The Definition and Epidemiology of Clusters of Suicidal Behavior: A Systematic Review

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Suicide clusters are a rare and underresearched phenomenon which attract wide media attention and result in heightened concern in the communities where they occur. We conducted a systematic literature review covering the definition and epidemiology of the time–space clustering of suicidal behavior. Of the 890 articles identified by electronic searching, 82 were selected for inclusion and the extracted data were analyzed by narrative synthesis. Less than a third of studies included a definition of a suicide cluster, and definitions varied considerably. Clusters occurred in various settings, including psychiatric hospitals, schools, prisons, indigenous communities, and among the general population. Most clusters involved young people. The proportion of all episodes that occurred in clusters varied considerably between studies and partly depended on study methodology (e.g., a larger proportion was found in studies of specific clusters compared with general population studies). Future studies should aim to combine the statistical analysis of time–space clustering with a case study of events, which examines potential links between individuals and the wider environmental context.

Reports of suicides occurring in apparent clusters are prominent in both the academic literature and mass media (Gould, Wallenstein, & Davidson, 1989; Lowe, 2008). Two types of cluster have been described: mass and point. In a mass cluster, suicides occur closer in time than would be expected by chance following media coverage (such as televised news reports or film portrayals) of suicides (Joiner, 1999). Evidence of mass clusters has been reviewed elsewhere (Gould, Jamieson, & Romer, 2003; Niederkrotenthaler et al., 2012). A point cluster involves suicides or episodes of suicidal behavior localized in both time and geographic space, often occurring within a small community or institutional setting (Mesoudi, 2009). Less research has focused on the epidemiology of point clusters (hereafter referred to as suicide clusters) than of mass clusters.

The causes and risk factors for suicide clusters are not well understood. Several social and psychological mechanisms contributing to the formation of suicide clusters have been suggested, including imitation, contagion, suggestion, social learning, and assortative relating (Haw, Hawton, Niedzwiedz,

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& Platt, 2013). Haw et al. (2013) identified a number of potential risk factors that were associated with increased risk of cluster suicide: male gender, adolescence, a history of substance misuse, self-harm, and psychiatric illness. However, due to the methodological challenges of researching suicide clusters, it is very difficult to rule out the possibility that these factors are general risk factors for suicide itself (noncluster suicides). It seems plausible that suicide clusters arise from the interaction of demographic, socioeconomic, environmental and cultural factors at both the individual and contextual levels.

More sophisticated statistical methods and techniques, such as geographical information systems, have been used to analyze epidemiological data in recent years (Pfeiffer et al., 2008). Many of these statistical techniques have been applied to the study of suicide clusters to improve understanding of the epidemiology and help in the surveillance of potential clusters (Larkin & Beautrais, 2012). These often require the *ad hoc* specification of temporal and spatial thresholds to define a cluster. However, there is no agreed operational definition of what constitutes a suicide cluster, especially regarding whether both completed suicides and other episodes of suicidal behavior should be included and the minimal number of events that should be called a cluster.

To progress the understanding of suicide cluster epidemiology, we conducted a systematic review which was intended to answer five research questions. How are suicide clusters defined in the literature? Is there evidence that suicides or suicidal behavior occurs in clusters? Does suicide or suicidal behavior cluster in specific settings? What proportion of suicides is estimated to occur in clusters? What are the key characteristics of suicide clusters (e.g. the size and duration)?

METHODS

We conducted electronic searches of eight databases: MEDLINE, PsycInfo, Web of Knowledge, Applied Social Sciences Index and Abstracts, Educational Information Resources Center, International Bibliography of the Social Sciences, Sociological Abstracts, and Social Services Abstracts. Searches were carried out during August to November 2011 and updated in March 2013, with no language or study design restrictions. Key words used included: "suicid$", "self mutilat$", "self poison$", "self injur$", "para-suicid$", "cluster$", "imitat$", "epidemic," and "copycat". Additional methodological details are found in Data S1 of the Supporting Information. Articles were eligible for inclusion if they were published in a scholarly journal and related to *both* the temporal *and* spatial clustering of suicide or suicidal behavior (including self-harm). Articles relating to perceived suicide clusters or the statistical analysis of suicide clusters were considered. All study designs were eligible for inclusion, and studies conducted in any country were considered, but non-English language articles were excluded from data extraction. Different articles reporting results from the same cluster or data were included if they contributed evidence (e.g. characteristics of clusters or statistical analysis) in addition to the original study.

Two reviewers (CLN and SP) assessed the identified records according to the criteria above. The references of articles selected for inclusion were checked for any additional articles. Meta-analysis was not attempted due to heterogeneity of study characteristics, including study populations, study designs, definitions of a suicide cluster, and methods. Narrative synthesis was therefore used to analyze the extracted data (Petticrew & Roberts, 2006). Narrative synthesis is an approach used in systematic reviews to combine results from several studies that relies on the use of words and text to summarize and explain the findings of the synthesis (Popay et al., 2006). Studies that examined *both* the relationships and links between individuals in a cluster *and* conducted statistical analysis of the time–space clustering of events were treated *a priori* as being of higher methodological quality. Therefore, studies that only provided statistical analysis or a descriptive account of

a cluster were considered lower quality. Study quality was considered during the narrative synthesis process, with the results of studies considered to be of higher quality given greater narrative "weight" and discussed first in the results sections reviewing evidence of clustering and the proportion of suicides estimated to occur in clusters.

RESULTS

Search Results

The electronic searches identified 890 unique publications (Figure 1). Of 128 publications selected for full-text screening, 78 did not meet the eligibility criteria, resulting in the inclusion of 50 articles from the searches. A further 29 articles meeting the eligibility criteria were identified via reference checks of included articles. An updated search in March 2013 generated another three articles for inclusion. In total, 82 articles published between 1960 and 2013 were selected for inclusion (see Data S2 and Table S3 in the Supporting Information for full references and details of the included articles). Seven articles that reported results from the same cluster or used data already reported in another study were included as they contributed additional evidence.

Definition of a Suicide Cluster

Twenty-five of the included articles provided an explicit definition of a suicide 'cluster', 'epidemic', 'outbreak', or 'aggregation', and 57 articles provided no definition. Two articles cited the Centers for Disease Control (CDC) definition provided in their recommendations for the prevention and containment of suicide clusters: "a group of suicides or suicide attempts, or both, that occur closer together in time and space than would normally be expected in a given community" (Centers for Disease Control, 1988). Three articles referred to the definition by Gould et al. (1989, p17): "an excessive number of suicides occurring in close

temporal and geographic proximity", and one included the definition by Joiner (1999, p89): "the factual occurrence of two or more completed or attempted suicides that are nonrandomly 'bunched' in space or time…". Some authors acknowledged the difficulty of providing a definition: "There is no adequate definition of a cluster suicide" (Davies & Wilkes, 1993, p517) and "…clusters tend to be defined subjectively; the detection and ascertainment of a cluster lie in the eyes of the beholder" (Gibbons, Clark, & Fawcett, 1990, pS183).

Seventeen articles included only completed suicides in their definitions, three articles included suicide attempts, three included suicidal "events" or "behavior", and two included only episodes of self-harm. Only six definitions provided an indication of the number of incidents that would constitute a cluster: either two or more (Rosen & Walsh, 1989; Taiminen, Kallio-Soukainen, Nokso-Koivisto, Kaljonen, & Helenius, 1998) or three or more events were specified in the definitions (Davidson, Rosenberg, Mercy, Franklin, & Simmons, 1989; Maris, 1997; Reser, 1989; Wilkie, Macdonald, & Hildahl, 1998). Most studies defined a suicide cluster as involving incidents close in both time and geographic space. However, only three provided an indication of temporal proximity. Rosen and Walsh (1989) and Taiminen et al. (1998) considered incidents occurring on the same day or consecutive days to be clustered, whereas Maris (1997, p540) stated that events were "…usually in a limited, contiguous time frame e.g. 7–10 days, 2 weeks, 1 month, or even longer". Most studies specified that incidents usually occurred within a defined geographic area or community, but two recognized that this could be an institution, such as a school or hospital. Four studies also defined a suicide cluster as including events that were 'linked' in some way other than by time and space. Morrison (1987, p536) defined a suicide cluster as "…a series of deaths that appear linked by geography, time, relationships, and possibly contagion" and Bechtold (1988, p26) stated that events in a cluster were
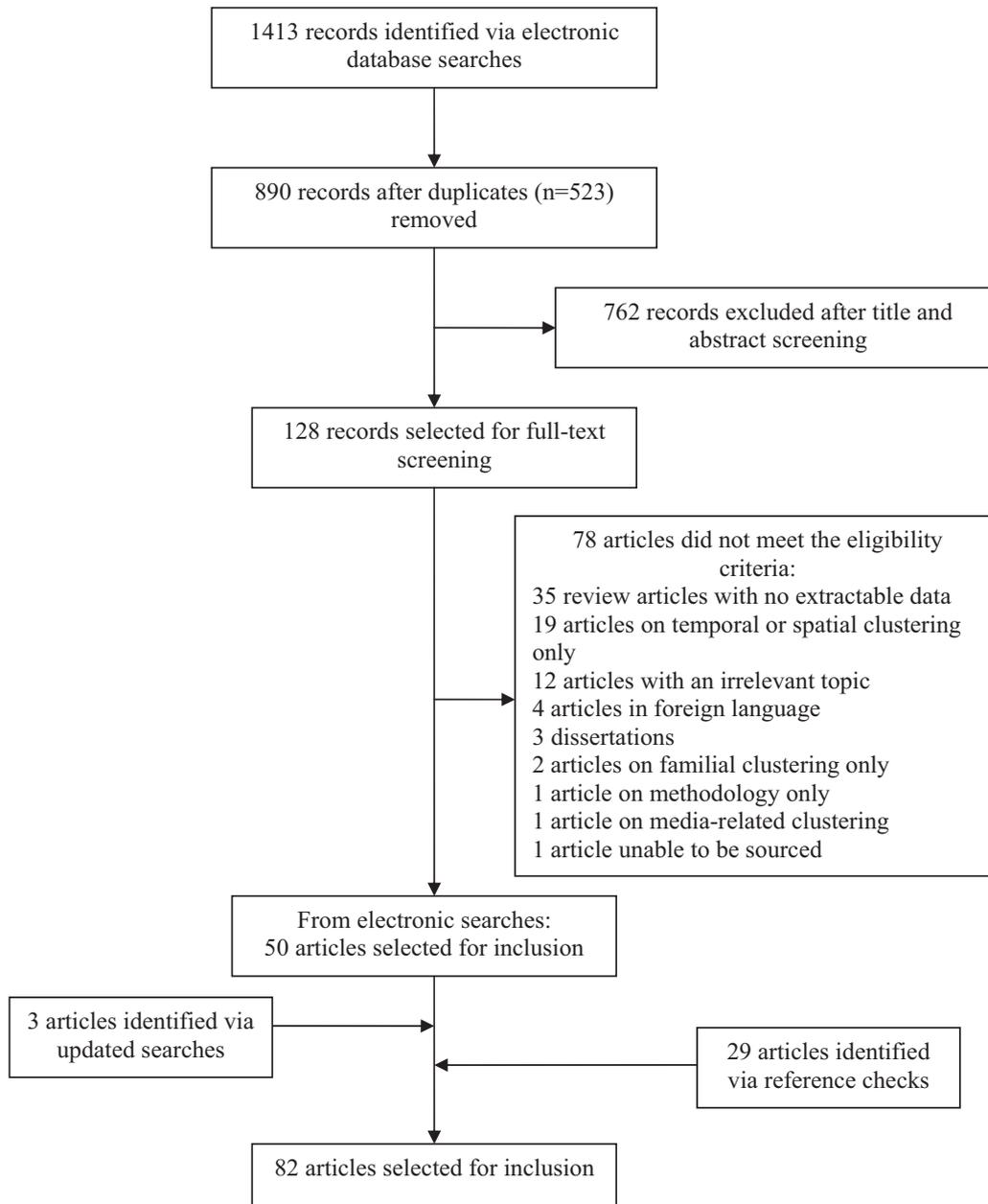
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│  1413 records identified via electronic │
│         database searches            │
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│  128 records selected for full-text   │
│             screening                 │
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78 articles did not meet the eligibility criteria:

35 review articles with no extractable data

19 articles on temporal or spatial clustering only

12 articles with an irrelevant topic

4 articles in foreign language

3 dissertations

2 articles on familial clustering only

1 article on methodology only

1 article on media-related clustering

1 article unable to be sourced

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┌─────────────────────────────────────┐
│      From electronic searches:        │
│   50 articles selected for inclusion  │
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3 articles identified via updated searches

29 articles identified via reference checks

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│  82 articles selected for inclusion   │
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Figure 1. Flow diagram of article identification, screening, eligibility, and inclusion.

"…etiologically related through the process of imitation".

Studies evaluating the statistical evidence for the time–space clustering of completed and attempted suicide used a variety of techniques, most frequently Knox, Poisson, or Scan tests. Techniques such as the Knox and Scan tests require the units defining temporal and spatial proximity to be specified *a priori* and usually investigate the distances between close pairs of suicides. A range of time frames was used, and a variety of temporal units were tested within some individual studies.

The maximum time frame used to define temporal closeness was highly variable, ranging from 1 to 2 weeks (Haw, 1994; Hourani, Warrack, & Coben, 1999a; Kirch & Lester, 1986b; Niemi, 1978; Rosen & Walsh, 1989) to over a year (Gibbons et al., 1990; Hanssens, 2008). Regarding the units used to define geographic proximity, studies focusing on institutional settings, such as a school or hospital, usually used incidents occurring within that institution. Nationwide studies within the USA tended to use county, borough, or city level as the spatial unit.

Settings and Locations of Studies

Studies examined suicide clusters which occurred in 14 different countries: United States ($N = 32$), Australia ($N = 8$), United Kingdom ($N = 8$), Canada ($N = 5$), Finland ($N = 5$), New Zealand ($N = 3$), Norway ($N = 2$), Sweden ($N = 2$), China ($N = 1$), India ($N = 1$), Israel ($N = 1$), Japan ($N = 1$), Marshall Islands ($N = 1$), and Switzerland ($N = 1$). In four studies, the geographic location was not provided: in three of these, the authors were located in the United States and author information was not available in the fourth. Seven types of setting were identified from the studies investigating potential suicide clusters, the most frequent being clusters in the general population, community, or peer group setting, psychiatric hospital or patient populations, and schools (Table 1). Some studies could be classified under more than one setting, such as a cluster that occurred within a school for indigenous groups and clusters that involved school pupils as well as individuals living in the surrounding community. In both cases, these studies were classified under the school setting. For clarity, each study was classified in one group only.

Overall Evidence of Suicide Clusters

Three types of evidence relating to suicide clusters were identified in the literature: studies that described the occurrence of

TABLE 1

Settings of the Identified Studies on Suicide Clusters

Setting	Number of studies identified
General population, community, or peer group	20
Psychiatric hospital or patient population	19
Schools	12
Indigenous communities	8
Prison populations	7
Work communities	5
Military populations	4

one or more perceived clusters, usually in a case study ($N = 38$); studies that statistically examined the temporal and geographic clustering of completed and attempted suicide, usually in a cross-sectional or cohort design ($N = 20$); and studies of higher methodological quality that included both a description of a suicide cluster and provided statistical analysis ($N = 17$). Descriptive evidence of perceived clusters was found for each of the seven settings identified: psychiatric hospitals ($N = 9$), schools ($N = 9$), general community or peer groups ($N = 5$), indigenous communities ($N = 5$), work communities ($N = 5$), prison populations ($N = 3$), and military populations ($N = 2$). The other forms of evidence for suicide clusters in each setting will now be discussed in more detail.

Fifteen studies provided statistical evidence for or against the time–space clustering of suicide and suicidal behavior in the general population or community setting. Using the Scan test, Robertson, Skegg, Poore, Williams, and Taylor (2012) found a cluster of eight suicides among adolescents that occurred in a New Zealand city district. There was also evidence to suggest that the individuals were linked via social media and text messages. This study was considered to be of good quality as it combined the statistical analysis of time–space clustering with information about how individuals in the cluster were linked. Davies

and Wilkes (1993) found similar statistical evidence and linkages between individuals in their study of a cluster in Western Canada, as did as Austin, van den Heuvel, and Byard (2011) in a study of suicides by hanging in South Australia. In their purely statistical analysis of suicides in Australia during 2004–2008, Cheung, Spittal, Williamson, Tung, and Pirkis (2013) identified eight statistically significant clusters using the state or territory as the spatial unit. Three studies provided further statistical evidence of clustering among adolescents (Gould, Wallenstein, & Kleinman, 1990; Gould, Wallenstein, Kleinman, O'Carroll, & Mercy, 1990; Wallenstein, Gould, & Kleinman, 1989). Gould, Petrie, Kleinman, and Wallenstein (1994) also found statistical evidence of the time–space clustering of hospital admissions for attempted suicides in New Zealand. Two studies found statistical evidence in support of a clustering effect among suicides by plastic bag asphyxia (Church & Phillips, 1984) and charcoal briquettes (Kamizato et al., 2009), and in a re-analysis of the data in the Church and Philips study, Kirch and Lester (1986a) found statistically significant evidence of clustering using 90- and 150-day time intervals. Two studies found no statistical evidence when examining suicides by jumping from the Golden Gate Bridge (Kirch & Lester, 1986b) and by hanging in Cardiff, Wales (James & Silcocks, 1992).

Ten studies provided statistical or cohort evidence relating to suicide clusters within psychiatric hospitals or psychiatric patient populations. Five studies found statistically significant evidence to support the presence of clusters of suicide (Anonymous, 1977; McKenzie et al., 2005) or self-harm (Rosen & Walsh, 1989; Taiminen et al., 1998; Walsh & Rosen, 1985). In addition to conducting statistical analysis, Rosen and Walsh (1989) analyzed links between subjects using a sociogram. In an analysis of a suicide cluster within a psychiatric hospital, Haw (1994) found no evidence for temporal clustering. However, the events were shown to be nonrandomly distributed using a Poisson probability analysis and were therefore considered to be a discrete cluster rather than a chance occurrence. This was also found for a perceived cluster of suicides within a similar setting (Taiminen & Lehtinen, 1990). Kirch and Lester (1990) found no evidence for the temporal clustering of suicides by jumping among patients of a psychiatric hospital originally reported by Goldney (1986). Similarly, Modestin and Wurmle (1989) found no evidence of clustering among suicides in two psychiatric hospitals, and King et al. (1995) found no evidence among self-harm incidents within an adolescent inpatient unit.

In the four studies examining the statistical evidence of clustering of suicides within prisons and police cells, two found supportive evidence of an effect and two found no evidence. The studies focusing on indigenous communities found no statistical evidence of a cluster of seven incidents which appeared close in time (Wissow, Walkup, Barlow, Reid, & Kane, 2001). Some statistical and descriptive evidence was found for suicide clustering in the Northern Territory, Australia (Hanssens, 2008). Hanssens also documented the occurrence of 'echo' suicide clusters, in which subsequent clusters occurred within close geographical proximity following an initial cluster. Three studies reported statistical evidence of suicide clusters within schools (Brent et al., 1989; Centers for Disease Control, 1991; Poijula, Wahlberg, & Dyregrov, 2001). Within the military setting, Hourani et al. (1999a) found a lack of statistical evidence for a clustering effect of suicides among US Marine Corps personnel, while Hourani, Warrack, and Coben (1999b) identified significant evidence for time–space clustering of suicides among US Navy personnel.

Characteristics of Suicide Clusters

Studies reporting particular instances of 'contagious' suicide clusters permit exploration of the distinguishing features of

the clusters, including the typical time period in which incidents occurred, the number of subjects involved, and the sociodemographic characteristics of the individuals. Most of this information was extracted from case studies which retrospectively documented the occurrence of a suicide cluster. The synthesis of results was limited due to study heterogeneity, especially regarding the reporting of episodes of suicidal behavior, and the incomplete reporting of the age and gender of subjects.

The time period in which suicide clusters were perceived to have occurred varied considerably. There were several reports of clusters occurring within a 2-week period. The minimum time period identified was 24 hr (Kaminer, 1986). The longest time period was 5 years, when a series of 11 suicides and 11 overdose-related deaths occurred in a small community (Hacker, Collins, Gross-Young, Almeida, & Burke, 2008). At least 12 of the subjects involved were connected via friendship, sports teams, or social media websites. Most other studies reported clusters that occurred within a 12-month period.

The number of incidents involved in clusters varied depending on the duration of the cluster and whether other episodes of suicidal behavior were included in addition to completed suicides. Generally, a higher number of incidents were found to occur within a more concentrated space of time among clusters in institutional settings, such as psychiatric hospitals, and among indigenous communities. Hawton (1978) reported the occurrence of a suicide followed by 11 suicide attempts among seven female psychiatric inpatients during a 1-month period. A cluster of nine completed suicides and 88 "verified suicide attempts or gestures" took place during a 2-month period among an indigenous community in the United States (Tower, 1989), and six suicide deaths and 14 suicide attempts occurred during a 3-month period among a Canadian indigenous community (Wilkie et al., 1998).

There was a preponderance of studies (N = 32) reporting clusters that involved only young adults aged 35 years and under, especially adolescents. Gould, Wallenstein, Kleinman, and O'Carroll, et al. (1990) provided statistical evidence that the risk of being involved in a suicide cluster was two to four times greater among adolescents and young adults compared with older adults within the United States. Similarly, statistical evidence suggested that the risk of clustering of attempted suicide was also greater among young adults than that among older age groups in New Zealand (Gould et al., 1994). The youngest individual thought to be part of a cluster was 10 years old (Callahan, 1996), and the oldest was 83 years old (Haw, 1994). Only one example was found where clusters involved no individuals aged under 35 years (Crawford & Willis, 1966). Clusters involving older age groups were typically located in an institutional setting, particularly within psychiatric hospitals or prisons. Most reports of suicide clusters involved both males and females, and the pattern of risk seemed similar to noncluster suicides in general. In the majority of clusters that involved only one gender, that gender was male. The clusters involving females only all involved attempted suicide or self-harm among psychiatric inpatients.

Percentage of Suicides Estimated to Have Occurred in Clusters

Twenty-seven studies provided an estimate of the proportion of incidents that were thought to occur as part of a cluster, or provided enough data to enable calculation, or found no evidence of clustering. Nine studies found no statistical support for the time–space clustering of suicide and/or suicidal behavior: Three of these were based on analyses of incidents in the community or general population, three on psychiatric inpatients, two on prison populations, and one on a military population. The remaining results will be presented by the type of setting.

Within the general population and community studies, there was a high degree

of heterogeneity in the study populations investigated. According to studies focusing on adolescents, approximately 1% of suicides within counties (Gould, Wallenstein, & Kleinman (1990); Wallenstein et al. (1989)) and 2.3% within towns of the United States occurred as part of clusters (Gould, Wallenstein, & Kleinman (1990)). Robertson et al. (2012) estimated that 37.5% of adolescent suicides were part of a cluster that occurred in a city district of New Zealand, rising to 50% if additional suicides were included on the basis of evidence that they were connected via social networking websites and text messages with other individuals who were part of the cluster. About one in fifteen (6.8%) of adolescent suicides were estimated to belong to two clusters that occurred in Umea, Sweden (Johansson, Lindqvist, & Eriksson, 2006). Although the authors did not conduct formal statistical analysis, the study was notable for obtaining evidence that individuals in the cluster knew each other and that their circumstances were very similar, based on interviews with investigating police officers and parents. Combining statistical analyses from both the national and state or territory levels, Cheung et al. (2013) estimated that 2.4% of suicides among individuals aged 10 years and over in Australia were part of clusters.

In a study of suicides by individuals who had recent contact with mental health services in the United Kingdom, McKenzie et al. (2005) estimated that 13.3% were imitative acts of suicide (using a 7 month threshold); when including imitation of method, the rate was estimated to be 10.1% (using a 10 month threshold). Rosen and Walsh (1989) found that 57.5% of self-harm incidents among 12 patients in a psychiatric unit were clustered in time. In a qualitative analysis of suicides among psychiatric inpatients in a UK hospital, 25% were classified as "similar pairs" in which imitation was thought to have contributed (Crawford & Willis, 1966). In their statistical analysis of suicides among prisoners in England and Wales, McKenzie and Keane

(2007) estimated that 5.8% were imitative suicides (using a 120-day threshold). Cox and Skegg (1993) found that 39.9% of suicides among men in prisons and police cells in New Zealand were part of clusters. Similarly, 40.0% of suicides among indigenous men in prison and police custody in North Queensland, Australia, were thought to belong to a cluster (Reser, 1989). In an Australian maximum security prison, 45.0% of male suicides were calculated to be clustered in time (Hurley, 1989).

Among an indigenous community in the Southwest USA, 15.6% of suicides were thought to be part of a cluster (Wissow et al., 2001). Silviken, Haldorsen, and Kvernmo (2006) estimated that 27.0% of suicides were part of a cluster among indigenous groups in Arctic Norway. Among indigenous groups in the Northern Territory of Australia, the suicide imitation rate was estimated to be around 12.5% (using a 360-day threshold), including imitation of method this rate increased to 21.0% (Hanssens, 2008). Analyzing suicides among Navy personnel in the USA, Hourani et al. (1999b) estimated that 1.6% of suicides were close in time and space (using a 14-day time threshold).

DISCUSSION

In this review, we aimed to conduct a systematic review of the research evidence concerning the definition and epidemiology of suicide clusters. Less than a third of studies contained an explicit definition of a suicide cluster. The definitions varied in terms of their inclusion of episodes of suicidal behavior and the number of events required to comprise a cluster. Most definitions specified that a suicide cluster involved events that shared temporal and spatial proximity, but few provided details of what was implied by proximity in time. This varied from one to two weeks up to over a year in studies in which statistical analyses were performed. Less variation between studies was apparent in the spatial

units used, with most using the institution in which the cluster took place or the county level in nationwide studies within the USA.

Suicide clusters appear to occur in specific institutional settings, such as psychiatric hospitals, schools, prisons, and military commands. There was also evidence to suggest that clusters occur among indigenous communities, the general population, and some work community settings. Drawing conclusions about the settings or geographic locations with an increased risk of clustering was difficult due to study heterogeneity in terms of the study designs, methods, populations, definitions of a suicide cluster, and the lack of control groups. Furthermore, it might be easier to identify clusters within institutional settings compared with the community because of the clear boundaries within which the populations are situated. It is also possible that the media coverage of certain clusters may have influenced the selection of clusters investigated. Study heterogeneity affected the ability to provide estimations of the proportion of incidents which clustered in time and space. Studies analyzing routine data on suicide concluded that approximately 1–2% of adolescent suicides were clustered in the USA and around 2.4% of all suicides in Australia. Estimates were much higher in studies reporting the occurrence of a specific suicide cluster, but varied by study setting. These estimates should be interpreted with caution, however, due to the small number of incidents in some studies.

The gender pattern of cluster incidents appeared similar to the known risk for noncluster suicide and suicidal behavior, where males are more likely to complete suicide and females are more likely to engage in self-harm (Hawton, 2000). Reports of clusters involving young adults were most frequent and statistical evidence suggested that adolescents were more at risk of clustering compared with older age groups. The duration of clusters varied considerably between studies. Within institutional settings and among indigenous communities, a greater number of incidents typically occurred within a shorter time period compared with the general community. The number of events occurring as part of a cluster also varied considerably, ranging from two incidents within 24 hr in a psychiatric hospital (Kamizato et al., 2009) to 97 incidents within 2 months among an indigenous community (Tower, 1989). Some studies reported exclusively on incidents of completed suicide, whereas others included additional episodes of suicidal behavior. This made it difficult to evaluate the full extent of those affected by a cluster. Given that most studies only documented the occurrence of completed suicides, it is likely that the number of individuals involved in clusters may be underestimated: there may have been further suicidal behavior which was not reported or detected.

Our review has a number of strengths, including the number of databases searched and the thorough systematic search of the literature. However, some limitations should be noted. Although we did not restrict our searches to English language articles, data were not extracted from non-English language articles. Only four potentially relevant foreign language articles were identified, however; it is unlikely that their exclusion would invalidate our main findings. Due to study heterogeneity, we did not conduct a full quality appraisal of the included studies. Studies using statistical techniques to assess the evidence for clustering do not necessarily provide better quality evidence than case studies and will be more likely to detect potential false-positive clusters. Most case studies described suicide clusters in which the community experienced a charged emotional atmosphere, described in one study as "...a reaction of fear, anger, hypervigilance and scapegoating" (Davies & Wilkes, 1993, p517), which may be one of the key risk factors for further suicides (O'Carroll & Mercy, 1990). Case studies may therefore provide more important evidence compared with studies adopting a solely statistical approach, which lack knowledge of the

subjective experience of the community involved (Boyce, 2011).

In the future investigation of suicide clusters, we recommend the use of mixed study designs. Cross-sectional designs using routine data could be utilized to identify a potential 'statistical' cluster, via the use of geographical information systems. Incidents that appear clustered might then be investigated further using a case study design to gain insight into the links between individuals and the environmental circumstances of the potential cluster. Similarly, researchers conducting case studies in which a cluster is perceived to have occurred should also consider conducting statistical analysis, taking into account the previous suicide rate appropriate to the particular setting and the time–space clustering of events. This could help further develop and refine the statistical techniques used to analyze suicide clusters and provide information about which statistical clusters involve individuals who share social connections. For the statistical analysis of suicide clusters, it is recommended that researchers perform sensitivity analyses using different statistical techniques with several temporal and spatial units to investigate whether the results differ depending on the methods used. In terms of the definition of suicide clusters, we recommend the use of the recently developed operational definition by Larkin and Beautrais (2012, p20): "a series of three or more closely grouped deaths within 3 months that can be linked by space or social relationships". They suggest that evidence of temporal and spatial proximity is required if transparent social connectedness is not apparent, but if there is evidence demonstrating social linkages between the individuals involved only events close in time are needed. To improve the comparability of studies, researchers should consider adopting this operational definition of a suicide cluster and provide the sociodemographic details of the individuals involved (if available). Studies should also take into account the social and economic context in which clusters have occurred: it may be

possible that particular economic environments, for example during times of economic recession, could influence cluster formation. Additional research is needed into the phenomenon of 'echo' suicide clusters (Hanssens, 2010; Larkin & Beautrais, 2012), which appear to occur particularly within indigenous communities.

A recent review focusing on postvention strategies following suicide clusters among young people identified a number of interventions that show promise in the prevention of further cluster suicides. These include developing community response plans, education and psychological debriefings, individual and group counseling, screening of high risk individuals, and the responsible media reporting of clusters (Cox et al., 2012). However, there was a lack of long-term evaluation of the postvention strategies, and the review was restricted to clusters involving young people in the community or school setting. It is likely that the effectiveness and relevance of particular postvention strategies varies by the cluster setting. For example, what may be effective in a school within a specific country may not be relevant for an indigenous community, military population, or indeed a school within a different country. As demonstrated in the study by Callahan (1996), there is also a risk of doing more harm, such as contributing to further contagion of suicidal behavior by using postvention activities which glorify suicide. It is recommended that studies reporting on the occurrence of a suicide cluster also provide details of any postvention activities that were implemented and, ideally, evidence of their effectiveness. The development of a community strategy in the settings identified may help in the early identification of potential clusters and the containment of a cluster (Lockley, Williamson, Robinson, Cox et al., 2012).

Although there has been widespread development of media guidelines for the reporting of suicide, there is evidence to suggest that the awareness, implementation, and opinion of media guidelines among

journalists could be improved (Bohanna & Wang, 2012). Given the potential for suicide contagion following media reporting of suicide, engagement with the media to further develop and disseminate guidelines for the reporting of suicide could have a key role in preventing contagion and also increasing mental health literacy among journalists and the general public. More recent reports of suicide clusters have documented the use of social media among the individuals involved (Austin et al., 2011; Robertson et al., 2012). Therefore, further research is required into the role of social media in suicide cluster formation. The CDC guidelines for the prevention and containment of suicide clusters also need to be updated to include new developments relating to the way in which suicide contagion may operate. To conclude, as suicide clusters are generally rare events, the importance of general suicide prevention, including addressing the social and economic determinants of suicide, cannot be underestimated. Prevention of the first (index) case has the potential to eliminate the occurrence of suicide clusters.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article:

Data S1 Additional methodological details.

Data S2 References of the included articles.

Table S1 Full details of the included articles.