# Review

# Systematic review and meta-analysis of the clinical factors associated with the suicide of psychiatric in-patients

**Objective:** To estimate the strength of the associations between the suicide of psychiatric in-patients and demographic, historical, symptomatic, diagnostic and treatment factors.
**Method:** A systematic review and meta-analysis of controlled studies of the suicide of psychiatric in-patients including suicides while on approved or unapproved leave.
**Results:** Factors that were significantly associated with in-patient suicide included a history of deliberate self-harm, hopelessness, feelings of guilt or inadequacy, depressed mood, suicidal ideas and a family history of suicide. Patients suffering from both schizophrenia and depressed mood appeared to be at particular risk. The association between suicidal ideas and in-patient suicide was weak and did not reach statistical significance after a quantitative correction for publication bias. A high-risk categorization as defined by a combination of retrospectively determined individual risk factors was strongly statistically associated with in-patient suicide (OR = 10.9), with a sensitivity of 64% and a specificity of 85%.
**Conclusion:** Despite the apparently strong association between high-risk categorization and subsequent suicide, the low base rate of in-patient suicide means that predictive value of a high-risk categorization is below 2%. The development of safer hospital environments and improved systems of care are more likely to reduce the suicide of psychiatric in-patients than risk assessment.

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## Summations

- A history of suicide attempts, depressive symptoms, a family history of suicide and suicidal ideation are moderately associated with in-patient suicide. Some factors known to be associated with suicide in the community, such as male sex, substance use and unemployment, are not significantly associated with in-patient suicide.
- High-risk status, retrospectively defined by the presence of multiple risk factors, is strongly associated with in-patient suicide. However, the overwhelming majority of patients categorized as at high risk of in-patient suicide will not suffer this harm, and some patients categorized as at low risk will commit suicide in hospital.

## Considerations

- The strengths of the associations between in-patient suicide and suicidal ideas and other risk factors calculated by meta-analysis are likely to have been inflated by reporting bias towards positive findings in the original publications.

- The strength of the association between high-risk categorization and later suicide is likely to have been inflated by retrospective definitions of what consititutes high risk in the original studies, and prospective studies of outcome in high-risk groups are required.

## Introduction

It has been estimated that about half of all suicides by people with schizophrenia occur during or soon after an admission to hospital (1) and that a psychiatric hospitalization is a time of increased risk of suicide in people with an affective disorder (2). In England and Wales, approximately 4% of all suicides are of current psychiatric in-patients (3). International surveys have found that most psychiatrists have personal experience of the suicide of at least one patient under their care in hospital (4). In addition to the loss of life and the trauma experienced by mental health staff and the patient's family, the suicide of an in-patient is usually followed by an enquiry resulting in real or implied criticism of the staff involved and the possibility of legal action against individual staff or the health service (5). It is important, therefore, to know the strength of association between risk factors for in-patient suicide and the extent to which these tragic events might be predicted and prevented.

Three recent qualitative systematic reviews of earlier studies of in-patient suicide have examined the socio-demographic and clinical factors associated with in-patient suicide (6–8). However, these studies listed the reported associations but did not perform a meta-analysis combining the results. This approach might repeat Type-I errors from chance findings of significant results in studies that examined a large number of factors. It could also result in Type-II errors because of the lack of statistical power inherent in examining a series of studies that each reported a small number of events. By contrast, a quantitative, meta-analytic approach allows an estimation of the strength and consistency of associations across studies and reduces the likelihood of both types of error.

Knowing which factors are associated with in-patient suicide and the strength of those associations could improve the clinical management and increase patient safety. By contrast, patient characteristics incorrectly believed to be associated with suicide in hospital might lead to more restrictive care for some patients and the misallocation of resources in the form of unnecessary treatment. Establishing risk factors would also guide further research and the evaluation of clinical strategies to reduce the incidence of in-patient suicide. In an attempt to improve the understanding of in-patient suicide, we have conducted a systematic review and meta-analysis of controlled studies of suicide in mental health settings.

### Aims of the study

The aim of this study was to synthesize the results of earlier controlled studies of the suicide of psychiatric in-patients to quantitatively assess the strength of the associations between clinical factors and suicide of psychiatric in-patients.

## Material and methods

### Search strategies

Using the search terms 'suicide' OR 'self-harm' (all fields) AND in-patient OR in-patient OR psychiatric hospital' (all fields), we searched for published studies and conference abstracts in English and in other languages in the following electronic databases: PsychINFO from January 1967 to February 2009, EMBASE from January 1980 to February 2009, Medline/PubMed from January 1950 to February 2009, CINAHL from January 1981 to February 2009 (see Fig. 1).

We also examined the lists of references in three recently published reviews (6–8) and hand-searched the reference lists of the studies located by electronic searches. ML and GS conducted the searches independently and located the same set of publications. AB considered German-language publications for inclusion or exclusion and provided preliminary translations of the data reported
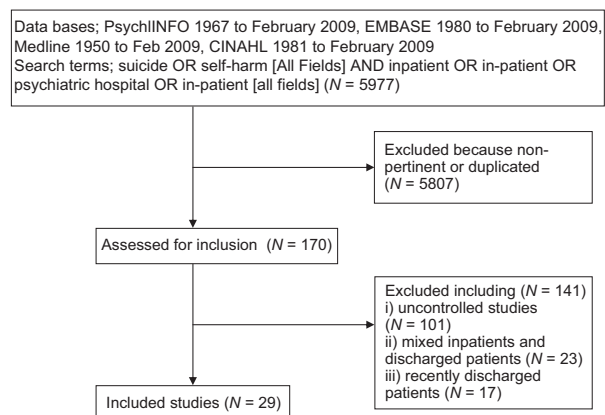


*Fig. 1.* Search strategy and results.

in the tables. An examination of the first 1000 results using the term 'in-patient suicide' in the search engine Google yielded no additional studies. Finally, we contacted the authors of relevant studies with a request for more data resulting in additional data from two studies (9, 10).

## Inclusion and exclusion criteria

Studies were included if they:

i) reported the characteristics of a sample of psychiatric in-patients who had completed suicide either as an in-patient or while on approved or unapproved leave from a mental health facility (11); *and*
ii) reported the characteristics of a control group of psychiatric in-patients who did not commit suicide and who were in-patients in the same or similar mental health facilities at close to the same time as the suicide cases; *and*
iii) employed a case–control, nested case–control or cohort control design.

We included studies reporting data collected prospectively by the use of a clinical database, studies reporting data obtained by a file audit after the suicide and studies relying on treating psychiatrists' reports.

Studies were excluded if they:

i) reported patients who did not complete suicide *or*
ii) reported suicides of patients after approved discharge from hospital *or*
iii) included suicides occurring in both in-patient and community settings *or*
iv) compared patients committing suicide while in hospital with control groups of patients committing suicide in the community *or*
v) were studies of suicide occurring in non-psychiatric medical facilities or in prisons.

## Selection of factors

We aimed to examine patient factors that are likely to be routinely assessed by clinicians working in in-patient settings. These included demographic factors, aspects of the patients' psychiatric history, aspects of the patient's mental state, psychiatric diagnoses and treatment factors. To minimize the likelihood of Type-I errors, we did not include factors that were reported in fewer than five studies in the meta-analyses. Factors reported in a small number of studies would be more likely to result from chance findings and reporting bias. Factors reported in fewer than five studies are also more

likely to be subject to Type-II errors because of the reduced statistical power of a random effects meta-analysis of a small number of studies. Moreover, a meaningful examination of between-study heterogeneity and publication bias requires a minimum of five studies (12).

## Data extraction

Full-text translations of German-language publications were provided by a German-speaking medical practitioner working in mental health (NN). The data were independently extracted by ML and SSh. Fourteen discrepancies, of a total of 1104 data points, were resolved by joint examination of the data. A third data extraction was performed by GS, with several further discrepancies again resolved by consensus. When related factors were reported in the same paper – for example, substance abuse and alcohol abuse – the more inclusive factor was used in the meta-analysis. No discrepancies were found in a final, blind check of all data points conducted by ML.

## Meta-analysis

Comprehensive Meta-Analysis (CMA) software version 2.2 (Biostat, Englewood, NJ, USA) was used to calculate a pooled estimate of the factors associated with in-patient suicide. CMA employs the same algorithms used by the Cochrane collaborators to assess effect size and study weight, the latter by the inverse variance method (13). CMA allows the transformation of data formats into a range of effect sizes, including odds ratios (OR). Uni-variate associations with in-patient suicide were used in the meta-analysis. Because almost all the data in the publications were categorical, results are reported as odds ratios. Effect sizes were classified as weak (OR between 1.5 and 2.5), moderate (OR between 2.5 and 4), strong (OR between 4 and 10) or very strong (OR greater than 10) (14). No correction was made to significance testing as a result of multiple meta-analyses. However, a Bonferroni correction for 25 uncorrelated factors suggests that any factor found to be associated with in-patient suicide with a $P$ value of $\leq 0.002$ would not be the result of a Type-I error.

## Quality considerations

The quality of included studies was assessed by

i) sample size,
ii) the use of a recognized diagnostic classification system,

iii) the proportion of in-patient suicide events later compared with controls,

iv) the use of a comparable control group,

v) whether or not the data were collected before the suicide or taken later from medical record and

vi) the use of multiple raters and blind rating in data extraction (for details see Table S1).

### Heterogeneity

Heterogeneity was assessed using a Q-value and I-square for each factor. The inclusion of suicides from a variety of in-patient settings from different countries and from different decades meant that we could not assume that the characteristics of the populations of in-patients were similar in each study. Hence, an *a priori* choice of a random effects model was made for the meta-analysis. Differences in the hospitals where the studies were conducted and the types of patients included in the studies might have resulted in differences between studies in the strength of association between some factors and in-patient suicide. Hence, the results of a meta-analysis can be considered to be more applicable to a wider range of mental health settings than can individual studies, but might not apply as directly to atypical hospitals or atypical groups of patients.

### Reporting and publication bias

Three methods were used to consider the presence and possible effect of publication and reporting bias. First, the Funnel (Egger's) plot of the effect size versus the standard error was inspected for each significant factor, specifically noting the presence or absence of small studies with a negative association with in-patient suicide (lower left of the Funnel Plot). A relative paucity of studies in the lower left base – when compared with the lower right base of the Funnel plot – suggests that small studies with positive associations might be more likely to be published than small negative studies (12). Second, the 'Classic Failsafe N' was used to estimate the number of hypothetical missing studies with an effect size of zero (OR = 1.0) which would be required to return $P$ to $> 0.05$. Third, using Duval and Teedie's 'Trim and Fill' method, we examined the possible effect of hypothetically missing studies on the pooled estimates of the odds ratios. This method adjusts the pooled estimates by considering the effect of small studies showing a significant relationship between the respective factors and in-patient suicide and calculates an adjusted odds ratio (15).

### Subgroup analysis

Subgroups of studies of patients with schizophrenia and affective disorder were examined separately because of the possibility that suicide among in-patients with different diagnoses might be associated with different factors.

### High-risk analysis

Data reporting the retrospective categorization of suicides and controls into high- and low-risk groups on the basis of multiple risk factors were included in the meta-analysis. The sensitivity and specificity of high-risk categorizations and the odds ratio of suicide in high-risk groups were calculated using meta-analysis. When publications reported more than one threshold for high-risk categorization, the category with the greatest sensitivity was chosen. No study had prospectively examined suicide in high- and low-risk groups.

## Results

### Included studies

The electronic searches, examination of the references in the three recent reviews and hand searches of reference lists yielded 29 studies in which a sample of patients who had committed suicide in hospital were compared with patients from the same or similar mental health settings who did not commit suicide (Fig. 1). The 29 studies included 12 studies that had not been considered in the earlier non-meta analytic reviews.

The 29 studies differed in the settings in which they were conducted and in their sampling methods (see Table S1). Most included patients on approved or unapproved leave, one study included only suicides occurring within the hospital grounds while a small number of studies did not define in-patient suicide. The samples in each of the studies were based on the systematically collected data from coroners' verdicts, police registries, hospital records or data collected by health services. None of the 29 studies included non-lethal suicide attempts or deaths where the cause of death was in doubt.

The included studies are summarized in Table 1. One study that originally met the inclusion criteria was subsequently excluded because many of the patients in the control group were taken from long-stay facilities and were significantly older than the suicide group, because only a little over half of the total number of suicides were included in the

Table 1. Controlled studies suicide among psychiatric in-patients

| Study name | Place and period | In-patient suicides | In-patient non-suicide controls |
|---|---|---|---|
| *Included case–control and cohort control studies* | | | |
| Beisser & Blanchette (1961) (31) | Metropolitan State Hospital New York 1916–1958 | 71 patients of mixed diagnosis | 71 cases matched for sex, race and admission date |
| Dong et al., (2005) (32) | 10 psychiatric hospitals in Hong Kong, China (1997–1999) | 93 of mixed diagnosis | 93 matched for sex, age, diagnosis, duration of care hospital and admission date |
| Gaertner et al., (2002) (33) | Tuebingen University Hospital (1980–1999) | 61 of mixed diagnosis | 26 455 admitted cohort and 61 patients matched for diagnosis age and sex |
| Gale et al., (1980) (34) | Five New York Hospitals 1975–1977 | 60 patients of mixed diagnosis | 5105 admitted cohort from the same hospitals |
| Havaki-Kontaxaki et al., (1994) (35) | Psychiatric Hospital Attica, Greece (1959–1987) | 22 patients with schizophrenia | 60 matched for diagnosis and admission date |
| Hunt et al., (2007) (9) | National sample from England and Wales (1999–2000) | 222 of mixed diagnosis | 222 matched for admission date |
| King et al., (2001) (22) | Hospitals in Wessex, England | 59 of mixed diagnoses | 106 matched for sex, age, diagnosis, ward, admission date |
| Klinkisch et al., (2003)† (36) | Bayreuth psychiatric clinic, Germany (1976–1998) | 64 of mixed diagnoses | 64 patients matched for admission date |
| Krupinski et al., (1998) (37) | University of Munich Psychiatric Hospital, Germany (1983–1986, 1990–1992) | 33 patients with depressive psychosis | 3759 admitted cohort |
| Krupinski et al., (2000) (38) | University of Munich Psychiatric hospital, Germany (1981–1992) | 19 patients with schizophrenia | 5257 admitted cohort |
| Li et al., (2008) (10) | Guangzhou Psychiatric Hospital, China (1956–2005) | 64 patients with schizophrenia | 64 matched for sex, age, diagnosis and admission date |
| Modestin & Kopp (1988) (20) | National sample, Switzerland (1960–1981) | 149 patients of mixed diagnoses | 149 patients matched for ward and admission date |
| Modestin et al., (1988) (39)† | National sample, Switzerland (1960–1981) | 75 patients with affective disorder | 50 matched for ward and diagnosis and admission date |
| Modestin et al., (1992) (40)† | National sample, Switzerland (1960–1981) | 53 patients with schizophrenia | 53 matched for ward diagnosis and admission date |
| Modestin et al., (1989)† (41) | National sample, Switzerland (1960–1981) | 22 psycho-geriatric patients of mixed diagnosis | 21 psycho-geriatric patients of mixed diagnosis |
| Neuner et al., (2008) (42) | University Hospital Regensburg, Germany (1995–2004) | 41 of mixed diagnosis | 20 543 admitted cohort |
| Neuner et al., (2010) (43)† | University Hospital Regensburg, Germany (1995–2004) | 20 of mixed diagnosis | 20 controls matched for age, sex, diagnosis and admission date |
| Powell et al., (2000) (24) | Hospitals in Oxfordshire, Berkshire, Buckinghamshire, Northamptonshire, England (1963–1992) | 97 of mixed diagnoses | 90 matched for hospital and admission date |
| Read et al., (1993) (44) | Three psychiatric hospitals in Wellington, New Zealand (1984–1989) | 27 of mixed diagnosis | 86 matched for hospital and admission date |
| Roy & Draper, (1995) (45) | Broockville Psychiatric Hospital, Canada (1970–1991) | 37 of mixed diagnoses | 37 matched for age, sex and admission date |
| Shah & Ganesvaran, (1997) (46) | Larundel, Mont Park, Pleny and the amalgamated hospital, Melbourne, Australia (1973–1993) | 60 of mixed diagnoses | 60 matched for place and admission date |
| Sharma et al., (1998) (47) | London psychiatric hospital, Ontario, Canada (1969–1995) | 44 of mixed diagnosis | 44 matched for admission date |
| Schlosser & Strehle-Jung, (1982) (48) | Psychiatric Clinic of Hanover Medical College (1972–1978) | 22 of mixed diagnosis | 5175 admitted cohort |
| Spießl et al., (2002) (23) | State Psychiatric Hospital Regensburg, Germany (1989–1999) | 30 of mixed diagnoses | 21 062 admitted cohort |
| Steblaj et al., (1999) (49) | University Psychiatric Hospital Ljubljana, Slovenia (1984–1993) | 59 of mixed diagnoses | 59 matched for age, sex, diagnosis and admission date. |
| Taiminen, (1993) (50) | Psychiatric clinic Turku University, Finland (1971–1998) | 25 of mixed diagnoses | 25 matched for sex, age, diagnosis and admission date |
| Wolfersdorf et al. (2003) (51) | Bayreuth psychiatric clinic, Germany (1976–1998) | 64 of mixed diagnoses | 64 patients matched for admission date |
| Wolfersdorf & Neher, (2003) (52) | Psychiatric clinics in Baden-Württemberg, Germany (1992–1993) | 80 patients with schizophrenia | 80 patients marched for diagnosis age and sex and admission date |
| *Excluded case–control study* | | | |
| Farberow et al. 1966 (53) | Neuro-psychiatric, General, TB and Veterans Hospitals after 1950, USA | 218 patients of mixed diagnosis | 220 controls poorly matched for age and place of admission |

†Subjects also included in larger studies.

case–control design and because, using the quality measures described in the methods section, the study was assessed as being of low quality. The remaining studies sampled patients from the same or similar facilities, had a control group with similar or matched demographic characteristics, were able to include a higher proportion of all in-patient suicides in the controlled study (Mean inclusion rate 92%) and were assessed to be of higher quality. All but five studies had a sample size of 30 or more suicides with a mean of 62.5 [standard deviation (SD) 46.3] suicides per study (Table S1).

The only non-English language papers that met the inclusion criteria were six papers written in German. Of the 28 included studies, five included subjects described in other publications located in the searches. Factors from these studies were excluded from the meta-analysis if they had been reported in the larger study (Table 1). Six studies used routinely collected data in a cohort design to compare the characteristics of patients who committed suicide with the characteristics of all other in-patients, whereas the remaining studies used a case–control design. Five studies considered suicide by patients with schizophrenia, and two further papers reported data for patients with schizophrenia separately. Two studies considered suicides among patients with affective disorders, and two further papers reported data for patients with the diagnosis of an affective disorder separately. The remaining studies included in-patients with a range of psychiatric diagnoses.

### Meta-analysis of possible factors associated with in-patient suicide

Twenty-nine factors were reported in five or more studies (Table 2, Tables S2–S30). Patients who had not been diagnosed with schizophrenia or with an

Table 2. Meta analysis of demographic, social, historical, clinical, diagnostic and treatment factors associated with suicide of psychiatric in-patients

|  | Suicide subjects (%) | Studies of studies | I-square | Odds ratio | Lower limit | Upper limit | Z | P |
|---|---|---|---|---|---|---|---|---|
| *Demographic and social factors* | | | | | | | | |
| Male sex | 482/817 (59) | 12 | 54.0 | 1.20 | 0.90 | 1.60 | 1.265 | 0.206 |
| Increased age | 278* | 8 | 62.7 | 1.08 | 0.70 | 1.68 | 0.362 | 0.717 |
| Married | 247/657 (38) | 11 | 58.1 | 1.02 | 0.69 | 1.50 | 0.105 | 0.916 |
| Living alone | 194/538 (36) | 7 | 0.0 | 1.22 | 0.94 | 1.57 | 1.482 | 0.138 |
| Unemployment | 339/626 (54) | 9 | 42.0 | 0.71 | 0.50 | 1.01 | −1.899 | 0.058 |
| Social or relationship problem | 291/750 (39) | 9 | 79.0 | 1.82 | 1.46 | 2.27 | 5.311 | <0.001 |
| *Historical factors* | | | | | | | | |
| Prior suicide attempt or deliberate self-harm | 727/1251 (58) | 21 | 29.6 | 3.95 | 3.22 | 4.84 | 13.229 | <0.001 |
| More prior psychiatric admissions | 340/714 (48) | 15 | 57.7 | 1.81 | 1.33 | 2.45 | 3.817 | <0.001 |
| Duration of psychiatric illness | 1013* | 14 | 58.1 | 1.14 | 0.87 | 1.50 | 0.965 | 0.334 |
| Physical illness | 106/442 (24) | 8 | 56.6 | 0.83 | 0.49 | 1.41 | −0.697 | 0.486 |
| Prior criminality or violence | 110/559 (20) | 6 | 67.7 | 0.93 | 0.50 | 1.70 | −0.246 | 0.806 |
| Family history of suicide | 62/432 (14) | 6 | 0.0 | 2.78 | 1.70 | 4.52 | 4.101 | <0.001 |
| Family history of mental illness | 143/378 (38) | 6 | 0.0 | 1.55 | 1.13 | 2.12 | 2.734 | 0.006 |
| *Behaviour and symptoms in relation to admission* | | | | | | | | |
| Suicide attempt at time of admission | 146/476 (31) | 8 | 75.0 | 2.41 | 1.21 | 4.78 | 2.510 | 0.012 |
| Suicidal ideas | 312/854 (37) | 12 | 81.5 | 2.63 | 1.52 | 4.56 | 3.439 | 0.001 |
| Depressed mood | 521/894 (58) | 13 | 70.1 | 3.92 | 2.59 | 5.92 | 6.490 | <0.001 |
| Agitation or anxiety | 106/361 (29) | 7 | 59.6 | 2.12 | 1.20 | 3.76 | 2.588 | 0.010 |
| Hopelessness | 197/571 (35) | 7 | 60.8 | 3.70 | 2.28 | 5.99 | 5.303 | <0.001 |
| Feelings of worthlessness, inadequacy or guilt | 140/354 (40) | 6 | 42.3 | 3.73 | 2.33 | 5.98 | 5.477 | <0.001 |
| Delusional ideas | 100/298 (34) | 6 | 72.4 | 1.40 | 0.69 | 2.85 | 0.924 | 0.355 |
| Hallucinations | 83/326 (25) | 5 | 57.5 | 1.10 | 0.61 | 1.99 | 0.312 | 0.755 |
| *Psychiatric diagnosis* | | | | | | | | |
| Schizophrenia | 396/914 (43) | 13 | 83.6 | 2.48 | 1.54 | 4.00 | 3.746 | <0.001 |
| Affective disorder | 388/906 (43) | 13 | 69.0 | 1.93 | 1.33 | 2.81 | 3.459 | 0.001 |
| Diagnosis other than affective disorder or schizophrenia | 121/843 (14) | 11 | 73.0 | 0.25 | 0.15 | 0.41 | −5.496 | <0.001 |
| Co-morbid substance abuse | 160/762 (21) | 9 | 69.7 | 0.70 | 0.43 | 1.15 | −1.408 | 0.159 |
| *Psychiatric treatment* | | | | | | | | |
| Admitted under the Mental Health Act | 293/828 (35) | 12 | 78.9 | 1.87 | 1.14 | 3.08 | 2.486 | 0.013 |
| Prescribed antidepressants | 168/380 (44) | 8 | 55.5 | 2.43 | 1.52 | 3.90 | 3.696 | <0.001 |
| Prescribed antipsychotics | 229/309 (74) | 7 | 72.9 | 1.09 | 0.48 | 2.45 | 0.202 | 0.840 |
| Longer length of hospital stay | 419* | 7 | 69.4 | 2.33 | 1.44 | 3.77 | 3.442 | 0.001 |
| *Patients categorized as high-risk on the basis of multiple risk factors* | | | | | | | | |
| High-risk | 420/672 (62) | 7 | 72.8 | 10.94 | 5.94 | 20.16 | 7.676 | <0.001 |

*Total suicide subjects only.

| Study name | Statistics for each study | | | | | Odds ratio and 95% CI |
|---|---|---|---|---|---|---|
| | Odds ratio | Lower limit | Upper limit | Z-value | P-value | |
| Dong (32) | 4.91 | 2.47 | 9.78 | 4.54 | 0.00 | |
| Hunt (9) | 4.56 | 3.05 | 6.80 | 7.43 | 0.00 | |
| King (22) | 8.10 | 3.68 | 17.83 | 5.20 | 0.00 | |
| Krupinski (37) | 18.76 | 7.22 | 48.72 | 6.02 | 0.00 | |
| Krupinski (38) | 23.70 | 8.97 | 62.66 | 6.38 | 0.00 | |
| Modestin (20) | 18.77 | 10.48 | 33.60 | 9.87 | 0.00 | |
| Powell (24) | 32.59 | 4.32 | 246.06 | 3.38 | 0.00 | |
| | 10.94 | 5.94 | 20.16 | 7.68 | 0.00 | |
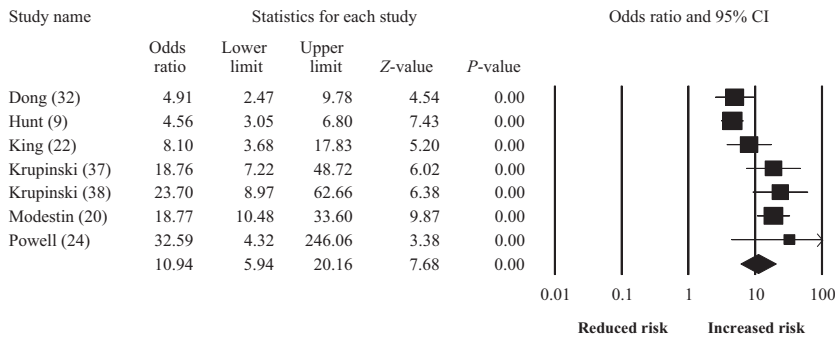


*Fig. 2.* The association between in-patient suicide and retrospective high-risk categorization.

affective disorder were less likely to commit suicide as in-patients (OR 0.25). A history of a suicide attempt was the strongest positive association (OR 3.95 for all patients, OR 4.14 for the subgroup of patients with schizophrenia).

Factors moderately associated with in-patient suicide (defined as an OR between 2.5 and 4) were depressed mood (OR 3.92), feelings of hopelessness (OR 3.70) and feelings of worthlessness, inadequacy or guilt (OR 3.73). Moderate positive associations were also found with a family history of suicide (OR 2.78), suicidal ideas while in hospital (OR 2.63), a diagnosis of schizophrenia (OR, 2.48) and having been prescribed antidepressant medication (OR 2.43).

Factors weakly associated with in-patient suicide included current relationship and social problems (OR 1.82), a higher number of previous psychiatric admissions (OR 1.81), a family history of mental illness (OR 1.55), a suicide attempt at the time of admission (OR 2.41), the presence of prominent agitation or anxiety (OR 2.13), a diagnosis of affective disorder (OR 1.93), involuntary admission (OR 1.87) and a longer duration of in-patient care (OR 2.33).

No demographic factor was significantly associated with suicide in hospital, although being unemployed approached significance as a protective factor (OR 0.71). Nor were physical illness, co-morbid substance abuse, a history of violence, a history of criminal conviction, the presence of hallucinations, delusional beliefs, or treatment with antipsychotic medication associated with in-patient suicide.

Within the subgroup of studies of patients with schizophrenia, depressed mood was strongly associated with in-patient suicide (OR 4.77). A prior suicide attempt and a higher number of previous admissions were also significantly associated with the in-patient suicide of patients with schizophrenia (see Tables S31–S35). There were not enough samples of in-patient suicide by patients with a diagnosis of affective disorder to allow a subgroup analysis of factors associated with in-patient suicide by patients with this disorder.

### Patients categorized as high risk on the basis of multiple risk factors

Seven studies reported the number of suicides and controls among groups of patients who were retrospectively classified as having been at high risk on the basis of the presence of multiple factors (Fig. 2, Table S36). There was a strong association between a high-risk categorization and in-patient suicide (OR = 10.94). The pooled estimate for the sensitivity of high-risk categorizations was 64% (95% CI 50–77%), and the pooled estimate for specificity was 85% (95% CI 75–91%).

### Publication and reporting bias

We found no reports of unpublished case–controlled studies of in-patient suicide in conference abstracts or by searches of the internet. However, it was clear that some studies had examined more factors than had been reported in the published papers. The mean number of factors reported in the included controlled studies was 21.3 (SD 14.8), whereas the mean number of data points collected was 68.6 (SD 75.6, see Table S1). A total of 29 factors were reported in five or more studies and could be subjected to meta-analysis. The mean number of studies for each factor was 9.6 (SD 4.00).

The effect size and standard error of factors found to be significantly associated with in-patient suicide were examined using a Funnel Plot. Inspection of the Funnel Plot showed that in 8 of 17 factors found to be significant, there were few smaller studies with a negative association with in-patient suicide. A Failsafe N test indicated that one factor (family history of suicide) would have returned to $P \geq 0.05$ had there been fewer than 15 studies with an OR of 1.0. The effect of reporting bias on the pooled estimate of the OR

Table 3. Tests of publication bias for those factors found to be significantly associated with the suicide of psychiatric in-patients

| | Unadjusted odds | Duval and Tweedie's trim and fill | | | Paucity of small negative studies (lower left on Funnel Plot) | Classic failsafe *n* |
| | | Adjusted odds ratio | 95% CI of adjusted odds ratio | Number of adjusted studies | | |
| --- | --- | --- | --- | --- | --- | --- |
| *Demographic and social factors* | | | | | | |
| Social or relationship problem | 1.82 | 1.59 | 0.89–2.84 | 1 | Yes | 59 |
| *Historical factors* | | | | | | |
| Prior suicide attempt or deliberate self-harm | 3.95 | 3.30 | 2.63–4.14 | 6 | No | 1379 |
| Prior psychiatric admissions | 1.81 | 1.58 | 1.13–2.19 | 2 | No | 114 |
| Family history of suicide | 2.78 | 2.78 | 1.70–4.52 | 0 | No | 13 |
| Family history of mental illness | 1.55 | 1.55 | 1.13–2.11 | 0 | No | 47 |
| *Behaviour and symptoms in relation to admission* | | | | | | |
| Suicide attempt at time of admission | 2.41 | 2.26 | 1.16–4.41 | 1 | No | 47 |
| Suicidal ideas | 2.63 | 1.52 | 0.87–2.63 | 5 | Yes | 159 |
| Depressed mood | 3.92 | 2.34 | 1.48–3.70 | 6 | Yes | 430 |
| Agitation or anxiety | 2.12 | 1.56 | 0.84–2.88 | 2 | Yes | 23 |
| Hopelessness | 3.70 | 2.83 | 1.69–4.73 | 2 | Yes | 124 |
| Feelings of worthlessness, inadequacy or guilt | 3.73 | 3.51 | 2.25–5.49 | 1 | Yes | 79 |
| *Psychiatric diagnosis* | | | | | | |
| Schizophrenia | 2.48 | 1.65 | 1.03–2.65 | 4 | Yes | 216 |
| Affective disorder | 1.93 | 1.93 | 1.33–2.81 | 0 | No | 129 |
| Diagnosis other than affective disorder or schizophrenia | 0.25 | 0.25 | 0.15–0.41 | 0 | No | 295 |
| *Psychiatric treatment* | | | | | | |
| Admitted under the Mental Health Act | 1.87 | 0.97 | 0.58–1.63 | 6 | Yes | 58 |
| Prescribed antidepressant medication | 2.43 | 2.43 | 1.51–3.90 | 0 | No | 56 |
| Length of hospital treatment | 2.33 | 2.33 | 1.44–3.77 | 0 | No | 64 |
| *Patients categorized as high-risk on the basis of multiple risk factors* | | | | | | |
| High-risk | 10.94 | 10.15 | 5.66–18.22 | 1 | Yes | 471 |

was examined using the Trim and Fill method (Table 3), which found that the significance of the associations between current social problems, suicidal ideas, the presence of agitation or anxiety and involuntary admission could have been because of non-reporting of negative associations between in-patient suicide and these factors by in some published studies.

## Discussion

The suicide of a patient in a psychiatric hospital is one of the most serious events faced by any mental health service. Understanding the factors associated with increased likelihood of these events has the potential to save lives. Our systematic search found a modest number of high-quality controlled studies relative to the number of publications about in-patient suicide. This might reflect both the small number of events in individual services or the methodological limitations imposed by the retrospective collection of data about patients who have completed suicide. For example, all but two studies had fewer than 100 subjects, most studies examined a limited subset of the possible factors, and in two-thirds of studies the potential for

hindsight bias was introduced by the retrospective extraction of data from medical records or interviews of the responsible clinicians.

Given these limitations, our main finding is that a number of factors appear to be moderately, but consistently, associated with an increased likelihood of in-patient suicide. These factors include a diagnosis of schizophrenia or affective disorder and the presence of prominent depressive symptoms, especially in patients with schizophrenia. Because most of the significant *P* values were below 0.002, it is unlikely that these results were because of a Type-I error.

A number of factors previously reported to be associated with in-patient suicide in qualitative reviews were not found to be significantly associated after meta-analysis of controlled studies. For example, the reported association of in-patient suicide with male sex (6, 7) and single marital status (7) were not confirmed. The findings of meta-analysis also challenge the validity of associations with in-patient suicide reported in individual studies. For example, the largest individual case–controlled study had found that involuntary admission was associated with a lower risk of in-patient suicide (9), whereas meta-analysis found

that involuntary legal status was associated with a higher risk of in-patient suicide, which is consistent with the finding that severe forms of psychotic illness are associated with an increased risk of in-patient suicide.

Another potentially important finding relates to the previously reported association between suicidal ideation and in-patient suicide. We found this association to be weaker than those of deliberate self-harm, depressive symptoms, more prior admissions or a family history of suicide. Moreover, substance use (16), a history of criminal convictions (17) and being unemployed (18), which are shown to be associated with suicide in the community, do not appear to be significantly associated with a higher risk of suicide in hospital. The reasons for these differences are unclear, but could be related to the effect of the treatment provided in hospital. For example, it is possible that being in a contained environment reduces the immediate risk of suicide by substance-abusing patients because they are usually not taking substances whilst in hospital, whereas patients with severe mood disorders and schizophrenia might remain unwell for some time after admission.

To date, three research groups have examined the suicide of in-patients and recently discharged patients from the same settings (9, 19–22). Hunt and associates found the risk factors for suicide among in-patients, and recently discharged patients were similar (9, 19), whereas King and associates found that while a prior history of self-harm was a risk factor for suicide as an in-patient and after discharge, a range of other factors, including involuntary admission, a forensic history and depressed mood, were associated with in-patient suicide and not suicide after discharge, while living alone, suicidal ideation, current social problems and recent unemployment were associated with the suicide of discharged patients but not in-patients (22). Modestin and associates (20, 21) also reported different factors to be associated with suicide in separate studies of in-patient suicide, and suicide after discharge. Modestin found that schizophrenia was associated with inpatient suicide and that male gender and pervious self-harm were the most important risk factors after discharge. When the findings of those studies are considered, the results of meta-analysis, revealing a trend towards a lower risk of suicide in hospital of patients who are unemployed, and the lack of any association with demographic factors such as young age, male gender and single marital status are unexpected. Possible differences in the risk factors for suicide among in-patients, former patients and those never admitted to hospital deserve further investigation.

We also found statistical evidence of a bias towards selective reporting of those factors found to be significantly positively associated with in-patient suicide. Overall, as few as half of the examined factors were published. It is understandable that authors would seek to report positive findings that might alert other clinicians to early warning signs and that they would want to make their published work as concise as possible by not reporting negative findings. However, the omission of some factors from the published articles suggests that the strengths of the associations estimated by meta-analysis of published data would have generally been lower if all the data had been available. Suicidal ideation is one such factor. Not every study reported an association between expressed suicidal ideation and in-patient suicide, but if studies that did not find an association between suicide ideation and in-patients suicide were less likely to report this factor than studies that did find an association, then meta-analysis would overestimate the strength of the association between suicidal ideas and subsequent in-patient suicide. A pooled estimate of the association with in-patient suicide after a statistical correction for reporting bias suggested that a weak, non-significant association might have been found if suicidal ideation had been reported in every study.

The major limitation of this meta-analysis of published studies is that the methods employed do not allow an examination of the extent of co-variation between risk factors. It is likely that affective disorder, depressed mood, guilt, worthlessness and the use of prescribed antidepressants are all highly correlated with each other and do not pose a cumulative risk. By contrast, some factors might have independent cumulative associations with in-patient suicide, for example the presence of depressed mood could further increase the already elevated risk of suicide of in-patients with schizophrenia. The second major limitation of the study was that we were unable to examine contextual factors contributing to individual suicides beyond the clinical factors recorded in the studies.

The authors of several of the studies included in this meta-analysis noted the difficulty of predicting suicide, even among patients who have been subjected to detailed interviews and close observation within the controlled environment of a mental health facility (22–24). Using the meta-analytic results for sensitivity of 64% and the specificity of 85% calculated from seven studies, and an estimate of in-patient suicide of one in every 300 admissions (25), the positive predictive value of high-risk categorizations is 1.4% of predictions, which indicates that more than 98 of 100 patients

classified as being at high-risk of committing suicide in hospital would not do so. The predictive value would be lower in in-patient settings with lower rates of in-patient suicides. Furthermore, in all of these studies, high risk was defined retrospectively, and a prospective study with predetermined risk factors would inevitably have a lower predictive value (26). This result is consistent with the findings of Pokorny (27, 28), who reported a sensitivity of 55.5% and a specificity of 74% and a positive predictive value of 2.9% for completed suicide after prospectively examining 4800 consecutive first admission patients over 5 years. Pokorny concluded, 'no compromise between sensitivity and specificity allowed useful identification of particular persons who will commit suicide'. This study would indicate that, if anything, prediction of in-patient suicide is more difficult than prediction of suicide in discharged patients because of the lower base rate of suicide over the shorter period of time of a hospital admission.

Inquiries and legal proceedings after in-patient suicides sometimes conclude that the event was foreseeable. However, the results of this study suggest that such findings are mostly attributable to hindsight bias and are not supported by current scientific evidence (29). Inquiries of the events leading up to in-patient suicide can demonstrate what appear to be failings in hospital systems for preventing self-harm. However, a different type of study comparing patients from different settings would have to be conducted to examine the external factors contributing to individual in-patient suicides, such as staffing levels, frequency of observation, and aftercare arrangements. The addition of an analysis of clusters of suicides in similar and dissimilar care settings might allow a calculation of the relative contribution of individual factors, institutional factors and failures of care to the outcome of in-patient suicide.

The modest strength of the associations with in-patient suicide demonstrated in this study, the low incidence of in-patient suicide and the experience of researchers attempting to develop instruments to predict suicide in community settings, suggests that in-patient suicide cannot be prevented by the categorization of some patients into high-risk groups. Clinicians with a sound knowledge of the risks associated with in-patient suicide might be able to modify care to minimize the risk in some patients identified as being at high risk, but the number of false positive predictions will be very high, and risk assessment will still miss at least 1 in 3 patients who go on to commit suicide in hospital or while on leave. By contrast, risk management can enhance protective factors, particularly in the environment of psychiatric wards (8, 30). The elimination of hanging points appears to be of particular importance because hanging is the method of suicide most used by in-patients (30). A common theme in accounts of in-patient suicide is the availability of means to commit suicide on impulse and the breakdown of systems of supervision of patients in acute distress. Hence, the best prospect for reducing in-patient suicide would appear to lie in improved psychiatric care and communication and in measures to reduce the opportunities to commit suicide while in hospital and not on the risk assessment of individual patients.

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## Supporting Information

Additional Supporting Information may be found in the online version of this article:

**Table S1.** Quality considerations in controlled studies of inpatient suicide.

**Table S2.** Meta analysis of the association between male sex and suicide of psychiatric inpatients.

**Table S3.** Meta analysis of the association between increased age and suicide of psychiatric inpatients.

**Table S4.** Meta analysis of the association between marriage and suicide of psychiatric inpatients.

**Table S5.** Meta analysis of the association between living alone and suicide of psychiatric inpatients.

**Table S6.** Meta analysis of the association between unemployment and suicide of psychiatric inpatients.

**Table S7.** Meta analysis of the association between current social or relationship problem and suicide of psychiatric inpatients.

**Table S8.** Meta analysis of the association between prior suicide attempts and deliberate self harm and suicide of psychiatric inpatients.

**Table S9.** Meta analysis of the association between more prior psychiatric admissions and suicide of psychiatric inpatients.

**Table S10.** Meta analysis of the association between duration of psychiatric illness and suicide of psychiatric inpatients.

**Table S11.** Meta analysis of the association between notable physical illness and suicide of psychiatric inpatients.

**Table S12.** Meta analysis of the association between prior violence or criminality and suicide of psychiatric inpatients.

**Table S13.** Meta analysis of the association between a family history of suicide and suicide of psychiatric inpatients.

**Table S14.** Meta analysis of the association between family history of mental illness and suicide of psychiatric inpatients.

**Table S15.** Meta analysis of the association suicide attempt at the time of admissions and suicide of psychiatric inpatients.

**Table S16.** Meta analysis of the association reported suicidal ideas and suicide of psychiatric inpatients.

**Table S17.** Meta analysis of the association between depressed mood and suicide of psychiatric inpatients.

**Table S18.** Meta analysis of the association between agitation or anxiety and suicide of psychiatric inpatients.

**Table S19.** Meta analysis of the association between feelings of hopelessness and suicide of psychiatric inpatients.

**Table S20.** Meta analysis of the association between feelings of worthlessness, inadequacy of guilt and suicide of psychiatric inpatients.

**Table S21.** Meta analysis of the association between delusional ideas and suicide of psychiatric inpatients.

**Table S22.** Meta analysis of the association between hallucinations and suicide of psychiatric inpatients.

**Table S23.** Meta analysis of the association between the diagnosis of schizophrenia and suicide of psychiatric inpatients.

**Table S24.** Meta analysis of the association between the diagnosis of an affective disorder and suicide of psychiatric inpatients.

**Table S25.** Meta analysis of the association between any psychiatric diagnosis other than schizophrenia or an affective disorder and suicide of psychiatric inpatients.

**Table S26.** Meta analysis of the association between a co-morbid drug or alcohol diagnosis and suicide of psychiatric inpatients.

**Table S27.** Meta analysis of the association between compulsory admission under the mental health act and suicide of psychiatric inpatients.

**Table S28.** Meta analysis of the association between treatment with antidepressant medication and suicide of psychiatric inpatients.

**Table S29.** Meta analysis of the association between treatment with antipsychotic medication and suicide of psychiatric inpatients.

**Table S30.** Meta analysis of the association between length of hospital admission and suicide of psychiatric inpatients.

**Table S31.** Meta analysis of the association between prior suicide attempts and deliberate self harm and suicide of psychiatric inpatients with the diagnosis of schizophrenia.

**Table S32.** Meta analysis of the association between more prior psychiatric admissions and suicide of psychiatric inpatients with the diagnosis of schizophrenia.

**Table S33.** Meta analysis of the association between duration of illness and suicide of psychiatric inpatients with the diagnosis of schizophrenia.

**Table S34.** Meta analysis of the association depressed mood and suicide of psychiatric inpatients with the diagnosis of schizophrenia.

**Table S35.** Meta analysis of the association anxiety or agitation and suicide of psychiatric inpatients with the diagnosis of schizophrenia.

**Table S36.** Meta analysis of high-risk categorisation and suicide of psychiatric inpatients.

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