

## Review article

# Predicting suicide following self-harm: systematic review of risk factors and risk scales

Melissa K. Y. Chan, Henna Bhatti, Nick Meader, Sarah Stockton, Jonathan Evans, Rory C. O'Connor, Nav Kapur and Tim Kendall

## Background

People with a history of self-harm are at a far greater risk of suicide than the general population. However, the relationship between self-harm and suicide is complex.

## Aims

To undertake the first systematic review and meta-analysis of prospective studies of risk factors and risk assessment scales to predict suicide following self-harm.

## Method

We conducted a search for prospective cohort studies of populations who had self-harmed. For the review of risk scales we also included studies examining the risk of suicide in people under specialist mental healthcare, in order to broaden the scope of the review and increase the number of studies considered. Differences in predictive accuracy between populations were examined where applicable.

## Results

Twelve studies on risk factors and 7 studies on risk scales were included. Four risk factors emerged from the meta-analysis, with robust effect sizes that showed little change when adjusted for important potential confounders. These included: previous episodes of self-harm (hazard ratio (HR)=1.68, 95% CI 1.38–2.05,  $K=4$ ), suicidal intent (HR=2.7, 95% CI 1.91–3.81,  $K=3$ ), physical health problems (HR=1.99, 95% CI 1.16–3.43,  $K=3$ ) and male gender (HR=2.05, 95% CI 1.70–2.46,  $K=5$ ). The included studies evaluated only three

risk scales (Beck Hopelessness Scale (BHS), Suicide Intent Scale (SIS) and Scale for Suicide Ideation). Where meta-analyses were possible (BHS, SIS), the analysis was based on sparse data and a high heterogeneity was observed. The positive predictive values ranged from 1.3 to 16.7%.

## Conclusions

The four risk factors that emerged, although of interest, are unlikely to be of much practical use because they are comparatively common in clinical populations. No scales have sufficient evidence to support their use. The use of these scales, or an over-reliance on the identification of risk factors in clinical practice, may provide false reassurance and is, therefore, potentially dangerous. Comprehensive psychosocial assessments of the risks and needs that are specific to the individual should be central to the management of people who have self-harmed.

## Declaration of interest

N.K. and T.K. were chair and facilitator, respectively, of NICE clinical guideline 133 on self-harm (longer term management). The other authors were members of the guideline development group. N.K. sits on the Department of Health's (England) National Suicide Prevention Strategy Advisory Group. Some authors were also co-authors on primary studies included in the review.

## Copyright and usage

© The Royal College of Psychiatrists 2016.

Suicide and self-harm are major public health concerns, both in the UK and internationally.<sup>1–4</sup> Self-harm is one of the most common reasons for hospital admission, and accounts for over 200 000 hospital attendances every year in England and Wales.<sup>5</sup> People who have self-harmed are at much greater risk of future episodes of self-harm and suicide than the general population.<sup>6</sup> It has been estimated that one in six people will repeat self-harm in the year after a hospital attendance.<sup>7</sup> The risk of suicide is elevated by between 30- and 100-fold in the year following self-harm,<sup>6,8</sup> and the risk persists: 1 in 15 people die by suicide within 9 years of the index episode.<sup>7</sup> It has been suggested that multiple repeat episodes of self-harm are associated with an even greater suicide risk.<sup>9</sup> A key priority for health service providers as well as national governments, therefore, is to better identify those individuals who are at high risk of suicide.<sup>10</sup> Investigating the utility of risk factors and risk scales in the prediction of suicide is central to this endeavour.

Much of our understanding of the risk factors for repeated self-harm and suicide is derived from individual studies of variable quality and size. Moreover, reviews of the literature to date have been either largely narrative, retrospective in nature<sup>11</sup> or look at non-fatal outcomes.<sup>12</sup> This raises concerns because prospective cohort studies are more appropriate than retrospective studies for identifying risk factors, and are less prone to bias.<sup>13</sup> A

refinement of a simple 'risk factor' approach to assessment is to incorporate individual factors into composite risk scales. These scales are specifically designed to quantify the risk of later suicide and are commonly used in clinical practice, leading clinicians to classify people as being at low, medium or high risk. A wide variety of risk assessment scales are currently used in different health settings. For example, a recent study in 32 English hospitals found that risk assessment scales were in widespread use, with many services using locally developed instruments.<sup>14</sup> The utility of scales has seldom been investigated in a systematic manner. A recent paper<sup>15</sup> reviewed a number of risk scales, but the researchers did not perform a meta-analysis because of the studies' heterogeneity; they only considered a restricted number of scales used in an emergency department and did not focus on suicide as an outcome.

Drawing on the international research literature, this is the first systematic review and meta-analysis of (a) prospective studies examining the factors associated with suicide following self-harm and (b) risk assessment scales predicting suicide in people who have self-harmed or were under specialist mental healthcare. We were keen to examine individual risk factors as well as combinations of risk factors (in the form of scales) in this paper. Both contribute to clinical assessments of risk in health service settings. The current analyses were initially undertaken

as part of the development of the guideline on the longer-term management of self-harm for National Institute for Health and Care Excellence (NICE).<sup>16</sup>

## Method

### Types of studies and search method

A search was conducted in Embase, MEDLINE, PsycINFO and CINAHL, from their inception up to February 2014, for English-language prospective cohort studies for inclusion in the review of risk factors and risk scales. The use of prospective studies provides some reassurance that the factors identified here are those most robustly linked to later suicide. The searches formed part of a wider search that was undertaken for the NICE guideline on the longer-term management of self-harm<sup>16</sup> and included research articles published up to February 2014. Additional articles were identified through discussion with the NICE Guideline Development Group and from reference lists of relevant studies, including grey literature. We also consulted experts in the field during the consultation period of the guideline by emailing them with a list of papers that had already been identified and asking for any additional studies that had been omitted. Citations from the searches were downloaded to the Reference Manager software tool and duplicates were removed. Records were then screened against the eligibility criteria of the review before being appraised. Full details of the search strategies used for MEDLINE are provided in online Table DS1. The PRISMA statement for this study can be found in online supplement DS1.

### Inclusion criteria

Population: risk factors and risk scales

We included studies of people who presented to hospital following self-harm. Consistent with current research and clinical practice in the UK (NICE clinical guideline 133),<sup>16</sup> we included all types of self-harm irrespective of motive.

For the risk scales review, we also included studies examining the risk of suicide in people under specialist mental healthcare. This was to broaden the scope of the review and increase the number of studies considered. Differences in scale performance between populations were examined where applicable.

Outcomes: risk factors and risk scales

Studies that reported an effect estimate (adjusted or unadjusted odds ratios, risk ratios or hazard ratios (HRs) with their 95% confidence interval) for the association between the examined risk factor and suicide following self-harm were included for meta-analysis. First, one of the authors (M.K.Y.C.) listed all of the risk factors and the reported effect estimates from each study in a table. Then, M.K.Y.C. grouped the risk factors with the reported hazard ratios from different studies. For example, three studies reported the adjusted hazard ratio for the risk factor 'history of previous self-harm' in relation to suicide following self-harm, and these were grouped together then meta-analysed.

Risk assessment scales required previous validation by at least one study to be included in the review. The psychometric properties of the scales that were examined included sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV), using predefined cut-off scores. For further details on the calculation of PPV and NPV, see Altman & Bland.<sup>17</sup> The main outcome was suicide. For studies that did not report PPV or NPV, these were calculated and authors H.B. and N.M. cross-checked each other's calculations.

### Assessment of bias in included studies

The risk factor review adopted the NICE methodology assessment checklist for cohort studies.<sup>18</sup> It consisted of six questions covering the representativeness of the sample, the effect of loss to follow-up, the measurement of prognostic factors and outcomes, the use of confounders and the appropriateness of the statistical analysis for the design of the study.

The quality assessment for the risk scales studies was conducted using the NICE methodology checklist: the Quality Assessment of Diagnostic Accuracy Studies (QUADAS) tool for diagnostic test accuracy.<sup>18</sup> The checklist covered the clarity of the selection criteria, the appropriateness of the reference standard in identifying the target condition, the clarity of the execution of the index test and reference standard to allow replication, and an explanation of drop-out.

There were insufficient studies in the meta-analysis to assess publication bias through standard techniques such as Egger's test.<sup>19</sup> In addition, there are currently no widely accepted techniques for assessing the risk of publication bias in diagnostic accuracy/screening studies,<sup>20</sup> therefore, we did not use any of these techniques.

Two reviewers (M.K.Y.C., H.B.) assessed the quality of each paper. The assessment of study quality was rated by one reviewer (H.B.) and checked by another (M.K.Y.C.). The second reviewer (M.K.Y.C.) checked individual items on the score sheets. For any disagreements that could not be resolved through inter-reviewer discussion, the issues were brought before the full Guideline Development Group (15 members, including experienced psychiatrists, psychologists, academic researchers, practitioners in the field of social care and service user representatives). Discrepancies were discussed until consensus was reached in the group.

### Statistical analysis

Data were extracted and entered into a spreadsheet independently by two reviewers (M.K.Y.C., H.B.) who then checked each other's data extraction and entry. Despite the limited number of studies, meta-analysis was conducted for both reviews because suicide is a rare outcome and meta-analyses may help to highlight the limitations of primary data more clearly.<sup>21</sup> 'K' represented the number of populations studied, and there was no duplication of samples in the meta-analyses. Risk factors robustly reported across multiple distinct samples may have greater validity than those reported in fewer samples. For the risk factor review, the natural log of the hazard ratios and the standard errors from the upper and lower confidence intervals reported for each risk factor were calculated. The natural logs of the ratios and their standard errors were entered into Review Manager 5 software according to the grouping of risk factors. A generic inverse variance method was used to calculate the pooled effect estimates of the hazard ratios. The random-effects model was used to ensure relative conservative results. The *I* statistic was used to quantify heterogeneity in terms of the proportion of total variation of the pooled effect.<sup>22</sup>

For the review of risk scales, data were required from a minimum of four separate samples to conduct bivariate meta-analysis – a limitation imposed by the software that was used. This reflects difficulties in model convergence that are commonly experienced when a smaller number of studies are included in a complex meta-analytic model. The 'metandi' command for Stata 12 was used to obtain pooled estimates of sensitivity and specificity. Review Manager 5 was also used for producing forest plots. Heterogeneity was assessed by visual examination of the

forest plots and the 95% prediction regions of the hierarchical summary receiver operator characteristic (ROC) curve plots.<sup>23</sup>

## Results

In total, 18 590 records were identified from the electronic search. Of these, 18 364 citations were excluded because they were not relevant, and 226 full-text articles were included in the review. There were 12 prospective cohort studies included in the meta-analysis for risk factors associated with suicide following self-harm.<sup>8,24–34</sup> For the full-text articles, studies were excluded if they were retrospective in their design, if the outcomes were not repeated self-harm or not extractable, and if the population did not meet our criteria.<sup>35,36</sup> More details can be found in online Fig. DS1(a). All participants had experienced at least one episode of self-harm and all were recruited in the hospital setting. They were followed up for variable time periods, with suicide most commonly determined from national registers.

Seven prospective cohort studies were included in the review of risk scales.<sup>37–43</sup> Studies were excluded when relevant data were unavailable or the reference standard did not meet the criteria. For example, studies that reported the development of a new measure<sup>44</sup> or did not provide usable data on the prediction of suicide<sup>45,46</sup> were excluded. More details can be found in online Fig. DS1(b). Participants who had self-harmed or were under mental healthcare had all been assessed using a risk assessment scale. They had then been followed up, during which time the number of deaths by suicide was determined in order to provide data for the predictive validity of the scales used.

A risk of bias assessment was conducted for the review of risk factors and risk scales. The two reviewers followed the guideline methodology for assessment, and they reached consensus in their ratings (see the Method section for details). A majority of studies (89.5%) met the criteria and overall they were of acceptable quality, with the exception that the majority of studies (95%) were

unclear about the reasons for loss to follow-up. For a full list of included studies and their characteristics, see online Tables DS2 and DS3.

## Risk factors

Several factors had robust evidence (the adjusted hazard ratio was statistically significant with low heterogeneity) to support their association with suicide following an index episode of self-harm. They included previous episodes of self-harm, suicidal intent, physical health problems and male gender. These factors emerged from the meta-analysis with robust effect sizes that changed little when adjusted for important confounders, and they appeared to be independent of each other.

There was insufficient evidence for other factors included in the meta-analysis to identify or discount an association with the risk of suicide following self-harm. For instance, alcohol misuse was of marginal significance with moderate heterogeneity; however, definitions varied between studies, making interpretation difficult. Psychiatric history and unemployment were also of marginal significance after pooling the effects.

Strong evidence for an association with suicide following self-harm

**Previous episodes of self-harm.** People with a history of self-harm prior to an index episode were at higher risk of completing suicide compared with those who did not have such a history (adjusted HR = 1.68, 95% CI 1.38–2.05,  $K=4$  studies, all were adjusted for confounders and non-significant heterogeneity was observed,  $I^2=19\%$ , Table 1).

**Suicidal intent.** People with suicidal intent were more likely to complete suicide following their index episode of self-harm (adjusted HR = 2.70, 95% CI 1.91–3.81,  $K=3$ , Table 1). The three studies had slightly different definitions of ‘suicidal intent’, although no heterogeneity was observed in our analysis. Aside

**Table 1** Summary of risk factors for adults following an episode of self-harm

Risk factors: evidence base ( <i>n</i> )	Pooled data <sup>a</sup>			Prevalence of risk factor (%), range	Duration of follow-up in years, range
	<i>n</i>	Adjusted HR (95% CI) $I^2$ , %	Unadjusted HR (95% CI) $I^2$ , %		
History of previous self-harm					
Four studies <sup>24,32–34</sup>	32 467	<b>1.68 (1.38–2.05)</b> 19		46–59	2–14
Two studies <sup>8,24</sup>	38 170		2.25 (1.75–2.89) 0	46–51	4–8
Psychiatric history <sup>b</sup>					
Four studies <sup>8,24,28,30</sup>	56 573	1.27 (0.94–1.73) 55		7–39	4–13
Three studies <sup>8,24,30</sup>	55 697		1.72 (0.91–3.22) 92	7–39	4–8
Alcohol misuse					
Three studies <sup>8,25,32</sup>	9 187	1.63 (1.00–2.65) 53		12–26	2–20
Two studies <sup>8,25</sup>	8 914		1.52 (0.79–2.94) 64	25–26	4–20
Physical health problems (chronic illness, physical comorbidity)					
Three studies <sup>8,27,28</sup>	12 143	<b>1.99 (1.16–3.43)</b> 29		5–21	1–13
Two studies <sup>8,27</sup>	11 267		3.67 (2.03–6.62) 29	5–7	1–4
Gender, male					
Five studies <sup>24,26,27,29,34</sup>	43 200	<b>2.05 (1.70–2.46)</b> 0		37–71	1–14
Five studies <sup>8,24,26,27,29</sup>	50 150		2.30 (1.96–2.69) 0	37–71	1–8
Suicidal intent					
Three studies <sup>8,25,34</sup>	9 932	<b>2.70 (1.91–3.81)</b> 0		12–28	4–20
Economic status – unemployed					
Three studies <sup>24,27,30</sup>	51 028	1.08 (0.65–1.8) 71		4–46	1–8
Three studies <sup>24,27,30</sup>	51 028		1.49 (0.66–3.35) 94	4–46	1–8

Results in bold are significant.

a. The ratios (adjusted or unadjusted) are based on what has been reported in the studies. See online Table DS4 for adjusted confounders.

b. Past history, treatments, admissions from records, psychiatric out-patient.

from a binary classification of ‘yes’ or ‘no’,<sup>34</sup> one study used ‘avoided discovery at the time of self-harm’<sup>8</sup> and another used ‘suicidal motive’.<sup>25</sup>

**Gender.** Compared with females, males were at higher risk of completing suicide following an episode of self-harm. Data were pooled to report an adjusted hazard ratio of 2.05 (95% CI 1.70–2.46,  $K = 5$ , Table 1). No heterogeneity was observed.

**Poor physical health.** People with poor physical health/chronic illness were at higher risk of suicide following self-harm. The adjusted hazard ratio for the association between poor physical health and completed suicide was statistically significant (adjusted HR = 1.99, 95% CI 1.16–3.43,  $K = 3$ ,  $I^2 = 29%$ , Table 1).

Marginal evidence for an association with suicide following self-harm

**History of psychiatric contact.** People with a history of contact with psychiatric services were found to be at a slightly higher risk of suicide following self-harm than those without such a history. An adjusted hazard ratio of 1.27, 95% CI 0.94–1.73 ( $K = 4$ ,  $I^2 = 55%$ ) was found (see Table 1 for the unadjusted hazard ratio). The heterogeneity might be explained by the inconsistency in the definition of psychiatric contact.

**Alcohol misuse.** The association between alcohol misuse and completed suicide following self-harm was found to be marginally significant. The adjusted hazard ratio was reported as 1.63, 95% CI 1.00–2.65,  $K = 3$ . However, high heterogeneity was observed ( $I^2 = 53%$  (heterogeneity over 50% was regarded as high)). Unadjusted data from two studies were also pooled, yet resulted in considerable heterogeneity ( $I^2 = 64%$ ) (Table 1). Participants in the studies had a psychiatric diagnosis of alcohol misuse, but

it was unclear whether alcohol was consumed shortly before they died by suicide.

**Economic status.** The pooled and adjusted hazard ratio for this association was not statistically significant (adjusted HR = 1.08, 95% CI 0.65–1.8,  $K = 3$ ) and high heterogeneity was observed ( $I^2 = 71%$ ). The wide confidence interval suggested no clear evidence of an association in the context of high heterogeneity. For the list of adjusted confounding factors, please refer to online Table DS4.

**Risk scales**

Three scales were included in this review: the Beck Hopelessness Scale (BHS),<sup>37</sup> the Suicide Intent Scale (SIS)<sup>39</sup> and the Scale for Suicide Ideation (SSI).<sup>38</sup> A brief description of what these tools were designed to measure/assess are listed in online Table DS5. Table 2 shows the results of the predictive validity of the scales reviewed.

Scales that predict suicide in clinical populations

Of the three included scales, meta-analysis was conducted for studies that used the BHS and SIS, whereas the SSI did not have enough data points. The analysis of the BHS for predicting suicide in high-risk groups comprised four studies: two with patients receiving mental healthcare (60 and 180 months’ follow-up)<sup>37,38</sup> and two with people who had self-harmed (4 and 144 months’ follow-up)<sup>40,43</sup> with a total sample size of 4302. When meta-analysed, the results showed moderate sensitivity (0.80; 95% CI 0.64–0.90) and low specificity (0.46, 95% CI 0.41–0.51). There was moderate to high heterogeneity for both sensitivity and specificity (see Fig. 1(a) for the summary ROC plot and Fig. 2(a) for forest plots). Although comparisons are limited by the small number of studies in the meta-analysis, the BHS appeared

Study, scale (cut-off score)	Sensitivity %	Specificity %	PPV %	NPV %	Prevalence <i>n/N</i> (%)	Risk of bias assessment <sup>a</sup>				
						Selection criteria	Reference standard	Index test sufficient detail to permit its replication?	Reference standard sufficient detail to permit its replication?	Withdrawals explained?
Beck <i>et al</i> (1985) <sup>37</sup> BHS (≥10)	91	50.6	11.6 <sup>b</sup>	98.7 <sup>b</sup>	11/165 (6.67)	Yes	Yes	Unclear	Unclear	Unclear
Beck <i>et al</i> (1999) <sup>38</sup> BHS (≥8) SSI-W (>16) SSI-C (≥2)	90 80 53	42 78 83	1.3 2.8 2.4	99.7 <sup>b</sup> 99.7 <sup>b</sup> 99.5 <sup>b</sup>	30/3701 (0.81) 30/3701 (0.81) 30/3701 (0.81)	No	Yes	Yes	Yes	Unclear
Nimeus <i>et al</i> (1997) <sup>40</sup> BHS (9) BHS (13)	77 77	42 61.3	8 13	96.5 <sup>b</sup> 97.6 <sup>b</sup>	13/212 (6.13) 13/212 (6.13)	No	Yes	No	Yes	Unclear
Nimeus <i>et al</i> (2002) <sup>41</sup> SIS (19)	59	77	9.7	97.8 <sup>b</sup>	22/555 (3.96)	Yes	Yes	Yes	Yes	Unclear
Suominen <i>et al</i> (2004) <sup>43,c</sup> BHS (≥9)	60	52	9.2	93.9 <sup>b</sup>	17/224 (7.6)	Yes	Yes	Yes	Yes	Unclear
Harriss & Hawton (2005) <sup>39</sup> SIS (10, male) SIS (14, female)	76.7 66.7	48.8 75.3	4.2 4	98.6 <sup>b</sup> 99.2 <sup>b</sup>	30/1049 (2.86) 24/1440 (1.67)	Yes	Yes	Yes	Yes	Unclear
Stefansson <i>et al</i> (2012) <sup>42</sup> SIS (16)	100	52	16.7	100 <sup>b</sup>	7/80 (8.75)	Yes	Yes	Yes	Yes	Unclear

a. Criteria for the risk of bias assessment: were the selection criteria clearly described?; was the reference standard likely to classify the target condition correctly?; was the execution of the index test described in sufficient detail to permit its replication?; was the execution of the reference standard described in sufficient detail to permit its replication?; were withdrawals from the study explained?  
b. Calculated score (not reported in original paper).  
c. Not reported in original paper, but obtained by McMillan *et al*<sup>47</sup> for their review by writing to the authors.

to be more sensitive for patients receiving mental healthcare than for people who had self-harmed, but in both groups it was similar in terms of specificity.

The highest sensitivity (100%) reported in any study was for the SIS (54 to 120 months' follow-up).<sup>42</sup> However, the sensitivity of the SIS was much lower in other studies that investigated this instrument. The meta-analysis of the SIS as a whole found relatively low sensitivity (0.73, 95% CI 0.58–0.84) and specificity (0.64, 95% CI 0.50–0.76) based on four populations from three studies and 3124 participants (see Figs. 1(b) and 2(b)).

## Discussion

### Main findings

This is the first meta-analysis of prospective studies investigating risk factors associated with suicide following an episode of self-harm. There is robust pooled evidence from 12 studies to show that four factors (previous episodes of self-harm, suicidal intent, poor physical health and male gender) are associated with a higher risk of dying by suicide following the index episode. In these studies, at least 32% of people had a prior history of self-harm before the index episode.

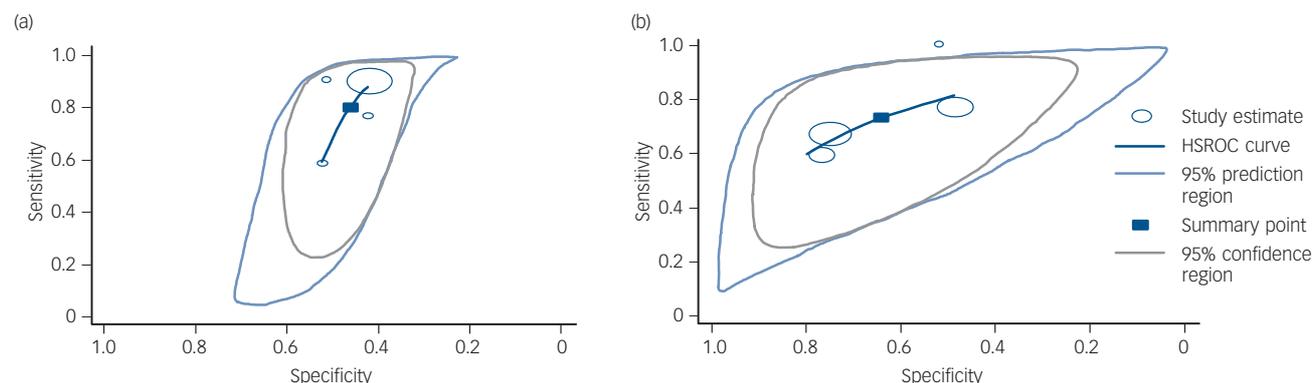
This is also the first systematic review and meta-analysis of a range of risk scales investigating their potential to improve the prediction of suicide in high-risk groups. However, despite using broad inclusion criteria, only seven studies providing data on three scales (BHS, SSI, SIS) met the criteria for our review. Of

these three scales, it was only possible to conduct meta-analysis on two (BHS, SIS). From this review, there is no robust evidence to support the use of one risk scale over another, and because all the scales reviewed had a low PPV with significant numbers of false positives these scales should not be used in clinical practice alone to assess the future risk of suicide. Taken together, our findings cast doubt on the current approach to 'risk assessment' in which risk tools and scales have become the norm.

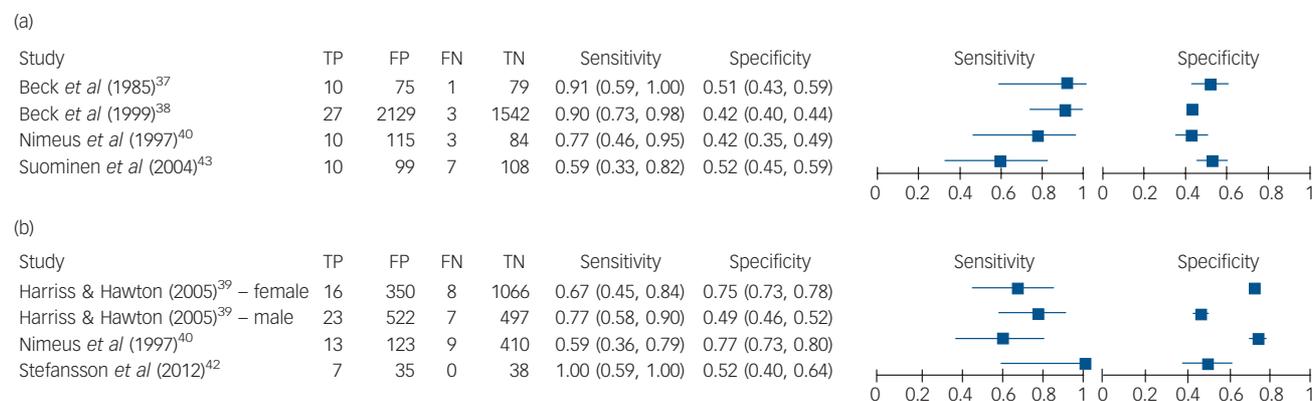
### Methodological issues

Although this review employed a systematic approach, the overlap of risk factors and the fact that very few studies adjust for the same confounders limits our confidence in the meta-analysis. In addition, comprehensive data on the factors associated with suicide following self-harm are not always available. Clearly, these problems limit the interpretation of our findings and leave some uncertainty about which factors should be regarded as the most important markers of risk. Moreover, studies measure risk factors in different ways, which may contribute to the heterogeneity and/or uncertainty of some of the results.

With regard to the risk scales review, a paucity of studies meant that there were limited options for conducting a meta-analysis. In addition, where meta-analyses were possible they were based on sparse data and high heterogeneity. Therefore, only limited conclusions can be drawn. An important drawback is that there were low PPVs (between 1.3 and 16.7%) found for all scales. It could be argued that the low PPV is simply a reflection of the



**Fig. 1** Hierarchical summary receiver operating characteristic (HSROC) plot for (a) Beck Hopelessness Scale and (b) Suicide Intent Scale for predicting suicide.



**Fig. 2** Forest plots for (a) Beck Hopelessness Scale and (b) Suicide Intent Scale for predicting suicide.

TP, true positive; FP, false positive; FN, false negative; TN, true negative.

low incidence of fatal outcomes. This suggests that such scales are identifying many false positives, thereby limiting their utility. However, these studies had very long follow-up periods (up to 15 years), which would increase the incidence of such outcomes. In the shorter term, it is thought that the PPV of these scales will be even lower. For example, Nimeus and colleagues<sup>40</sup> used the shortest follow-up period (4 months) compared with the other studies and found a PPV of 8%. Nevertheless, the clinical implications drawn from studies using long follow-up periods may be of limited use because clinicians' primary concern is to predict suicide in the immediate period following an act of self-harm, rather than in the subsequent months or years. It is also important to recognise that different studies used different risk scales, and some used different cut-off scores for the same risk scales (BHS and SIS). This is probably because reported cut-off scores were determined *post hoc* based on optimal performance derived from the ROC curve. Such approaches are likely to overestimate the screening accuracy of the test, which further raises concerns regarding the performance of all risk scales. Taking these limitations into account, we can conclude that there is insufficient evidence to support the use of risk scales and tools in clinical practice. Nevertheless, given the complexity in this area, the utility of novel risk factors, groups of risk factors and interactions between risk factors in assessment might be helpfully explored in future studies.

### Clinical implications

Self-harm is a major health problem in many countries. People who self-harm have poorer physical health and a lower life expectancy than the general population.<sup>24</sup> What do the results of our review tell us about how we should manage self-harm? Clearly, some factors indicate an increased risk of suicide in this population. We found the strongest evidence for long-recognised risk factors – previous episodes of self-harm, suicidal intent, poor physical health and male gender. The major advantage of our study over previous work was the ability to specifically investigate predictors of suicide risk following self-harm, and to pool findings across studies to produce robust estimates of the magnitude of any increased risk. However, when assessing people following an act of self-harm, being able to identify these associated factors is still unlikely to help us to predict the risk of later suicide,<sup>48</sup> because these characteristics are common in clinical populations.

All of the scales and tools reviewed here had poor predictive value. The use of these scales or an over-reliance on the identification of risk factors in clinical practice, is, in our view, potentially dangerous and may provide false reassurance for clinicians and managers. The idea of risk assessment as risk prediction is a fallacy and should be recognised as such. We are simply unable to say with any certainty who will and will not go on to have poor outcomes. People who self-harm often have complex and difficult life circumstances, and clearly need to be assessed – but we need to move away from assessment models that prioritise risks at the expense of needs.

An alternative approach to the assessment of people who have self-harmed might be to characterise the prior act of self-harm, determine the specific factors that precipitated that episode for that individual and identify those personal factors that could increase the likelihood of later suicide. This may include recognition of the more robust factors identified by this review, including male gender, suicidal intent, having poor physical health and having self-harmed before. It would also include other factors not necessarily common to other people who have self-harmed. To do this would involve: first, understanding the meaning of the act of self-harm for that individual, taking into account their

current relationships, context and past experiences; and, second, understanding how the act of self-harm, the person's intent and their affective state interrelate. No doubt, many of the factors identified in the previous or current reviews will be relevant at assessment. But many will not be. Importantly, there is some evidence that thorough assessments after self-harm may on their own improve outcomes.<sup>49,50</sup> The opportunity for service users to discuss their concerns and formulate action plans may drive the improvements, or it may be that thorough assessments facilitate access to aftercare.

In our collective quest to reduce the risk of suicide following self-harm by building highly structured assessment tools from risk factors, rather than encouraging a real engagement with the individual, we may well be putting our own professional anxieties above the needs of service users and, paradoxically, increasing the risks of suicide following self-harm.

**Melissa K. Y. Chan**, MSc, Centre for Suicide Research and Prevention, University of Hong Kong, Pok Fu Lam, Hong Kong; **Henna Bhatti**, MSc, Centre for Addiction and Mental Health, Toronto, Ontario, Canada; **Nick Meader**, PhD, Centre for Reviews and Dissemination, The University of York, York, UK; **Sarah Stockton**, BA(Hons), National Collaborating Centre for Mental Health, Royal College of Psychiatrists' Research and Training Unit, London, UK; **Jonathan Evans**, MRCPsych, Centre for Academic Mental Health, School of Social & Community Medicine, University of Bristol, Bristol, UK; **Rory C. O'Connor**, PhD, Institute of Health and Wellbeing, University of Glasgow, Glasgow, UK; **Nav Kapur**, FRCPsych, Centre for Suicide Prevention, Centre for Mental Health and Safety, University of Manchester, and Manchester Mental Health and Social Care Trust, Manchester, UK; **Tim Kendall**, FRCPsych, National Collaborating Centre for Mental Health, Royal College of Psychiatrists' Research and Training Unit, London, UK

**Correspondence:** Melissa K. Y. Chan, University of Hong Kong, Centre for Suicide Research and Prevention, 5 Sassoon Road, Pok Fu Lam, Hong Kong. Email: ckymelissa@gmail.com

First received 20 May 2015, final revision 10 Feb 2016, accepted 21 Mar 2016

### Funding

This study was funded in part by NICE during the development of the NICE guideline for self-harm: longer term management.

### Acknowledgements

The authors would like to acknowledge and thank all members of the Guideline Development Group for the NICE Self-harm (longer term management) Guidelines. We would also like to acknowledge the help of Dr Clare Taylor and Ms Nuala Ernest for their help with editing the final version of the manuscript.

### References

- Office for National Statistics. Suicides in the United Kingdom, 2012 Registrations. ONS, 2014 ([www.ons.gov.uk/ons/dcp171778\\_351100.pdf](http://www.ons.gov.uk/ons/dcp171778_351100.pdf)).
- Sullivan EM, Annett JK, Luo F, Simon T, Dahlberg L. Suicide among adults aged 35–64 years – United States, 1999–2010. *MMWR Morb Mortal Wkly Rep* 2013; **62**: 321–5.
- Australia Bureau of Statistics. *Suicide in Australia*. Australia Bureau of Statistics, 2012.
- Home Office. *Homicides, Firearm Offences and Intimate Violence*. Home Office, 2012.
- Hawton K, Bergen H, Casey D, Simkin S, Palmer B, Cooper J, et al. Self-harm in England: a tale of three cities. *Soc Psychiatry Psychiatr Epidemiol* 2007; **42**: 513–21.
- Hawton K, Zahl D, Weatherall R. Suicide following deliberate self-harm: long-term follow-up of patients who presented to a general hospital. *Br J Psychiatry* 2003; **182**: 537–42.
- Owens D, Horrocks J, House A. Fatal and non-fatal repetition of self-harm Systematic review. *Br J Psychiatry* 2002; **181**: 193–9.
- Cooper J, Kapur N, Webb R, Lawlor M, Guthrie E, Mackway-Jones K, et al. Suicide after deliberate self-harm: a 4-year cohort study. *Am J Psychiatry* 2005; **162**: 297–303.
- Zahl DL, Hawton K. Repetition of deliberate self-harm and subsequent suicide risk: long-term follow-up study of 11 583 patients. *Br J Psychiatry* 2004; **185**: 70–5.

- 10 Department of Health. The NHS Mandate. Department of Health, 2012 ([www.gov.uk/government/publications/the-nhs-mandate](http://www.gov.uk/government/publications/the-nhs-mandate)).
- 11 Fliege H, Lee J-R, Grimm A, Klapp BF. Risk factors and correlates of deliberate self-harm behavior: a systematic review. *J Psychosom Res* 2009; **66**: 477–93.
- 12 Larkin C, Di Blasi Z, Arensman E. Risk factors for repetition of self-harm: a systematic review of prospective hospital-based studies. *PLoS One* 2014; **9**: e84282.
- 13 Mann C. Observational research methods. Research design II: cohort, cross sectional, and case-control studies. *Emerg Med J* 2003; **20**: 54–60.
- 14 Quinlivan L, Cooper J, Steeg S, Davies L, Hawton K, Gunnell D, et al. Scales for predicting risk following self-harm: an observational study in 32 hospitals in England. *BMJ Open* 2014; **4**: e004732.
- 15 Randall JR, Colman I, Rowe BH. A systematic review of psychometric assessment of self-harm risk in the emergency department. *J Affect Disord* 2011; **134**: 348–55.
- 16 National Institute for Health and Care Excellence. *Self-harm in Over 8s: Long-Term Management*. Clinical Guidance 133. NICE, 2011 (<https://www.nice.org.uk/guidance/cg133>).
- 17 Altman DG, Bland JM. Statistics Notes: Diagnostic tests 2: predictive values. *BMJ* 1994; **309**: 102.
- 18 National Institute for Health and Care Excellence. *The Guidelines Manual*. NICE, 2009.
- 19 Egger M, Smith GD, Schneider M, Minder C. Bias in meta-analysis detected by a simple, graphical test. *BMJ* 1997; **315**: 629–34.
- 20 Deeks J, Bossuyt P, Gatsonis C. *Cochrane Handbook for Systematic Reviews of Diagnostic Test Accuracy Version 1.0.0*. The Cochrane Collaboration, 2009.
- 21 Higgins JP, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. *BMJ* 2003; **327**: 557.
- 22 Higgins J, Thompson SG. Quantifying heterogeneity in a meta-analysis. *Statist Med* 2002; **21**: 1539–58.
- 23 Rutter CM, Gatsonis CA. A hierarchical regression approach to meta-analysis of diagnostic test accuracy evaluations. *Statist Med* 2001; **20**: 2865–84.
- 24 Bergen H, Hawton K, Waters K, Ness J, Cooper J, Steeg S, et al. Premature death after self-harm: a multicentre cohort study. *Lancet* 2012; **380**: 1568–74.
- 25 Bjornaas MA, Jacobsen D, Haldorsen T, Ekeberg O. Mortality and causes of death after hospital-treated self-poisoning in Oslo: a 20-year follow-up. *Clin Toxicol* 2009; **47**: 116–23.
- 26 Chen VCH, Tan HKL, Chen C-Y, Chen THH, Liao L-R, Lee CTC, et al. Mortality and suicide after self-harm: community cohort study in Taiwan. *Br J Psychiatry* 2011; **198**: 31–6.
- 27 Chen VC, Chou JY, Hsieh TC, Chang HJ, Lee CT, Dewey M, et al. Risk and predictors of suicide and non-suicide mortality following non-fatal self-harm in Northern Taiwan. *Soc Psychiatry Psychiatr Epidemiol* 2013; **48**: 1621–7.
- 28 Holley H, Fick G, Love E. Suicide following an inpatient hospitalization for a suicide attempt: a Canadian follow-up study. *Soc Psychiatry Psychiatr Epidemiol* 1998; **33**: 543–51.
- 29 Kuo C-J, Gunnell D, Chen C-C, Yip PSF, Chen Y-Y. Suicide and non-suicide mortality after self-harm in Taipei City, Taiwan. *Br J Psychiatry* 2012; **200**: 405–11.
- 30 Madsen T, Agerbo E, Mortensen PB, Nordentoft M. Deliberate self-harm before psychiatric admission and risk of suicide: survival in a Danish national cohort. *Soc Psychiatry Psychiatr Epidemiol* 2013; **48**: 1481–9.
- 31 Miller M, Hempstead K, Nguyen T, Barber C, Rosenberg-Wohl S, Azrael D. Method choice in nonfatal self-harm as a predictor of subsequent episodes of self-harm and suicide: implications for clinical practice. *Am J Public Health* 2013; **103**: e61–8.
- 32 Monnin J, Thiemard E, Vandell P, Nicolier M, Tio G, Courtet P, et al. Sociodemographic and psychopathological risk factors in repeated suicide attempts: Gender differences in a prospective study. *J Affect Disord* 2012; **136**: 35–43.
- 33 Nordentoft M, Breum L, Munck LK, Nordestgaard AG, Hunding A, Bjaeldager PL. High mortality by natural and unnatural causes: a 10 year follow up study of patients admitted to a poisoning treatment centre after suicide attempts. *BMJ* 1993; **306**: 1637–41.
- 34 Suokas J, Suominen K, Isometsä E, Ostamo A, Lönnqvist J. Long-term risk factors for suicide mortality after attempted suicide – findings of a 14-year follow-up study. *Acta Psychiatr Scand* 2001; **104**: 117–21.
- 35 Brown GK, Beck AT, Steer RA, Grisham JR. Risk factors for suicide in psychiatric outpatients: a 20-year prospective study. *J Consult Clin Psychol* 2000; **68**: 371.
- 36 Fawcett J, Scheftner WA, Fogg L, Clark DC. Time-related predictors of suicide in major affective disorder. *Am J Psychiatry* 1990; **147**: 1189–94.
- 37 Beck AT, Steer RA, Kovacs M, Garrison B. Hopeless and eventual suicide: a 10-year prospective study of patients hospitalized with suicidal ideation. *Am J Psychiatry* 1985; **142**: 559–63.
- 38 Beck AT, Brown GK, Steer RA, Dahlsgaard KK, Grisham JR. Suicide ideation at its worst point: a predictor of eventual suicide in psychiatric outpatients. *Suicide Life Threat Behav* 1999; **29**: 1–9.
- 39 Harriss L, Hawton K. Suicidal intent in deliberate self-harm and the risk of suicide: the predictive power of the Suicide Intent Scale. *J Affect Disord* 2005; **86**: 225–33.
- 40 Nimeus A, Träskman-Bendz L, Alsén M. Hopelessness and suicidal behavior. *J Affect Disord* 1997; **42**: 137–44.
- 41 Nimeus A, En M, Traskman-Bendz L. High suicidal intent scores indicate future suicide. *Arch Suicide Res* 2002; **42**: 137–44.
- 42 Stefansson J, Nordström P, Jokinen J. Suicide Intent Scale in the prediction of suicide. *J Affect Disord* 2012; **136**: 167–71.
- 43 Suominen K, Isometsä E, Ostamo A, Lönnqvist J. Level of suicidal intent predicts overall mortality and suicide after attempted suicide: a 12-year follow-up study. *BMC Psychiatry* 2004; **4**: 11.
- 44 Steeg S, Kapur N, Webb R, Applegate E, Stewart S, Hawton K, et al. The development of a population-level clinical screening tool for self-harm repetition and suicide: the ReACT Self-Harm Rule. *Psychol Med* 2012; **42**: 2383–94.
- 45 Cooper J, Kapur N, Dunning J, Guthrie E, Appleby L, Mackway-Jones K. A clinical tool for assessing risk after self-harm. *Ann Emerg Med* 2006; **48**: 459–66.
- 46 Bolton JM, Spiwak R, Sareen J. Predicting suicide attempts with the Sad Persons scale: a longitudinal analysis. *J Clin Psychiatry* 2012; **73**: e735–41.
- 47 McMillan D, Gilbody S, Beresford E, Neilly L. Can we predict suicide and non-fatal self-harm with the Beck Hopelessness Scale? A meta-analysis. *Psychol Med* 2007; **37**: 769–78.
- 48 Large M, Sharma S, Cannon E, Ryan C, Nielssen O. Risk factors for suicide within a year of discharge from psychiatric hospital: a systematic meta-analysis. *Aust NZ J Psychiatry* 2011; **45**: 619–28.
- 49 Kapur N, Murphy E, Cooper J, Bergen H, Hawton K, Simkin S, et al. Psychosocial assessment following self-harm: results from the multi-centre monitoring of self-harm project. *J Affect Disord* 2008; **106**: 285–94.
- 50 Bergen H, Hawton K, Waters K, Cooper J, Kapur N. Psychosocial assessment and repetition of self-harm: the significance of single and multiple repeat episode analyses. *J Affect Disord* 2010; **127**: 257–65.



Data supplement to Chan et al. Predicting suicide following self-harm: systematic review of risk factors and risk scales. Br J Psychiatry doi: 10.1192/bjp.bp.115.170050

**Table DS1** Search strategies

Review area	Search construction	Study design	Database/ date range
Risk and protective factors	[(Self-harm terms) AND (Risk and protective factor terms) AND (Observational study filter)]	Observational studies	CINAHL, EMBASE, MEDLINE, PsycINFO [inception of databases up to February 2014]
Risk assessment, needs assessment and psychosocial assessment	*[(Self-harm terms) AND (SR study filter)] [(Self-harm terms) AND (Risk assessment, needs assessment, psychosocial assessment terms) AND (Observational study filter)] [Self-harm terms) AND (predictive/repetition terms) AND (diagnostic accuracy filter terms) AND (named assessment tool terms)]	Systematic reviews  Observational studies  N/A – no study design limit	CINAHL, EMBASE, MEDLINE, PsycINFO [January 1995 up to February 2014]  CINAHL, EMBASE, MEDLINE, PsycINFO [inception of databases up to February 2014]
<p><b>Population search terms</b>  <b>a) Self-harm – population search terms</b>  MEDLINE – Ovid SP interface</p>			

1. overdose / or self-injurious behavior / or self mutilation / or suicidal ideation / or suicide / or suicide, attempted /
2. (autoaggress\$ or auto aggress\$ or automutilat\$ or auto mutilat\$ or cutt\$ or overdoses\$ or (self adj2 cut\$) or selfdestruct\$ or self destruct\$ or selfharm\$ or self harm\$ or selfimmolat\$ or self immolat\$ or selfinflic\$ or self inflict\$ or self injur\$ or self injur\$ or selfmutilat\$ or self mutilat\$ or selfpoison\$ or self poison\$ or suicid\$).ti,ab.
3. or /1-2

**Risk and protective factors**

MEDLINE – Ovid SP interface

*What are the risk and protective factors (internal and external) amongst people who self-harm that predict outcomes?*

1. risk factors/
2. (risk\$ adj2 relative).ti,ab.
3. ((predict\$ or protect\$ or risk\$) adj2 (associat\$ or attribut\$ or correlat\$ or determinant\$ or factor\$ or variable\$)).ti,ab.
4. or /1-3
5. ((predict\$ or risk\$) adj2 (ongoing or recur\$ or re cur\$ or reattempt\$ or re attempt\$ or recur\$ or repeat\$ or repetit\$)).ti,ab.
6. prospective repetit\$.ti,ab.
7. ((associat\$ or attribut\$ or correlat\$ or determinant\$ or factor\$ or variable\$) adj8 (ongoing or recur\$ or re cur\$ or reattempt\$ or re attempt\$ or recur\$ or repeat\$ or repetit\$) adj8 (autoaggress\$ or aggress\$ or automutilat\$ or cutt\$ or destruct\$ or dsh or episode\$ or harm\$ or immolat\$ or inflict\$ or injur\$ or mutilat\$ or overdoses\$ or (self adj2 cut\$) or poison\$ or selfdestruct\$ or selfharm\$ or selfimmolat\$ or selfinflic\$ or selfinjur\$ or selfmutilat\$ or selfpoison\$ or sh or suicid\$)).ti,ab.
8. or /5-7
9. resilience, psychological/
10. (buffer\$ or cope\$ or recovery or resiliens).ti,ab.
11. or /9-10
12. or /4,8,11

**Risk assessment, needs assessment and psychosocial assessment**

MEDLINE – Ovid SP interface

*For people who self-harm, does formal risk assessment, needs assessment and psychosocial assessment improve outcomes?*

1. (checklist/ or geriatric assessment/ or interview/ or interview, psychological/ or mass screening/ or nursing assessment/ or "outcome and process

assessment (health care)"/ or "outcome assessment (health care)"/ or exp personality assessment/ or exp psychiatric status rating scales/ or exp psychological tests/ or questionnaires/)

2. (form\$1 or checklist\$ or check list\$ or index\$ or indices or interview\$ or instrument\$ or inventor\$ or item\$1 or measure\$ or psychometric\$ or psychometric\$ or question\$ or scale\$ or score\$ or scoring or self report\$ or subscale\$ or test\$ or tool\$).ti,ab.

3. 1 or 2

4. "predictive value of tests"/ or recurrence/ or risks\$.hw.

5. (predict\$ or ongoing or recur\$ or re cur\$ or reattempt\$ or re attempt\$ or recur\$ or repeat\$ or repetit\$ or risk\$).ti,ab.

6. 4 or 5

7. area under curve/ or exp sensitivity and specificity/

8. ((area under adj2 curve) or auc or (diagnostic adj2 odds ratio\$) or ((false or true) adj negative) or ((false or true) adj positive) or (likelihood adj3 ratio\$) or ((pretest or pre test or posttest or post test) adj2 probabilit\$) or (predict\$ adj3 value\$) or receiver operating characteristic or (roc adj2 (analy\$ or curv\$ or plot\$)) or sensitiv\$ or specificit\$).tw.

9. 7 or 8

10. and/3,6,9

11. needs assessment/ or risk assessment/

12. ((client\$ or clinical\$ or consumer\$ or need\$ or patient\$ or psychiatric or psychological or psychosocial or psycho social or risk or service user\$ or therapeutic) adj2 (assess\$ or evaluat\$)).ti,ab.

13. (((assess\$ or predict\$ or risk\$) adj2 (form\$1 or checklist\$ or check list\$ or index\$ or indices or interview\$ or instrument\$ or inventor\$ or item\$1 or measure\$ or psychometric\$ or question\$ or scale\$ or score\$ or scoring or self report\$ or subscale\$ or test\$ or tool\$)) or (comprehensive adj (assessment\$ or evaluation\$)).ti,ab.

14. (adult suicidal ideation questionnaire or asiq or (beck depression inventory or bdi) or (beck hopelessness scale or bhs) or ((beck scale adj2 suicide ideation) or bsi) or ((brief reasons adj2 living inventory) or brfl) or (brief symptom inventory or bsi) or ((college student reasons adj2 living inventory) or csrl) or (csr li) or ((edinburgh risk adj2 repetition scale) or errs) or (firestone assessment adj2 self-destructive thoughts) or ((global clinical assessment) or gca) or ((hamilton depression rating scale) or hdrs) or ((hamilton rating scale adj2 depression) or hand or ham d or hrsd or hrs d) or ((intersect scale adj2 suicidal thinking) or iss) or lethality scale\$ or (life satisfaction scale or ls scale) or lifetime parasuicide count or ((inehan reasons adj2 living inventory) or lrfl) or ((manchester self harm rule) or mshr) or ((modified scale adj2 suicide ideation) or mssi) or (parasuicide history interview or phi) or ((quiz adj2 depression adj2 suicide adj2 later life) or qdsl) or (reasons adj2 living inventory) or ((reasons adj2 living scale adj2 older adult questionnaire) or rfl oa) or ((reasons adj2 living scale adj2 younger adult questionnaire) or rly a) or risk rescue rating or ((scale adj2 suicide ideation) or ssi) or (self-inflicted injury severity form or siisf or sii sf) or (self-monitoring suicide ideation scale or smsis of sms is) or (suicidal behaviors interview or sbi) or (suicidal ideation questionnaire or sig) or (suicidal ideation screening questionnaire or sisq or sis q) or (suicidal intent scale or sis) or ((suicide

assessment scale) or suass) or (suicide behaviors questionnaire or sbq) or (suicide intervention response inventory or sir-i) or (suicide opinion questionnaire or soq) or (suicide potential rating scale or suicide lethality scale or spls or spl s) or (suicide probability scale or sps) or (suicide status form or ssf) or ((symptom driven diagnostic system adj2 primary care) or sddspc or sdds pc) or ((positive adj2 negative suicide ideation inventory) or pansij).ti,ab.  
 15. or/11-14  
 16. and/6,9,14  
 17. or/10,15-16

***Systematic review search filter – adapted from a filter designed by the Health Information Research Unit of McMaster University, Ontario, Canada.***

MEDLINE – Ovid SP interface

1. meta-analysis/ or meta-analysis as topic /
2. meta-analysis.pt.
3. ((evidence or quantitative\$ or systematic\$) adj2 (overview or review)).ti,ab.
4. (((bibliographic or electronic) adj database\$) or bids or cochrane or embase or index medicus or isi citation or medline or psyclit or psychlit or pubmed or scisearch or science citation or (web adj2 science)).ti,ab. and review.pt.
5. (metaanal\$ or meta anal\$ or metasynthes\$ or meta synthes\$).ti,ab.
6. ((pool\$ or combined or combining) adj2 (data or trials or studies or results)).ti,ab.
7. or/1-6

***Observational study filter – developed in-house.***

MEDLINE – Ovid SP interface

1. case-control studies/
2. cohort studies/
3. cross-sectional studies/
4. epidemiologic studies/
5. follow-up studies/
6. longitudinal studies/
7. prospective studies/
8. retrospective studies/
9. (cohort\$1 or cross section\$ or crosssection\$ or followup\$ or follow up\$ or followed or longitudinal\$ or prospective\$ or retrospective\$).ti,ab.

10. (case adj2 (control\$ or series)).ti,ab.

11. or/1-10

**Table DS2** Included study characteristics of risk factor review

Study ID	Country	Study length, years	<i>n</i>	Age	% female	Prior history of self-harm before index episode presented at hospital, %	Recruitment setting
Bergen <i>et al</i> (2012) <sup>24</sup>	UK	8	30202	Median: 27 female, 31 male	58.6	46	A&E
Bjornaas <i>et al</i> (2009) <sup>25</sup>	Norway	20	946	Median 31	51	Unclear	Patients discharged from hospital following index episode of self-harm
Chen <i>et al</i> (2011) <sup>26</sup>	Taiwan	6	1083	Mean 37	63	Unclear	Hospital record of self-harm
Chen <i>et al</i> (2013) <sup>27</sup>	Taiwan – Taoyuan	1.5	3299	Mean 36	70.6	Unclear	Self-harm records at hospital A&E
Cooper <i>et al</i> (2005) <sup>8</sup>	UK	4	7968	Median 30	57	51	A&E
Holley <i>et al</i> (1998) <sup>28</sup>	Canada	13	876	35–39% age 21–30	62	Unclear	Hospital admission following self-harm
Kuo <i>et al</i> (2012) <sup>29</sup>	Taiwan – Taipei	5	7601	Median: 34 male, 32 female	69.5	Unclear	Self-harm records at hospital A&E
Madsen <i>et al</i> (2013) <sup>30</sup>	Denmark	4	17257	Median 40	55	32	Patients admitted with self-harm
Miller <i>et al</i> (2013) <sup>31</sup>	USA	5	3600	50% age 15–34 38% age 35–54 12% age ≥55	58.4	0 (in 3 years prior to index attempt (inclusion criteria))	Patients discharged from hospital following index episode of self-harm
Monnin <i>et al</i> (2012) <sup>32</sup>	France	2	273	Mean 37.6	69	59%	Psychiatric emergency unit
Nordentoft <i>et al</i> (1993) <sup>33</sup>	Denmark	10	974	Age 15 or above	63	Unclear	Presented to hospital following self-harm
Suokas <i>et al</i> (2001) <sup>34</sup>	Finland	13–14	1018	54% age below 35	53	48	A&E

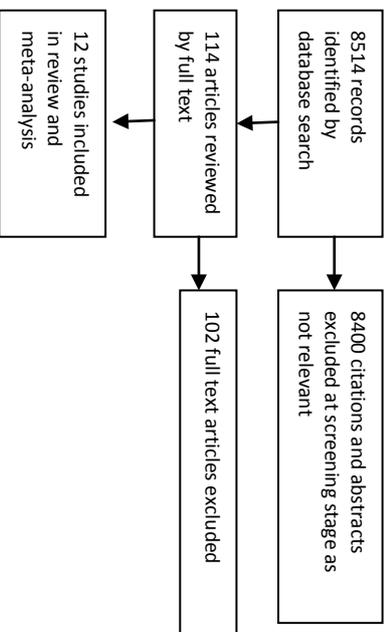
A&E, accident and emergency.

**Table DS3** Included study characteristics for risk scales review

Study ID	Population	Follow-up (months)	N used in analysis	Mean age (years)	% of female	Reference standard
Beck <i>et al</i> (1985) <sup>37</sup>	Psychiatric in-patients	60	165	34	54	Deaths judged as suicide by the Philadelphia (or other) medical examiner's office/coroner's office
Beck <i>et al</i> (1999) <sup>38</sup>	Psychiatric out-patients	180	SSI 3701, BHS	39	57	Suicide ascertained by National Death Index (computer database)
Harriss & Hawton (2005) <sup>39</sup>	People presenting to hospital following self-harm	62.4	2489	Not reported	58	Office of National Statistics for England and Wales, the Central Services Agency in Northern Ireland and the General Register Office for Scotland.
Nimeus <i>et al</i> (1997) <sup>40</sup>	Patients being treated in a psychiatric intensive care unit following suicide attempt	4	212	38	57	Completed suicide ascertained by Lund Department of Forensic Medicine
Nimeus <i>et al</i> (2002) <sup>41</sup>	Patients being treated in a psychiatric intensive care unit following suicide attempt	54 (mean)	555	39	63	Completed suicide ascertained by Lund Department of Forensic Medicine and Swedish National Central Bureau of Statistics
Stefansson <i>et al</i> (2012) <sup>42</sup>	Individuals who have attempted suicide	120	80	37	57	Suicide ascertained by Cause of death register; National Board of Health and Welfare in Sweden
Suominen <i>et al</i> (2004) <sup>43</sup>	Individuals who have attempted suicide	144	224	36	56	Data obtained from national statistics

**Figure DS1** Study flow chart for (a) risk factors review and (b) risk scales review

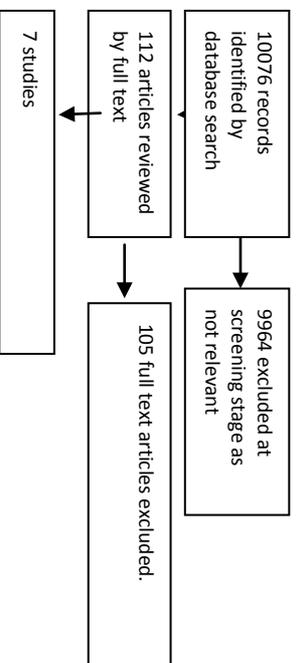
**(a)**



102 full text risk factors articles excluded for the following reasons:

- 18% case-control/ retrospective studies
- 40% population does not fit our criteria (general/ with a specific mental health disorder/ older adults/ adolescents in school/ with intellectual disabilities/ with ideation only)
- 4% mixed population (general plus those with self harm attempt)
- 24% outcomes are not in the format that's extractable or outcomes are not about repeated self-harm (eg/high levels of hostility and hopelessness scores associate with repetition)
- 5% paper not in English or a language that researchers can find resource to translate
- 9% other reasons (couldn't find full text: conference abstract: unrelated)

**(b)**



105 full text risk scales articles excluded for the following reasons:

- 25% were excluded due to reference standard not meeting our criteria ('no data on completed suicide')
- 55% excluded for not providing relevant data to be included in the review ('not possible to populate 2x2 table')
- 18% excluded as not a relevant population

**Table DS4** Adjusted confounds and risk of bias assessment in risk factors studies

<b>Risk factors</b>	<b>Outcome</b>	<b>Depressive symptoms</b>	<b>Previous history of</b>	<b>Age</b>	<b>Gender</b>	<b>Previous psychiatric treatment</b>	<b>Suicide intent</b>	<b>Method of self-harm</b>	<b>Schizophrenia</b>	<b>Physical health problem</b>	<b>Anxiety</b>	<b>Substance abuse</b>	<b>Psychiatric diagnosis</b>	<b>Marital status</b>	<b>Employment</b>	<b>Socioeconomic status</b>	<b>Education</b>	<b>Living alone</b>	<b>Others</b>
History of previous self-harm	Suicide following self-harm <b>Adjusted hazard ratio 1.68 [1.38, 2.05] (I<sup>2</sup>=19%)</b> 4 studies, N=32467 (NORDENTOFT1993, SUOKAS2001, BERGEN2012;MONNIN2012)	K=1, N=273	N/A	K=2; N=31174	K=2; N=31220	K=2; N=31220	K=1; N=1018		K=1; N=273	K=1; N=1080 (Somatic disease)	K=1; N=273	K=1; N=273	K=1; N=30202		K=1; N=30202			K=1; N=974	adjusted for psychosocial assessment in last episode, relationship problem, financial problem, bereavement problem, consequence of previous abuse (K=1, N=30202)  adjusted for smokers, follow up care, current treatment (K=1, N=273)
	<b>Risk of bias:</b>  <i>Study sample – All studies met criteria (represents population of interest regard to key characteristics, sufficient to limit potential bias to results?)</i> <i>Loss to follow-up – None met criteria (whether loss to follow up is unrelated to key characteristics, sufficient to limit potential bias)</i> <i>Putative risk factor - All studies met criteria (adequately measured in study participants)</i> <i>Outcome of interest - All studies met criteria (adequately measured in study participants, sufficient to limit bias)</i> <i>Potential confound- None met criteria (important ones are appropriately accounted for, limiting potential bias with respect to prognostic factor of interest)</i> <i>Statistical analysis- All studies met criteria (is appropriate for design of study, limiting potential for presentation of invalid results)</i>																		

<b>Risk factors</b>	<b>Outcome</b>	<b>Depressive symptoms</b>	<b>Previous history of</b>	<b>Age</b>	<b>Gender</b>	<b>Previous psychiatric</b>	<b>Suicide intent</b>	<b>Method of self-harm</b>	<b>Schizophrenia</b>	<b>Physical health</b>	<b>Anxiety</b>	<b>Substance abuse</b>	<b>Psychiatric diagnosis</b>	<b>Marital status</b>	<b>Employment</b>	<b>Socioeconomic status</b>	<b>Education</b>	<b>Living alone</b>	<b>Others</b>
Psychiatric history (past history, treatments, admissions from records, psychiatric outpatient)	Suicide following self-harm  Adjusted hazard ratio 1.27 [0.94, 1.73] (I <sup>2</sup> = 55%)  4 studies, N=56573 (COOPER2005, HOLLEY1998, BERGEN2012, MADSEN2013)			K=3; N=48605	K=1; N=30202	K=2; N=31078	N/A	K=1; N=7968 (avoided discovery)	K=2, N=8844	K=1, 17527	K=2, N=8844	<b>K=4</b>	K=3, N=48605	K=2; N=47729	K=2; N=18403	K=2; N=47729	K=1, N=17527	K=2; N=25495 (not living with close relatives)	adjusted for psychosocial assessment in last episode, relationship problem, financial problem, bereavement problem, consequence of previous abuse (K=1, N=30202)
<p><b>Risk of bias:</b></p> <p><i>Study sample – 3 of 4 studies met criteria</i></p> <p><i>Loss to follow-up – None met criteria</i></p> <p><i>Putative risk factor - 3 of 4 studies met criteria</i></p> <p><i>Outcome of interest – All studies met criteria</i></p> <p><i>Potential confound- 1 of 4 studies met criteria</i></p> <p><i>Statistical analysis- All studies met criteria</i></p>																			



Risk factors	Outcome	Depressive symptoms	Previous history of	Age	Gender	Previous psychiatric treatment	Suicide intent	Method of self-harm	Schizophrenia	Physical health problem	Anxiety	Substance abuse	Psychiatric diagnosis	Marital status	Employment	Socioeconomic status	Education	Living alone	Others
Physical health problems (chronic illness, physical comorbidity)	Suicide following self-harm Adjusted hazard ratio <b>1.99 [1.16, 3.43]</b> (I <sup>2</sup> =29%) 3 studies, N=12143 (HOLLEY1998, COOPER2005, CHEN2013)		K=1; N=876	K=1, N=3299	K=2; N=4175	K=2, N=8844	K=1; N=7968 (avoided discovery)	K=3(violent method, cutting)				K=2 (alcohol misuse/ as a factor) N=8844	K=2; N=4175	K=1; N=876	K=1, N=3299	K=1; N=876		K=1; N=7968 (not living close with relatives)	Adjusted for residence (urban vs rural); reasons for self harm – problem with romantic relation; problem with family (K=1, N=3299)
<p><b>Risk of bias:</b></p> <p><i>Study sample – 2 of 3 studies met criteria</i></p> <p><i>Loss to follow-up – None met criteria</i></p> <p><i>Putative risk factor - 2 of 3 studies met criteria</i></p> <p><i>Outcome of interest – All studies met criteria</i></p> <p><i>Potential confound- 1 of 3 studies met criteria</i></p> <p><i>Statistical analysis- All studies met criteria</i></p>																			

<b>Risk factors</b>	<b>Outcome</b>	<b>Depressive symptoms</b>	<b>Previous history of</b>	<b>Age</b>	<b>Gender</b>	<b>Previous psychiatric treatment</b>	<b>Suicide intent</b>	<b>Method of self-harm</b>	<b>Schizophrenia</b>	<b>Physical health problem</b>	<b>Anxiety</b>	<b>Substance abuse</b>	<b>Psychiatric diagnosis</b>	<b>Marital status</b>	<b>Employment</b>	<b>Socioeconomic status</b>	<b>Education</b>	<b>Living alone</b>	<b>Others</b>	
Gender – Male	Suicide following self-harm  <b>Adjusted hazard ratio 2.05 [1.70, 2.46] (I<sup>2</sup>=0%)</b>  5 studies, N=43200 (SUOKAS2001, CHEN2011, BERGEN2012, KUO2012, CHEN2013)		K=2; N=31220	K=4; N=42182		K=2; N=31220	K=1; N=1080	K=3; N=11980		K=2; N=1080 (Somatic disease)=3299		K=1; N=30202 (alcohol in last episode)	K=2; N= 33501		K=2; N= 33501					adjusted for psychosocial assessment in last episode, relationship problem, financial problem, bereavement problem, consequence of previous abuse (K=1, N=30202)  Adjusted for residence (urban vs rural); reasons for self-harm – problem with romantic relation; problem with family (K=1, N=3299)
<p><b>Risk of bias:</b></p> <p><i>Study sample – All studies met criteria</i></p> <p><i>Loss to follow-up – 1 of 4 studies met criteria</i></p> <p><i>Putative risk factor – All studies met criteria</i></p> <p><i>Outcome of interest – All studies met criteria</i></p> <p><i>Potential confound- None met criteria</i></p> <p><i>Statistical analysis- All studies met criteria</i></p>																				

Risk factors	Outcome	Depressive symptoms	Previous history of	Age	Gender	Previous psychiatric treatment	Suicide intent	Method of self-harm	Schizophrenia	Physical health problem	Anxiety	Substance abuse	Psychiatric diagnosis	Marital status	Employment	Socioeconomic status	Education	Living alone	Others
Suicide intent	Suicide following self-harm  <b>Adjusted hazard ratio 2.70 (1.91, 3.81) (I<sup>2</sup>=0%)</b>  3 studies, N=9932 (SUOKAS2001, COOPER2005, BJORNAAAS2009)	K=1, N=1018			K=2, N=1964	K=3	N/A			K=2, N=8986		K=2, N=8914				K=1, N=946		K=1, N=7968	adjusted for level of consciousness (K=1, N=946)
<p><i>Risk of bias:</i></p> <p><i>Study sample – All studies met criteria</i></p> <p><i>Loss to follow-up – None met criteria</i></p> <p><i>Putative risk factor – 1 of 3 studies met criteria</i></p> <p><i>Outcome of interest – All studies met criteria</i></p> <p><i>Potential confound- 1 of 3 met criteria</i></p> <p><i>Statistical analysis- All studies met criteria</i></p>																			



**Table DS5** Risk assessment tools and description

<i>Scale</i>	<i>Description</i>
<i>Beck Hopelessness Scale (BHS)</i>	<i>Measures the extent of positive and negative beliefs about the future. Self-report questionnaire consisting of 20 items.</i>
<i>Scale for Suicide Ideation (SSI)</i>	<i>Measures the severity of suicide ideation. Clinician rated questionnaire consisting of 19 items.</i>
<i>Suicide Intent Scale (SIS)</i>	<i>Measures the level of intent to complete suicide in a person who has already attempted it. Interviewed by clinician consisting of 15 items.</i>

## Online supplement DS1 PRISMA statement

<i>PRISMA statement</i>			
Section/topic	Item No	Checklist item	Reported
<b>Title</b>			
Title	1	Identify the report as a systematic review, meta-analysis, or both	✓
<b>Abstract</b>			
Structured summary	2	Provide a structured summary including, as applicable, background, objectives, data sources, study eligibility criteria, participants, interventions, study appraisal and synthesis methods, results, limitations, conclusions and implications of key findings, systematic review registration number	✓
<b>Introduction</b>			
Rationale	3	Describe the rationale for the review in the context of what is already known	✓
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS)	✓
<b>Methods</b>			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (such as web address), and, if available, provide registration information including registration number	✓
Eligibility criteria	6	Specify study characteristics (such as PICOS, length of follow-up) and report characteristics (such as years considered, language, publication status) used as criteria for eligibility, giving rationale	✓
Information sources	7	Describe all information sources (such as databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched	✓
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated	✓ and online Table DS1
Study selection	9	State the process for selecting studies (that is, screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis)	✓
Data collection process	10	Describe method of data extraction from reports (such as piloted forms, independently, in duplicate) and any processes for obtaining and confirming data	✓

		from investigators	
Data items	11	List and define all variables for which data were sought (such as PICO, funding sources) and any assumptions and simplifications made	✓
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis	✓
Summary measures	13	State the principal summary measures (such as risk ratio, difference in means).	✓
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (such as $I^2$ statistic) for each meta-analysis	✓
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (such as publication bias, selective reporting within studies)	✓
Additional analyses	16	Describe methods of additional analyses (such as sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified	n/a
<b>Results</b>			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram	✓ and online Fig. DS1(a) and (b)
Study characteristics	18	For each study, present characteristics for which data were extracted (such as study size, PICO, follow-up period) and provide the citations	✓ and online Tables DS2 and DS3
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome-level assessment (see item 12).	Table 2 and online Table DS4
Results of individual studies	20	For all outcomes considered (benefits or harms), present for each study (a) simple summary data for each intervention group and (b) effect estimates and confidence intervals, ideally with a forest plot	✓
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency	✓ and Tables 1 and 2, Fig. 1 and 2
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see item 15)	✓
Additional analysis	23	Give results of additional analyses, if done (such as sensitivity or subgroup analyses, meta-regression) (see item 16)	n/a

<b>Discussion</b>			
Summary of evidence	24	Summarise the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (such as health care providers, users, and policy makers)	✓
Limitations	25	Discuss limitations at study and outcome level (such as risk of bias), and at review level (such as incomplete retrieval of identified research, reporting bias)	✓
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research	✓
<b>Funding</b>			
Funding	27	Describe sources of funding for the systematic review and other support (such as supply of data) and role of funders for the systematic review	✓

✓, included in main text.

# BJPpsych

The British Journal of Psychiatry

## Predicting suicide following self-harm: systematic review of risk factors and risk scales

Melissa K. Y. Chan, Henna Bhatti, Nick Meader, Sarah Stockton, Jonathan Evans, Rory C. O'Connor, Nav Kapur and Tim Kendall

*BJP* published online June 23, 2016 Access the most recent version at DOI: [10.1192/bjp.bp.115.170050](https://doi.org/10.1192/bjp.bp.115.170050)

---

### Supplementary Material

Supplementary material can be found at:  
<http://bjp.rcpsych.org/content/suppl/2016/06/13/bjp.bp.115.170050.DC1.html>

### References

This article cites 0 articles, 0 of which you can access for free at:  
<http://bjp.rcpsych.org/content/early/2016/06/10/bjp.bp.115.170050#BIBL>

### Reprints/permissions

To obtain reprints or permission to reproduce material from this paper, please write to [permissions@rcpsych.ac.uk](mailto:permissions@rcpsych.ac.uk)

### P<P

Published online 2016-06-23T00:05:12-07:00 in advance of the print journal.

### You can respond to this article at

</letters/submit/bjprcpsych;bjp.bp.115.170050v1>

### Downloaded from

<http://bjp.rcpsych.org/> on June 26, 2016  
Published by The Royal College of Psychiatrists

---

Advance online articles have been peer reviewed and accepted for publication but have not yet appeared in the paper journal (edited, typeset versions may be posted when available prior to final publication). Advance online articles are citable and establish publication priority; they are indexed by PubMed from initial publication. Citations to Advance online articles must include the digital object identifier (DOIs) and date of initial publication.

---

To subscribe to *The British Journal of Psychiatry* go to:  
<http://bjp.rcpsych.org/site/subscriptions/>

---