequent association with a desire for personal notoriety than with cases of poisoning, therefore perpetrators of tampering incidents would need to seek some publicity around the act having taken place. In contrast, one would expect most homicidal poisoners to be less likely to engage in any action that would draw attention to the death or deaths. In comparison to tamperings, poisonings were more often motivated by other financial gains, most frequently life insurance claims. While a greater proportion of product tamperings than poisonings were accounted for by political activism, it is interesting that political attacks were found as frequently in both forms of malicious contamination.

These kinds of contamination crimes are of particular concern in relation to modern terrorism. While ‘old terrorism’ was characterized as aiming for ‘a lot of people watching not a lot of people dead’ (Jenkins 1987:583), proponents of new terrorism see a move towards inflicting mass casualties as the central aim of the action (e.g. Tucker 2001). In our sample, 40 of the cases were driven by terrorist or extremist political motivations, being found in both the poisoning and product tampering groups as well as accounting for a large proportion of the indeterminate cases. Although there were very few mass casualty terrorist acts in our sample the vulnerability of the water supply as well as the food chain to terrorist attack remains a concern for counter-terrorism.

There were a small number of cases in our sample where the perpetrator attempted or committed suicide after poisoning their victim or victims. That these cases were all associated with poisonings gives more weight to the expressive nature of poisoning crimes discussed previously. While rare, there is a whole class of murder/suicide crimes which are typically associated with parents and children, usually involving the father as the perpetrator and the mother and/or children as the victims (e.g. Friedman et al. 2005). Since the majority of murder-suicides occur within families (Eliason 2009), it is not surprising that all of the victims in such cases in the current sample were previously known to the perpetrator.

Many studies of crime are biased in terms of only being based on the offences of those that are caught. While our sample did contain unsolved crimes, there are no doubt many more crimes which go unnoticed, the offender having ‘got away with it’. Malicious contamination crimes may be even more prone to this bias as it is possible to maintain a physical and temporal distance between the poisoner and their victim, meaning that less evidence may be available to an investigation. Indeed, poisoners may select their agent based on its ability to make the victim’s death appear accidental (Trestrail 2007; Westveer et al. 2004).

While there is a clear rationale to creating a definitional framework to advance criminological research, providing for a distinction between these crimes can also have practical value for law enforcement investigators. Given the large variation in the behavioural make-up of contamination crimes, a clearer categorisation enables a better insight into the possible motivations and offender characteristics required in order to prioritise likely suspects. This is particularly important for cases of product tampering as the perpetrators of these crimes have received very little academic attention previously, but also for poisoning cases, many of which may remain unsolved - or undiscovered. As roughly one quarter of lone poisoners were known to have some knowledge of poisons, it would be a good idea for police to take into consideration the past and present employment of the suspects under investigation, as such a job handling poisonous substances could be a prerequisite for engaging in a poisoning act. In addition, as nearly one-fifth of poisonings involved non-extortion monetary gain, it would be useful to explore whether any insurance claims were made or inheritance issued in cases in which an individual is found to have been murdered by poison.

As mentioned, while 'successful' poisonings may be under-represented in research it is almost certain that product tamperings are as well. Many cases are not reported to the police for fear of adding more publicity to the incident which can do damage to the company's reputation, whether the contamination is real or not (Cremin 2001). This may be particularly problematic in cases of false victimisation, where the claimed victim of the tampering is in fact the perpetrator of the act. Although few of these cases were found in this sample, it is possible that many false victim cases go undiscovered, with companies unwilling to engage in any in-depth investigations for fear of such incidents gaining wider publicity. With this definition, it is believed that companies will be better able to identify authentic cases of tampering, and to distinguish these from false victimisation claims, which may more closely resemble poisoning incidents. However, based on the small sample of false victimisation cases, further study is required in this area before conclusions can be drawn.

Nevertheless, the current research has used as representative a sample of malicious contamination crimes as possible and demonstrated that it is possible to construct operational definitions that identify product tampering and poisoning as two clear subsets. These definitions will enable future research to be clear about what constitutes these crimes and lay the foundations for further research to guide law enforcement response and investigation. The wide range of motivations within the crimes studied suggests that further research would be well directed at understanding additional sub-types of malicious contamination crimes and their likely perpetrators. It is hoped that a better understanding of these crimes and the individuals who perpetrate these acts can help law enforcement to identify where the greatest threats are likely to occur, and to focus their attention where it is most needed.

REFERENCES

Adelson, Lester. 1987. "Homicidal Poisoning: A Dying Modality of Lethal Violence?" *The American Journal of Forensic Medicine and Pathology* 8(3):245-251.

Anderson, Craig A. and Brad J. Bushman. 2002. "Human Aggression." *Annual Review of Psychology* 53:27-51.

Aquino, Karl, Thomas M. Tripp and Robert J. Bies. 2001. "How Employees Respond to Personal Offense: The Effects of Blame Attribution, Victim Status, and Offender Status on Revenge and Reconcilliation in the Workplace." *Journal of Applied Psychology* 86:52-59.

Ball, Richard A. and G. David Curry. 1995. "The Logic of Definition in Criminology: Purposes and Methods for Defining "Gangs"." *Criminology* 33(2):225-245.

Borg, Ingwer and Samuel Shye. 1995. *Facet Theory: Form and Content.* Thousand Oaks, CA: Sage.

Bushman, Brad J. and Craig A. Anderson. 2001. "Is it Time to Pull the Plug on the Hostile Versus Instrumental Aggression Dichotomy?" *Psychological Review* 108:273-279.

Carus, W. Seth. 2002. *Bioterrorism and Biocrimes: The Illicit Use of Biological Agents Since 1900.* Fredonia Books.

Caulkins, Jonathan P. 2007. "Price and Purity Analysis for Illicit Drug: Data and Conceptual Issues." *Drug and Alcohol Dependence* 90:S61-S68.

Cremin, Brian. 2001. “Extortion by Product Contamination.” *American Behavioral Scientist* 44(6):1042-1052.

Dalziel, G. R. 2009. *Food Defence Incidents 1950-2008: A chronology and analysis of incidents involving the malicious contamination of the food supply chain.* Nanyang, Singapore: Centre of Excellence for National Security.

Eliason, Scott. 2009. “Murder-Suicide: A Review of the Recent Literature.” *The Journal of the American Academy of Psychiatry and the Law* 37(3):371-376.

Farrell, Amanda L., Robert D. Keppel, and Victoria B. Titterington. 2011. “Lethal Ladies: Revisiting What We Know About Female Serial Murderers.” *Homicide Studies* 15(3):228-252.

Federal Anti-Tampering Act (FATA). 1983. 18 U.S.C. § 1365.

Fitness, Julie. 2001. “Betrayal, Rejection, Revenge and Forgiveness: An Interpersonal Script Approach.” Pp 73-103 in *Interpersonal Rejection*, edited by M. Leary. New York: Oxford University Press.

Fox, James Alan and Jack Levin. 1998. “Multiple Homicide: Patterns of Serial and Mass Murder.” *Crime and Justice* 23:407-455.

Friedman, Susan Hatters, Debra R. Hrouda, Carol E. Holden, Stephen G. Noffsinger, and Phillip J. Resnick. 2005. "Filicide-Suicide: Common Factors in Parents Who Kill Their Children and Themselves." *Journal of the American Academy of Psychiatry and the Law* 33(4):496-504.

Gleick, Peter H. 2006. "Water and Terrorism." *Water Policy* 8:481-503.

Graves, Mark, Alex Smith, and Bruce Batchelor. 1998. "Approaches to Foreign Body Detection in Foods." *Trends in Food Science & Technology* 9(1):21-27.

Gurian, Elizabeth A. 2009. "Female Serial Murderers: Directions for Future Research on a Hidden Population." *International Journal of Offender Therapy and Comparative Criminology* 55(1):27-42.

Guttman, Louis. 1971. "Measurement as Structural Theory." *Psychometrika* 36(4):329-347.

Guttman, Ruth and Charles W. Greenbaum. 1998. "Facet Theory: Its Development and Current Status." *European Psychologist* 3(1):13-36.

Hagan, Frank E. 2006. "'Organized crime' and 'organized crime': Indeterminate problems of definition." *Trends in Organized Crime* 9(4):127-137.

Henney, Jane E., Jeffrey E. Shuren, Stuart L. Nightingale, and Thomas J. McGinnis. 1999. "Internet Purchase of Prescription Drugs: Buyer Beware." *Annals of Internal Medicine* 131(11):861-862.

James, Bryony. 2005. “Foreign Body Contamination of Food - Scanning Electron Microscopy and Energy Dispersive Spectroscopy as Tools for Identification.” *International Journal of Food Engineering* 1(1):1-15.

Jenkins, Brian Michael. 1987. “The future course of international terrorism.” In Contemporary Research on Terrorism, edited by P. Wilkinson and A. M. Stewart. Aberdeen: University Press.

Kao, Shih Ling, Cheng Leng Chan, Belinda Tan, C.C. Tchoyoson Lim, Rinkoo Dalan, Daphne Gardner, Edward Pratt, Marilyn Lee, and Kok Onn Lee. 2009. “An Unusual Outbreak of Hypoglycemia.” *New England Journal of Medicine* 360(7):734-736.

Khan, Ali S., David L. Swerdlow, and Dennis D. Juranek. 2001. “Precautions against Biological and Chemical Terrorism Directed at Food and Water Supplies.” *Public Health Reports* 116:3-14.

Kilbane, Sarah. 2015. “Poison Expertise and Agent Selection in Cases of Malicious Contamination.” Presented to the Annual Meeting of the American Society of Criminology, Washington, DC, 18-21 November.

King, L. A. 1997. “Drug Content of Powders and Other Illicit Preparations in the UK.” *Forensic Science International* 85(2):135-147.

Kockler, Tim R., Matthew S. Stanford, Chad E. Nelson, J. Reid Meloy, and Keith Sanford. 2006. “Characterizing Aggressive Behavior in a Forensic Population.” *American Journal of Orthopsychiatry* 76(1):80-85.

Landis, J. Richard and Gary G. Koch. 1977. "The Measurement of Observer Agreement for Categorical Data." *Biometrics* 33(1):159-174.

Logan, Barry. 1993. "Product Tampering Crime: A Review." *Journal of Forensic Sciences* 38(4):918-927.

Malphurs, Julie E. and Donna Cohen. 2005. "A Statewide Case-Control Study of Spousal Homicide-Suicide in Older Persons." *American Journal of Geriatric Psychiatry* 13:211-217.

McEllistrem, Joseph E. 2004. "Affective and Predatory Violence: A Bimodel Classification System of Human Aggression and Violence." *Aggression and Violent Behavior* 10(1):1-30.

Meloy, J. Reid. 2006. "Empirical Basis and Forensic Application of Affective and Predatory Violence." *Australian and New Zealand Journal of Psychiatry* 40:539-547.

Myers, Wade C., Erik Gooch, and J. Reid Meloy. 2005. "The Role of Psychopathy and Sexuality in a Female Serial Killer." *Journal of Forensic Sciences* 50(3):652-657.

Nagy, Victoria M. 2014. "Narratives in the Courtroom: Female Poisoners in Mid-Nineteenth Century England." *European Journal of Criminology* 11(2):213-227.

Rosette, J. L. 1992. "Tamper Evident Packaging: Law Enforcement and the Consumer." *FBI Law Enforcement Bulletin* 16-19.

Shepherd, Greene and Brian C. Ferslew. 2009. “Homicidal Poisoning Deaths in the United States 1999-2005.” *Clinical Toxicology* 47:342-347.

Stanford, Matthew S., Rebecca J. Houston, Nicole R. Villemarette-Pittman, and Kevin W. Greve. 2003. “Premeditated Aggression: Clinical Assessment and Cognitive Psychophysiology.” *Personality and Individual Differences* 34:773-781.

Trestrail III, John. H. 2007. *Criminal Poisoning: Investigational Guide for Law Enforcement, Toxicologists, Forensic Scientists, and Attorneys.* 2nd ed. Totowa, New Jersey: Humana Press.

Tucker, David. 2001. “What’s New About the New Terrorism and How Dangerous Is It?” *Terrorism and Political Violence* 13:1-14.

Westveer, Arthur E., John P. Jarvis, and Carl J. Jensen III. 2004. “Homicidal Poisoning.” *FBI Law Enforcement Bulletin* 73(8):1-8.

World Health Organization (WHO). 2008. *Terrorist Threats to Food: Guidance for Establishing and Strengthening Prevention and Response Systems.* Geneva: Department of Food Safety, Zoonoses and Foodborne Diseases.

World Health Organization (WHO). 2010. *The ICD-10 Classification of Mental and Behavioural Disorders: Clinical Descriptions and Diagnostic Guidelines.* Geneva: WHO.

Zaitsu, Wataru. 2010. “Homicidal Poisoning in Japan: Offender and Crime Characteristics.” *International Journal of Police Science and Management* 12(4):503-515.

Figure captions

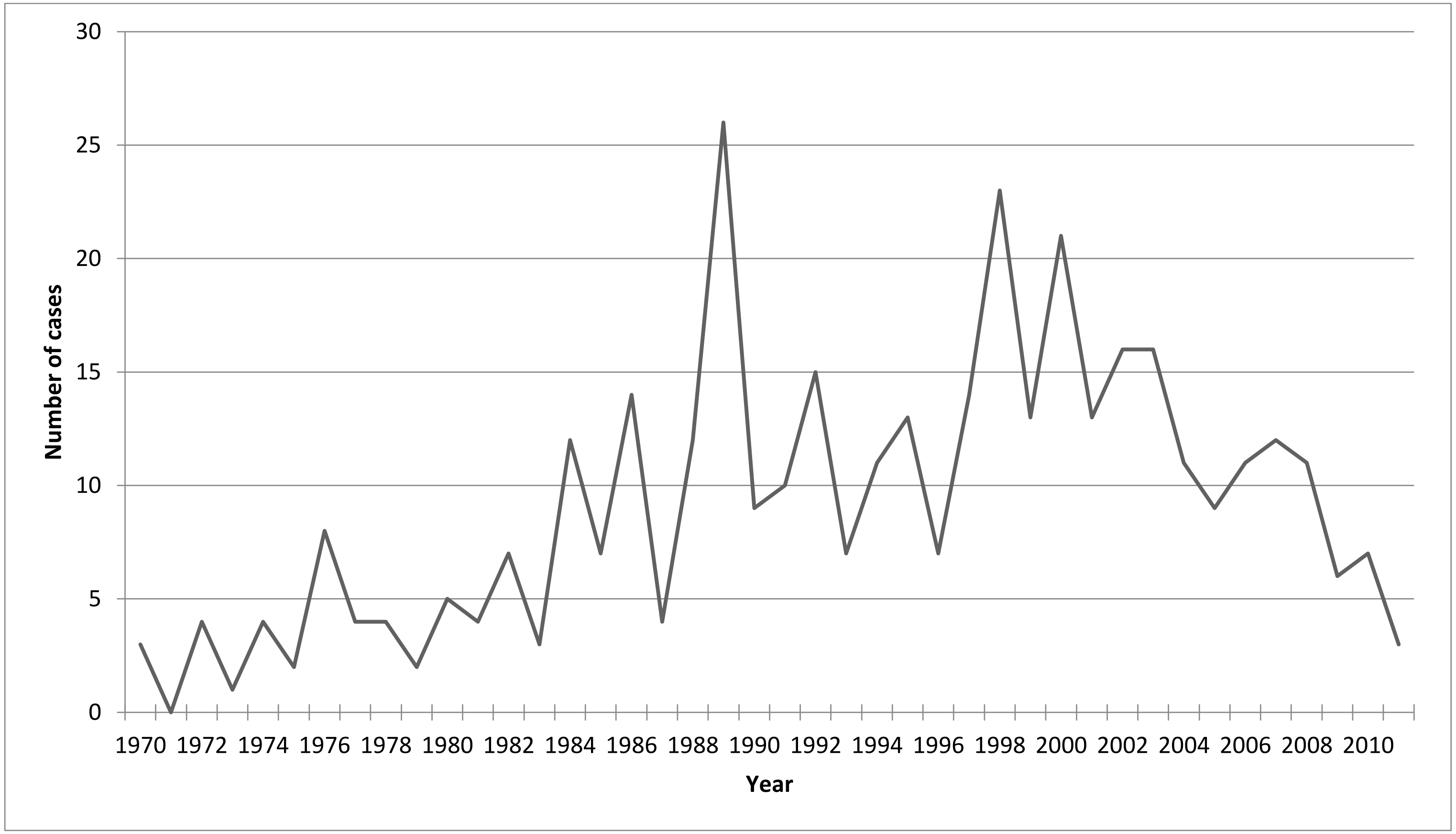
Figure 1: Total number of malicious contamination incidents in this sample per year from 1970 to 2011.

Figure 2: Mapping Sentence for the operational definition of product tampering and poisoning.

Figure 3: Distribution of overall poisoning and tampering scores for the entire dataset.

Figure 4: Corresponding tampering and poisoning scores for all cases, with the total number of cases with each score for those classified as poisonings (circle), tamperings (triangle), and unclassified (x).

Figure 1



30
25
20
15
10
5
0
Number of cases
1970 1972 1974 1976 1978 1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010
Year

Figure 2

A crime which aims to cause harm to another through the use of a contaminant which

$\begin{bmatrix}\text{1. is actually}\\ \text{2. is claimed to have been}\end{bmatrix}$ introduced $\begin{bmatrix}\text{1. in the supply chain}\\ \text{2. post supply chain}\end{bmatrix}$ to a(n)

$\begin{bmatrix}\text{1. packaged consumable}\\ \text{2. open consumable}\\ \text{3. open access product}\end{bmatrix}$ which $\begin{bmatrix}\text{1. is not}\\ \text{2. is}\end{bmatrix}$ given directly to $\begin{bmatrix}\text{1. no intended}\\ \text{2. unspecified}\\ \text{3. specified}\end{bmatrix}$ victim(s)

$\begin{bmatrix}\text{1. with}\\ \text{2. without}\end{bmatrix}$ an existing personal relationship in a $\begin{bmatrix}\text{1. retail outlet}\\ \text{2. home}\end{bmatrix}$ and $\begin{bmatrix}\text{1. involving}\\ \text{2. not involving}\end{bmatrix}$ a

commercial company with whom contact $\begin{bmatrix}\text{1. is}\\ \text{2. is not}\end{bmatrix}$ made is to be defined as $\rightarrow$

$\begin{bmatrix}\text{product tampering}\\ \updownarrow\\ \text{poisoning}\end{bmatrix}$

Figure 3

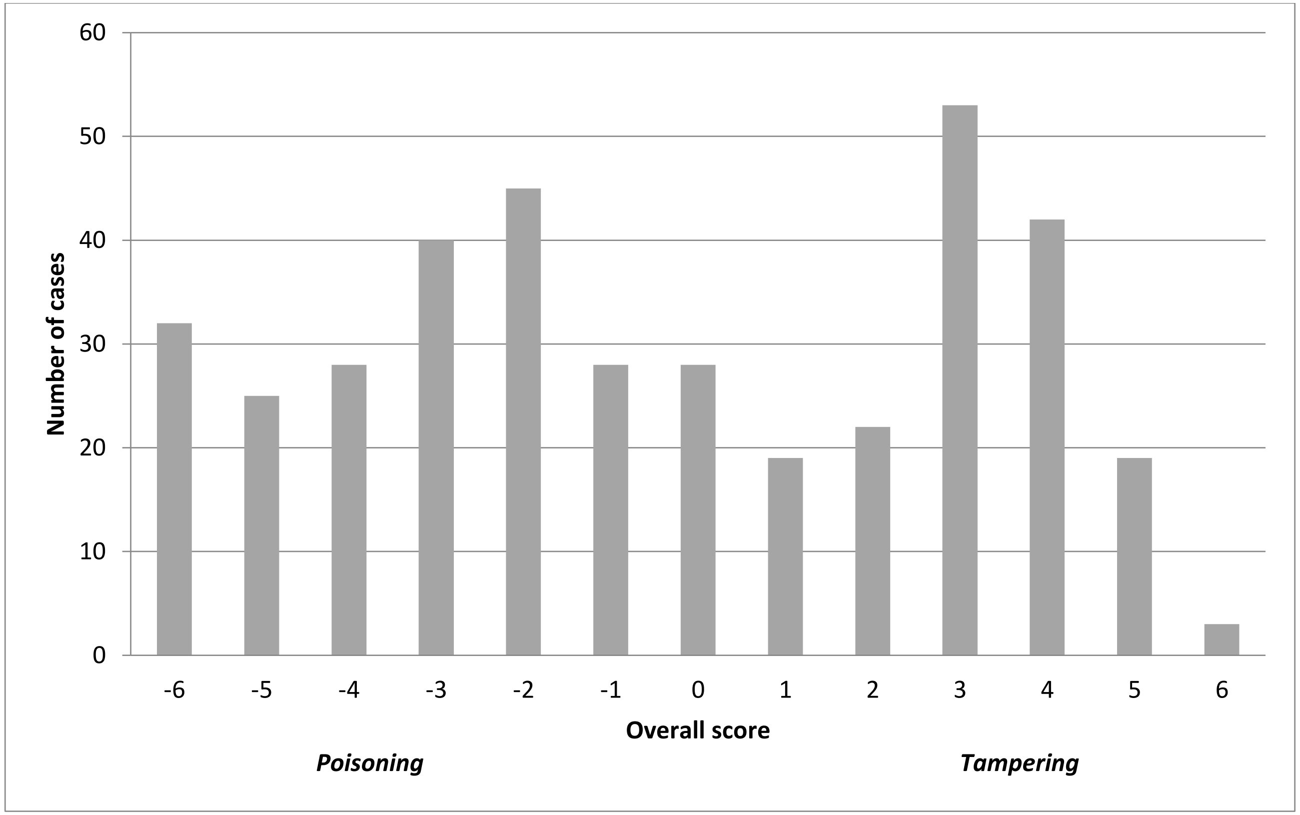
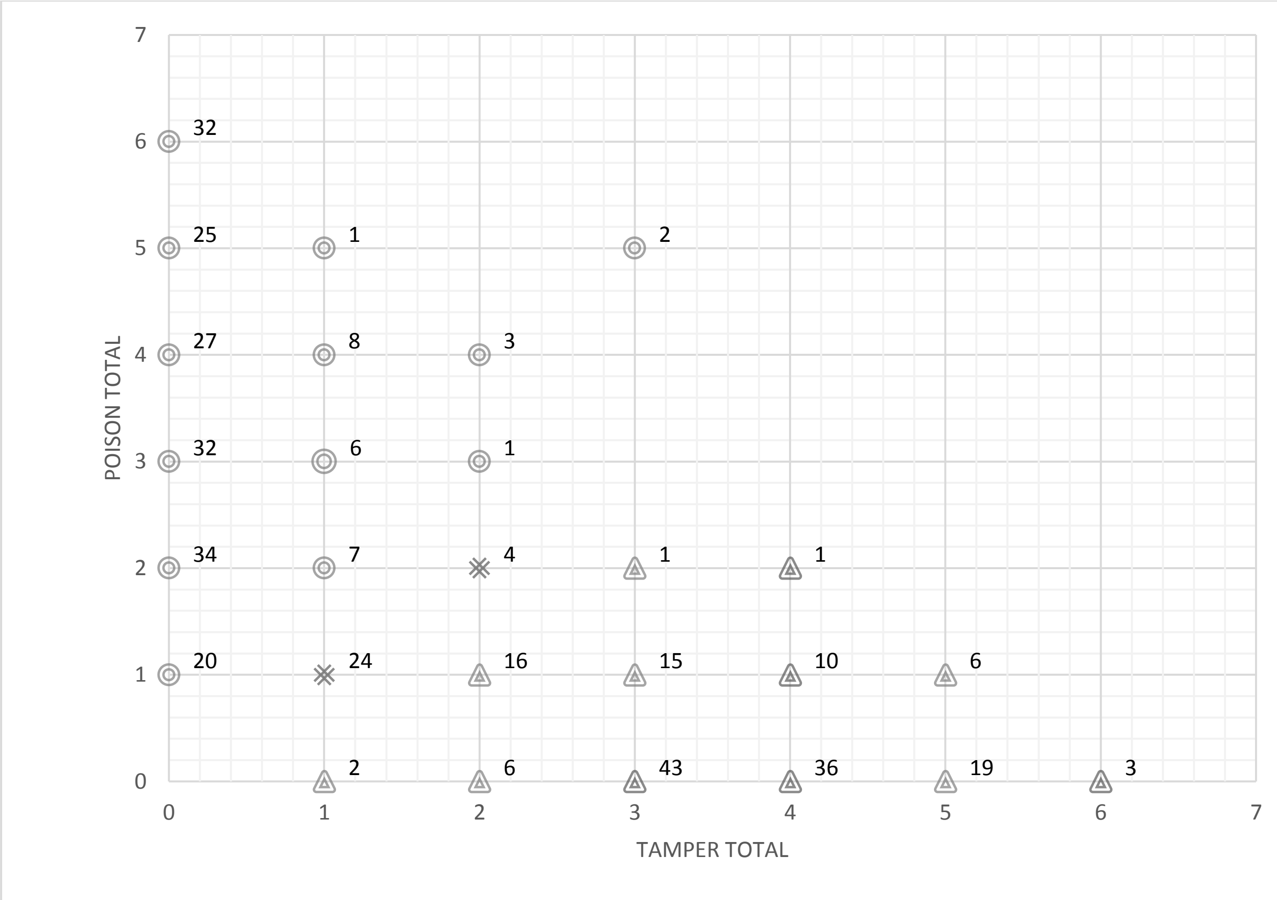

60
50
40
30
20
10
0
Number of cases
-6
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
Overall score
Poisoning
Tampering

Figure 4



POISON TOTAL
TAMPER TOTAL
0
1
2
3
4
5
6
7
32
25
1
2
27
8
3
32
6
1
34
7
4
1
1
20
24
16
15
10
6
2
6
43
36
19
3

Table 1

Prevalence of malicious contamination cases in total by each region

Geographical region	**n**	**% of sample**
North America	135	35.2
Central & South America	2	0.5
Europe	119	31.0
Africa	19	4.9
Middle East	21	5.5
Asia	83	21.6
Australia & Oceania	9	2.3
Total	**388**	**101.0***

**Note.* Several cases spanned multiple regions, and so locations are not mutually exclusive.

Table 2

Tampering and poisoning measurement variables

	Variables
Tampering variables	Unspecified victims
	No intended victim
	Commercial target
	Packaged consumable
	In supply chain
	Retail outlet
	Communication with target
Poisoning variables	Personal relationship
	Home
	Specified victims
	Open consumable
	Open access product
	Post supply chain
	Given directly

Table 3

Chi-square relationships for poison knowledge within poisonings and product tamperings for lone offenders known to the authorities (df = 1, α = .00263 Bonferroni corrected)

Variable	Poisoning n=124	Product Tampering n=58	Pearson Chi-square	Asymptotic sig. (2-tailed)
Poison knowledge	24.2% (n=30)	12.1% (n=7)	3.587	p = .058
Professional poison knowledge	17.7% (n=22)	12.1% (n=7)	.949	p = .330
Personal poison research	6.5% (n=8)	0.0% (n=0)	3.914	p = .057*

**Note.* At least one cell had an expected frequency of less than 5. Fisher's Exact p has been used.

Table 4

Chi-square relationships for the different motives within poisonings and product tamperings for all cases (df = 1, α = .00263 Bonferroni corrected)

Variable	Poisoning n=198	Product Tampering n=158	Pearson Chi-square	Asymptotic sig. (2-tailed)
Non-extortion monetary gain	19.7% (n=39)	6.3% (n=10)	13.230	$p < .001$
Political activism	18.2% (n=36)	13.9% (n=22)	1.168	$p = .280$
Extortion	0.0% (n=0)	31.0% (n=49)	71.206	$p < .001$
Revenge	23.2% (n=46)	9.5% (n=15)	11.682	$p = .001$
Attention / notoriety	2.0% (n=4)	10.1% (n=16)	10.891	$p = .001$

Table 5

Chi-square relationships for the agents selected within poisonings and product tamperings for all cases (df = 1, α = .00263 Bonferroni corrected)

Variable	Poisoning n=198	Product Tampering n=158	Pearson Chi-square	Asymptotic sig. (2-tailed)
Chemical agent	75.8% (n=150)	58.2% (n=92)	12.405	p < .001
Biological agent	7.1% (n=14)	17.7% (n=28)	9.580	p = .002
Foreign body	2.0% (n=4)	13.3% (n=21)	17.097	p < .001
Radiological agent	3.5% (n=7)	0.6% (n=1)	3.370	p = .081*

**Note.* At least one cell had an expected frequency of less than 5. Fisher's Exact p has been used.

Table 6

Chi-square relationships for the different attack locations within poisonings and product tamperings for all cases (df = 1, α = .00263 Bonferroni corrected)

Variable	**Poisoning n=198**	**Product Tampering n=158**	**Pearson Chi-square**	**Asymptotic sig. (2-tailed)**
Restaurant	2.0% (n=4)	7.0% (n=11)	5.317	p = .021
Prison	3.5% (n=7)	0.0% (n=0)	5.698	p = .019*
Hospital	3.0% (n=6)	3.8% (n=6)	0.159	p = .690
Sent to company	1.0% (n=2)	10.8% (n=17)	16.533	p < .001

**Note.* At least one cell had an expected frequency of less than 5. Fisher's Exact p has been used.