Suicide following presentation to hospital for non-fatal self-harm in the Multicentre Study of Self-harm: a long-term follow-up study

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Summary

Background Self-harm is the strongest risk factor for subsequent suicide, but risk may vary. We compared the risk of suicide following hospital presentation for self-harm according to patient characteristics, method of self-harm, and variations in area-level socioeconomic deprivation, and estimated the incidence of suicide by time after hospital attendance.

Methods In this ongoing Multicentre Study of Self-harm in England, the study population consists of individuals aged at least 15 years who had attended the emergency department of five general hospitals in Oxford, Manchester, and Derby after non-fatal self-harm between Jan 1, 2000, and Dec 31, 2013. Information on method of self-harm was obtained through systematic monitoring in hospitals. Level of socioeconomic deprivation was based on the Index of Multiple Deprivation (IMD) characterising the area where patients lived, grouping them according to IMD quintiles. Mortality follow-up was up to Dec 31, 2015, resulting in up to 16 years of follow-up. We calculated incidence of suicide since first hospital presentation by follow-up period and estimated the association between individual factors (age, gender, method of self-harm, IMD, and number of non-fatal self-harm presentations to hospital) and suicide using mixed-effect models.

Findings Between Jan 1, 2000, and Dec 31, 2013, there were 92 177 presentations to the study hospitals by 51 108 individuals. 1325 patients involved in 1563 self-harm episodes were excluded from the study because they had missing information on gender, age, or mortality. The resulting study sample consisted of 90 614 hospital presentations by 49 783 individuals. By the end of follow-up on Dec 31, 2015, 703 patients had died by suicide. The overall incidence of suicide was 163·1 (95% CI 151·5–175·6) per 100 000 person-years, and 260·0 (237·4–284·8) per 100 000 person-years in men and 94·6 (83·3–107·4) per 100 000 person-years in women. The incidence of suicide was highest in the year following discharge from hospital (511·1 [451·7–578·2] per 100 000 person-years), particularly in the first month (1787·1 [1423·0–2244·4] per 100 000 person-years). Based on all presentations to hospital, men were three times more likely than women to die by suicide after self-harm (OR 3·36 [95% CI 2·77–4·08], p<0·0001). Age was positively related to suicide risk in both genders, with a 3% increase in risk for every one-year increase in age at hospital presentation (OR 1·03 [1·03–1·04], p<0·0001). Relative to hospital presentations after self-poisoning alone, presentations involving both self-injury and self-poisoning were associated with higher suicide risk (adjusted OR 2·06 [95% CI 1·42–2·99], p<0·0001], as were presentations after self-injury alone (adjusted OR 1·36 [1·09–1·70], p=0·007). Similarly, relative to self-harm by self-poisoning alone, attempted hanging or asphyxiation (adjusted OR 2·70 [1·53–4·78], p=0·001) and traffic-related acts of self-injury (adjusted OR 2·99 [1·17–7·65], p=0·022) were associated with greater risk of suicide. Self-cutting combined with self-poisoning was also associated with increased suicide risk (adjusted OR 1·36, [1·08–1·71], p=0·01). Compared with those patients living in the most deprived areas, those who lived in the least deprived areas (first national IMD quintile) had a greater risk of dying by suicide (adjusted OR 1·76 [1·32–2·34], p<0·0001) after adjusting for gender, age, previous self-harm, and psychiatric treatment, as did those living in the second least deprived areas (adjusted OR 1·64 [1·20–2·25], p=0·002).

Interpretation Patients attending hospital for self-harm are at high risk of suicide, especially immediately after hospital attendance. Certain patient characteristics and methods of self-harm, together with living in areas of low socioeconomic deprivation, can increase patients' subsequent suicide risk. However, while specific risk factors can be usefully integrated into the assessment process, individual factors have poor utility in predicting suicide, so the needs and risks of all patients should be assessed to develop appropriate aftercare plan, including early follow-up.

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Research in context

Evidence before this study

Every year, there are approximately 200 000 presentations to emergency departments in hospitals across England following acts of non-fatal self-harm. Self-harm is associated with increased mortality, especially by suicide, but further information is needed on this association. We searched PubMed up to May 3, 2019, with the terms "self-harm", "self-injury", "self-poisoning", "suicide attempt", "attempted suicide", "suicide", "method", "socioeconomic deprivation", "socioeconomic disadvantage", and "socioeconomic position". We did not apply any language restrictions. Risk of suicide has been shown to vary between patients who present to clinical services after self-harm in terms of gender, age, and, in some studies, methods of self-harm, although it is increasingly recognised that the predictive value of such risk factors is low. Socioeconomic position has been linked to both self-harm and suicide, but there are no published data on whether variations in socioeconomic deprivation are related to risk of suicide in individuals who self-harm. Repetition of self-harm is common and the methods tend to change between episodes. Other characteristics of the individual may also vary between episodes. This can be best captured by using presentations to hospital as the unit for analysis.

Added value of this study

This study confirmed the high risk of suicide in the first year after presentation to hospital for self-harm, and showed that this risk was particularly elevated in the first month. The increased incidence of suicide mortality relative to the general population was greatest in patients at least 55 years of age at study entry. Presentations to hospital which involved both self-injury and self-poisoning were associated with the highest likelihood of subsequent suicide, followed by presentations involving acts of self-injury alone. Episodes involving self-cutting had equivalent risk of future suicide to episodes involving self-poisoning alone, while use of both methods in the same episode indicated heightened risk. Presentations after traffic-related acts of self-injury were associated with almost three times the risk of subsequent suicide relative to presentations involving self-poisoning alone. Individuals living in the least socioeconomically deprived areas at the time of self-harm had a considerably higher suicide risk relative to those living in the most deprived areas.

Implications of all the available evidence

Risk of suicide following hospital presentation for self-harm is very high immediately following hospital discharge, emphasising the need for provision of early follow-up care and attention to risk reduction strategies. Those living in areas of least socioeconomic deprivation appear to be at greatest risk. The reasons for this seemingly paradoxical finding merit further research. In conducting a psychosocial assessment of individuals who have self-harmed, clinicians should be aware of characteristics which increase risk of subsequent suicide, such as male gender, older age, method of self-harm, and socioeconomic circumstances. However, it is also important to recognise the findings of other studies which show that individual factors have poor utility when evaluating the risk of suicide. This underscores the need for effective clinical management to include both a comprehensive assessment of the patients' mental state, needs, and risks, together with implementation of risk reduction strategies, including safety planning, for all patients.

Introduction

It has been estimated that every year there are approximately 200 000 presentations to emergency departments in hospitals across England following acts of non-fatal self-harm.[1,2] Self-harm is associated with increased mortality, especially by suicide.[3] Approximately 50% of individuals who die by suicide have a history of self-harm,[4] hospital presentation for self-harm often occurring shortly before suicide.[5]

Risk of suicide may vary between patients who present to clinical services after self-harm. Certain methods of self-harm with high potential lethality may be associated with a particularly high risk of subsequent suicide. Studies have shown that, relative to patients who self-harm by poisoning, suicide risk is higher in patients whose self-harm involves attempted hanging or asphyxiation,[6–9] self-drowning,[7] self-injury using firearm,[10] and carbon monoxide poisoning.[8] Presentation to clinical services after self-cutting has been associated with a higher risk of suicide in some[6,7,9] but not all studies.[10] Data from the Multicentre Study of Self-harm in England[9] showed that traffic-related self-injury in the last presentation to hospital was associated with higher suicide risk relative to self-poisoning. We are not aware of other reports on the risk of suicide following traffic-related intentional self-injury.

The time closer to discharge from hospital after an episode of self-harm has been shown as a period of high suicide risk. Hawton and colleagues[11] showed that 201 (39%) of 513 suicides in their study occurred in the first year after first hospital attendance, 149 (74%) of these occurring within the first 6 months. In another study,[12] the risk of all-cause mortality was highest during the first month after discharge from hospital following admission for self-harm, although cause-specific mortality was not reported. Understanding how risk of suicide varies by time has important implications for the timing of post-discharge care.

Repetition of self-harm is common and may convey greater risk of suicide.[13,14] In most studies of suicide risk after self-harm the analyses have been based on a single (index) episode, usually the first recorded hospital presentation for self-harm[6–8,10] or the last recorded episode.[9] However, with repetition of self-harm the methods tend to change between episodes.[15] Other risk factors, such as level of socioeconomic deprivation, marital status, and level of education, may also vary between presentations;

these can be better captured by using presentations to hospital as the unit for analysis.

Socioeconomic position has been linked to self-harm and suicide. Numerous studies have shown that socioeconomic disadvantage is positively related to both self-harm and suicide.[16] However, to the best of our knowledge, there are no data to date on how socioeconomic variation may influence the risk of suicide in individuals who self-harm.

We aimed to examine the short-term and long-term incidence of suicide in people presenting to hospital for non-fatal self-harm, and compare the risk of suicide according to method of self-harm, area-level sociodemographic deprivation, and repetition of self-harm, with a focus on the implications of these factors for clinical practice.

Methods

Study design and participants

In this ongoing Multicentre Study of Self-harm in England, the study population consists of individuals aged at least 15 years who had attended the emergency department of five general hospitals (one in Oxford, three in Manchester, and one in Derby) after non-fatal self-harm between Jan 1, 2000, and Dec 31, 2013. Information on demographic and clinical characteristics were collected through completion of psychosocial assessments (of the patient's mental state, risks and needs) by specialist psychiatric clinicians in the general hospital. Less complete data were extracted by trained staff from emergency department electronic databases for patients who did not receive a psychosocial assessment. Clinical staff received induction training to ensure consistency in data collection.

If an individual died as a direct result of the self-harm act, they were removed from the analysis, as these were no longer self-harm acts, but suicides. Mortality follow-up was up to Dec 31, 2015, resulting in up to 16 years of follow-up. We excluded observations if patients had missing information on gender, age, or mortality.

All three research sites covering the five general hospitals have approvals to collect data on self-harm for their local monitoring systems of self-harm and for multicentre projects and separate agreement with NHS Digital to carry out the mortality linkage with respect to their cohort. The three monitoring systems are fully compliant with the Data Protection Act (1998) and have approval under Section 251 of the National Health Service Act (2006) to collect patient-identifiable information without explicit patient consent.

Procedures

Self-harm refers to any act of intentional self-poisoning or self-injury, irrespective of the nature of the motivation including degree of suicidal intent.[17] Self-poisoning includes the intentional ingestion of any drug in an amount that is more than that prescribed, or the ingestion of substances not intended for ingestion, overdoses of recreational drugs, and severe alcohol intoxication, where clinical staff consider this to be an act of intentional self-harm. Self-injury is defined as any injury that has been intentionally self-inflicted. We distinguished between episodes which involved self-poisoning alone, self-injury alone, or both self-injury and self-poisoning. We further divided self-injury into specific methods: self-cutting or stabbing, jumping from heights, hanging or asphyxiation, drowning, gunshot, traffic-related injuries (by motor vehicles or railways), and other methods. For history of self-harm, patients were assigned a positive status if they had a previous recorded presentation to hospital in the study database (applies to second and subsequent episodes), reported previous self-harm during their psychosocial assessment, or were identified with a previous self-harm episode through the hospital electronic records (data collectors had access to hospital electronic records).

We used the English Index of Multiple Deprivation (IMD) as an official measure of socioeconomic deprivation of small geographical areas in England. IMD combines scoring from several domains, including income and employment, health and disability, education, skills and training, barriers to housing and services, living environment, and crime, to derive a relative deprivation score. The 32 844 such areas across England are ranked from 1 (most deprived) to 32 844 (least deprived). Oxford, Manchester, and Derby have distinctly different profiles in terms of the extent of deprivation. Based on the 2015 IMD,[18] Manchester was ranked 5 (worst), Derby 55, and Oxford 166. The IMD score was derived from the patient's postal address at a given presentation to hospital, using GeoConvert. The IMD of patients with no valid address was recorded as missing. We classified the cohort into six categories based on national IMD quintiles: first category for individuals with an IMD score range of up to 8·49 (least deprived), second for 8·5–13·79, third for 13·8–21·35, fourth for 21·36–34·17, fifth for 34·18 or more (most deprived), and sixth for individuals with no valid IMD score.

For **GeoConvert** see http://geoconvert.mimas.ac.uk/help/faq.html

For the **national IMD quintiles** see https://tools.npeu.ox.ac.uk/imd/

Patients who were identified as having previous or current psychiatric treatment in a specific episode through either their psychosocial assessment or their hospital electronic records were assigned a positive status for psychiatric care in this and all subsequent episodes. A negative status was assigned to patients who were identified as having no psychiatric treatment through both their psychosocial assessment and the hospital records. Otherwise, this item was considered as not known.

Mortality and cause of death were ascertained through linkage with data from the UK Office for National Statistics (through NHS Digital). Deaths are coded according to ICD-10. ICD-10 codes of underlying cause of death which indicated intentional self-harm (codes X60–X84) or undetermined intent (codes Y10–Y34) were defined as deaths

by suicide, in keeping with current practice in UK suicide research and policy.[19] These deaths are subsequently referred to as suicides.

Outcomes

The main outcomes of this study were suicide after presentation to hospital for non-fatal self-harm, and time-to-death by suicide from first recorded hospital presentation for non-fatal self-harm.

Statistical analysis

We estimated the incidence of suicide per 100 000 person-years in the study cohort, using each person's first recorded presentation to hospital (index episode) only, and the 95% CI. Incidence of suicide was estimated from the number of suicides (numerator) divided by the number of patients presenting to hospital (population at risk) each year. The CIs were estimated using the quadratic approximation to the Poisson log likelihood for the log-rate parameter. Time-to-event after hospital discharge was estimated by length of follow-up from index episode and categorised into single years of follow-up (with years 14–16 combined owing to small numbers). For patients who died within a year of the index episode, time-to-event was further categorised into first month, second month, third month, 4–6 months, and 6–12 months. The time periods selected were based on previous research.[6,8,9,20]

National annual incidence of suicide and CIs were estimated from the number of deaths by suicide in England each year between 2000 and 2013 (numerator),[21] divided by the estimated population in England in each year during 2000–2013 (denominator)[22] to derive the incidence of suicide per 100 000 person-years. These data were available from the UK Office for National Statistics. CIs were estimated with the Poisson exact method. Analyses were run by gender and age group (15–24 years, 25–34 years 35–54 years, and at least 55 years). We also calculated the ratio of the total number of observed deaths in the 12 months after discharge from hospital to the number expected from gender and age-specific rates of suicide in England during the study period. In a sensitivity analysis, we restricted the sample to presentations that occurred between Jan 1, 2003, and Dec 31, 2013, to investigate the possibility of falsely assigning an episode as the (first) index episode (in case a patient had a self-harm episode before study entry).

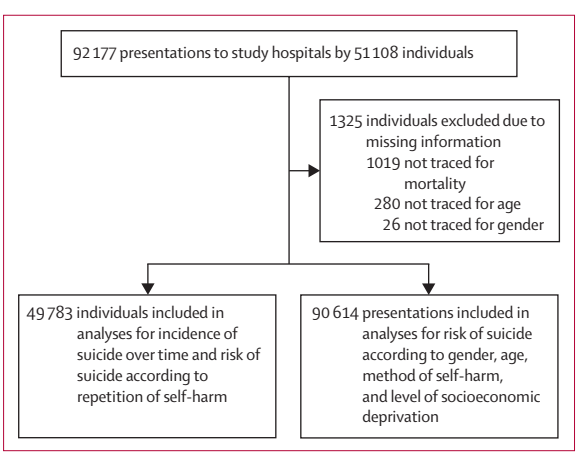

Figure 1: **Study cohort selection process**

Pearson's χ^2 was used to assess differences in the proportion of patients who died by self-injury and self-poisoning in relation to the method they used in their last presentation to hospital for non-fatal self-harm.

Three separate mixed-effect logit regression models were run to examine the associations between three variables of interest: (1) overall method of non-fatal self-harm, (2) specific method of non-fatal self-injury, (3) IMD and subsequent suicide. All episodes of self-harm were used in these regression analyses with suicide as the dependent variable and random intercepts at patient level to account for clustering of episodes in patients.[23] Unstructured covariance of multiple episodes per patient was specified. Postestimation intraclass correlation coefficients were used to estimate the amount of variation accounted for by the latent variable (patient). Likelihood ratio tests indicated that clustering of patients in hospitals was not required. Gender, age (in years), previous self-harm, psychiatric treatment, and hospital were included in the regressions as covariates unless otherwise specified. These covariates were selected a priori as they have been shown to affect suicide risk and were associated with the exposure variables of interest.[24] In a sensitivity analysis, we excluded patients from the fully adjusted models where their psychiatric treatment status was unknown, because this variable was missing in 20% of self-harm episodes. In the regression model with specific method of self-injury as the variable of interest, we excluded the data on presentations which involved both self-injury and self-poisoning to test if the specific method of injury in itself was related to the outcome. We subsequently conducted a sensitivity analysis whereby we also included episodes involving both self-injury and self-poisoning in order to examine how this combination relates to suicide. We also re-ran the analysis using penalised maximum likelihood regression to explore a possible sparse data bias. Finally, we re-ran the models also adjusting for the year of presentation to hospital.

A logistic regression model (done at patient level) was used to estimate the likelihood of subsequent suicide in patients with single versus multiple self-harm episodes, adjusting for relevant confounders: gender, age (in years), previous self-harm, psychiatric treatment, and hospital. Statistical analyses were done using Stata (version 14.1; StataCorp, College Station, TX, USA).

Role of the funding source

The views expressed are those of the authors and not necessarily those of the UK Department of Health and

Social Care. The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

Between Jan 1, 2000, and Dec 31, 2013, there were 92 177 presentations to the study hospitals by 51 108 individuals. 1325 patients involved in 1563 self-harm episodes were excluded from the study because they had missing information on gender, age, or mortality. The resulting study sample consisted of 90 614 hospital presentations by 49 783 individuals (figure 1), 28 560 of whom were women (table 1). Patients presented to the emergency department for self-harm between once and 239 times during 2000–13: 36 624 (73·6%) presented once. 72 108 (80%) presentations involved an act of self-poisoning, while 22 445 (25%) involved self-injury. Self-poisoning alone was slightly more common in women than in men. Self-poisoning alone was also more common with increasing age group.

Overall, 4058 patients died, 703 (17·3%) by suicide. 456 (64·9%) of these 703 suicides occurred by self-injury. The main method of self-injury was by hanging or asphyxiation (288 [63·2%] of 456), other self-injury deaths involved traffic-related injuries (29 [6·4%]), jumping from a high place (27 [5·9%]), drowning (24 [5·3%]), and use of a sharp object (20 [4·4%]). The remaining 68 (14·9%) patients died by other means of injury, including firearm, smoke and flames, and unspecified means of injury. Of the 247 suicides by self-poisoning, commonly used substances included psychotropic drugs or sedatives (68 [27·5%] of 247), narcotics or psychodysleptics (56 [22·7%]), analgesics (22 [8·9%]), and unspecified substances (71 [28·7%]). 126 (77·3%) of 163 patients whose last episode had involved self-injury (alone) also used self-injury when they died by suicide. 38 (77·5%) of 49 patients whose last episode had involved self-injury and self-poisoning also used self-injury when they died by suicide, whereas 292 (59·2%) of 491 patients whose last presentation to hospital had been due to self-poisoning alone switched to self-injury when they died by suicide (χ^2=30·8, degrees of freedom=2, p<0·0001; appendix p 1).

The overall incidence of suicide was 163·1 (95% CI 151·5–175·6) per 100 000 person-years, and 260·0 (237·4–284·8) per 100 000 person-years in men and 94·6 (83·3–107·4) per 100 000 person-years in women. The incidence of suicide in the first 12 months following the index presentation to hospital for self-harm was 55·5 times (95% CI 49·2–62·8) higher than expected in the general population in England (2000–13)—53·2 times higher in men and 61·7 times higher in women. The highest inflation in 12-month suicide rates relative to the general population was observed in adults aged at least 55 years (table 2). Similar findings were obtained from the sensitivity analysis in which presentations between Jan 1, 2000, and Dec 31, 2002, were excluded (appendix p 5).

Overall, 252 (35·9%) of 703 suicides occurred within a year from the patient's index presentation to hospital. The incidence of suicide was highest in the year following discharge from hospital (511·1 [95% CI 451·7–578·2]

	Men	Women	Total
Age (years)	n=21 223	n=28 560	n=49 783
15–24	6829 (32·2%)	12 654 (44·3%)	19 483 (39·1%)
25–34	5564 (26·2%)	6066 (21·2%)	11 630 (23·4%)
35–54	7176 (33·8%)	8038 (28·1%)	15 214 (30·6%)
≥55	1654 (7·8%)	1802 (6·3%)	3456 (6·9%)
Age at presentation to hospital for self-harm (years)	n=37 319	n=53 295	n=90 614
15–24	9816 (26·3%)	20 230 (38·0%)	30 046 (33·2%)
25–34	9970 (26·7%)	12 434 (23·3%)	22 404 (24·7%)
35–54	14 767 (39·6%)	17 645 (33·1%)	32 412 (35·8%)
≥55	2766 (7·4%)	2986 (5·6%)	5752 (6·3%)
Method of self-harm	n=37 319	n=53 295	n=90 614
Self-poisoning alone	27 300 (73·2%)	40 869 (76·7%)	68 169 (75·2%)
Self-injury alone	8427 (22·6%)	10 079 (18·9%)	18 506 (20·4%)
Self-poisoning and self-injury	1592 (4·3%)	2347 (4·4%)	3939 (4·4%)
History of self-harm	n=37 319	n=53 295	n=90 614
Yes	23 378 (62·6%)	35 613 (66·8%)	58 991 (65·1%)
No	6779 (18·2%)	9097 (17·1%)	14 876 (17·5%)
Unknown	7162 (19·2%)	8585 (16·1%)	15 747 (17·4%)
Psychiatric care	n=37 319	n=53 295	n=90 614
Yes	22 124 (59·3%)	34 086 (64·0%)	56 210 (62·0%)
No	6813 (18·2%)	9255 (17·4%)	16 068 (17·7%)
Unknown	8382 (22·5%)	9954 (18·7%)	18 336 (20·3%)

Data are n (%) by individuals (n=49 783) or episodes (n=90 614). Characteristics of individuals were recorded at study entry, at first presentation to the study hospitals during the study period.

Table 1: **Characteristics of the study population**

	First 12 months after discharge in the study population (incidence; number of suicides)*	General population in England, 2000–13	SMR
Total	511·1 (451·7–578·2); 252	10·5 (10·4–10·6)	55·5 (49·1–62·8)
Men	845·9 (730·0–980·2); 177	16·3 (16·1–16·4)	53·2 (46·0–61·7)
15–24 years	308·55 (201·2–473·2); 21	9·8 (9·5–10·1)	31·5 (20·5–48·3)
25–34 years	797·8 (593·7–1072·1); 44	17·8 (17·5–18·3)	44·8 (33·4–60·2)
35–54 years	1176·4 (948·7–1458·8); 83	20·7 (20·4–21·0)	56·8 (45·8–70·5)
≥55 years	1873·7 (1302·0–2696·2); 29	13·9 (13·7–14·2)	134·8 (93·7–194·0)
Women	264·2 (210·7–331·3); 75	5·1 (5·0–5·1)	61·7 (49·2–77·3)
15–24 years	110·8 (65·6–187·1); 14	2·8 (2·6–2·9)	39·6 (23·4–66·8)
25–34 years	165·5 (89·1–307·6); 10	4·6 (4·4–4·8)	36·0 (19·4–66·9)
35–54 years	362·9 (252·2–522·2); 29	6·2 (6·0–6·3)	58·5 (40·7–84·2)
≥55 years	1282·0 (844·1 -1947·0); 22	5·2 (5·0–5·3)	246·5 (162·4–374·4)

SMR=ratio of the total number of observed deaths in the 12 months after discharge from hospital to the number expected from gender and age-specific rates of suicide in England during the study period. *Incidence of suicide in the first 12 months after discharge from hospital following the first (index) recorded presentation to hospital in the study period.

Table 2: **Incidence of suicide per 100 000 person-years in study population and in the age and gender equivalent general population in England during the study period**

See Online for appendix

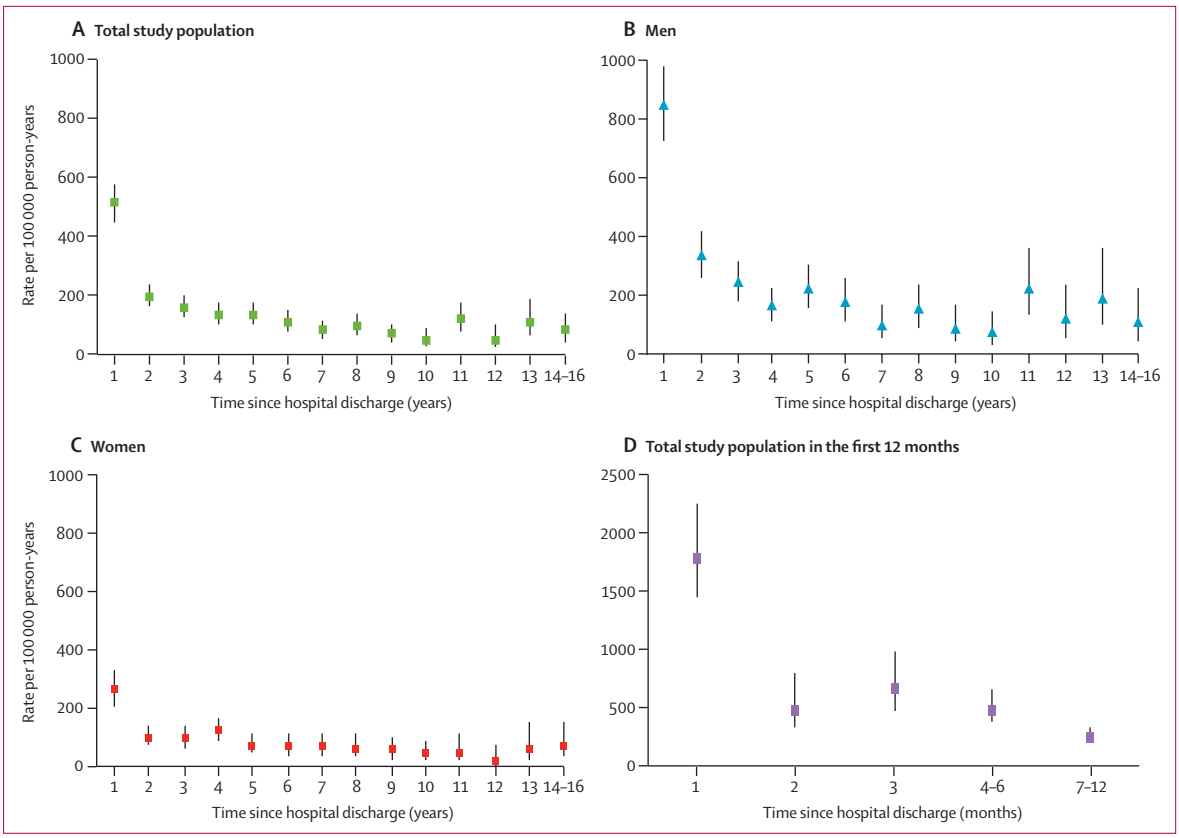

Figure 2: **Incidence of death by suicide by time of follow-up since first hospital presentation for non-fatal self-harm**
Error bars are 95% CIs.

per 100 000 person-years) and then declined markedly, although it remained high relative to the general population for the following 15 years (figure 2A). The pattern was similar for men and women, although the heightened risk earlier on was more pronounced in men (figure 2B and 2C). 74 (29·3%) of the 252 suicides in the first year occurred in the first month, with an incidence of 1787·1 (1423·0–2244·4) per 100 000 person-years (figure 2D).

Patients who presented to hospital for self-harm more than once were more likely to die by suicide than those with a single presentation, including after adjusting for gender, age, previous self-harm, psychiatric treatment, and hospital (2–9 presentations adjusted odds ratio [OR] 1·23 [95% CI 1·04–1·46], p=0·020; at least 10 presentations adjusted OR 1·57 [0·99–2·50], p=0·060).

Based on all presentations to hospital, men were three times more likely than women to die by suicide after self-harm (OR 3·36 [95% CI 2·77–4·08], p<0·0001). Age was positively related to suicide risk in both genders, with a 3% increase in risk for every one-year increase in age at hospital presentation (OR 1·03 [1·03–1·04], p<0·0001).

Self-injury at hospital presentation for self-harm was associated with a greater risk of subsequent suicide relative to self-poisoning alone, including after adjusting for covariates (gender, age, previous self-harm, psychiatric treatment, and hospital; adjusted OR 1·36 [1·09–1·70], p=0·007; table 3). See appendix (p 2) for the associations between the covariates and suicide. Presentations to hospital involving both self-injury and self-poisoning were associated with a greater risk of suicide relative to both presentations after self-poisoning alone (adjusted OR 2·06 [1·42–2·99], p<0·0001), and presentations after self-injury alone (adjusted OR 1·52 [1·02–2·27], p=0·042).

Relative to self-harm by self-poisoning alone, attempted hanging or asphyxiation (adjusted OR 2·70 [1·53–4·78], p=0·001) and traffic-related acts of self-injury (adjusted OR 2·99 [1·17–7·65], p=0·022) were associated with greater risk of suicide. There was no evidence of greater risk of suicide in patients who presented to hospital after self-cutting (adjusted OR 1·21 [0·93–1·56], p=0·20). These models were adjusted for covariates (gender, age, previous self-harm, psychiatric treatment, and hospital) and were based on a sub-sample of 86 675 presentations that excluded 3939 (4%) episodes involving self-injury and self-poisoning. The intraclass correlation coefficient was 0·63 (95% CI 0·57–0·69), indicating strong correlation between episodes within the patient cluster variable.

A subsequent analysis including presentations that involved both self-poisoning and self-injury produced consistent results with respect to self-injury by hanging and asphyxiation and also self-harm by traffic-related

injuries, but showed that self-cutting was associated with increased likelihood of death by suicide (adjusted OR 1·36 [1·08–1·71], p=0·010), which suggests that self-cutting in combination with self-poisoning could signal increased suicide risk.

In terms of socioeconomic deprivation, 38 518 (42·5%) patients were living in areas in the most deprived category at the time of their self-harm episodes (38 518 episodes; table 4). Compared with those patients living in the most deprived areas, those who lived in the least deprived areas (first national IMD quintile) had a greater risk of dying by suicide (adjusted OR 1·76 [1·32–2·34], p<0·0001) after adjusting for gender, age, previous self-harm, and psychiatric treatment, as did those living in the second least deprived areas (adjusted OR 1·64 [1·20–2·25], p=0·002). This greater risk was not found for individuals living in areas categorised into the third and fourth quintile groups, and for individuals with no information on IMD, who most likely had no fixed address at their hospital attendance (intraclass correlation coefficient 0·63 [0·58–0·69]). Furthermore, in 3538 (32·8%) of the 10 803 presentations by individuals who lived in the least deprived areas, patients were known to be in psychiatric care (either inpatients or outpatient care at time of hospital presentation for self-harm). By comparison, 7596 (19·7%) of the 38518 presentations by individuals who lived in the most deprived areas were by patients known to be in psychiatric care.

Results from the sensitivity analysis in which episodes with missing information on psychiatric treatment were excluded from the regression models were consistent with those of the main analysis. Results from further adjustment of all models for the year of hospital presentation for self-harm (appendix pp 3–4) and from the re-analysis using penalised maximum likelihood regression were also consistent with those of the main analysis (appendix pp 6–7).

	Number of presentations; number of suicides	Crude OR (95% CI)	p value	Adjusted OR (95% CI)*	p value
Self-harm method at hospital presentation (n=90 614)					
Self-poisoning alone	68 169; 491	1 (ref)	..	1 (ref)	..
Self-injury alone	18 506; 163	1·39 (1·12–1·71)	0·003	1·36 (1·09–1·70)	0·007
Self-poisoning and self-injury	3939; 49	2·01 (1·41–2·86)	<0·0001	2·06 (1·42–2·99)	<0·0001
Specific method of self-injury (n=86 675)†					
Self-poisoning	68 169; 491	1 (ref)	..	1 (ref)	..
Self-cutting or stabbing	14 114; 108	1·18 (0·92–1·51)	0·18	1·21 (0·93–1·56)	0·20
Jump from heights	533; 6	1·64 (0·64–4·22)	0·31	1·34 (0·50–3·59)	0·60
Hanging or asphyxiation	1142; 22	3·27 (1·90–5·63)	<0·0001	2·70 (1·53–4·78)	0·001
Drowning	156; 2	1·74 (0·33–9·18)	0·51	1·19 (0·21–6·75)	0·84
Gunshot	24; 1	8·74 (0·56–137·36)	0·12	5·16 (0·31–86·65)	0·30
Traffic-related self-injury	375; 8	3·63 (1·48–8·92)	0·005	2·99 (1·17–7·65)	0·02
Other self-injury	2162; 16	1·11 (0·63–1·97)	0·72	0·96 (0·52–1·74)	0·90

All presentations were during 2000–13, with follow-up for mortality through 2015. OR=odds ratio. *Adjusted for gender, age, previous self-harm, psychiatric treatment, and hospital. †Excluding 3939 episodes involving self-injury and self-poisoning.

Table 3: **Association of self-harm method with death by suicide in study population**

	IMD score range	Number of presentations; number of suicides	Crude OR (95% CI)	p value	Adjusted OR (95% CI)*	p value
5	≥34·18	38 518 (42·5%); 260	1 (ref)	..	1 (ref)	..
4	21·36–34·17	16 040 (17·7%); 117	1·13 (0·87–1·46)	0·35	1·18 (0·90–1·55)	0·23
3	13·8–21·35	11 673 (12·9%); 93	1·18 (0·90–1·57)	0·24	1·22 (0·90–1·64)	0·20
2	8·5–13·79	8 395 (9·3%); 85	1·56 (1·16–2·09)	0·003	1·64 (1·20–2·25)	0·002
1	≤8·49	10 803 (11·9%); 112	1·65 (1·26–2·16)	<0·0001	1·76 (1·32–2·34)	<0·0001
6	NA	5185 (5·7%); 36	1·03 (0·69–1·53)	0·90	0·92 (0·61–1·40)	0·70

The study cohort is classified into six groups, defined by their IMD score range. Group 1 is considered least deprived, group 5 is considered most deprived, and group 6 has no fixed or valid address. Number of presentations is described as a percentage of the total (n=90 614). IMD=Index of Multiple Deprivation. *Adjusted for gender, age, previous self-harm, and psychiatric treatment.

Table 4: **Association of IMD with death by suicide in study population**

Discussion

The highest incidence of suicide following self-harm was observed in the 12 months after discharge from hospital, when it rose to more than 50 times the rate of suicide in the general population in England. After the first 12 months, rates of suicide declined but remained markedly higher than the general population throughout the follow-up, especially in patients at least 55 years of age at study entry. Previous research[8,9,25] has shown that the 12-month risk of suicide is 37–131 times greater in patients who present to clinical services for self-harm than that expected in the general population. We have also shown that the incidence of suicide is extremely high in the month following discharge from hospital.

Hospital presentations that involved both self-injury and self-poisoning were associated with the highest likelihood of subsequent suicide, followed by presentations after self-injury alone. Our finding that attempted hanging or asphyxiation is associated with a greater risk of subsequent suicide compared with self-poisoning is consistent with results of previous studies.[6–9,20] However, our finding that non-fatal traffic-related injuries are associated with almost three times the risk of suicide compared with self-poisoning alone has not been shown before, apart from in an earlier report[9] using 2000–07 data from the same Multicentre Study of Self-harm in England. Although a less commonly encountered method of non-fatal self-injury, the results highlight a group of patients with a risk of suicide which is comparable to that of patients presenting to hospital after hanging or asphyxiation.

Presentations following self-cutting or stabbing were associated with heightened suicide risk only after including patients who also self-poisoned in the same episode. Some,[6,7,9] but not all[10,20] studies have found an increase in suicide risk after self-cutting relative to self-poisoning. Certain types of self-cutting or the involvement of other methods, as well as differences in data analysis,

might explain these inconsistencies. Interestingly, Haw and colleagues[26] found that suicide intent scores of patients who presented to hospital after self-injury and self-poisoning in the same episode were higher than those of patients who presented with either self-injury or self-poisoning alone. Nevertheless, we have previously shown that self-cutting in the last presentation to hospital was associated with increased suicide risk relative to self-poisoning,[9] a finding which we observed again in this study, also after excluding episodes that involved both self-poisoning and self-injury. These findings underscore the importance of providing a comprehensive psychosocial assessment, including of risk of suicide, for patients who present to hospital after self-cutting or stabbing as well as those who present following other methods of self-harm. This needs emphasising because self-cutting is often associated with discharge from hospital without a psychosocial assessment being conducted.[27]

We further showed that patients living in areas considered least socioeconomically deprived were more likely to die by suicide following presentation to hospital for self-harm relative to patients from highly deprived areas. This finding seems to contrast with a large body of research showing that socioeconomic deprivation is positively related to risk of self-harm and suicide in the general population.[16] Indeed, 42% of our study cohort were living in neighbourhoods ranked nationally as most deprived socioeconomically. Although patients from the least socioeconomically deprived areas might be more likely to receive a psychosocial assessment after hospital presentation for self-harm,[28] and a reduction in adverse outcomes might be expected after this psychosocial assessment, engagement in self-harm by individuals from areas with low deprivation (where there may be greater access to protective factors such as health care and housing) could point to other factors which affect the risk of self-harm and suicide in this population, such as severe psychiatric or substance use disorder. Indeed, around 30% of patients from the two least deprived areas in this study were in current psychiatric treatment (inpatient or outpatient) at the time of hospital presentation, compared with around 20% of patients living in the most deprived area, although this might also reflect access to care rather than illness severity. Martin and colleagues[29] examined cause-specific mortality in patients with schizophrenia and bipolar disorder relative to the general population and, consistent with our findings, showed that in these patients the incidence of suicide was highest in those residing in the least deprived areas (but that their risk of death by other causes was lower relative to the patients living in the most deprived areas). Further examination of the patients' method of self-harm according to level of socioeconomic deprivation in our study showed only small differences, suggesting that this is not an obvious contributing factor. It is also possible that the problems which lead to self-harm and subsequently to death by suicide vary by level of socioeconomic deprivation. Our previous work on problems precipitating presentation to hospital for self-harm identified some differences in problems between subgroups of patients who self-harm,[30] but we did not examine associations with socioeconomic deprivation. In another study, problems which precipitated presentation to hospital for self-harm were found to vary by socioeconomic deprivation, for instance, young men from less socioeconomically deprived areas were more likely to have financial difficulties than those from more deprived areas.[31] This suggests that inconsistencies between area-level and individual-level characteristics could have contributed to our findings. In keeping with this suggestion, Neeleman and Wessely[32] observed that rates of suicide in ethnic minority groups in areas of London were inversely related to local density of ethnic minority populations. This line of research in relation to self-harm merits further work. Information on the socioeconomic circumstances of patients who engage in self-harm could have implications for their treatment needs and prevention.

This study spanned up to 16 years of follow-up and involved a large number of patients, which allowed us to accrue sufficient data on the relatively rare outcome of suicide and to investigate the risks associated with specific and less commonly observed methods of non-fatal self-harm. Furthermore, our approach to data analysis enabled us to use the wealth of available data by including all hospital presentations for self-harm rather than a single (index) episode, and enabled us to account for variations in methods used by patients who present to hospital more than once. This analytical approach also allowed further reduction of missing data on two important covariates (history of self-harm and psychiatric treatment). This was done by using data collected at any given time-point during the observation period to inform these variables. However, it was not possible to eliminate missing data entirely for patients who had self-harmed once during the observation period and did not receive a psychosocial assessment, or where information could not be extracted from hospital electronic records, although this issue was addressed through a sensitivity analysis.

One limitation of this study is that the data were collected from three research sites in three cities, so generalisability from these data to the population of England as a whole should be treated with caution. Nevertheless, the study population is socioeconomically diverse (reflected by the IMD ranking of the three cities involved in the study) and information on IMD is based on the scoring system that was available closest to the time of presentation to hospital. The IMD scoring system changes to some extent every few years, meaning that some small areas might have changed their rating between different episodes of the same person. However, this risk is mitigated in our episode-based analytical approach that accounted for this variation. Sparse data bias might have also affected the study, however the results of the penalised maximum likelihood regression

indicated little effect of this bias on the results. It should be noted that our measure of socioeconomic deprivation is based on the characteristics of the locality where an individual lives, which may differ from their personal characteristics. Finally, at the time of this analysis, information on mortality was not available beyond 2015 owing to delays in obtaining linked data following the enactment of the recent General Data Protection Regulation.[33]

Findings from this and previous reports show that individuals who present to clinical services for self-harm are at considerable risk of subsequent death by suicide. Presentation to hospital for self-harm offers an opportunity for intervention. A comprehensive assessment of the patients' mental state, needs, and risks, as specified in national guidance,[2,34] is essential to devise an effective plan for their follow-up care. The peak in risk of suicide which follows immediately after discharge from hospital underscores the need for provision of early and effective follow-up care.

Awareness of characteristics which increase the risk of subsequent suicide, including male gender, older age, method of self-harm, and area of residence can assist in understanding risk of suicide as part of a comprehensive assessment after an episode of self-harm. However, previous studies[35] have shown that individual factors have poor utility when evaluating the risk of suicide at the time of hospital presentation for self-harm. This highlights the importance of comprehensive assessment followed by risk reduction strategies, including safety planning,[36] for all patients.

Contributors

KH and GG were responsible for study conception and design, and interpretation of the results. GG was responsible for data analysis. KH, DC, LB, FB, NK, CC, JN, and KW acquired the data. AT contributed substantially to the development of the analytic strategy and interpretations of the manuscript. BF contributed to the interpretation of the paper. GG drafted the report, which all authors critically revised for intellectual content. All authors approved the final report and are accountable for all aspects of this work. KH supervised the study and is the guarantor.

Declaration of interests

KH and NK sit on the National Suicide Prevention Strategy Advisory Group of the UK Department of Health and Social Care. KH has sat on a committee related to developing clinical and public health guidelines for the National Institute for Health and Care Excellence. NK reports grants from the UK Department of Health and Social Care, the Healthcare Quality Improvement Partnership, and the National Institute for Health Research, outside the submitted work. He has chaired or sat on a number of committees related to developing clinical and public health guidelines for the National Institute for Health and Care Excellence. KH, NK, KW, GG, DC, LB, FB, CC, JN, and BF report grants from the UK Department of Health and Social Care, during the conduct of the study. AT declares no competing interests.

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