Clustering of suicides among people with mental illness

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Background Most previous investigations of imitative suicide have reported suicide clustering in the general population, either temporal clustering following media reporting of suicide or case studies of geographically localised clusters.

Aims To determine whether space–time and space–time–method clustering occur in a national case register of those who had recent contact with mental health services and had died by suicide and to estimate the suicide imitation rate in this population.

Method Knox tests were used for space–time and space–time–method clustering. Model simulations were used to estimate effect size.

Results Highly significant space–time and space–time–method clustering was found in a sample of 2741 people who died by suicide over 4 years who had had recent contact with one of 105 mental health trusts. Model simulations with an imitation rate of 10.1% (CI 4–17) reproduced the observed space–time–method clustering.

Conclusions This study provides indirect evidence that imitative suicide occurs among people with mental illnesses and may account for about 10% of suicides by current and recent patients.

Declaration of interest None.

Concerns that people may imitate suicidal behaviour have a long history (Phillips, 1974). Ascertaining the reasons for a suicide after the event is often difficult or impossible so investigators have looked for clustering of suicides as indirect evidence of imitation. Different types of clustering have been reported (Gould *et al*, 1989; Joiner, 1999): time clustering following media coverage of a suicide, real or fictional, and point clusters, localised in time and space, have been put forward as evidence for imitation (Stack, 2000; Gould, 2001; Stack, 2003). There are fewer reports of imitative suicide among people with mental illness. Several case studies of sequential suicides report strong clinical grounds for believing that imitation took place (e.g. Anonymous, 1977; Zemishlany *et al*, 1987; Taiminen *et al*, 1992). Three studies that used statistical methods to detect suicide clustering found inconclusive results, although two of the studies reported clinical grounds for believing imitation had occurred (Modestin & Würmle, 1989; Haw, 1994; Taiminen & Helenius, 1994).

METHOD

We used data collected by the National Confidential Inquiry into Suicide and Homicide by People with Mental Illness (NCI; Appleby *et al*, 1999) to look for clustering of suicides in space, time and method among people with mental illness over the whole of the UK, using epidemiological techniques first suggested by Knox (1964) and Mantel (1967) for the study of infectious diseases.

Since 1996 information on deaths with a verdict of suicide or an open verdict in a coroner's court has been forwarded to the NCI, who then submitted identifying details to the main hospitals or trusts providing mental health services in the victim's health district. Hospital records were checked to identify those who had had contact with mental health services in the 12 months preceding their death by suicide. A questionnaire was sent to the responsible medical officer (RMO) requesting further information about the suicide and care provided in the period before death. For the purposes of this study, date of death, method of suicide and coded identities for trust and person completing the questionnaire were used to test for clustering of suicide in time, space and by method. Prior ethical approval was obtained.

To investigate clustering, all possible pairs of suicides were considered and, following Knox (1964), the number of pairs 'close' in space and time (or space, time and method) according to chosen criteria was taken as the test statistic. Knox showed that under certain assumptions this statistic follows a Poisson distribution under the null hypothesis of independence of suicide location and time. A permutational approach suggested by Mantel (1967) enables the distribution of the test statistic to be derived empirically, avoiding such assumptions. The spatial labels of the suicides are randomly permuted while holding the time labels fixed (or vice versa). The number of close pairs is calculated for each permutation. A one-sided P value of the test is given by:

$$P=(1+\text{number of permutations where value of test statistics} \geqslant \text{observed value})/(1+\text{number of permutations}).$$

Similarly, to test the null hypothesis of independence of suicide location, time and method the labels of two of the variables can be independently permuted to derive the distribution of the space–time–method test statistics under the null hypothesis.

The Knox procedure required selection of criteria for closeness in space, time and method.

Closeness in space

The selection of a criterion for closeness in space required taking into account the model of 'suggestion' as a cause for clustering: closeness in space should define an appropriate 'communication unit' whose members become aware of the suicide of one of their number and may go on to imitate the suicidal behaviour. It was assumed that patients meet and interact socially primarily at the level of a geographical sector served by a single community mental health team and ward team under the clinical leadership of a consultant psychiatrist (the RMO). Some contact would be expected

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between patients of adjacent sectors within a single trust, allowing news of a suicide to spread within a trust. Data on sectors were not collected as such, although where the RMO completed the NCI questionnaire it was possible to use the identity of the RMO as a proxy for sector. This had certain limitations: the RMO did not always complete the questionnaire, leading to potential gaps in the data, and it was evident from descriptive analysis of the data that there was a fairly high rate of turnover of RMOs, so that the same RMO was not necessarily covering the same sector for the whole period of data collection. The trust was therefore our primary choice as a variable for categorising communication units, and pairs of cases were defined as close in space if they occurred in the same trust. We repeated the analysis defining suicide cases as close in space if their suicide was recorded by the same RMO in the same trust.

A further consideration was mergers between trusts. Trusts were set up in the mid-1990s by the then government as part of the creation of the internal market in healthcare. They were typically based on the services provided by one or two local hospitals. The current government made changes to the commissioning of healthcare and encouraged trusts to merge into larger units. A number of the merged trusts comprised geographically dispersed community teams and in-patient units much larger than the ideal 'communication unit' referred to previously. It was unlikely that news of a suicide would spread through all the different constituent sites. Hence it was decided to include only trusts that did not merge before the end of the study period. This also reduced the possibility that changes in management structure could have given rise to gaps in identifying cases that had been in contact with mental health services.

Closeness in time

There was no *a priori* principle on which to base the criterion of closeness in time. It might be expected that news of a suicide would take some time to disseminate through the patient population and the recollection of the suicide would remain with a patient for some time and might influence suicidal behaviour some time after the index event. This might happen, for instance, if a patient later experienced a period of low mood and suicidal ideation and the previous suicide seemed to offer a way out. It seemed plausible that a suicide could influence behaviour for several months and it could even be that the 1-year anniversary of a suicide might influence another patient to take their own life. The test procedure was repeated for a range of plausible threshold values for 'closeness' from 30 to 360 days. As the different threshold test statistics are highly correlated, the significance level should not be greatly affected by multiple testing.

Closeness in method

Suicides were defined as close in method if the method employed was the same using the classifications given in Table 1. The percentages of suicides according to method in the sample studied are also shown. Cases for which the suicide method did not fall into one of the broad categories or was not known were excluded from the assessment of space–time–method clustering.

Choice of study period

Since systematic gaps in the data could also give rise to space–time clustering, steps were taken to ensure that the data were as complete as possible. The NCI assessed the accuracy of detecting a previous contact with mental health services and found a 97% detection rate (Appleby *et al*, 1999). By comparing the accumulated sample at two points 1 year apart, mid-2001 and mid-2002, a period from February 1996 to February 2000 was identified when the annual number of suicides had built up to a fairly constant level, indicating that data collection was approximately complete. As additional safeguards, to ensure full reporting: (a) only those trusts were selected that had a first case on or before the first day of the study period and a last case on or after the last day; (b) where trusts subsequently merged the merged trust did not have a first case before February 2000. The optimum study period was chosen so that it maximised the number of suicides to be included within these limits.

Table 1 Classification of method of suicide[1]

Method	Deaths (%)
Hanging	33.1
Self-poisoning	31.8
Carbon monoxide poisoning	6.9
Jumping from height or multiple injuries	7.1
Jumping or lying in front of moving vehicle	2.6
Drowning	6.1
Firearms	0.9
Cutting or stabbing	1.5
Suffocation	1.5
Burning	1.6
Electrocution	0.3
Other or not known	6.5

1. Among 2741 suicides in 105 trusts over the period from 10 June 1996 to 30 January 2000 inclusive.

Estimation of effect size

If significant clustering were found it would be important to estimate the effect size. The non-parametric test did not automatically provide estimates of parameters that could lead to an estimate of numbers of imitative suicides. However, the test statistic (observed number of close pairs) and its empirical distribution under the null hypothesis provide some information about suicide imitation parameters.

We defined an excess pair statistic as the difference between the observed number of close pairs and the number expected under independence. This is affected by the delay time (between index case and imitative suicide) and rate of imitative suicide. Assuming that imitative suicides occur in the same space unit (and by the same method) as the index case we expect that the excess pairs will reach a maximum when the threshold used to define closeness in time approaches the true maximum delay in imitative suicide, T: with increasing time threshold the observed number of close pairs, and hence the excess pairs statistic, gradually includes more imitative suicides close to their index cases until T is reached. However, as the time threshold increases beyond T, more and more pairs involving imitative cases are also included in the expected number of pairs under independence and hence excluded from the excess pairs statistic. The combined effect of these two opposing mechanisms should result in a maximum value for excess pairs at time threshold T. It can be shown (see data supplement 1 to the online version of this paper) that under certain restrictive assumptions the excess pairs statistic at threshold T provides an estimate of the number of imitative suicides and the relative excess (number of excess pairs divided by the sample size) an estimate of the suicide imitation rate.

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To obtain an unbiased estimate of the suicide imitation rate and to quantify its precision we used simulation models. This approach (see data supplement 2 to the online version of this paper) entails simulating values of the test statistics from a suicide model with a given imitation rate to generate a distribution under the model. Such distributions are generated for a range of possible suicide rates and then the suicide rate is estimated by the rate of the model that fits the observed value of the test statistic most closely. Since each computer simulation took an appreciable time to complete, we limited the number of simulations to 200 for each possible suicide rate. An attractive feature of the chosen procedure for simulating is that it maintains the marginal distribution of suicide times and locations and can be thought of as a generalisation of the Mantel permutation procedure.

RESULTS

The study period that maximised suicide numbers was 1330 days from 10 June 1996 to 30 January 2000. There were 2741 suicides recorded by 105 unmerged trusts deemed to be recording during this period (minimum 1 suicide per trust, maximum 72, median 22). The suicide method was identified in 2562 cases (see Table 1). Approximately 15% were in-patients at the time of death.

Space–time clustering and space–time–method clustering were tested for separately and the results are shown in Tables 2 and 3. Each table shows the total number of possible distinct pairs of suicides and the observed and expected numbers of close pairs for increasing thresholds of closeness in time. Significant space–time clustering (Table 2) and space–time–method clustering (Table 3) were found for time thresholds from 30 to 360 days.

The relative excess pairs close in space and time (Table 2) provides an estimate of the suicide imitation rate and increases from 3.8% at 30 days to reach a maximum value of 13.7% at a 210-day time threshold. (The pattern of steady increase to a maximum value followed by decrease remained when values of relative excess pairs were calculated for delay times <30 days and >360 days.) Assuming that imitative suicide is the sole reason for space–time clustering and such suicides occur in the same trust as the index cases, the maximum delay between an index case and an imitative case can be estimated as in the region of 6–9 months. A model simulation with a maximum imitation delay of 7 months gave an estimation of 13.3% (95% CI 3–22) for imitative suicides as a percentage of all suicides that copy the act of suicide of an index case but not necessarily the method of the index case.

The relative excess pairs close in space, time and method (Table 3) reaches a maximum value of 13.0% at a 300-day time threshold. Assuming a true maximum delay of 10 months, the model simulation including method gave an estimation of 10.1% (95% CI 4–17) for imitative suicides as a percentage of all suicides that copy the act and method of suicide of an index case.

The clustering analysis was repeated using RMO as the space variable. The optimum study period was determined as 845 days, during which 328 RMOs reported 888 cases of suicide. Space–time clustering was again highly significant for time thresholds from 60 to 360 days. Space–time–method clustering did not reach significance, perhaps because reduced numbers limited the power to detect clustering. The relative excess pairs statistic reached a maximum value of 10.2% at a time threshold of 8 months.

DISCUSSION

We have found highly significant time–space and time–space–method clustering of suicides among people with mental illnesses who were in contact with mental health services or had been within 12 months of death. The clustering of suicides occurred over a 44-month period from June 1996 among patients of one of 105 mental health trusts distributed throughout the UK.

Imitation as cause of clustering

The observed clustering might have been caused by several factors operating singly or together. The first of these is imitation of suicidal behaviour. If this were the sole cause of the clustering, a model used to simulate the effect of imitation gave a possible effect size of about 10% (95% CI 4–17) of suicides imitating the method of and being close in time to an index case in the same trust. Imitations appear to build up in number steeply initially and then level off over a 7- to 10-month time scale.

Strengths of study

A strength of the study is the much larger numbers of cases and locations analysed than in previous studies, leading to greater statistical power to detect clustering. The methodology also has the advantage of being sensitive only to space–time or space–time–method interactions and so is

Table 2 Tests for space–time clustering based on 2741 suicides in 105 trusts over 1330 days. There were 3 755 170 possible distinct suicide pairs

	Threshold for closeness in time, days											
	30	60	90	120	150	180	210	240	270	300	330	360
Observed pairs close in space and time, *n*	2270	4454	6537	8509	10 466	12 419	14 325	16 128	17 901	19 593	21 159	22 735
Expected close pairs under the null hypothesis, *n*	2166	4255	6277	8257	10 194	12 088	13 950	15 762	17 538	19 246	20 903	22 501
Standard deviation of no. of close pairs under the null hypothesis	45	65	72	84	97	100	113	120	120	124	129	141
Relative excess, %	3.8	7.3	9.5	9.2	9.9	12.1	13.7	13.3	13.2	12.7	9.3	8.5
P (one-sided)[1]	0.012	0.003	0.001	0.003	0.001	0.001	0.001	0.002	0.003	0.004	0.025	0.058

1. Calculated from 999 permutations, smallest possible value of $P=0.001$.

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not confounded by local differences in rates or method of suicide that do not change over the study period, or changes over time affecting all locations equally, such as seasonal variations (Preti, 2000; Hakko *et al*, 2002).

Other possible causes of observed clustering

A weakness of the study, shared by other studies of clustering, is that the evidence for imitative suicide is indirect and other causes for the observed clustering cannot be ruled out.

Quality of care or socio-economic conditions

A change in local factors, such as the quality of care or socio-economic conditions, that alters the suicide rate in some trusts but not others can result in time–space clustering. It is less plausible, however, that this mechanism on its own could also account for the observed space–time–method clustering of suicides. The time scale of about 9 months suggested by the analysis, with clustering also observed at time thresholds down to 30 days, seems too short for differential changes in the quality of care in trusts or other local factors affecting the suicide rate to have occurred.

Missing data

Systematic gaps in data collection can also give rise to apparent clustering. This possibility was minimised by including only trusts that identified a first case on or before the start of the study period and a last case on or after the last day, thereby ensuring as far as possible that the trusts had systems in place for reporting during the whole of the study period. Trusts that merged during the study period were excluded, thereby eliminating possible gaps in reporting caused by changes in management structure after a merger. In addition the NCI conducted an audit of the accuracy of reporting by trusts and found a 97% identification rate of cases (Appleby *et al*, 1999).

Coroners' courts

Variations over time between coroners' courts in identifying suicides and cause of

CLINICAL IMPLICATIONS

- Imitative suicide probably occurs among those with mental illness and may account for about 10% of suicides.
- Mental health professionals should be aware of the risk of imitative behaviour after a death by suicide.
- More research is needed on ways to reduce the risk of imitative suicide.

LIMITATIONS

- Factors other than imitation cannot be ruled out as a cause of the observed clustering of suicides.
- News of an index suicide may not have reached all members of the group considered at risk in the analysis.
- The sample was restricted to suicides in smaller trusts that had not merged into large units.

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Table 3 Tests for space–time–method clustering based on 2562 suicides in 105 trusts over 1330 days. There were 3 280 641 possible distinct suicide pairs

	Threshold for closeness in time, days											
	30	60	90	120	150	180	210	240	270	300	330	360
Observed pairs close in space, time and method, *n*	552	1054	1512	1977	2420	2903	3351	3783	4206	4627	4978	5310
Expected close pairs under the null hypothesis, *n*	483	951	1400	1838	2271	2694	3109	3512	3912	4294	4663	5020
Standard deviation of no. of close pairs under the null hypothesis	22	32	40	47	55	60	65	70	74	80	86	89
Relative excess, %	2.7	4.0	4.4	5.4	5.8	8.2	9.5	10.6	11.5	13.0	12.3	11.3
P (one-sided)[1]	0.004	0.002	0.003	0.004	0.005	0.001	0.001	0.002	0.001	0.001	0.001	0.002

1. Calculated from 999 permutations, smallest possible value of $P=0.001$.

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death could also cause apparent clustering. It seems unlikely, however, that there could have been sufficient variation between coroners' courts in identifying cases on the timescale suggested by the data.

Findings from previous studies

Support for imitation as an explanation of the observed clustering of suicides among people in contact with mental health services is given by studies which have explored imitation of suicidal behaviour in the general population. It seems likely that imitation would occur to an equal or greater degree among people with mental illnesses. Various mechanisms have been proposed: low mood and low self-esteem may render an individual less able to resist copying a behaviour that seems to offer a way out. Of three previous quantitative studies of clustering of suicides among those with mental illnesses only one found significant clustering (Haw, 1994) although two found clinical evidence suggesting that imitation had occurred (Modestin & Würmle, 1989; Taiminen & Helenius, 1994). The latter studies may have had sample sizes that were too small to detect clustering that was present.

Conclusion

If imitation is implicated as a causal factor in a significant percentage of suicides, it will be important to consider how best to reduce its impact as part of a drive to cut the national suicide rate among people with mental illnesses (Department of Health, 2002). Suggestions for prevention of suicide 'epidemics' were made by Rissmiller & Rissmiller (1990) but more research is required to identify effective strategies, and parallel efforts should be made to raise mental health professionals' awareness of this phenomenon.

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