Mortality in children and adolescents who present to hospital following non-fatal self-harm: an observational cohort study based on the Multicentre Study of Self-harm in England

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Abstract

Background

Self-harm and suicide in children and adolescents are both growing problems, with self-harm associated with a significant risk of subsequent death, particularly suicide. Long-term follow-up studies are necessary to examine the extent and nature of this association.

Method

We used data from the Multicentre Study of Self-harm in England to investigate deaths following self-harm to the end of 2015 in 9173 10-18 year-olds who had 13,175 self-harm presentations to the emergency departments of the study hospitals between 2000 and 2013. Deaths were identified through the Office for National Statistics via linkage with data from NHS Digital. Risk factors were examined using survival models.

Findings

By the end of the follow-up period 124 (1%) of the cohort (N=9173) had died. Fifty-five (44%) of the deaths were suicides, 27 (22%) accidental and 42 (34%) due to other causes. Most suicide deaths involved self-injury (n=45, 82%). There was often a method switch from self-harm to suicide, especially from self-poisoning to hanging or asphyxiation. The incidence of suicide in the 12 months after self-harm was over 30 times the rate expected in the general population of 10-18 year-olds in England (SMR 31·0, 95% CI 18·2-30·9). The majority of the suicides (n=42, 77%) occurred after age 18 years and the incidence rate remained similar over more than 10 years follow-up. Increased suicide risk was associated with male gender, being an older teenager, use of self-injury (especially hanging/asphyxiation) for self-harm and

repeating self-harm. Accidental poisoning deaths involving substance misuse were especially frequent in males.

Interpretation

Children and adolescents who self-harm have a considerable risk of future suicide, especially males, older teenagers, and those who repeat self-harm. Risk may persist over several years. Switching of method from self-poisoning in self-harm to self-injury, especially hanging or asphyxiation, for suicide is common. Self-harm is also associated with risk of death from accidental poisoning, particularly involving drugs of abuse, especially in males.

Funding

UK Department of Health and Social Care.

Key words: children and adolescents; self-harm; suicide; accidents; risk factors

Research in context

Evidence before this study

Non-fatal self-harm is common in children and adolescents, especially females, and appears to be increasing in several countries, particularly in younger females. Given the recognised association between self-harm in general and subsequent deaths, especially by suicide, and the limited number of published studies on deaths after self-harm in this age-group, it is important to investigate the long-term mortality in children and adolescents who self-harm. We searched PubMed up to June 27th, 2019, with the terms “self-harm”, “self-injury”, “self-poisoning”, “suicide attempt”, “attempted suicide”, “suicide”, “method”, “children”, “adolescents”, “young”, “youth”. We did not apply any language restrictions.

There have been few studies focussed on the longer-term outcome following self-harm in children and adolescents. These have shown that self-harm is associated with excess subsequent mortality, especially by suicide and in the first year following presentation for self-harm, and also by accidents. Suicide risk may be associated with certain characteristics of individuals and also with some specific methods of self-harm, especially violent methods, including possibly self-cutting. However, we concluded that studies of outcome following self-harm in children and adolescents have often focussed on the short-term. Also, because deaths, including by suicide are relatively rare, long-term follow-up studies of large patient cohorts are essential to be able to study a significant number of individuals with the outcome of interest.

Added value of this study

The results of our study confirmed the findings of some other studies in showing that children and adolescents who self-harm have a considerable risk of future suicide,

especially males, older teenagers, and those who repeat self-harm. Our study indicated that increased risk may persist over several years. Also, suicide risk appears to differ according to method of self-harm. Children and adolescents who presented to hospital after self-injury alone in our study were twice as likely to die by suicide than those who presented after self-poisoning alone, and those who attempted hanging or suffocation were approximately five times more likely to die by suicide than their self-poisoning peers, although this finding was based on a small number of children. Self-cutting was associated with a risk of suicide equivalent to that of self-poisoning. Our results also show that there is commonly switching of method from self-harm to suicide, especially from self-poisoning to self-injury, particularly hanging or asphyxiation. Self-harm is also associated with long-term risk of death from accidental poisoning, particularly involving drugs of abuse, especially in males.

Implications of all the available evidence

The results emphasise the importance of effective management following self-harm in children and adolescents in order that vulnerability to future suicide and other causes of death might be reduced. This includes the need for careful psychosocial assessment to identify factors that might indicate particular risk and to plan appropriate aftercare. This should incorporate assessment for possible substance misuse. It is important that clinicians do not regard self-cutting as indicating lower risk of future suicide than other methods of self-harm. There is also clearly a need to identify preventive interventions that might reduce the incidence of self-harm in children and adolescents.

Introduction

Self-harm (intentional non-fatal self-poisoning or self-injury) is very common in children and adolescents, especially females, in both community and hospital populations.[1-6] In the UK, incidence rates of presentation to clinical services following self-harm appear to have increased in females in recent years, with a rise of 68% being reported in 13-16 year-old females between 2011 and 2014.[7]

Self-harm is the most important risk factor for subsequent suicide in young people.[8,9] Suicide is the second most common cause of death in 15-24 year-olds worldwide.[10] and the leading cause of death in young people in the UK, where rates of suicide have increased in 10-19 year-olds of both genders in recent years.[11] At least half of all young people who die by suicide have previously self-harmed, with almost three-quarters of females having done so.[12] In a recent large follow-up study based on English data on hospital presentations, together with presentations to primary care, the risk of subsequent suicide in 13-19 year-olds was approximately 17 times the risk in other adolescents.[7] In another follow-up study half of all deaths in 10-18 year-olds who self-harmed were due to suicide.[13] In the USA, adolescents who self-harmed were found to have a 46 times greater risk of suicide in the subsequent year than adolescents in the general population, which was greater than the relative risk in young adults.[14] In a Canadian study of adolescents who had self-poisoned, the risk was 32 times the risk in population-based controls.[15]

Self-harm is also associated with risk of subsequent death from accidents, with a quarter of deaths in one study from England being recorded as accidents[13] and a six-fold greater risk of death by accidents being recorded in another.[7] Increased risk of accidental deaths was also found following self-poisoning in Canadian adolescents.[15]

Furthermore, young people who self-harm have an increased risk of dying due to substance misuse.[7]

Identification of those most at risk of suicide following self-harm is clearly very important. There has been a limited number of mortality follow-up studies of young people who have presented to hospital following self-harm in which risk factors have been examined. In 15-24 year-olds who self-harmed in England risk of suicide was associated with male gender, previous self-harm (i.e. having repeated self-harm), having a history of psychiatric treatment, and higher suicidal intent associated with self-harm. [8] There were similar findings in a follow-up study of 10-18 year-olds in England, with an additional somewhat surprising risk factor being identified, namely use of self-cutting as a method of self-harm.[13] However, this study was limited by a relatively low number of suicides (N=25). Another finding from this study was that the method used for suicide was often different to that used for self-harm.

The aim of the present study was to investigate the risk of death, with a specific focus on suicide and accidental death, in children and adolescents presenting to hospital following non-fatal self-harm using a large cohort of 10-18 year-olds from the Multicentre Study of Self-harm in England.[16,17] Specifically, we have studied risk factors associated with subsequent death by suicide, the timing of deaths in relation to self-harm, methods used for suicide compared to those used for non-fatal self-harm, and risk of death by accident.

Methods

Study design and population

This prospective cohort study is based on data from the Multicentre Study of Self-Harm in England.[16] This is an ongoing project in which data are collected on all presentations following self-harm to the emergency department in five general hospitals in Oxford (one hospital), Manchester (three hospitals) and Derby (one hospital). Demographic and clinical data are collected through completion of psychosocial assessments by specialist psychiatric clinicians (also by emergency department staff in Manchester). Patients who present to hospital but do not receive a psychosocial assessment are identified through scrutiny of emergency department electronic databases by trained staff, who extract less complete data from case records. Information is collected by clinicians using pen and paper (Oxford and Manchester), or electronic (Derby and Manchester since mid-2008) forms.

Self-harm is defined as intentional non-fatal self-poisoning or self-injury, irrespective of type of motivation including degree of suicidal intent.[18] Self-poisoning includes the intentional ingestion of more than the prescribed amount of any drug, whether or not there is evidence that the act was intended to result in death. This also includes poisoning with non-ingestible substances, overdoses of 'recreational drugs' and severe alcohol intoxication where clinical staff consider such cases to be an act of intentional self-harm. Self-injury is defined as any injury that has been intentionally self-inflicted.

The study sample included all individuals aged 10 to 18 years in the Multicentre dataset who presented to the study hospitals between 1st January 2000 and 31st December 2013. Information on deaths was obtained up to 31st December 2015.

Therefore all individuals in this study were followed-up for at least two years, with a maximum follow-up period of 16 years.

We have included adolescents up to and including 18 years in this study. However, we recognise that a contemporary view is that adolescence should be considered as continuing up to age 24 years.[19] In contrast, child and adolescent mental health services, for whom the findings of this study will be particularly relevant, usually define their patient group as age 18 years and younger. We have therefore restricted the upper age limit in this study accordingly.

Mortality linkage

Information on mortality was obtained from NHS Digital, to which the identities of individuals included in the Multicentre Study self-harm database were submitted. Deaths were based on data held by the Office for National Statistics (ONS) taken from civil registration records. The underlying cause of death is derived from the sequence of conditions leading directly to the death as recorded on the death certificate. Deaths are coded in line with the International Statistical Classification of Diseases and Related Health Problems version 10 (ICD-10).

In this study death was defined as suicide where the ICD-10 underlying cause code indicated intentional self-harm (ICD-10 codes X60-X84) or undetermined intent (ICD-10 codes Y10-Y34). This was in line with current practice in UK suicide research and policy where official statistics are used [20,21]. These deaths are subsequently referred to as ‘suicides’. Other causes of death were grouped as follows: accidental death (ICD-10 codes V01-X59), which includes transport accidents (ICD-10 codes V01-V99) and other external causes of accidental injury (ICD-10 codes W00-X59)

including accidental self-poisoning (ICD-10 codes X40-X49), and all other causes including R99 (ill-defined or unspecified cause).

In this report, we excluded the data of individuals who could not be traced by NHS Digital or if they were missing information on gender, age at study entry or at follow-up for mortality. Two percent of individuals were missing information and therefore were excluded from the analysis.

Missing data

Data are near complete for some core variables describing sociodemographic and clinical characteristics, including age, gender and details of the method of self-harm. Percentages of missing data were <5% for these variables due to missing data in hospital records.

Some variables could only be reliably determined for individuals who received a psychosocial assessment (approximately 57%); these include history of previous self-harm, and psychiatric treatment (current and past). However, information on previous self-harm also appeared in hospital records. Accordingly, a patient was considered to have a history of self-harm if they either self-reported previous self-harm or this was documented through hospital records. This enabled us to ascertain previous self-harm status for a further 205 non-assessed patients. However, this variable was missing for 41% of patients.

Basic comparison of patients who received and those who have not received psychosocial assessment at their first (index) presentation to hospital for self-harm showed differences between assessed and non-assessed in terms of gender, age, and self-harm method. The comparison showed that males and patients aged 10-15 years were less likely to receive a psychosocial assessment. Those least likely to

have received an assessment were patients who had self-injured alone while those most likely to be assessed were individuals who presented to hospital after using both self-poisoning and self-injury.

Ethical approval

All three sites of the Multicentre Study of Self-harm in England have approvals to collect data on self-harm for their local monitoring systems of self-harm and for multicentre projects. The monitoring systems in Oxford and Derby have received approval from national health research ethics committees to collect data on self-harm. Self-harm monitoring in Manchester is part of a local clinical audit system ratified by the local research ethics committee. All three monitoring systems are fully compliant with the Data Protection Act (1998) and have approval under Section 251 of the National Health Service (NHS) Act (2006) to collect patient-identifiable information without explicit patient consent. The centres also have ethical approval to release patient details to the Data Linkage and Extract Service from NHS Digital (formerly the Health and Social Care Information Centre) for the retrieval of mortality information on these individuals and with NHS Digital to receive data on their respective cohorts.

Statistical analyses

Cox proportional hazard models were used to quantify the associations between specific patient characteristics and mortality. We report the results in terms of hazard ratios (HR), with 95% confidence intervals (CI). Time-To-Event analyses were based on the patients' first recorded presentation (index episode) to the study hospitals

following non-fatal self-harm. We investigated three outcome variables in three separate models: suicide, accidents, and accidental poisonings. The cox regression models were adjusted for relevant confounders. We accounted for clustering by hospital by fitting models with shared frailty. Proportional hazard assumptions were tested using Schoenfeld residuals and there was no evidence of violation in any of the models (see Table 1S, appendix 1, pp. 1-2). Gender, age (in years), and previous self-harm were selected a priori to be included in the regression models as covariates unless otherwise specified. These covariates have been shown to influence suicide risk and to be associated with methods of self-harm[9] but are not assumed to be on their causal pathway. Accordingly, in the examining the association between gender and suicide risk we included age as a potential confounder because age is strongly related to suicide and also gender patterns in self-harm are strongly related to age. However, although previous self-harm is associated with increased suicide risk it is also likely to be influenced by gender (i.e. repetition of self-harm could be on the gender to suicide causal pathway). Nevertheless, history of self-harm is also likely to be associated with the method of self-harm such that repeaters are more likely or less likely to use specific methods; it is also a factor known to influence suicide risk, hence it is included in the models where methods of self-harm were assessed as risk factors for subsequent suicide.

Kaplan-Meier survival curves were used to examine the probability of survival over time according to gender, age group (10-15 years and 16-18 years) at index self-harm presentation, and method of self-harm. The Log-rank test was used to assess group differences in survival functions.

We calculated the incidence rate of suicide per 100,000 person-years and 95% CIs since *first* presentation to hospital in the study cohort. To assess possible change in

rate of over time, we split the analysis by time period since the index episode during the study period: 1st year after self-harm presentation, 1-2 years after presentation, 2-4 years, 4-10 years, and 10-16 years after presentation.

We also estimated the incidence rate of suicide in England per 100,000 person-years from the number of suicides in 10-18 years in England in 2000-2013[22] and mid-year population estimates for England for this age group.[23] Subsequently, we calculated the ratio of the total number of observed deaths in the 12 months after discharge from hospital to the number expected from the age-specific suicide rates in England during the study period (standardised mortality ratio, or SMR).

The last recorded presentation to hospital was selected as the index episode in the analysis examining change in methods used for self-harm and method of suicide.

Sensitivity analysis

Data in Manchester during 2000-2002 were collected on patients who received a psychosocial assessment only. We ran sensitivity analysis excluding these from the cohort to evaluate the impact of missing data on the effect estimates in models assessing risk factors. We also conducted sensitivity analysis omitting the data during 2000-2009 from two hospitals in Manchester because during this time there was incomplete identification of under 16 year-olds.

The analysis was carried out using Stata 14.1.

Role of the funding source

The Department of Health and Social care had no role in study design, data collection, analysis, and interpretation of data, or in the writing of the report, and in the decision to submit the paper for publication.

Results

Population characteristics

During the 14-year period 1 January 2000 to 31 December 2013, 9303 10-18 year-olds presented to the emergency departments of the study hospitals following self-harm. After excluding 130 individuals (107 of whom could not be traced through the national mortality register and 23 persons were missing information on gender or age) the analytic sample included 9173 individuals (99% of the intended sample) who were involved in 13,175 presentations for self-harm to the study hospitals whilst aged 10-18 years. Taking account of self-harm episodes that occurred in this cohort after age 18 years the total number of presentations was 16,764. The number of self-harm episodes by an individual varied between one and 146; 6452/9173 (70%) had a single episode recorded for them in the study period.

The characteristics of the children and adolescents by gender, age group, and self-harm method at first presentation when aged 10-18 years are shown in Table 1. This also shows the number of self-harm episodes occurring after age 18 years.

(Table 1 about here)

Deaths

Of the 9,173 10-18 year-olds who presented to the study hospitals between 2000 and 2013, 9,025 were known to be alive by the end of 2015 and 124 (1%) had died (24 (<1%) had emigrated). The distribution of gender and age group at the time of first presentation to hospital according to follow-up status is presented in Table 2. In terms of gender, 2% of males (55 of 2345 males) and 1% of females (69 of 6828)

had died by the end of follow-up. The mortality rate was greater in males relative to females [hazard ratio (HR) 2·66, 95% CI 1·57-4·42, p<·0001], also after controlling for age at presentation to hospital [adjusted HR (aHR) 2·49, 95% CI 1·46-4·25, p=0·001].

(Table 2 about her)

Causes of death

In terms of causes of death, 55 (44%) of the 124 deaths were due to suicide, 27 (22%) were accidental deaths (ICD-10 codes V01-X59) and 39 (32%) individuals died by other causes, including natural causes and external non-accidental causes (Table 2). The remaining 3 (2%) persons (1 males and 2 females) had an ICD-10 code R99 which denotes ill-defined or unspecified cause. These individuals were combined with the 'other causes' group.

Age at death by suicide

Of the 55 individuals who died by suicide, 13 died while under 19 years of age, the remainder (N=42, 76%) dying in adulthood. Of those aged 10-15 years at their first presentation in the study period four died by suicide while aged 10-18 years. Of the 44 individuals aged 16-18 years at first presentation, nine died while in this age range and 35 in adulthood, all before they reached 33 years.

Suicide method

Self-injury was the main method of suicide (45/55, 82%). In males, self-injury accounted for 96% of all suicide deaths (25 of 26) while in females it accounted for 69% (20 of 29 suicide deaths)

Hanging/asphyxiation was the most common method of suicide (31 of 55 suicides, 56%). Hanging/asphyxiation accounted for 64% of self-injury-related suicides in males (16/25) and 75% in females (15/20). The next most frequent method of suicide was self-poisoning (N=10, all but one in females).

There were considerable differences in the methods used for suicide compared to those used for self-harm (Table 3). The main change in method was from self-poisoning to self-injury, especially hanging/asphyxiation. Thus, of the 55 children and adolescents who died by suicide, 34 had presented to hospital after using self-poisoning alone, but the vast majority (85%) died by self-injury (29/34 deaths by self-injury), primarily by hanging/asphyxiation.

(Table 3 about here)

Timing of suicide following self-harm

Eight patients whose first presentation to the study hospitals occurred during 2000-2013 died by suicide within the first year after discharge (8/9173, <1%) (incidence rate 87.3, 95% CI 43.7-174.6), including 1/3210 aged 10-15 years and 7/5963 aged 16-18 years. The rate of suicide following first presentation to hospital for self-harm appeared to be maintained over the follow-up period (Figure 1). However, it should be noted that this analysis is based on a relatively small number of individuals (55 deaths by suicide over approximately 16 years of follow-up).

(Figure 1 about here)

The 12-month incidence of suicide in the study cohort was over 30 times the incidence rate expected in the general population of 10-18 year-olds in England during the study period (SMR 31·0, 95% CI 18·2-30·9).

Factors associated with suicide following self-harm

Using the first presentation for self-harm as the index episode, suicide risk was higher in males (Figure 2a), in patients who presented to the hospital for the first time aged 16-18 years (Figure 2b) and in individuals who used self-injury alone as their method of self-harm (Figure 2c). The gender difference in risk of suicide following self-harm in males persisted after adjustment for age at first presentation to hospital for self-harm. The risk of suicide associated with use of self-injury alone also persisted after adjustment for gender, age, and history of self-harm. Use of hanging or asphyxiation at first recorded presentation to hospital for non-fatal self-harm was associated with a greater risk of death by suicide relative to self-poisoning (see Table 4). Self-cutting was also associated with greater risk of suicide than self-poisoning in the unadjusted model but not after adjustment (p=0.05)

(Figures 2a – 2c about here)

Using information on all episodes of self-harm in the cohort, including after age 18 years, of the 55 children and adolescents who died by suicide, 29 (53%) had a single episode before they died by suicide, 15 (27%) presented twice to the ED of the study centres between 2000 and their death, while the remainder 11 (20%) presented between 3 and 146 times prior to death by suicide. The suicide rate was higher in children and adolescents who presented to the ED twice or more relative to those who presented once during the study period (HR 1·94, 95% CI 1·14-3·29, p=0·014). This finding persisted also after adjustment for gender, age at study entry (in years),

and method of self-harm (aHR 1·92, 95% CI 1·13-3·27, p=0·016), and also after further adjustment for a history of self-harm prior to study entry (aHR 1·87, 95%CI 1·10-3·20, p=0·022) (Table 4). However, in this last analysis information on previous self-harm was missing for 41% of patients. Therefore we derived a new variable to identify patients who were known to have more than one episode of self-harm either through the psychosocial assessment or because they presented to the study hospitals more than once in the study period 2000-2013, as a proxy for history of self-harm. Using this method reduced the proportion of patients with missing information to 29%. We re-ran the models using this covariate instead, adjusting for age and gender and being a repeater of self-harm. The conclusions from these models were consistent with the main analysis. For example, in the association between overall method of self-harm and suicide risk, patients who presented with self-injury alone were at 2.15 times higher risk of dying by suicide relative to patients who presented to hospital after self-poisoning (95% CI 1.20-3.85, p=0.01). In the association between specific method of self-injury and suicide risk, patients who presented after attempted hanging or asphyxiation were at 5.00 times higher risk of dying by suicide relative to patients who presented to hospital after self-poisoning (95% CI 1.52-16.77, p=0.008) while patients who self-cut were at 1.83 times higher risk of suicide (95% CI 1.00-3.33, p=0.049).

(Table 4 about here)

The two sensitivity analyses we ran excluding Manchester patients from 2000-2002 because only patients who received a psychosocial assessment were identified and

patients from the same centre for 2000-2009 because of incomplete identification of patients under 16 years during this period did not affect the findings, except for repetition of self-harm as a risk factor, which became non-significant in both analyses (Appendix 1, Tables 2S and 3S, pp. 3-6).

Accidental deaths

Twenty seven individuals received a verdict of death by accident. The incidence rate of accident deaths was more than four times greater in males relative to females (HR 4·38, 95% CI 2·03-9·45, p<0·0001), a difference which persisted after adjusting for age (aHR 4·30, 95% CI 1·98-9·35, p<0·0001).

Of these 27 children and adolescents, 13 (4 females and 9 males) died by accidental poisoning. The death rate by accidental poisoning was approximately seven times greater in males relative to females (OR 6·81, 95% CI 2·09-22·15, p=0·001), including after adjusting for potential confounders as above (aOR 7·05, 95% CI 2·14-23·09, p=0·001). Eleven of 13 died due to poisoning by narcotics and psychodysleptics (hallucinogens) while one died due to exposure to antiepileptic, sedative-hypnotic, anti-parkinsonian and/or psychotropic drugs, and the other due to ingestion of unspecified drugs.

Two sets of sensitivity analyses were run to account for missing data in one site (for details see methods above). The conclusions from the cox regression models to examine risk factors remained unchanged following these analyses (See appendix 1, Tables 4S, pp. 5-6) .

Discussion

Nearly half of the deaths in this study of outcome following hospital presentation for non-fatal self-harm in children and adolescents were due to suicide (44%). This is in keeping with the greatly elevated risk of suicide in young people who self-harm.[7,8] The suicide risk in the first year following self-harm was over thirty times that of young people in the general population. The rate of suicide appeared consistent over 10 years of follow-up. While this finding should be considered with caution because of the relatively small number of suicides, it highlights the importance when assessing suicide risk in young adults of asking about occurrence of self-harm during the teenage years.

Risk of suicide following self-harm was greater in older than younger adolescents, and there was twice the risk in males compared to females, which is consistent with findings from other studies.[14,15] Risk was increased in those whose first presentation for self-harm involved self-injury. In Sweden, risk of future suicide was elevated nearly eightfold in adolescents who had used violent methods of self-harm compared with those who self-poisoned.[24] We previously reported that increased risk of suicide was specifically associated with self-harm involving self-cutting,[13] a finding which was contrary to general clinical opinion but which has also been found in studies of adults who self-harm,[25,26] and in young females.[24] In this study the same association was found, although not statistically significant in the fully adjusted Cox regression model. Certainly self-cutting should not be regarded as indicating low risk.

As we have previously shown,[13] there was a very marked difference in the methods used for non-fatal self-harm and those used for suicide, with a switch from self-poisoning to self-injury, especially hanging/asphyxiation, being the most common

pattern. Overall, 56% of the suicides involved hanging/asphyxiation. Such method switching, which has been noted elsewhere,[15] may reflect an increase in suicidal intent.[27]

A substantial number of deaths in this study received coroners' verdicts of accident (22% if the total). In a study of children and adolescents based on self-harm identified through primary care there was nearly a six-fold excess of deaths due to accidents relative to their peers without a recorded history of self-harm[7] and in a US study the risk following self-poisoning was raised to a similar extent.[15] In our study accident deaths occurred more than four times as frequently in males as females, a ratio similar to that for accidental deaths in young people in the general population.[28] Nearly half of these deaths involved poisoning, mostly with narcotics and hallucinogens. This highlights the high risk of death from drug-related substance misuse in young people who self-harm.[7] In follow-up studies of community cohorts of both Australian and UK adolescents, those who self-harmed in their early teens had a considerable risk of subsequently being diagnosed with substance misuse [29,30] This may reflect general vulnerability, but also that self-harm may be a marker of risk of current or subsequent substance misuse.

Strengths and limitations

The large sample and the long follow-up is a clear strength of this study. There may be some limitation in the extent to which the sample is representative of children and adolescents who present to hospital following self-harm because the data were collected in just three centres, with predominantly urban catchment areas. However, the areas have a wide range of levels of socio-economic deprivation.[17] Being focussed entirely on hospital-presenting self-harm the results cannot be extrapolated

to children and adolescents who self-harm in the community and do not present to hospital, especially as there are big differences in the patterns of self-harm between the two groups, particularly in terms of the methods used for self-harm.[1] However, those who do present to hospital are likely to be more accessible to clinical intervention in terms of provision of both assessment and aftercare.

For individuals who did not receive a psychosocial assessment following self-harm there would have been some missing data, especially for history of previous self-harm and psychiatric treatment, which would have limited the size of the populations available for analyses which included these variables. However, with regard to previous self-harm, we were able to conduct analyses with a reduced amount of missing information by taking account of individuals' repeat presentations during the study period. This did not affect the effect estimates. Also, there were differences between those who did and did not receive an assessment, with assessment occurring more often in females, older adolescents and those who self-poisoned. This may have introduced a selection bias so the results should be interpreted within this limitation. Also, we were unable to assess the possible impact of some potentially relevant confounders, such as drug misuse. Furthermore, although this is a long-term follow-up study of a large cohort, it should be acknowledged that the analysis is based on relatively small number of patients with the outcomes of interest because mortality in general, and suicide in particular, are relatively rare outcomes in this age group. This point is exemplified by the fact that the result for repetition of self-harm as a risk factor for suicide became non-significant in sensitivity analyses with smaller cohort sizes. Finally, at the time of this analysis, information on mortality was not available beyond 2015 due to delays in obtaining linked data following the enactment of the recent General Data Protection Regulation (GDPR).[31]

Conclusions

Children and adolescents who self-harm have an increased risk of subsequent death, especially by suicide and accidents, many deaths in the latter category being related to drug misuse. The level of risk appears to be sustained for several years. The methods used for suicide usually differ from those used for self-harm, with a switch to hanging/asphyxiation being particularly common. Risk of suicide is increased in older compared with younger adolescents, in males and those who repeat self-harm. Self-cutting should not be regarded as indicating lower risk of future suicide compared to other methods and patients using this method of self-harm should be given similar clinical attention to those using other methods.

Some of the implications for future research in this area arising from this study include the need to examine: factors that might influence the pathways between self-harm and suicide, such as the influence of clinical care inputs and life events; the relationship between self-harm method switching and outcome; and the temporal relationship between repeated self-harm and subsequent suicide.

There is clearly a need to identify preventive interventions that may reduce risk of self-harm in children and adolescents, repetition of the behaviour and premature death due to suicide and other preventable causes in the self-harm population. Also, assessment of young people who self-harm should include investigation of possible substance misuse, and referral to treatment agencies where possible.

Contributors

KH and GG were responsible for study conception and design, and interpretation of the results. GG was responsible for data analysis. KH, LB, FB, ET, JN, KW, CC, NK and GG acquired the data. KH 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 declare grants from the National Institute for Health Research. NK also declares funding from the Health Quality Improvement Partnership and that he chairs the National Institute of Health and Care Excellence (NICE) self-harm and NICE depression groups. All other authors declare no competing interests.

KH is a National Institute for Health Research (NIHR) Senior Investigator (Emeritus). The views expressed are those of the authors and not necessarily those of the NHS, the NIHR, or the Department of Health and Social Care.

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Table 1. Number and percent of children and adolescents who presented to hospital for self-harm between 2000 and 2013 and who were followed-up for mortality until the end of 2015, by gender, age and self-harm method

	N (%)		
	Males	**Females**	**Both genders**
Individuals[a]			
10-15 years	593 (25·3)	2,617 (38·3)	3,210 (35·0)
16-18 years	1,752 (74·7)	4,211 (61·7)	5,963 (65·0)
Total	2,345	6,828	9,173
Episodes			
10-15 years	725 (18·5)	3,517 (27·4)	4,242 (25·3)
16-18 years	2,383 (60·7)	6,550 (51·0)	8,933 (53·3)
Total	3,108	10,067	13,175
Over 18 years[b]	815 (20·8)	2,774 (21·6)	3,589 (21·4)
Total	3,923	12,841	16,764
Method of self-harm[a]			
Self-poisoning alone	1,612 (68·7)	5,497 (80·5)	7,109 (77·5)
Self-injury alone	623 (26·6)	992 (14·5)	1,615 (17·6)
Self-poisoning and self-injury	110 (4·7)	339 (5·0)	449 (4·9)
Total	2,345	6,828	9,173

[a]Characteristics at study entry (first presentation to the study hospitals during the study period)

[b]10-18 years at first presentation but over 18 years at one or more subsequent presentations

Table 2. Number and percent of 10-18 year-olds who presented to hospital for self-harm between 2000 and 2013 according to vital status and cause of death at the end of 2015, by gender and age group at the time of first presentation to hospital for self-harm

	n (%)			
Vital status	**Died**	**Alive**	**Unknown[a]**	**Total**
	124 (1·4)	**9,025 (98·4)**	**24 (0·3)**	**9,173**
Both genders				
10-15 years	33 (1·0)	3,172 (98·8)	5 (0·2)	3,210
16-18 years	91 (1·5)	5,853 (98·2)	19 (0·3)	5,963
Males	**55 (2·4)**	**2,287 (97·5)**	**3 (0·1)**	**2,345**
10-15 years	6 (1·0)	587 (99·0)	0 (0·0)	593
16-18 years	49 (2·8)	1,700 (97·0)	3 (0·2)	1,752
Females	**69 (1·0)**	**6,738 (98·7)**	**21 (0·3)**	**6,828**
10-15 years	27 (1·0)	2,585 (98·8)	5 (0·2)	2,617
16-18 years	42 (1·0)	4,153 (98·6)	16 (0·4)	4,211
Cause of death	**Suicide**	**Accidents**	**Other causes[b]**	**Total**
	55 (43·9)	**27 (22·0)**	**42 (34·1)**	**124**
Both genders				
10-15 years	11 (33·3)	7 (21·2)	15 (45·5)	33
16-18 years	44 (48·4)	20 (22·0)	27 (29·6)	91
Males	**26 (47·3)**	**16 (29·1)**	**13 (23·6)**	**55**
10-15 years	2 (33·3)	2 (33·3)	2 (33·3)	6
16-18 years	24 (49·0)	14 (28·6)	11 (22·5)	49
Females	**29 (42·0)**	**11 (16·0)**	**29 (42·0)**	**69**
10-15 years	9 (33·3)	5 (18·5)	13 (48·2)	27
16-18 years	20 (47·6)	6 (14·3)	16 (38·1)	42

[a]Unknown: includes individuals who 'emigrated' (including to Northern Ireland) and for whom vital status could not be determined

[b]Includes 3 individuals (1 males, 2 females) whose ICD-10 code was R99 which denotes ill-defined or unspecified cause and individuals whose cause of death was natural or external but not classified as accidental (e.g. assault)

Table 3. Method of non-fatal self-harm at last presentation to hospital during 2000-2013 and subsequent method of suicide by the end of 2015, N=55 patients who presented to hospital for the first time aged 10-18 years

	Method of non-fatal self-harm (last episode)			
Method of suicide (ICD-10 code)	***Self-poisoning alone***	***Self-injury alone***	***Self-poisoning and self-injury***	***Total***
Self-poisoning				
X61-X69/Y11-Y19	5 (14·7)	5 (29·4)	0 (0·0)	10
Self-injury				

X70-X84/Y20-Y34	29 (85·3)	12 (70·6)	4 (100·0)	45
Total	**34**	**17**	**4**	**55**

Table 4: Hazard ratios (HR) and 95% confidence interval (CI) for death by suicide by the end of 2015 in children and adolescent presenting to hospital for non-fatal self-harm during 2000-2013, N=9173 10-18 year-olds at first presentation to hospital

	N	*n of suicides*	*Crude HR (95% CI)*	*P*	*Adjusted HR (95% CI)*	*P*
Age group at 1st presentation						
10-15 years	3,210	11	1·0		1·0	
16-18 years	5,963	44	2·04 (1·05-3·96)	0·034	1·82 (0·93-3·54)[a]	0·079
Gender						
Female	6,828	29	1·0		1·0	
Male	2,345	26	2·66 (1·57-4·42)	0·001	2·50 (1·46-4·26)[b]	0·001
Self-harm method at 1st presentation						
Self-poisoning alone	7,109	35	1·0		1·0	
Self-injury alone	1,615	18	2·65 (1·50-4·69)	0·001	2·11 (1·17-3·81)[c,d]	0·013
Self-poisoning and self-injury	449	2	0·96 (0·23-3·99)	0·95	0·86 (0·21-3·61)[c,d]	0·83
Specific method of self-injury						
Self-poisoning alone	7,109	35	1·0		1·0	
Self-cut	1,595	16	2·23 (1·23-4·03)	0·008	1·83 (1·00-3·37)[c,d]	0·050
Hanging/Asphyxiation	143	3	6·04 (1·85-19·71)	0·003	4·90 (1·47-16·39)[c,d]	0·010
Other self-injury	306	0	n/a	1·0	n/a	n/a
Unknown subtype of self-injury	20	1	10·46 (1·43-76·55)	0·021	11·50 (1·55-86·56)[c,d]	0·017
Number of episodes of self-harm						
Single episode	6452	29	1·0		1·0	
Two of more episodes[e]	2721	26	1·94 (1·14-3·29)	0·014	1·87 (1·10-3·20)	0·022

[a]Adjusted for gender

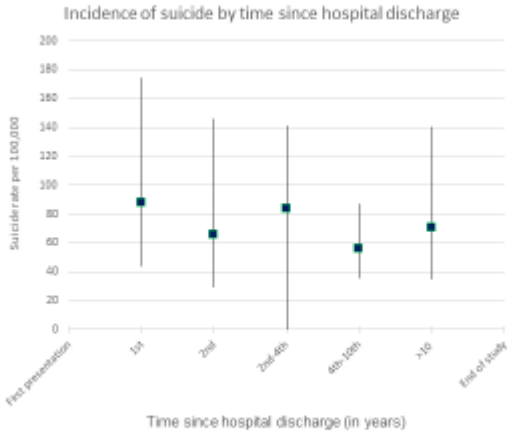
[b]Adjusted for age (in years)

[c]Adjusted for gender, age (in years), previous self-harm

[d]Previous self-harm either self-reported or documented through hospital records

[e]Adjusted for gender, age (in years), method of self-harm and previous self-harm

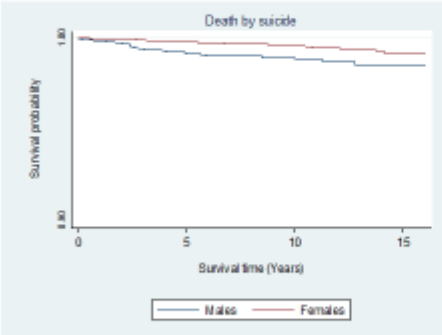
Figure 1: Incidence rate of suicide by time of follow-up since first hospital presentation for self-harm



Time of follow-up since first presentation to hospital for self-harm is split into the following durations: 1st year: discharge to 1 year follow-up; 2nd year: from 1st year after discharge to 2 years follow-up; 2-4 years: from 2 years after discharge to 4 years; 4-10 years after discharge; 10+ years after discharge

Figure 2: Probability of death by suicide after first presentation to hospital for non-fatal self-harm

a) Gender



b) Age group

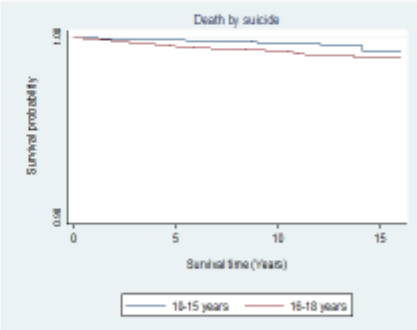
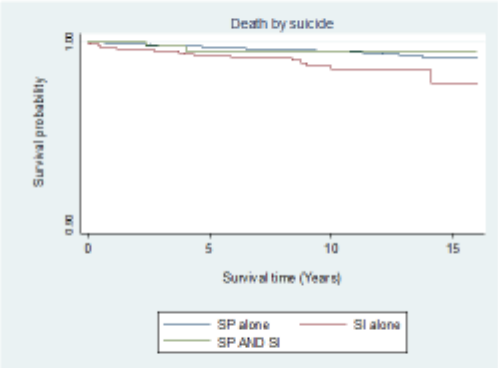


Figure 2: Probability of death by suicide after first presentation to hospital for non-fatal self-harm

c) Method of self-harm



Appendix 1 Additional analyses

Tests of proportional hazards assumption

Table 1S: Test of proportional hazards assumption in the main analysis Table 4 (N=9,173) using Schoenfeld residuals

	Crude HR (95% CI)	**Global test Chi^2 (df)**	**P value for**	**Adjusted HR (95% CI)**	**Global test Chi^2 (df)**	*P value*
Age group at 1st presentation		**0.88 (1)**	**0.35**		**3.62 (2)**	**0.10**
10-15 years	1·0			1·0		
16-18 years	2·04 (1·05-3·96)			1·82 (0·93-3·54)[a]		
Gender		3.17 (1)	0.08		4.08 (2)	0.13
Female	1·0			1·0		
Male	2·66 (1·57-4·42)			2·50 (1·46-4·26)[b]		
Self-harm method at 1st presentation		**0.45 (2)**	**0.80**		**4.70 (6)**	**0.59**
Self-poisoning alone	1·0			1·0		
Self-injury alone	2·65 (1·50-4·69)			2·11 (1·17-3·81)[c,d]		
Self-poisoning and self-injury	0·96 (0·23-3·99)			0·86 (0·21-3·61)[c,d]		

	Crude HR (95% CI)	**Global test Chi^2 (df)**	**P value for**	**Adjusted HR (95% CI)**	**Global test Chi^2 (df)**	*P value*
Specific method of self-injury		**1.70 (4)**	**0.79**		**5.75 (7)**	**0.57**
Self-poisoning alone	1·0			1·0		
Self-cut	2·23 (1·23-4·03)			1·83 (1·00-3·37)[c,d]		
Hanging/Asphyxiation	6·04 (1·85-19·71)			4·90 (1·47-16·39)[c,d]		
Other self-injury	n/a			n/a		
Unknown subtype of self-injury	10·46 (1·43-76·55)			11·50 (1·55-86·56)[c,d]		

[a]Adjusted for gender

[b]Adjusted for age (in years)

[c]Adjusted for gender, age (in years), previous self-harm

[d]Previous self-harm either self-reported or documented through hospital records

n/a – not applicable since no suicide deaths were observed in this group

df – degrees of freedon

Sensitivity analyses

Table 2S: Hazard ratios (HR) and 95% confidence interval (CI) for death by suicide by the end of 2015 in children and adolescent presenting to hospital for non-fatal self-harm during 2000-2013: sensitivity analyses excluding data for 2000-02 in Manchester due to incomplete data, N=8,420

	N	n of suicides	Crude HR (95% CI)	P	Adjusted HR (95% CI)	P
Age group at 1st presentation						
10-15 years	3,023	9	1·0		1·0	
16-18 years	5,397	38	2·30 (1·11-4·75)	0·025	2·04 (0·98-4·25)	0·056
Gender						
Female	6,265	22	1·0		1·0	
Male	2,155	25	2·62 (1·47-4·64)	0·001	2·44 (1·11-4·75)	0·001
Self-harm method at 1st presentation						
Self-poisoning alone	6,484	31	1·0		1·0	
Self-injury alone	1,516	15	2·45 (1·32-4·56)	0·004	1·92 (1·01-3·64)	0·045
Self-poisoning and self-injury	420	1	0·50 (0·07-3·68)	0·50	0·44 (0·06-3·27)	0·43
Specific method of self-injury						

	N	n of suicides	Crude HR (95% CI)	P	Adjusted HR (95% CI)	P
Self-poisoning alone	6,484	31	1·0		1·0	
Self-cut	1,478	13	2·01 (1·05-3·84)	0·035	1·63 (0·84-3·16)	0·15
Hanging/Asphyxiation	138	3	6·58 (2·00-21·63)	0·002	5·37 (1·59-18·17)	0·007
Other self-injury	301	0	n/a		n/a	
Unknown subtype of self-injury	19	0	n/a		n/a	
Number of episodes of self-harm						
Single episode	5,961	27	1·0		1·0	
Two of more episodes[e]	2,459	20	1·63 (0·91-2·91)	0·099	1·59 (0·89-2·84)	0·12

[a]Adjusted for gender

[b]Adjusted for age (in years)

[c]Adjusted for gender, age (in years), previous self-harm

[d]Previous self-harm either self-reported or documented through hospital records

[e]Adjusted for gender, age (in years), method of self-harm and previous self-harm

n/a – not applicable since no suicide deaths were observed in this group

Table 3S: Hazard ratios (HR) and 95% confidence interval (CI) for death by suicide by the end of 2015 in children and adolescent presenting to hospital for non-fatal self-harm during 2000-2013: sensitivity analysis excluding data for 2000-2009 of under 16 years in Manchester due to incomplete data, N=8,377

	N	n of suicides	Crude HR (95% CI)	P	Adjusted HR (95% CI)	P
Age group at 1st presentation						
10-15 years	2,414	8	1·0		1·0	
16-18 years	5,963	44	2·00 (0·94-4·26)	0·074	1·72 (0·80-3·70)	0·16
Gender						
Female	6,206	26	1·0		1·0	
Male	2,171	26	2·90 (1·68-4·99)	<0·0001	2·77 (1·60-4·81)	<0·0001
Self-harm method at 1st presentation						
Self-poisoning alone	6,470	34	1·0		1·0	
Self-injury alone	1,485	16	2·39 (1·32-4·34)	0·004	1·90 (1·03-3·52)	0·041
Self-poisoning and self-injury	422	2	0·96 (0·23-3·99)	0·95	0·86 (0·21-3·62)	0·84
Specific method of self-injury						
Self-poisoning alone	6,470	34	1·0		1·0	

	N	n of suicides	Crude HR (95% CI)	P	Adjusted HR (95% CI)	P
Self-cut	1,483	15	2·11 (1·15-3·87)	0·035	1·75 (0·94-3·26)	0·079
Hanging/Asphyxiation	131	3	6·20 (1·90-20·26)	0·003	4·97 (1·48-16·69)	0·010
Other self-injury	279	0	n/a		n/a	
Unknown subtype of self-injury	14	0	n/a		n/a	
Number of episodes of self-harm						
Single episode	5,939	29	1·0		1·0	
Two of more episodes[e]	2,438	23	1·73 (1·00-2·99)	0·052	1·71 (0·99-2·97)	0·057

[a]Adjusted for gender

[b]Adjusted for age (in years)

[c]Adjusted for gender, age (in years), previous self-harm

[d]Previous self-harm either self-reported or documented through hospital records

[e]Adjusted for gender, age (in years), method of self-harm and previous self-harm

n/a – not applicable since no suicide deaths were observed in this group

Table 4S: Hazard ratios (HR) and 95% confidence interval (CI) for *death by accident* by the end of 2015 in children and adolescent presenting to hospital for non-fatal self-harm during 2000-2013: sensitivity analyses excluding data for one centre due to incomplete data

	N	n of deaths	Crude HR (95% CI)	P	Age adjusted HR (95% CI)	P
Excluding data for 2000-2002 in one centre						
Death by accident	8,420	24				
Gender						
Female	6,265	10	1·0		1·0	
Male	2,155	14	4·14 (1·84-9·32)	0·001	4·10 (1·81-9·31)	0·001
Death by accidental poisoning	8,420	13				
Gender						
Female	6,265	4	1·0		1·0	
Male	2,155	9	6·68 (1·84-9·32)	0·002	7·00 (2·14-22·89)	0·001
Excluding data for 2000-2009 of under 16 year-olds in one centre						
Death by accident	8,377	26				
Gender						
Female	6,206	11	1·0		1·0	

	N	n of deaths	Crude HR (95% CI)	P	Age adjusted HR (95% CI)	P
Male	2,171	15	3·91 (1·81-8·57)	0·001	4·05 (1·85-8·91)	<0·00001
Death by accidental poisoning	8,377	13				
Gender						
Female	6,206	4	1·0		1·0	
Male	2,171	9	6·57 (2·02-21·35)	0·002	7·23 (2·21-23·67)	0·001

n/a – not applicable since no deaths were observed in this group