Title

Understanding Suicide Clusters Through Exploring Self Harm Behaviors: a 10-year data-linkage cohort follow-up study of a Suicide Cluster using the Secure Anonymised Information Linkage (SAIL) Databank

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Abstract

Background

There is little information about characteristics and long-term outcomes of individuals who self-harm during a suicide cluster.

Aims

To compare characteristics of individuals who self-harmed during a suicide cluster in South Wales (~10 deaths between Dec 2007 and Mar 2008) with others who self-harmed prior to the cluster, and to evaluate 10-year self-harm and mortality outcomes.

Method

Using records from the hospital serving the catchment area of the suicide cluster, enhanced by national routinely collected linked data, we created two groups: individuals who self-harmed a) during the suicide cluster, and b) one year before. We compared individuals' characteristics and performed logistic regression to compute odds ratios of 10-year self-harm and mortality outcomes.

Results

Individuals who self-harmed during the cluster were less likely to be hospitalized or have a mental health history than those who self-harmed prior to the cluster. No significant group differences were found for 10-year self-harm outcomes, but all-cause mortality was higher for males.

Limitations

Sample size was small, and data were lacking on psychological and social proximity to individuals who died during the suicide cluster.

Conclusion

Our findings highlight the importance of long-term healthcare follow-up of those who self-harm during a suicide cluster, particularly males.

Keyword:

self-harm; suicide; suicide cluster; data linkage; mortality

Abbreviations

BC – Before the Cluster

CI – Confidence Interval

DC – During the Cluster

ED – Emergency Department

ESM – Electronic Supplementary Material

ICD – International Classification of Diseases

LAA – Local Authority Area

NHS – National Health Service

OR – Odds Ratio

SAD – SAD PERSONS score

SAIL – Secure Anonymised Information Linkage

VIF – Variance Inflation Factor

Introduction

Although relatively uncommon, suicides may occur in clusters, particularly in young people (Haw et al., 2013). There are two main types of clusters described in the literature, namely, mass clusters and point clusters. While for mass clusters, often associated with media reporting of the death of a celebrity, suicide rates increase across a population within a time period, point clusters involve a concentration of suicide deaths within time and a specific locality (Joiner, 1999). There is no doubt that suicide clusters generate high levels of community distress and often widespread media attention (Hawton et al., 2015).

Several non-mutually exclusive mechanisms have been proposed underlying the initiation and maintenance of suicide clusters (Haw et al., 2013; Hawton et al., 2020). The social transmission mechanism suggests that exposure to the suicide of a significant other increases vulnerability to further suicide via imitation and suggestion or projective and pathological identification (Marchant et al., 2020). Underlying the descriptive norms is the more prevalent suicidal behavior is perceived to be, the more normalised it becomes. The assortative relating theory (Joiner, 1999; Robinson et al., 2016) proposes that the clustering of suicide is explained primarily by a group of individuals sharing certain risk factors who associate with each other and the social integration and relating mechanism refers to the effect of close-knit social networks in disseminating news and beliefs about suicides in a locality.

Nonetheless, little is known about the characteristics and long-term outcomes of those who self-harm during a suicide cluster (Haw et al., 2013). A recent qualitative study of individuals presenting with near-fatal self-harm during a suicide cluster suggested that the negative impact of the cluster could have long-term effects (John et al., 2022). We aimed to compare characteristics and long-term self-harm and mortality outcomes for individuals who self-harmed during a point cluster, with an estimated 10 deaths, which occurred in South Wales, UK, between December 2007 and March 2008 in young people aged 15-34 years (Jones et al., 2013) with those who self-harmed prior to it. This cluster was highly publicised locally and nationally by media, with a high volume of sensational reporting throughout the cluster (John et al., 2016; Marchant et al., 2020).

Methods

Study design and participants

This was a retrospective data linkage cohort study (RECORD checklist in Electronic Supplementary Material (ESM) 1) based in the Local Authority Area (LAA; population

140,000) of a suicide cluster (December 27, 2007-March 17, 2008). We used paper-based emergency department (ED) records (Suppl. Methods in ESM 2) from the district general hospital serving the locality and privacy protected routinely collected data for the Wales population from the Secure Anonymised Information Linkage (SAIL) Databank (www.saildatabank.com).

We derived two groups for this study where each group included individuals who self-harmed during the period where the suicide cluster occurred (DC group) and those who self-harmed during the corresponding period one year before (BC group). We excluded individuals who self-harmed during both periods, i.e., excluding individuals in both BC and DC groups.

ED dataset

This dataset consisted of individuals who presented to the ED of the district hospital following self-harm (index self-harm) between December 27, 2006 and March 17, 2008 by hand screening for any mention of self-harm (Suppl. Methods in ESM 2). These were then converted to electronic data by researchers for quantitative analysis. We compared characteristics and outcomes of individuals ascertained during the suicide cluster, between December 27, 2007 and March 17, 2008 (DC group, Suppl. Fig. 1 in ESM 3), with those ascertained between December 27, 2006 and March 17, 2008 (BC group, Suppl. Fig. 1 in ESM 3).

Enhanced dataset

We used routinely collected data from SAIL databank covering the Wales population between January 01, 2000 and March 16, 2018 (Suppl. Fig. 1 in ESM 3). Within the two ascertainment periods (DC and BC), we identified individuals who resided in the LLA or presented to health services located in the LAA with self-harm (primary care and hospital admission data). These individuals and those from the ED dataset were combined creating enhanced DC and BC groups (Suppl. Fig. 1 in ESM 3). Long-term outcomes were assessed by following the enhanced datasets for 10 years, starting from the date of the index self-harm event (Fig. 1A).

Data Linkage

Data from the ED dataset were uploaded to the SAIL databank, a databank that contains anonymised privacy protecting person-based linkable data from healthcare and public settings (Ford et al., 2009; Lyons et al., 2009). All data linkage was handled in accordance with the Data Protection Act 2018 and disclosure control methods were used to restrict the

reporting of small numbers (categories containing <5 individuals and related categories leading to secondary disclosure) to protect vulnerable individuals. Data between database were linked by identity matching and creation of unique anonymised linking field via a trusted organisation mandated to hold personally identifiable data. Data encryption using deterministic matching was based on National Health Service (NHS) number or probabilistic matching using available demographics (Ford et al., 2009; Lyons et al., 2009). For probabilistic linkage, a matching score was calculated to reflect the odds of matches of demographic variables for an individual. We included individuals whose data were either deterministically linked or probabilistically linked with matching score of ≥0.9. Using the matching criteria, overall accuracies of ≥99.8% could be attained and ≥94.1% of the records could be successfully linked (Lyons et al., 2009).

We used the following SAIL datasets to link the ED dataset at individual level and to identify individuals for the enhanced dataset: Welsh Demographic Service, General Practice Database, Patient Episode Database for Wales and deaths register from Office for National Statistics. Descriptions of each dataset are summarised in Suppl. Table 1 in ESM 3.

Measures

Self-harm, suicide risk, and mortality outcome

Data for current and history of self-harm, suicide attempts, and 'suicide risk' measured by the modified SAD PERSONS (SAD) score (Patterson et al., 1983) were extracted from individuals' ED record. Self-harm events and methods (categorized into overdose/poisoning, hanging/strangulation, cutting, and others/unknown) were also extracted from the primary and secondary care SAIL datasets based on previously used Read and International Classification of Diseases (ICD) version 10 codes (Marchant, Turner, et al., 2020). We extracted mortality data using ICD-10 codes and classified cause of death into all-cause, natural, unnatural, and suicide as described previously (John et al., 2018).

Other covariates

For the ED dataset, we included: sex, age, marital and household status, area deprivation as proxied by the Welsh Index of Multiple Deprivation, and urban/rural indicator. For the enhanced dataset, the same variables were used, except marital and household status (unavailable in the SAIL Databank). Other variables included physical comorbidity, previous self-harm, mental health diagnoses, alcohol and drug use, and prescription of psychotropic and opiate medications (see details in Suppl. Methods in ESM 2). These variables were

included based on previous studies on suicide and premature mortality following self-harm (Carr et al., 2017; John et al., 2020).

Statistical analysis

Full descriptions of the statistical methods are summarized in Suppl. Method (ESM 2). In brief, we compared descriptive statistics of individuals' characteristics, self-harm mortality outcomes between DC and BC groups with 95% confidence intervals (CIs). Due to small sample size, Fisher's exact tests, likelihood ratio tests and Bayes factors were used to estimate independence of variables for all contingency tables. Effect modification of stratified cross-tabulation by sex and age was tested by the homogeneity of odds ratios and Firth logistic regression model, independent sample *t* test and the associated Bayes factors were used to compare group means for continuous variables.

For the enhanced dataset, we performed univariable and multivariable Firth logistic regressions to evaluate the odds ratios (ORs) on the long-term mortality outcomes. The use of Firth regression was to circumvent the small sample bias due to small size and separation issues (Firth, 1993; Heinze & Schemper, 2002). For reference, we also presented results from conventional logistic regression for all adjusted analyses. For all adjusted analyses, we performed diagnostic checks on multicollinearity using the variance inflation factors (VIFs) of all independent variables. VIF >3 was used as a threshold of presence of multicollinearity (Miles & Shevlin, 2001).

Ethical Approval

Ethical approval was obtained from Southwest Wales NHS Local Research Ethics Committee (reference 15/WA/0366) and the Swansea University Information Governance Review Panel (reference 0319).

Results

Cohort characteristics

496 individuals were identified in ED records during December 27, 2006-March 17, 2008 and data for 402 individuals (81.0% out of 496) were successfully linked to the SAIL databank (Suppl. Fig. 1 in ESM 3). Among the 129 individuals (32.1% out of 402) who self-harmed either during the suicide cluster (DC) or during the same period a year before (BC), 86 individuals (66.7% out of 129) were from the DC and 43 (33.3%) from the BC group. From SAIL, we identified 424 additional individuals to form the enhanced dataset (N = 489) with 280 (57.3% out of 489) in the DC and 209 (42.7%) in BC group. Only <5 and 17 individuals

were excluded from the ED (<2% out of 129) and enhanced datasets (3.5% out of 489) respectively as they were ascertained in both DC and BC groups (Suppl. Fig. 1 in ESM 3).

There was no statistical evidence of differences in sociodemographic, SAD scores, and clinical characteristics between the DC and BC groups of the ED dataset (Suppl. Table 1-4 in ESM 3). However, fewer individuals in the DC group were admitted to a general or psychiatric hospital following self-harm, 7.0% (out of 86; 95% CI: 2.9%-15.1%) vs. 32.6% (out of 43; 95% CI: 19.5%-48.7%).

Sociodemographic and clinical characteristics in the enhanced DC and BC groups were similar (Suppl. Table 5-8 in ESM 3). Fewer individuals in the enhanced DC group were hospitalized with self-harm, 20.0% (out of 280; 95% CI: 15.6%-25.3%) vs. 34.0% (out of 209; 95% CI: 27.7%-40.9%); self-harmed by overdosing/poisoning, 66.4% (95% CI: 60.5%-71.9%) vs. 76.1%; (95% CI: 69.6%-81.6%), and had a history of diagnosis of any mental health condition, 63.2% (95% CI: 57.2%-68.8%) vs. 74.2% (95% CI: 67.6%-79.8%). Although not statistically evident, more individuals self-harmed by hanging/strangulation in the DC group (4.3% vs. <2.0%). Differences in distributions of sex and age group were not significantly different between DC and BC groups in the ED and enhanced dataset (Suppl. Table 9 in ESM 3).

10-year Self-harm and mortality outcomes

From the enhanced dataset, we identified 157 (56.1% out of 280) in the DC group and 123 (58.9% out of 209) individuals in the BC group who self-harmed during the 10-year follow-up, with no statistical evidence for group differences (unadjusted OR: 0.9, 95% CI: 0.6-1.3, p = 0.580; Bayes factors: 0.1-0.3, evidence in favor of independence between self-harm and group, Fig. 1 and Suppl. Table 7-8 in ESM 3). All-cause mortality was higher in the DC than the BC group (unadjusted OR = 1.9, 95% CI: 1.0-3.6, p = 0.047; Bayes factors: 3.9-11.5, moderate/strong evidence in favor of dependence between all-cause mortality and group). More individuals in the DC group, died by natural causes. Mean age of death, mortality by unnatural causes and suicide were similar between groups. Results from Firth logistic regressions show statistically higher mortality for males in the DC group compared to other three groups (Suppl. Table 10-11 in ESM 3). Older age group was also statistically associated with higher mortality.

VIFs for all independent variables in all corresponding adjusted regressions for this study ranged between 1.0 and 2.2, which were lower than the adopted threshold of three. This suggests that multicollinearity was not an issue for all our adjusted models.

Discussion

For the first time to our knowledge, this study compared characteristics of individuals who self-harmed during a suicide cluster with those who self-harmed one year before and followed them for up to 10 years for self-harm and mortality outcomes. While our observation of higher number individuals who self-harmed during the cluster might reflect an actual increase, it could also be due to the heightened awareness and thus change in behavior of recording self-harm from clinicians at the time of the cluster in comparison to the situation where self-harm were under-reported or poorly recorded out of the period of the cluster. We found an increase in the number of individuals who self-harmed during the cluster but with less related hospitalisation, which may reflect self-harm severity, methods used or clinical practice during a cluster with increased demand. It may also reflect policy/practice to reduce public concerns. SAD scores, and histories of self-harm was similar between groups. There was some evidence of greater use of hanging as a method for self-harm during the cluster, consistent with methods widely reported in the media at the time (Marchant, Turner, et al., 2020). Individuals who self-harmed during the suicide cluster were similarly likely to those from the non-cluster to repeat self-harm over the 10-years follow-up. Males who self-harmed during the cluster had higher long-term all-cause mortality risks. Since these findings were not predicted a priori and require replication and the contributing factors remain unclear, further investigations on long-term outcomes are warranted (Haw et al., 2013).

Strengths and limitations

This unique study compared individuals who self-harmed during a suicide cluster with non-cluster self-harm cases and evaluating long-term self-harm and mortality outcomes by linking clinical assessment to routinely collected data. The high data coverage in the SAIL databank facilitated comparisons of individual characteristics and increased sample size by identifying individuals using diagnostic codes for self-harm. However, small sample size is still a huge issue in this study. We used both frequentist and Bayesian approaches to test our hypotheses and results were in tight agreement between approaches. We collected ED admission data from a single hospital only as this hospital is the only district general hospital providing secondary care services covering the relevant LAA. We included individuals based on geographical proximity only and not on psychological or social proximity, which are important factors in clustering of suicides (Hawton et al., 2020); data and measures for these two dimensions are required in future research. We excluded a small number of individuals who self-harmed during both pre-cluster (BC) and cluster periods (DC) to ensure tenability of data stratification and statistical analyses. While the corresponding proportions to the whole datasets were small (<3.5%), such exclusion may still introduce bias particularly for the BC

group, which may be less likely to experience outcomes in the 10-year follow-up. As for other research using routinely collected data, we are likely to underestimate self-harm for those who do not contact health services or have their conditions misclassified.

Implications for policy and practice

Our findings can inform intervention strategies to prepare for, identify, and respond to suicide clusters (Public Health England, 2019). Increased self-harm risk during a cluster is not confined to those with pre-existing mental health diagnoses and long-term outcomes of those who self-harm are broader. We highlight a potential need for long-term monitoring and intervention in those who self-harm during suicide clusters. While it is crucial to identify and provide timely interventions/support to vulnerable individuals following suicide clusters, attention should also be paid to the general health and wellbeing of the whole community, particularly for males following a cluster.

Authors biographies

Sze Chim Lee, PhD, is a senior research data scientist in Medicine, Health and Life Science at Swansea University Medical School. His research uses administrative data and surveys to study a range of biological, psychosocial, and environmental circumstances that may be associated with mental health issues, suicide, and self-harm.

Olivier Y. Rouquette, PhD, is researcher and data scientist in the Population Psychiatry, Suicide and Informatics (PPSI) team at Swansea University Medical School, working in prof. Ann John's team. Olivier's research encompasses mental health and wellbeing of children and young people using routinely collected population linked data.

Keith Hawton is professor of Psychiatry and Director of Centre for Suicide Research at the University of Oxford. Professor Hawton has a particular interest in epidemiology and clinical management of self-harm, suicide and self-harm in adolescents, media influences on self-harm and evaluation of suicide prevention initiatives.

Louise Cleobury, PhD, is Senior Lecturer in Health Data Science and Programme Director for Population Health and Medical Sciences at Swansea University Medical School. Louise's areas of interest are in Clinical, Applied, and Health Psychology. Louise Cleobury has over 15 years' experience in multidisciplinary applied health research across settings.

Sarah Spencer is retired from a successful career in NHS including: Emergency Medicine consultant, Head of Postgraduate Training in Emergency Medicine, Clinical Director Acute & Emergency Services, Deputy Medical Director, Locality Group Director (Primary, Community, Secondary Acute and Mental Health Services).

Keith Lloyd is professor of psychiatry at Swansea University Medical School and a clinical academic specialising in psychiatry. Keith's research interests are in epidemiology, suicide, and the use of routine health data in mental health research. He is pro-vice chancellor for medicine, health, and life science at Swansea University.

David Gunnell, FMedSci, is Emeritus Professor of Epidemiology at the University of Bristol, UK. He is a public health physician and epidemiologist with a longstanding research interest in the etiology and prevention of suicide and in improving population mental health.

Jonathan Scourfield is Professor of Social Work and Deputy Director of CASCADE, the Children's Social Care Research and Development Centre at Cardiff University. His research includes child and family services, working with men, social work education, research capacity-building, the social context of suicide and self-harm, and identity and religion in children.

Ann john is Professor in Public Health and Psychiatry at the Swansea University Medical School. She chairs the National Advisory Group to Welsh Government on the prevention of suicide and self-harm. Her research targets suicide, self-harm prevention and mental health with an emphasis on translating research into policy and practice.

Electronic Supplementary Material

– ESM 1. RECORD checklist (RECORD_Checklist.docx).

– ESM 2. Suppl. Methods (Suppl_Methods.docx).

The document shows additional descriptions of methodology and statistical analysis.

– ESM 3. Suppl. Tables 1-11 and Suppl. Fig. 1 (Suppl_Tables_Figures.docx).

The document shows additional tables and figures not shown in the main text.

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Figure Legends

Fig. 1. (A) Schematic diagram of observation period of this study. DC: Self-harm ascertainment period during to the suicide cluster (December 27, 2007-March 17, 2008); BC: Self-harm ascertainment period one year before the suicide cluster (December 27, 2006-March 17, 2007); X: index self-harm event during ascertainment period. (B) Comparison of self-harm and mortality outcomes during a 10-year follow-up. Odds ratios (ORs) are analysed by univariable Firth regression. Error Bars: 95% CIs.