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Meta-analysis of suicide rates in the first week and first month after psychiatric hospitalisation

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ABSTRACT

Objective

To assess the magnitude of suicide rates in the first week and first month post-discharge from psychiatric hospitalisation.

Design

Systematic meta-analysis of relevant English-language, peer-reviewed located in Medline, PsychINFO or Embase and supplemented by hand searching and by personal communication. In all analyses a generalized linear mixed effects model

was fitted to the number of suicides, with a Poisson distribution, log link, and log of person years as an offset. All models included a random effects model at the level of study.

Outcome Measures

Suicides per 100,000 person years in the week and first month after discharge from psychiatric hospitalisation.

Results

Twenty-nine studies reported 3,551 suicides during 222,546 patient years in the first month post-discharge. The pooled estimate of the first month post-discharge suicide rate was 2,060 (95% confidence interval (CI) = 1,300–3,280 suicides per 100,000 person years with high between study heterogeneity (I^2=89.5). Twenty-four studies reported 1,928 suicides during 60,880 patient years in the first week post-discharge. The pooled estimate of the first month post-discharge suicide rate was 2,950 (95% CI = 1,740–5,000 suicides per 100,000 person years with high between study heterogeneity, I^2 = 87.7)

Conclusion

Acknowledging the presence of marked heterogeneity between studies, the first month post-discharge form psychiatric hospitalisation, particularly the first week, is a time of extraordinary suicide risk. Short-term follow-up of discharged patients should be augmented with greater focus on safe transition from hospital to community care.

Registration

Prospero registration CRD42016038169

Funding

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Strengths and limitations of this study

- Published and previously unavailable data were synthesised to estimate rates of suicide in the first week and first month post discharge from psychiatric hospitalisation
- Rates of suicide were about 3000 and 2000 per 100,000 person years respectively in the first week and first month post discharge
- Published studies reported higher suicide rates than data obtained by personal communication
- High between study heterogeneity impacts on the generalizability of our estimated rates
- The period immediately following discharge from psychiatric hospitalisation should be regarded as a distinct phase of care associated with an extraordinary suicide risk.

Data Sharing

All Individual study data is available in the supplementary material.

Introduction

Suicidal thoughts and behaviour are among the most common reasons for in-patient psychiatric care.[1 2] Despite the care and protection against suicide offered by psychiatric hospitalisation, rates of suicide by current inpatients are worryingly high [3] and appear to be further elevated after discharge. A recent meta-analysis estimated a rate of suicide of 1,132 per 100,000 person years in the first three months post-discharge.[4] Although several primary studies have reported on suicide in the immediate post-discharge period [5-7] expected rates of suicide in the first week and month of transition from the hospital to the community remain uncertain.

The aim of this study was to calculate a pooled estimate and statistical dispersion (range, median and quartile values) of one-week and one-month post-discharge suicide rates.

Methods

The meta-analysis was registered with PROSPERO [8] (Registration CRD42016038169) and conducted according to PRISMA[9] and MOOSE[10] guidelines.

Search Strategy and Selection Criteria

We included studies that reported the number of adults discharged and the number of suicides in the first week (one-week) and first month or 28 days post-discharge (referred to here as one-month) after psychiatric hospitalisation. In order to focus on the suicides after discharge from acute adult psychiatric hospitalisation, we excluded studies of post-discharge suicide after release from child and adolescent wards, long-stay wards, forensic facilities, emergency departments, and medical or surgical wards of general hospitals. Studies were excluded if the number of suicides and number of person years were not reported, could not be calculated, or could not be obtained by email from the authors.

Two authors (DC and ML) independently searched Medline, PsychINFO and Embase for relevant papers published in English (See Figure 1). Electronic searches were supplemented by hand searches of the relevant review articles. Grey literature was not considered. DC and ML independently winnowed titles, abstracts, and full text papers. Whenever possible the authors of studies reporting post-discharge suicide rates over periods of longer than a month were contacted by email for data regarding suicides in the one-week and one-month periods, and those reporting post-discharge suicide in the first month or 28 days were contacted for data about suicides in the first week post-discharge.

Data extraction

SS and MW independently extracted the data and ML and DC performed a further independent check of the data jointly. The number of person years was calculated using the number of discharges and the period of follow-up of 28 or 31 days when it was not directly reported in the paper. Where the follow up was specified to be 'one-month' the length of follow up was assumed to be 365/12 = 30.4 days. Separate figures were extracted for

men and women and for the first and subsequent weeks of follow up where possible.

A predetermined list of moderator variables was extracted for each sample: including the country in which the study was conducted, whether the data was obtained by personal communication with the authors and according to a strength of reporting scale.

The strength of reporting of each study was assessed using a 0-4 point scale derived from the Newcastle-Ottawa Scale for assessing the quality of nonrandomised studies[11] and used in a previous meta-analysis of post-discharge suicide rates.[4] One point was awarded if the study: identified suicides using coroners' records or a national mortality database (rather than using hospital records); included all the post-discharge suicides in a defined geographic region (rather than suicides from a particular care setting); included open verdicts in suicide numbers; reported the number of discharges (rather than the number of individuals).

Data analysis

The effect sizes of interest were the incidence rate (IR), expressed as suicides per 100,000 person years and the incidence rate ratio (IRR). In all analyses a generalized linear mixed effects model was fitted to a count response (number of suicides), with a Poisson distribution, log link, and log of person years as an offset. All models included a random effect (intercept) for study. Confidence intervals were based on t-distribution with df equal to the number of studies. All models were fitted with the R package lme4. Some standard errors were calculated using the delta method from the R package car.

Pre-specified subgroup analyses according to the period of follow up, source of the data (published or obtained by personal communication), country of publication, sex, and strength of reporting.

Publication bias was assessed by comparing the results reported in published studies to that obtained by personal communication and by the examination of Funnel Plots.

Patient and Public Involvement

The results of this study were discussed with Easter Suburbs Mental Health Service, Consumer Advisory Group for their views on suicide prevention in the suicide in the post discharge period.

Results

Two independent searches (DC and ML) identified 24 of 26 papers reporting on suicides occurring in the first week or first month after discharge. A further 8 studies could be included after data were provided by personal communication with the authors, such that results for suicides in the first week or first month (or both) post-discharge was available from 34 papers (Table 1, eSupplement 1.). Of the 34 studies, 8 were from Asian countries, 1 was from Australia, 13 from mainland Europe and Nordic countries, 7 from North America and 5 from the United Kingdom. The earliest study was published in 1983, the median year of publication was 2009 and the most recent was published in 2017. Twenty-nine papers contained data pertaining to the first month post-discharge (eSupplement 2). Twenty-four papers reported on suicides in the first week post-discharge (eSupplement 3).

There were disagreements about 6 of the 68 data points relating to effect size. All disagreements were resolved by a second examination of the data by DC and ML.

Twenty-nine studies reported 3,551 suicides in the first month after discharge during 222,546 person years. The mean number of suicides per study was 122.4 (SD 442.9) and the mean number of person years per study was 7,674 (SD 22 581). Four studies with no suicides were included in the analysis. The median sample suicide rate was 2,333 per 100,000 person years with a range of 0 to 30,252 per 100,000 person years. The first and third quartiles were 601 and 4,555 per 100,000 person years, respectively (see Figure 2. Forrest Plot of suicide rates in one month following discharge from psychiatric hospitalisation)

The pooled rate of one-month post-discharge suicide was 2,060 per 100,000 person years (95% CI 1,300–3,280) with very high between-sample heterogeneity ($Q = 266.8$, $p < 0.001$, $I^2 = 89.51$). The eight studies deemed to have stronger reporting strength had a lower pooled suicide rate of 1,360 per 100,000 person years compared to the 20 studies with less

strong reporting that had a pooled suicide rate of 2,720 per 100,000 person years (IRR 2.00 95% CI 1.98–2.01). The eight studies from Asian countries had the highest pooled suicide rate of 3,230 per 100,000 person years (95% CI 1,470–7,100), followed by the 10 studies from European countries (2,340 per 100,000 person years, 95% CI 1,170-4,680), the five studies from the UK (2,020, 95% CI 630-6,490), and the 6 North American studies had the lowest rate (1,030, 95% CI 450–2,380).

Data for male and female suicides was available for 10 of the 29 studies reporting one-month post-discharge suicides including 6 studies with gendered data obtained by personal communication. Men had a significantly higher pooled rate of suicide (1,400 per 100,000 person years, 95%, CI 780 – 2,500) than women (720 per 100,000 person years, 95%, CI 390 – 1,320: IRR 1.94 95%, CI 1.54 – 2.44) and a higher rate of suicide in each of the 10 studies (See eSupplement 4 & 5).

Excluding four studies that reported no suicides in the first week or first month, fifteen studies reported suicides in the first month post-discharge and reported suicides in the first week post-discharge allowing a direct comparison of the suicide rate in the first week post-discharge to the remaining 8-31 days. Among these studies, the pooled suicide rate in the first week post-discharge was 3,170 per 100,000 (95%, CI 1,710–5,890) compared to a rate of 1,060 per 100,000 person years (95% CI, 660–1,700; IRR 2.99 95% CI 2.24- 3.97) in post-discharge day 8-31. Suicide rates were higher in the first week than in the subsequent period in every study that had 1 or more suicides in the first week (See eSupplement 6 & 7).

The seven data points obtained by personal communication had a significantly lower one-month post-discharge suicide rate of 920 suicides per 100,000 person years compared to 22 data points extracted directly from the publications of 2 880 per 100,000 person years (IRR 3.14, 95% CI 1.29 – 7.63). The Funnel Plot was characterised by 8 studies with lower suicide rates than the pooled estimate and 5 studies with higher suicide rates than the pooled estimate lying outside the Funnel (eSupplement 8).

Data from 24 studies could be included in a meta-analysis of one-week post-discharge suicide rates. These included the 15 studies reporting suicides within a month and a week, four studies that reported no suicides in the first month, and an additional five studies that did not report suicides in the first month. The 24 studies reported a total of 1,928 suicides (mean = 80.3 per study, SD= 315.5, median = 8) per study during 60,880 person years (mean = 2536.7 per study, SD = 7783, median = 174.5). The median sample suicide rate was 3 186 per 100,000 person years (range 0–75,000 per 100,000, first quartile = 567, third quartile = 6,730).

The pooled one-month post-discharge suicide rate was 2,950 suicides per 100,000 person years (24 studies, 95% CI 1,740-5,000) with very high between study heterogeneity (Q = 186.4. $p < 0.0001$), $I^2 = 87.66$). (see Figure 3. Forrest Plot of suicide rates in one week following discharge from psychiatric hospitalisation). Studies considered to have a lower strength of reporting had a higher rate of suicide (19 studies, 3,950 per 100,000 person years, 95% CI 3,910–3,990) than studies with less strong reporting (5 studies, 1,400 per 100,000 person years, 95% CI 1,380-1,410; IRR 2.83 95% CI 2.80-2.85).

Data extracted from published papers suggested a significantly higher rate of suicide (16 studies, 5,090 per 100,000 person years, 95% CI 2,930-8,840) than personally communicated data (8 studies, 1,400 per 100,000 person years, 95% CI 740–2,680; IRR 3.63, 95% CI 1.55 – 8.49). The Funnel Plot was characterised by 5 studies with lower suicide rates than the pooled estimate and 4 studies with higher suicide rates than the pooled estimate lying outside the Funnel (eSupplement 9).

Discussion

This study synthesises over thirty years of research into suicide rates in the immediate period after a psychiatric hospitalisation. One-week post-discharge suicide rates were approximately 3,000 suicides per 100,000 person years while one-month rates were approximately 2,000 per 100,000 person years. Rates from the beginning of the second week to the end of the fourth week or one-month post-discharge were approximately 1,000 per 100,000 person years. These rates can be seen in relation to national suicide rates and compared to earlier meta-analytic estimates of post-discharge suicide over longer periods of follow up. Rates of suicide of 2000 to 3,000 per 100,000 person years are about 200–300 times typical rates of suicide rate in the general populations[12] and are twice to three time estimated rates of suicide of 1,132 per 100,000 person years in the first three months and first year post-discharge respectively.[4] The six-fold risk of suicide in the first week post-discharge compared to the long term rates of suicide after psychiatric discharge of about 500 per 100,000 person years can be compared to meta-analytic estimates of the strength of clinical risk factors for suicide (odds ratio =1.50) [13] and high-risk models for suicide (odds ratio = 4.84) [14] reported in longitudinal studies. This confirms the view that period following discharge is at least as important, and likely a more important suicide risk factor than other clinical risks factors.[15]

The main limitation or our study is that there remains uncertainty about the extent to which our pooled estimates can be generalised. We observed very high between-study heterogeneity that was at least partly explained by publication bias towards studies with high suicide rates in this period. Moreover, in all likelihood there are real differences in post discharge suicide rates between settings some of which might be explained by the characteristics of the patients who are admitted and quantity and quality of post-discharge care. Finally, we found some evidence of lower rates of suicide reported in studies that we considered had stronger methods and therefore less risk of biased findings.

Our findings emphasise the importance of post-discharge follow up. Currently in the United States only around half of commercially insured

patients and a third of Medicare patients in the US received a psychiatric follow-up visit within 7 days of hospital discharge for a mental illness.[16] In the United Kingdom, the NICE guidelines suggest that people discharged from mental health settings are followed up within seven days. [17] While the introduction of a seven day follow period is one of a suite of measures that do seem to be associated lower suicide rates in the UK[18] it is sobering to consider that some patients who are scheduled to be followed up at the seven day mark will die before they are ever reassessed.

The very high rates of suicide in the immediate post-discharge should encourage clinicians to think carefully about the patient's transition from hospital to the community. Qualitative research suggests that the transition from hospital to home is associated with the re-emergence of pre-existing social stresses and new stresses associated with hospitalisation.[19-21] Clinicians should consider strategies that might improve this transition, including pre- and post-discharge patient psychoeducation, a formal needs based assessments, use of transitional care teams and improved communication between the inpatient team, and greater involvement of the patient's outpatient team and family.[22] The high risk of suicide during the period immediately following hospital discharge provides a clinical rationale for conceptualizing the first post-discharge month as a distinct phase of recovery and treatment, especially in the context of pervasive gaps in treatment following psychiatric hospitalization. Traditional case management approaches to continuity of care following psychiatric hospitalisation have not consistently yielded promising results. In one review, two of seven studies of telephone follow-up and one of five studies that involved facilitating communication between inpatient and outpatient clinicians resulted in a significant increase in continuity of care [22]. Intensive interventions that involve home visits, social support, motivational interviewing, and accompanying patients to outpatient appointments have yielded more encouraging results.[23 24]

Our finding of higher rates of suicides by men in the immediate post-discharge period is unsurprising because of the preponderance of men among all suicides [12] but is in contrast with less clear gender effects on inpatient suicide rates. [25 26]

Other limitations relate to the representativeness of the included studies. All of the research came from high-income economies of Asia, Australasia, North America, and Europe and our results might not be representative of post-discharge suicide in low and middle-income countries. Moreover, there were an insufficient number of studies to determine whether apparent differences in suicide rates between regions were real or were simply the result of the set of available studies. Differences between rates of post-discharge suicide between countries are plausible because of differences in national suicide rates, [12] progress towards deinstitutionalisation, [27] and likely national differences in the quality of mental health care systems [28]

Although it has been argued that one way of combatting post-discharge suicide is to focus on individual patients with clinical characteristics that signify a high suicide risk,[29 30] the very high suicide rates calculated in this study and the known limitations of suicide risk assessment [31] suggest that a narrow focus on clinical risk assessment might mislead clinicians into thinking that some patients can be regarded as being at low risk post-discharge.[32] Our findings better support the views of authors who believe in an approach to suicide prevention focussed on whole cohorts of discharged patients.[33]

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There was no funding source for this study.

Conflicts of Interest

Dr. Olfson reports grants from Janssen Scientific Affairs, outside the submitted work.

Author Contributions

Daniel Chung - literature search, study design, data interpretation and writing.
Mr Dusan-Hadzi Pavlovic - figures, data analysis, study design, writing
Maggie Wang - data collection, data interpretation and writing
Sascha Swaraj - data collection, data interpretation and writing
Mark Olfson - literature review, data collection, data interpretation, writing and critical review and writing.
Matthew Large - study supervision, literature search, study design, data interpretation and writing

Dr Large has full access to all the data in the study and takes responsibility for the integrity of the data and accuracy of the analysis

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Table

Table 1. List of included studies

Study	Location	Period	Suicide Ascertainment	Type of Patient	Discharges	Suicides in the first week	Suicides on the first month
Castelein et al., (2015) [34]	Psychiatric hospitals in Groningen, the Netherlands	2000-2011	Regional psychiatric case register	Recent onset psychosis	424	1	-
De Leo & Heller (2007) [35]	Gold Coast Hospital, Queensland, Australia	2002-2005	Not specified	Previous suicide attempters	60	0	0
Deisenhammer et al. (2016) [36]	Three psychiatric hospitals, Tyrol, Austria	2004-2011	Not specified	Unselected adults	65,652	25	51
Erlangsen (2006) [37]	All psychiatric hospitals, Denmark	1990-2001	Coronial records	Adults aged >60 years	72,701	77	-
Geddes et al. (1997) [38]	All psychiatric hospitals,	1968-1993	Coronial records	Unselected adults	338,013	-	367

	Scotland, UK						
Goldacre et al. (1993) [39]	Hospitals within the Oxford Regional Health Authority, UK	1979-1986	Coronial records	Unselected adults	26,864	-	44
Hayashi et al. (2012) [40]	Tokyo Metropolitan Matsuzawa Hospital, Japan	2006-2009	Not specified	Admitted suicidal patients	3,450	-	0
Healy et al. (2006) [41]	Unspecified hospitals, North Wales UK	1994-2003	Coronial records	Psychotic patients	133	-	2
Ho (2003) [5]	All psychiatric wards and hospitals in Hong Kong, China	1997-2000	Coronial records	Unselected adults	21,921	-	124
Isometsa (2014) [42]	All psychiatric wards and hospitals, Finland	1987-2004	Coronial records	Adults with bipolar disorder	52,747	53	158

Johansson (1996) [43]	All psychiatric inpatients in southern Stockholm, Sweden	1984-1985	Coronial records	Unselected adults	3,862	4	12
Kessler et al. (2015) [44]	US Army psychiatric hospitals and wards, USA	2004-2009	Coronial records	US army psychiatric patients	53,769	5	17
Lee & Lin (2009) [45]	All psychiatric wards and hospitals in Taiwan	2001-2005	Coronial records	Patients with schizophrenia	435	22	39
Links et al. (2012) [46]	St Michael's Hospital, Toronto, Canada	2007-2009	Not specified	Patients with previous suicidal behaviour or ideation	120	-	3
Luxton et al. (2013) [47]	US Military treatment facilities, USA	2001-2011	Coronial records	US service members	68,947	-	35
Madsen & Nordentoft (2013) [48]	All psychiatric wards and hospitals in	1998-2006	Coronial records	Unselected adults	287,866	175	374

	Denmark						
Naik et al. (1997) [49]	Saxondale Hospital, Nottinghamshire, England, UK	1974-1992	Local registers and NHS central register	Unselected adults	86	-	0
Nyman (1986) [50]	Unspecified psychiatric hospital, Sweden	1964-1968	Coronial records	Patients with schizophrenia	110		0
Olfson (2016) [51]	Psychiatric patients from 45 American states	2001-2008	Coronial records	Unselected adults	770,643	49	151
Park et al. (2013) [52]	Asan Medical Center, Seoul, South Korea	1989-2006	Coronial records	Unselected adults	8,403	10	26
Pedersen et al. (2014) [53]	All psychiatric hospitals and wards in Denmark	2005-2010	Coronial records	Patients with schizophrenia	7,107	6	-
Pirkola et al. (2007) [54]	All psychiatric hospitals	1985-2001	Coronial records	Unselected adults	355,000	1,164	1,698

	and wards in Finland						
Pokorny (1983)[55]	Houston Veterans Administration Medical Centre, Texas, USA	Not specified	Coronial records	Veterans administration patients	4,800	10	16
Qurashi et al. (2006) [56]	Unspecified hospital, Manchester, England, UK	Not specified	Not specified	Unselected adults	69	1	-
Riblet (2017) [57]	All American Veteran Health mental health inpatient units	2002-2015	Coronial records	Unselected American service-people	1,126,179	141	-
Ruengorn et al. (2011) [58]	Suanprung Psychiatric Hospital, Chiang Mai, Thailand	2007-2010	Hospital records	Mood disorder patients admitted for suicide attempt	235	1	1
Sani et al. (2011) [59]	Belvedere Montello Hospital,	1964-1998	Coronial records	Unselected adults	4,441	2	-

	Rome, Italy						
Seemuller et al. (2014) [60]	Twelve centres across Germany	Not specified	Study follow up	Patients with major depression	1,014	1	1
Tejedor et al. (1999) [61]	Psychiatric Department of Santa Cruz y San Pablo Hospital, Barcelona, Spain	1983-1997	Study follow up	Suicide attempters	150	0	1
Tsai (2002) [62]	Taipei City Psychiatric Center, Taiwan	1985-1997	Coronial Records	Patients with mood disorders	2,133	0	24
Tseng et al. (2006) [63]	Unspecified psychosomatic ward, Taiwan	2000-2002	Study follow up	Patients with major depression	67		2
Valenstein (2009)[64]	All US veteran psychiatric inpatient facilities	1999-2004	Coronial data	American veterans with mood disorders	184,093	50	127
Winkler et al. (2015) [65]	All psychiatric hospitals and	2006-2012	Coronial records	Unselected adults	137,290	131	258

	psychiatric wards, Czech Republic						
Yim (2004) [66]	Pamela Youde Nethersole Eastern Hospital, Hong Kong	1996-1999	Coronial records	Unselected adults	6,292	-	20

Figures 1-3

Figure 1. Prisma Flow Chart

Figure 2. Forrest Plot of suicide rates in one month following discharge from psychiatric hospitalisation

Figure 3. Forrest Plot of suicide rates in one week following discharge from psychiatric hospitalisation

eSupplements 1-9

1. Strength of reporting items of included studies
2. Suicide rates in one month following discharge from psychiatric hospitalisation
3. Suicide rates in one week following discharge from psychiatric hospitalisation
4. Suicide rates in one month following discharge from psychiatric hospitalisation with gender subgroups.
5. Forest Plot of studies reporting suicides by men and women in one month following discharge from psychiatric hospitalisation
6. Suicide rates in one week and two-four weeks following discharge from psychiatric hospitalisation
7. Forrest Plot Suicide rates in one week and two-four weeks following discharge from psychiatric hospitalisation
8. Funnel Plot of Suicide rates in one month following discharge from psychiatric hospitalisation
9. Funnel Plot of Suicide rates in one week following discharge from psychiatric hospitalisation

Figure 1. Prisma Flow Chart

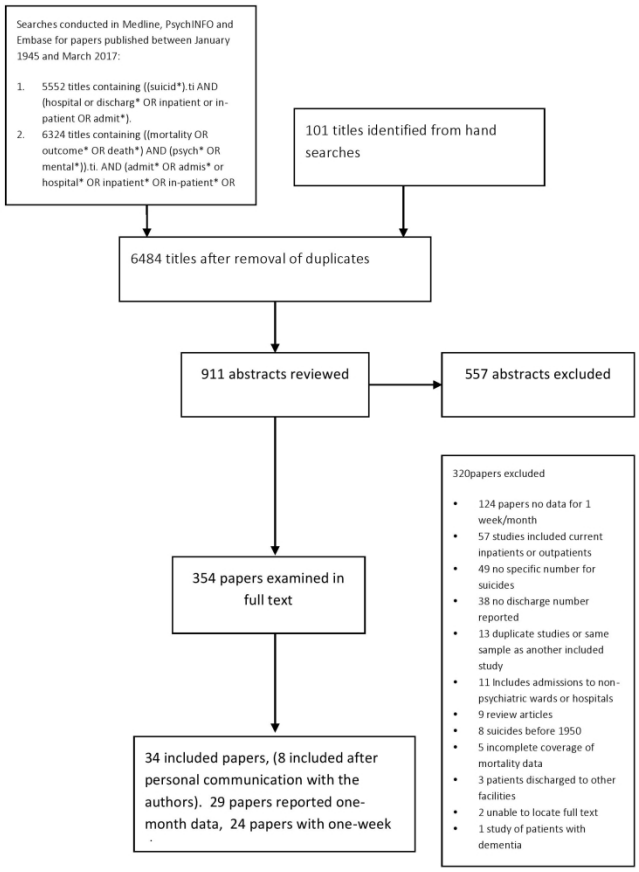

Figure 1.Figure 1. Prisma Flow Chart of Searches

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Figure 2. Forrest Plot of suicide rates in one month following discharge from psychiatric hospitalisation

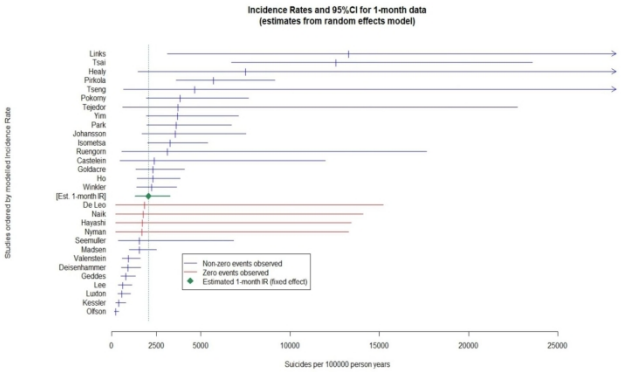

Figure 2. Forrest Plot of suicide rates in one month following discharge from psychiatric hospitalisation

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Figure 3. Forrest Plot of suicide rates in one week following discharge from psychiatric hospitalisation

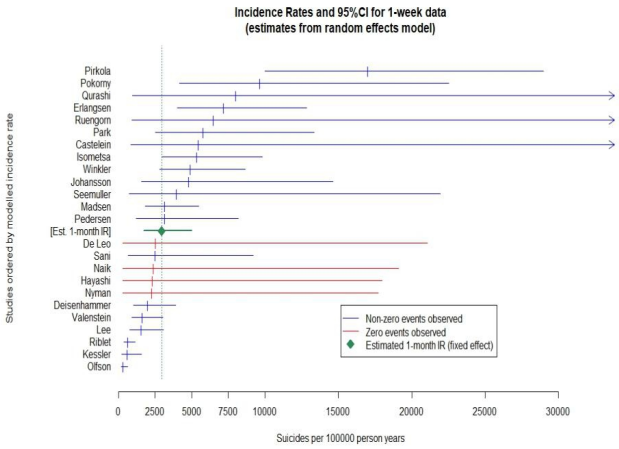

Figure 3. Forrest Plot of suicide rates in one week following discharge from psychiatric hospitalisation

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eSupplement 1. Strength of reporting items of included studies

Study name	Coronial Verdicts	Counts admissions	Defined Population	Includes Undetermined deaths	Strength of Reporting Score
Castelein 2015	0	0	1	0	1
De Leo 2007	0	0	0	0	1
Erlangsen 2006	1	0	1	0	2
Deisenhammer 2016	1	1	1	0	3
Geddes 1997	1	0	1	1	3
Goldacre 1993	1	1	1	1	4
Hayashi 2012	0	0	0	0	0
Healy 2006	1	0	1	0	2
Ho 2003	1	0	1	1	3
Isometsa 2014	1	1	1	0	3
Johansson 1996	1	0	0	1	2
Kessler 2015	1	1	1	0	3
Lee 2009	1	1	1	0	3
Links 2012	0	0	0	0	0
Luxton 2013	1	0	1	0	2
Madsen 2013	1	0	1	0	2
Naik 1997	1	0	0	0	1
Nyman 1986	1	1	0	0	2
Olfson 2016	1	0	1	0	2
Park 2013	1	0	0	0	1
Pedersen	1	0	1	0	2
Pirkola 2007	1	0	1	0	2
Pokorny 1983	1	0	0	0	1
Qurashi 2006	0	0	0	0	0
Riblet 2017	1	1	1	0	3
Ruengorn 2011	0	0	0	0	0
Sani 2011	1	0	0	0	1
Seemuller 2014	0	0	0	0	0

Tejedor 1999	0	0	0	0	0
Tsai 2002	0	0	0	0	0
Tseng 2006	0	0	0	0	0
Valenstein 2009	1	0	1	0	2
Winkler 2015	1	0	1	0	2
Yim2004	1	0	1	1	3

eSupplement 2 – Suicide rates in one month following discharge from psychiatric hospitalisation

Study	PY	Suicides	Observed	Fitted	LL	UL
Castelein	36.01	1	0.0278	0.0240	0.0048	0.1196
De Leo	5.00	0	0.0000	0.0186	0.0023	0.1321
Deisenhammer	5471.00	51	0.0093	0.0095	0.0055	0.0162
Geddes	44634.20	367	0.0082	0.0082	0.0051	0.0132
Goldacre	1875.00	44	0.0235	0.0234	0.0134	0.0407
Hayashi	8.83	0	0.0000	0.0174	0.0023	0.1342
Healy	11.08	2	0.1805	0.0751	0.0149	0.3795
Ho	5314.00	124	0.0233	0.0233	0.0142	0.0383
Isometsa	4769.00	158	0.0331	0.0330	0.0202	0.0540
Johansson	321.00	12	0.0374	0.0358	0.0171	0.0753

Kessler	4480.75	17	0.0038	0.0041	0.0021	0.0079
Lee	6250.00	39	0.0062	0.0064	0.0037	0.0112
Links	9.92	3	0.3025	0.1329	0.0312	0.5853
Luxton	6050.13	35	0.0058	0.0060	0.0034	0.0106
Madsen	23911.92	374	0.0156	0.0157	0.0097	0.0252
Naik	7.25	0	0.0000	0.0179	0.0023	0.1409
Nyman	9.17	0	0.0000	0.0173	0.0023	0.1328
Olfson	63288.60	151	0.0024	0.0024	0.0015	0.0039
Park	700.25	26	0.0371	0.0364	0.0198	0.0670
Pirkola	29583.33	1698	0.0574	0.0574	0.0360	0.0914
Pokorny	400.00	16	0.0400	0.0386	0.0194	0.0766
Ruengorn	19.58	1	0.0511	0.0315	0.0056	0.1663
Seemuller	79.25	1	0.0126	0.0157	0.0036	0.0683
Tejedor	12.50	1	0.0800	0.0373	0.0061	0.2272
Tsai	177.75	24	0.1350	0.1258	0.0672	0.2257
Tseng	5.58	1	0.1791	0.0468	0.0066	0.3289
Valenstein	13149.47	127	0.0097	0.0097	0.0059	0.0160
Winkler	11440.8	258	0.0226	0.022	0.0140	0.0364

	3			5		
Yim	524.33	20	0.0381	0.0371	0.0194	0.0610

eSupplement 3. Suicide rates in one week following discharge from psychiatric hospitalisation						
Study	PY	Observed	Observed	Fitted	LL	UL
Castelein	8.14	1	0.1229	0.0548	0.0085	0.3523
DeLeo	5.00	0	0.0000	0.0255	0.0031	0.2109
Deisenhammer	1262.54	25	0.0198	0.0201	0.0103	0.0390
Erlangsen	1058.72	77	0.0727	0.0720	0.0404	0.1283
Hayashi	8.83	0	0.0000	0.0234	0.0030	0.1796
Isometsa	974.00	53	0.0544	0.0539	0.0296	0.0980
Johansson	74.08	4	0.0540	0.0481	0.0158	0.1461
Kessler	1034.00	5	0.0048	0.0062	0.0024	0.0157
Lee	1442.00	22	0.0153	0.0156	0.0079	0.0308
Madsen	5518.13	175	0.0317	0.0317	0.0183	0.0550
Naik	7.25	0	0.0000	0.0242	0.0031	0.1911
Nyman	9.17	0	0.0000	0.0232	0.0030	0.1773
Olfson	14776.80	49	0.0033	0.0034	0.0019	0.0063
Park	161.60	10	0.0619	0.0581	0.0253	0.1336
Pedersen	187.40	6	0.0320	0.0317	0.0123	0.0819
Pirkola	6826.92	1164	0.1705	0.1703	0.1081	0.2896
Pokorny	92.30	10	0.1083	0.0968	0.0417	0.2252
Qurashi	1.33	1	0.7536	0.0803	0.0095	0.6766

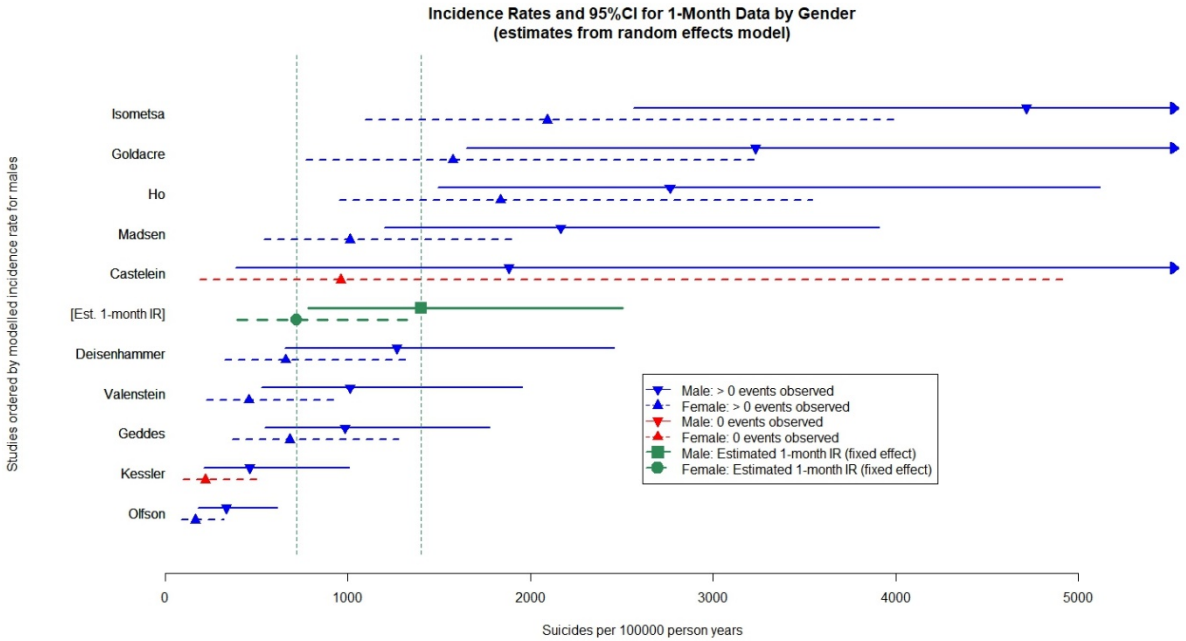
Riblet	21657.30	141	0.0065	0.0066	0.0038	0.0115
Ruengorn	4.52	1	0.2212	0.0650	0.0091	0.4651
Sani	85.31	2	0.0234	0.0251	0.0069	0.0919
Seemuller	18.29	1	0.0547	0.0399	0.0073	0.2194
Valenstein	3026.18	50	0.0165	0.0167	0.0091	0.0304
Winkler	2640.19	131	0.0496	0.0494	0.0283	0.0863

eSupplement 4 – Suicide rates in one month following discharge from psychiatric hospitalisation with gender subgroups.

Study	Sex	PY	Suicides	Residual	Observed	Fitted	LL	UL
Castelein	F	10.36	0	-0.447	0.0000	0.0096	0.0019	0.0491
Castelein	M	25.65	1	0.646	0.0390	0.0188	0.0039	0.0921
Deisenhammer	F	3006.00	20	0.026	0.0067	0.0066	0.0033	0.0133
Deisenhammer	M	2465.00	31	-0.045	0.0126	0.0127	0.0066	0.0246
Geddes	F	24113.30	171	0.477	0.0071	0.0068	0.0037	0.0128
Geddes	M	20520.90	196	-0.456	0.0096	0.0099	0.0055	0.0178
Goldacre	F	1072.00	16	-0.205	0.0149	0.0158	0.0077	0.0322
Goldacre	M	803.00	28	0.383	0.0349	0.0323	0.0165	0.0633
Ho	F	2582.00	53	0.830	0.0205	0.0184	0.0095	0.0354
Ho	M	2732.00	71	-0.543	0.0260	0.0276	0.0149	0.0512
Isometsa	F	2614.00	52	-0.352	0.0199	0.0209	0.0110	0.0400
Isometsa	M	2155.00	106	0.413	0.0492	0.0471	0.0256	0.0867
Kessler	F	887.64	0	-2.004	0.0000	0.0022	0.0010	0.0050
Kessler	M	3593.11	17	0.096	0.0047	0.0046	0.0021	0.0101
Madsen	F	12533.41	125	-0.171	0.0100	0.0101	0.0054	0.0189

Madsen	M	11378.51	249	0.157	0.0219	0.0217	0.0120	0.0391
Olfson	F	35113.50	58	-0.181	0.0017	0.0017	0.0009	0.0032
Olfson	M	28175.10	93	-0.069	0.0033	0.0033	0.0018	0.0061
Valenstein	F	1065.11	2	-1.504	0.0019	0.0046	0.0023	0.0092
Valenstein	M	12084.36	125	0.215	0.0103	0.0101	0.0053	0.0196

eSupplement 5. Forest Plot of studies reporting suicides by men and women in one month following discharge from psychiatric hospitalisation

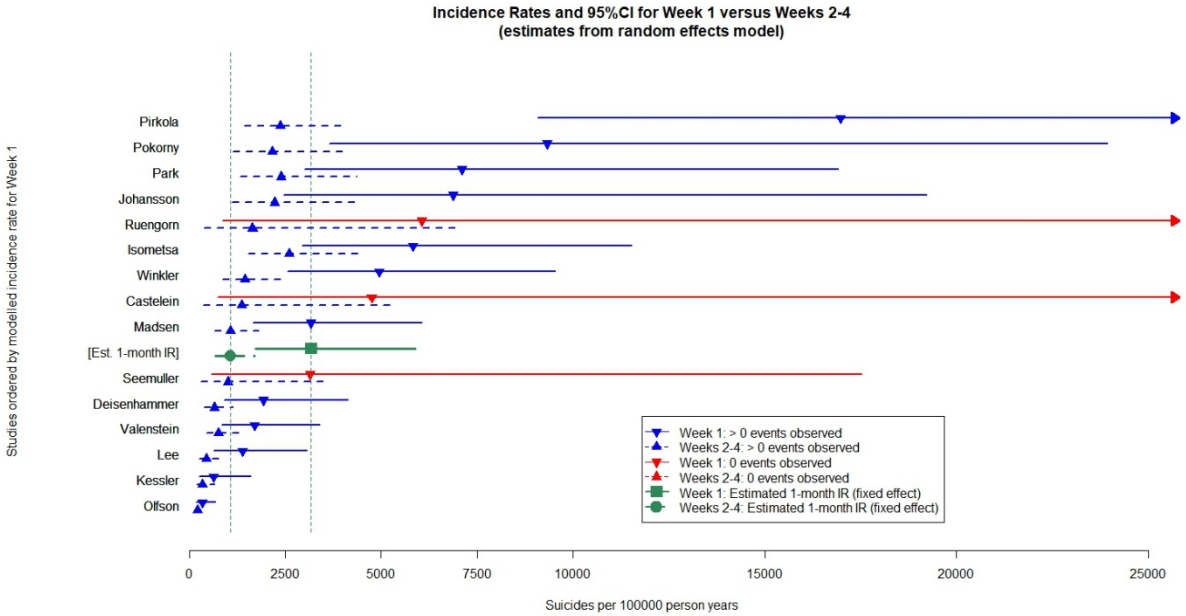


eSupplement 6. Suicide rates in one week and two-four weeks following discharge from psychiatric hospitalisation							
Study	Week	PY	Observed	IR Observed	IR Fitted	LL	UL

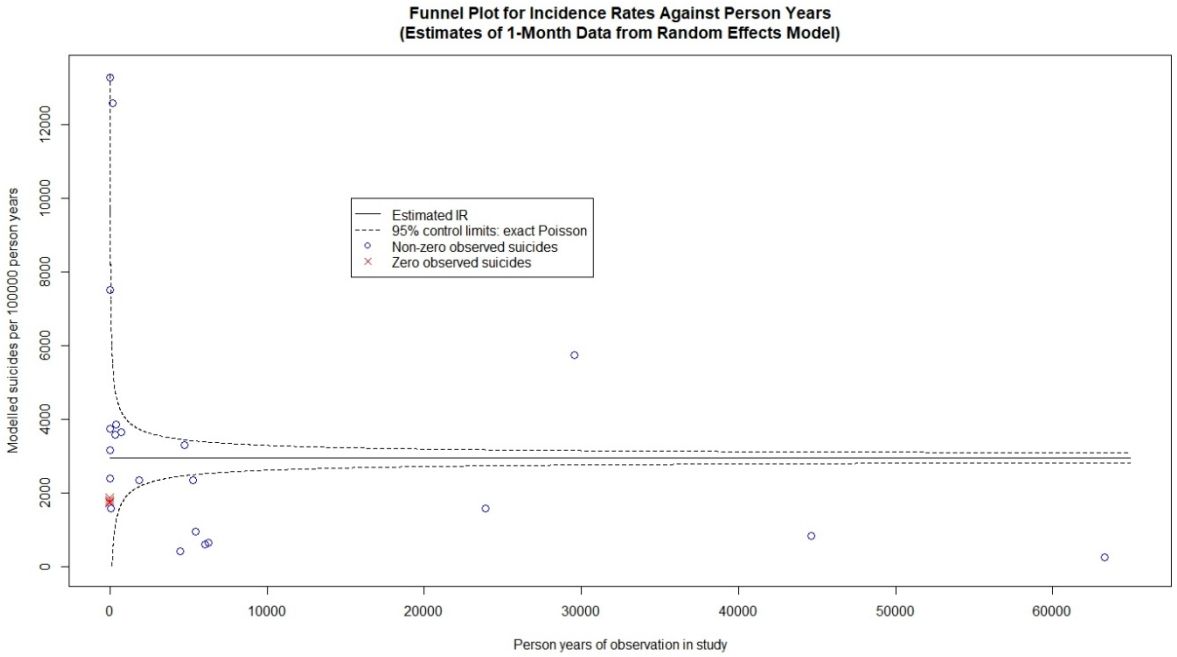
Castelein	1	8.14	1	0.1229	0.0475	0.0074	0.3028
Castelein	2-4	27.88	0	0.0000	0.0137	0.0035	0.0532
Deisenhammer	1	1262.54	25	0.0198	0.0192	0.0089	0.0413
Deisenhammer	2-4	4208.46	26	0.0062	0.0066	0.0038	0.0114
Isometsa	1	974.00	53	0.0544	0.0582	0.0294	0.1153
Isometsa	2-4	3795.00	105	0.0277	0.0261	0.0154	0.0443
Johansson	1	74.08	4	0.0540	0.0688	0.0246	0.1923
Johansson	2-4	246.92	8	0.0324	0.0223	0.0112	0.0444
Kessler	1	1034.00	5	0.0048	0.0063	0.0025	0.0160
Kessler	2-4	3446.75	12	0.0035	0.0034	0.0018	0.0064
Lee	1	1442.00	22	0.0153	0.0138	0.0063	0.0305
Lee	2-4	4808.00	17	0.0035	0.0043	0.0025	0.0076
Madsen	1	5518.13	175	0.0317	0.0317	0.0166	0.0605
Madsen	2-4	18393.79	199	0.0108	0.0108	0.0064	0.0181
Olfson	1	14776.80	49	0.0033	0.0034	0.0017	0.0068
Olfson	2-4	48511.80	102	0.0021	0.0021	0.0012	0.0036
Park	1	161.60	10	0.0619	0.0711	0.0299	0.1691
Park	2-4	538.65	16	0.0297	0.0240	0.0132	0.0435
Pirkola	1	6826.92	1164	0.1705	0.1698	0.0909	0.3173
Pirkola	2-4	22756.41	534	0.0235	0.0237	0.0142	0.0395
Pokorny	1	92.30	10	0.1083	0.0934	0.0364	0.2393
Pokorny	2-4	307.70	6	0.0195	0.0216	0.0114	0.0409
Ruengorn	1	4.52	1	0.2212	0.0606	0.0086	0.4286
Ruengorn	2-4	15.06	0	0.0000	0.0165	0.0039	0.0699
Seemuller	1	18.29	1	0.0547	0.0314	0.0056	0.1751
Seemuller	2-4	60.96	0	0.0000	0.0101	0.0029	0.0347
Valenstein	1	3026.18	50	0.0165	0.0170	0.0085	0.0339

Valenstein	2-4	10123.29	77	0.0076	0.0075	0.0044	0.0127
Winkler	1	2640.19	131	0.0496	0.0495	0.0258	0.0954
Winkler	2-4	8800.64	127	0.0144	0.0144	0.0083	0.0243

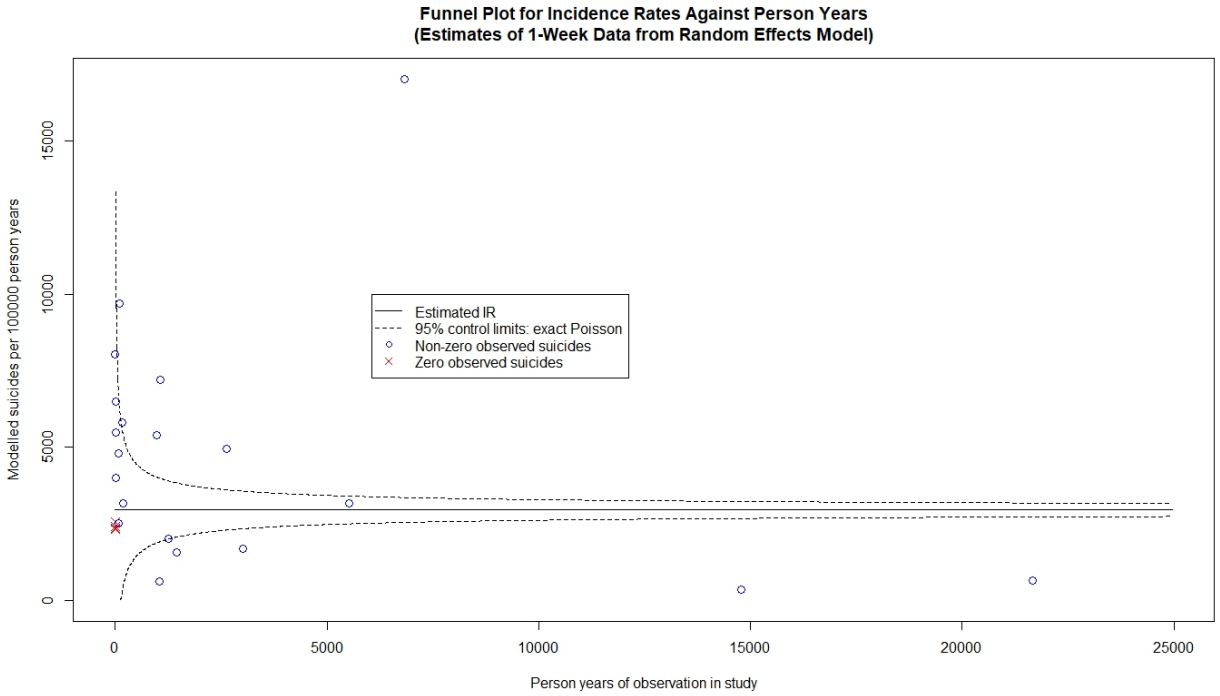
eSupplement 7. Forrest Plot Suicide rates in one week and two-four weeks following discharge from psychiatric hospitalisation



eSupplement 8. Funnel Plot of Suicide rates in one month following discharge from psychiatric hospitalisation



eSupplement 9. Funnel Plot of Suicide rates in one week following discharge from psychiatric hospitalisation



PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	1
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	4
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	4
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	4
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	4
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	4
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	4
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	5
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.	5
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	5
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	5

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	5
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	5
RESULTS			
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.	28
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	table 1
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).	data supplement
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	29
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	7-9, 29
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	9
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	9
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	10
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	11-12
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	12
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	13

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

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Meta-analysis of suicide rates in the first week and first month after psychiatric hospitalisation

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Meta-analysis of suicide rates in the first week and first month after psychiatric hospitalisation

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ABSTRACT

Objective

To assess the magnitude of suicide rates in the first week and first month post-discharge following psychiatric hospitalisation.

Design

Meta-analysis of relevant English-language, peer-reviewed papers published in Medline, PsychINFO or Embase between 1 January 1945 and 31 March 2017 and supplemented by hand searching and by personal communication. A generalised linear effects model was fitted to the number of suicides, with a Poisson distribution, log link, and log of person years as an offset. A random effects model was used to calculate the over all pooled rates and within subgroups in sensitivity analyses.

Outcome Measures

Suicides per 100,000 person years in the week and first month after discharge from psychiatric hospitalisation.

Results

34 included papers comprised 29 studies reported suicides in the first month post-discharge (3,551 suicides during 222,546 patient years) and 24 studies reported suicides in the first week post-discharge (1,928 suicides during 60,880 patient years). The pooled estimate of the suicide rate in the first month post-discharge suicide was 2,060 per 100,000 person years (95% confidence interval (CI) = 1,300 – 3,280, I^2=90). The pooled estimate of the suicide rate in the first week post-discharge suicide was 2,950 suicides per 100,000 person years (95% CI = 1,740–5,000, I^2 = 88). Eight studies that were included after personal communication had lower pooled rates of suicide than studies included after data extraction and there was evidence of publication bias towards papers reporting a higher rate of post discharge suicide.

Conclusion

Acknowledging the presence of marked heterogeneity between studies and the likelihood of bias towards publication of studies reporting a higher post discharge suicide rate, the first week and month post-discharge following psychiatric hospitalisation are periods of extraordinary suicide risk. Short-term follow-up of discharged patients should be augmented with greater focus on safe transition from hospital to community care.

Registration

Prospero registration CRD42016038169

Funding

No funding source involved.

Strengths and limitations of this study

- Published and previously unavailable data were synthesised to estimate rates of suicide in the first week and first month post discharge following psychiatric hospitalisation
- Pooled rates of suicide were about 3000 and 2000 per 100,000 person years respectively in the first week and first month post discharge
- Published studies reported higher suicide rates than data obtained by personal communication
- High between study heterogeneity and the likelihood of publication bias towards studies with higher suicide rates may impact the generalizability of our estimated rates
- The period immediately following discharge from psychiatric hospitalisation should be regarded as a distinct phase of care associated with an extraordinary suicide risk.

Data Sharing

All Individual study data is available in the supplementary material.

Introduction

A recent meta-analysis of suicide mortality after discharge from psychiatric facilities estimated a rate of 484 per 100,000 person years among 100 studies reporting on suicides after any period of follow up and 1132 suicides per 100,000 person years among 18 studies reporting on suicides in the first three months. [1] These alarming figures suggest that the suicide rate among this vulnerable patient group is about 100 times global suicide rate and that being a recently discharged patient confers a higher risk of suicide death than any other risk factor. [2] However, the earlier meta-analysis did not report estimates over periods shorter than three months[1] because the methods used excluded the duplicated patient samples with smaller number of patient years and because no steps were taken to obtain further data by personal communication. As a result, the earlier study included only two studies that reported suicide rates in the first month post hospital discharge.[1] Although several primary studies have reported on suicide in the immediate post-discharge period [3-5] expected rates of suicide in the first week and month of transition from the hospital to the community remain uncertain. Knowledge of the extent and trajectory of the suicide risk in the weeks following hospital discharge would inform the timing and duration of interventions aimed at reducing these tragic events.

The primary aim of this study was to calculate a pooled estimate and statistical dispersion (range, median and quartile values) of one-week and one-month post-discharge suicide rates. The secondary aim was to examine the possible moderators of the suicide rates over these two periods of follow up according to the characteristics of the primary research.

Methods

The meta-analysis was registered with PROSPERO [6] (Registration CRD42016038169) and conducted according to PRISMA[7] and MOOSE[8] guidelines.

Search Strategy and Selection Criteria

We included longitudinal studies that reported the number of person years and the number of suicides in the first week (one-week) and first month (or 28 days) post-discharge (one-month) after discharge from acute adult psychiatric hospitalisation. We defined acute adult psychiatric hospitalisation broadly so as to include hospitalisations, patients admitted with specific psychiatric diagnoses, psychiatric discharges of older people and after psychiatric hospitalisation in military settings. We excluded studies of post-discharge suicide after release from child and adolescent psychiatric wards, long-stay mental health wards, forensic psychiatric facilities, and patients who were admitted to non-psychiatric settings (such as emergency departments or the medical or surgical wards of general hospitals). Studies were excluded if the number of suicides and number of person years were not reported, could not be calculated, or could not be obtained by email from the authors.

Two authors (DC and ML) independently searched Medline, PsychINFO and Embase for relevant papers published in English between 1 January 1945 and 31 March 2017 (See Figure 1, eSupplement 1). Electronic searches were supplemented by hand searches of the relevant review articles and the full text papers located in the searches conducted for a related meta-analysis [1] were re-examined. Grey literature was not considered. DC and ML independently winnowed titles, abstracts, and full text papers. The authors of studies that met inclusion criteria except for reporting post-discharge suicide rates over periods of longer than a month were contacted by email for data regarding suicides in the one-week and one-month periods. Authors of papers that reported post-

discharge suicide in one-month but not report one-week and the converse were also contacted. A total of 27 authors were contacted.

Data extraction

SS and MW independently extracted the data and ML and DC performed a further check of the data. The number of person years was calculated using the number of discharges and the period of follow-up of 28 or 31 days when it was not directly reported in the paper. Where the follow up was specified to be 'one-month' the length of follow up was assumed to be 365/12 = 30.4 days. Separate figures were extracted for men and women and for the first and subsequent weeks of follow up where possible.

A predetermined list of effect size and moderator variables was extracted. The variables collected were i) number of suicides and number of patient years, ii) period of follow up (one-month versus one week), iii) sex (where specified), iv) diagnostic group (where specified), v) whether the primary study of was people admitted for suicidal thoughts and behaviours, vii) country in which the study was conducted, vii) whether the data were obtained by personal communication with the authors, and viii) study quality items.

We assessed study quality using a 0-4 point scale derived from the Newcastle-Ottawa Scale for assessing the quality of nonrandomised studies[9] and used in a previous meta-analysis of post-discharge suicide rates.[1] One point was awarded if the study: i) identified suicides using coroners' records or a national mortality database (rather than using hospital records), ii) included all the post-discharge suicides in a defined geographic region (rather than suicides from a particular care setting), iii) included open verdicts in suicide numbers; iv) reported the number of discharges (rather than the number of individuals).

Data analysis

The effect sizes of interest were the incidence rate (IR), expressed as suicides per 100,000 person years and the incidence rate ratio (IRR). In all analyses a generalized linear mixed effects model was fitted to a count response (number of suicides), with a Poisson distribution, log link, and log of person years as an offset allowing the inclusion of fitted values for zero suicide studies. All models included a random effect (intercept) for study. Confidence intervals were based on t-distribution with df equal to the number of studies. All models were fitted with the R package lme4. Standard errors were calculated using the delta method from the R package car. Pre-specified subgroup analyses were conducted according to the period of follow up, source of the data (published or obtained by personal communication), country of publication, sex, and study quality using a mixed effects model. Publication bias was examined directly by i) comparing extracted data to that obtained by personal communication, ii) examination of Funnel Plots and iii) Egger's regression tests based on the fitted values.

Patient and Public Involvement

The results of this study were discussed with Easter Suburbs Mental Health Service, Consumer Advisory Group for their views on suicide prevention in the suicide in the post discharge period.

Results

Search results and data extraction

Independent searches (DC and ML) both identified 24 of 26 papers reporting on suicides occurring in the first week or first month after discharge. A further 8 studies were included after data were provided by personal communication with the authors, such that either one-week or one-month data or both periods was available from 34 papers (Table 1, eSupplement 2.). The earliest study was published in 1983, the median year of publication was 2009 and the most recent was published in 2017. Twenty-nine papers contained data pertaining to the first month post-discharge (eSupplement 3). Twenty-four papers reported on suicides in the first week post-discharge (eSupplement 4).

There were disagreements concerning 6 of the 68 data points relating to either the number of suicides or number of patient years. All disagreements were resolved by a second examination of the data by DC and ML.

Suicides within a month of discharge

Twenty-nine studies (inclusive of 4 studies with no suicides) reported 3,551 suicides in the first month after discharge during 222,546 person years. The mean number of suicides per study was 122 (SD 443) and the mean number of person years per study was 7,674 (SD 22,581). The median sample suicide rate was 2,333 per 100,000 person years with a range of 0 to 30,252 per 100,000 person years. The first and third quartiles were 601 and 4,555 per 100,000 person years, respectively (see Figure 2. Forrest Plot of suicide rates in one month following discharge from psychiatric hospitalisation). The pooled rate of one-month post-discharge suicide was 2,060 per 100,000 person years (95% CI 1,300–3,280) with very high between-sample heterogeneity (Q = 266.8, $p < 0.001$, $I^2 = 90$) (Table 2).

Separate data for men and women were available for 10 studies reporting one-month post-discharge suicides including 6 studies obtained by personal communication. Men had almost twice the pooled rate of suicide of women (IRR 1.94 95%, CI 1.54 – 2.44; See Table 2, eSupplement 5 & 6).

Studies of patients admitted for suicidal thoughts or behaviours had over three times the rate of suicide than studies of psychiatric patients who were not selected in this way (IRR 3.56, 95% CI 1.29-7.63) but this result was based on a small number of studies and suicides among patients presenting with suicidal thoughts or behaviours. The analysis of suicide rates according to diagnostic group was also limited by a small number of studies but suggested that groups of patients with a mood disorder might have higher rates of one-month post discharge suicide than groups of patients that were not selected by diagnosis (Table 2).

The eight studies deemed to be of low quality had a higher pooled suicide rate compared to the studies deemed to be of higher quality (IRR 1.99 95% CI 1.98–2.01). The eight studies from Asian countries had the highest pooled suicide rate of suicide, followed by the 10 studies from European countries; the five studies from the UK, Canada, and Australia; while the 6 US studies had the lowest rate (Table 2).

Excluding four studies that reported no suicides, fifteen studies reported one-month and one-week suicides allowing a direct comparison of the suicide rates over the first week post-discharge to the remaining 8-31 days. Among these studies, the one-week pooled suicide rate was almost three times the rate in the 8-31 day period (IRR 2.99 95% CI 2.24- 3.97; See Table 2, eSupplement 7 & 8).

Data obtained direct extraction from published papers had a significantly higher one-month post-discharge suicide than data obtained by personal communication (IRR 3.14, 95% CI 1.29 – 7.63). The Funnel Plot was characterised by 8 studies with lower

suicide rates than the pooled estimate and 5 studies with higher suicide rates than the pooled estimate lying outside the Funnel (eSupplement 9). An Eggers test confirmed the likelihood of publication bias towards studies with a higher post discharge suicide rate (Eggers Bias = 4.94, 95% CI 1.38-8.50, df = 27, P<.004)

Suicide rates in the first week post discharge

24 studies were included in a meta-analysis of one-week post-discharge suicide rates. These comprised 15 studies reporting suicides at both one-month and one-week (as above, Table 2), five studies reporting suicides in one-week but not one month and four studies with no suicides. The 24 studies reported a total of 1,928 suicides (mean = 80.3 per study, SD= 315.5, median = 8) during 60,880 person years (mean = 2,536.7 per study, SD = 7783, median = 174.5). The median sample suicide rate was 3,186 per 100,000 person years (range 0–75,000 per 100,000, first quartile = 567, third quartile = 6,730).

The pooled one-month post-discharge suicide rate was 2,950 suicides per 100,000 person years (95% CI 1,740-5,000) with very high between study heterogeneity (Q = 186.4, $p < 0.0001$), $I^2 = 88$). (see Figure 3. Forrest Plot of suicide rates in one week following discharge from psychiatric hospitalisation).

Data extracted from published papers had a significantly higher rate of suicide than personally communicated data (IRR 3.63, 95% CI 1.55 – 8.49). The Funnel Plot was characterised by 5 studies with lower suicide rates than the pooled estimate and there were 4 studies with higher suicide rates than the pooled estimate lying outside the Funnel (eSupplement 10). An Eggers test confirmed the likelihood of publication bias towards studies with a higher post discharge suicide rate (Eggers Bias = 4.31, 95% CI .85-7.78, df = 22, p <.008).

Studies considered to have a lower quality had a higher rate of suicide than those assessed to have a lower quality (IRR 2.83 95% CI 2.80-2.85).

Discussion

This study synthesised over thirty years of research on suicide risk during the period immediately following psychiatric hospitalisation. The study builds on a previous meta-analysis of post psychiatric discharge suicide rates [1] by including unpublished data and data that were excluded from an earlier meta-analysis of suicide rates post discharge [1] to estimate suicide rates over the first week and first month post discharge. One-week post-discharge suicide rates were approximately 3,000 suicides per 100,000 person years while one-month rates were approximately 2,000 per 100,000 person years. Rates from the beginning of the second week to the end of the fourth week or one-month post-discharge were approximately 1,000 per 100,000 person years. Rates of 2,000 to 3,000 per 100,000 person years are respectively about 200–300 times the global suicide rate.[10] Our results also compare with a recent meta-analysis that estimated 1,132 suicides per 100,000 person years among 18 studies of the first three months and 484 per 100,000 person years among 100 studies of any period of follow up. [1] This suggests a six-fold risk of suicide in the first week post-discharge compared to the long-term rates of suicide after psychiatric discharge of about 500 per 100,000 person years. It further suggests that length of time since discharge is at least as important as clinical risk factors for suicide (odds ratio =1.50) [11] and high-risk models for suicide (odds ratio = 4.84) [12] reported in longitudinal studies.[13]

Our finding of higher rates of suicides by men in the immediate post-discharge period is unsurprising because of the preponderance of men among all suicide deaths [10] but is in contrast with less clear gender effects on inpatient suicide rates. [14 15]

The main limitation or our study is uncertainty about the extent to which our pooled estimates can be generalised. We observed very high between-study heterogeneity that may be partially explained by publication bias towards studies with high suicide rates and aspects of study quality. However, in all likelihood there are real differences

in post discharge suicide rates between settings that cannot be examined using the existing literature. Most importantly, this study was not able to ascertain the role of the availability and quality of post-discharge care in determining post discharge suicide rates.

Our findings emphasise the importance of post-discharge follow up. Currently in the United States only around half of commercially insured patients and a third of Medicare patients in the US received a psychiatric follow-up visit within 7 days of hospital discharge for a mental illness.[16] In the United Kingdom, the NICE guidelines suggest that people discharged from mental health settings should be followed up within seven days. [17] While the introduction of a seven day follow period is one of a suite of measures that do seem to be associated lower suicide rates in the UK,[18] it is sobering to consider that some patients who are scheduled to be followed up at the seven day mark will die before they are ever reassessed.

Very high rates of suicide in the immediate post-discharge period should encourage clinicians to think carefully about the patient's transition from hospital to the community. Qualitative research suggests that the transition from hospital to home is associated with re-emergence of pre-existing social stresses and new stresses associated with hospitalisation.[19-21] Clinicians should consider strategies that might improve this transition, including pre- and post-discharge patient psycho-education, formal needs based assessments, use of transitional care teams, improved communication between the inpatient team, and greater involvement of the patient's outpatient team and family.[22]

The high risk of suicide during the period immediately following hospital discharge provides a clinical rationale for conceptualizing the first post-discharge month as a distinct phase of recovery and treatment, especially in the context of pervasive gaps in treatment following psychiatric hospitalization. Traditional case management approaches to continuity of care following psychiatric hospitalisation have not consistently yielded promising results. In one review, two of seven studies of telephone follow-up

and one of five studies that involved facilitating communication between inpatient and outpatient clinicians resulted in a significant increase in continuity of care [22]. Intensive interventions that involve home visits, social support, motivational interviewing, and accompanying patients to outpatient appointments have yielded more encouraging results.[23 24]

Other limitations relate to the representativeness of the included studies. All of the research came from high-income economies of Asia, Australasia, North America, and Europe and our results might not be representative of post-discharge suicide in low and middle-income countries. Moreover, there were an insufficient number of studies to determine whether apparent differences in suicide rates between regions were real or were simply the result of available studies. Differences between rates of post-discharge suicide between countries are plausible because of differences in national suicide rates, [10] progress towards deinstitutionalisation, [25] and likely national differences in the quality of mental health care systems [26]

Although it has been argued that one way of combatting post-discharge suicide is to focus on individual patients with clinical characteristics that signify a high suicide risk,[27 28] the very high suicide rates calculated in this study and the known limitations of suicide risk assessment [29] suggest that a narrow focus on clinical risk assessment might mislead clinicians into thinking that some recently discharged psychiatric inpatients can be regarded as being at low risk post-discharge.[30] Our findings support an approach to suicide prevention focussed on whole cohorts of discharged patients.[31]

Role of the funding source

There was no funding source for this study.

Conflicts of Interest

Dr. Olfson reports grants from Janssen Scientific Affairs, outside the submitted work.

Author Contribution Statement

Study Design; DC, ML

Data Collection; DC, ML, MO, SS, MW

Data Analysis; DH-P, ML

Interpretation and Critical Review; ML, MO, DH-P

Manuscript Preparation: DC, DH-P, ML, MO, SS, MW

Dr Large has full access to all the data in the study and takes responsibility for the integrity of the data and accuracy of the analysis

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Tables

Table 1. List of included studies

Study	Location	Period	Suicide Ascertainment	Type of Patient	Discharges	Suicides in the first week	Suicides on the first month
Castelein et al., (2015) [32]	Psychiatric hospitals in Groningen, the Netherlands	2000-2011	Regional psychiatric case register	Recent onset psychosis	424	1	-
De Leo & Heller (2007) [33]	Gold Coast Hospital, Queensland, Australia	2002-2005	Not specified	Previous suicide attempters	60	0	0
Deisenhammer et al. (2016) [34]	Three psychiatric hospitals, Tyrol, Austria	2004-2011	Not specified	Unselected adults	65,652	25	51
Erlangsen (2006) [35]	All psychiatric hospitals, Denmark	1990-2001	Coronial records	Adults aged >60 years	72,701	77	-
Geddes et al. (1997) [36]	All psychiatric hospitals, Scotland, UK	1968-1993	Coronial records	Unselected adults	338,013	-	367
Goldacre et al. (1993) [37]	Hospitals within the Oxford Regional Health Authority, UK	1979-1986	Coronial records	Unselected adults	26,864	-	44
Hayashi et al. (2012) [38]	Tokyo Metropolitan Matsuzawa	2006-2009	Not specified	Admitted suicidal patients	3,450	-	0

	Hospital, Japan						
Healy et al. (2006) [39]	Unspecified hospitals, North Wales UK	1994-2003	Coronial records	Psychotic patients	133	-	2
Ho (2003) [3]	All psychiatric wards and hospitals in Hong Kong, China	1997-2000	Coronial records	Unselected adults	21,921	-	124
Isometsa (2014) [40]	All psychiatric wards and hospitals, Finland	1987-2004	Coronial records	Adults with bipolar disorder	52,747	53	158
Johansson (1996) [41]	All psychiatric inpatients in southern Stockholm, Sweden	1984-1985	Coronial records	Unselected adults	3,862	4	12
Kessler et al. (2015) [42]	US Army psychiatric hospitals and wards, USA	2004-2009	Coronial records	US army psychiatric patients	53,769	5	17
Lee & Lin (2009) [43]	All psychiatric wards and hospitals in Taiwan	2001-2005	Coronial records	Patients with schizophrenia	435	22	39
Links et al. (2012) [44]	St Michael's Hospital, Toronto, Canada	2007-2009	Not specified	Patients with previous suicidal behaviour or ideation	120	-	3
Luxton et al. (2013) [45]	US Military treatment facilities, USA	2001-2011	Coronial records	US service members	68,947	-	35
Madsen &	All psychiatric	1998-	Coronial	Unselected	287,866	175	374

Nordentoft (2013) [46]	wards and hospitals in Denmark	2006	records	adults			
Naik et al. (1997) [47]	Saxondale Hospital, Nottinghamshire, England, UK	1974-1992	Local registers and NHS central register	Unselected adults	86	-	0
Nyman (1986) [48]	Unspecified psychiatric hospital, Sweden	1964-1968	Coronial records	Patients with schizophrenia	110		0
Olfson (2016) [49]	Psychiatric patients from 45 American states	2001-2008	Coronial records	Unselected adults	770,643	49	151
Park et al. (2013) [50]	Asan Medical Center, Seoul, South Korea	1989-2006	Coronial records	Unselected adults	8,403	10	26
Pedersen et al. (2014) [51]	All psychiatric hospitals and wards in Denmark	2005-2010	Coronial records	Patients with schizophrenia	7,107	6	-
Pirkola et al. (2007) [52]	All psychiatric hospitals and wards in Finland	1985-2001	Coronial records	Unselected adults	355,000	1,164	1,698
Pokorny (1983)[53]	Houston Veterans Administration Medical Centre, Texas, USA	Not specified	Coronial records	Veterans administration patients	4,800	10	16
Qurashi et al. (2006) [54]	Unspecified hospital, Manchester, England, UK	Not specified	Not specified	Unselected adults	69	1	-
Riblet (2017)	All American	2002-	Coronial	Unselected	1,126,17	141	-

[55]	Veteran Health mental health inpatient units	2015	records	American service-people	9		
Ruengorn et al. (2011) [56]	Suanprung Psychiatric Hospital, Chiang Mai, Thailand	2007-2010	Hospital records	Mood disorder patients admitted for suicide attempt	235	1	1
Sani et al. (2011) [57]	Belvedere Montello Hospital, Rome, Italy	1964-1998	Coronial records	Unselected adults	4,441	2	-
Seemuller et al. (2014) [58]	Twelve centres across Germany	Not specified	Study follow up	Patients with major depression	1,014	1	1
Tejedor et al. (1999) [59]	Psychiatric Department of Santa Cruz y San Pablo Hospital, Barcelona, Spain	1983-1997	Study follow up	Suicide attempters	150	0	1
Tsai (2002) [60]	Taipei City Psychiatric Center, Taiwan	1985-1997	Coronial Records	Patients with mood disorders	2,133	0	24
Tseng et al. (2006) [61]	Unspecified psychosomatic ward, Taiwan	2000-2002	Study follow up	Patients with major depression	67		2
Valenstein (2009)[62]	All US veteran psychiatric inpatient facilities	1999-2004	Coronial data	American veterans with mood disorders	184,093	50	127
Winkler et al. (2015) [63]	All psychiatric hospitals and psychiatric	2006-2012	Coronial records	Unselected adults	137,290	131	258

	wards, Czech Republic						
Yim (2004) [64]	Pamela Youde Nethersole Eastern Hospital, Hong Kong	1996-1999	Coronial records	Unselected adults	6,292	-	20

Table 2. Suicide rates in the first first month post discharge from psychiatric settings							
	N Studies	Suicides	Patient years	Pooled estimate	Lower Limit	Upper Limit	
One month	29	3551	222546	2060	1300	3280	
Subgroup of studies reporting follow up at 1 week and 2-4weeks							
One Week	15	1928	60854	3170	1710	5890	
Two to four weeks	15	1229	115858	1060	660	1070	
Subgroup of studies reporting suicides by men and women							
Male	10	917	83913	1400	780	2500	
Female	10	497	82989	720	390	1320	
Subgroup of studies according to data source							
Extracted directly	22	2672	107439	2880	1770	4670	
Personally communicated	7	879	115107	920	430	1930	
Subgroups of studies according to selection for suicidal thoughts or behaviours							
Admitted with suicidal thoughts or behaviours	5	5	56	6210	1550	24860	
Unselected by suicidally	24	3546	222490	1850	1170	2920	
Subgroups of studies according to selection by diagnosis							
Patients with a mood disorder	6	312	18201	3370	1240	9180	
Patients with a schizophrenia spectrum disorder	3	41	6270	1720	330	9110	

Unselected by diagnosis	20	3198	198075	1830	1080	3110	
Subgroups of studies according to study quality							
Higher Quality†	8	820	73318	1360	1350	1370	
Lower Quality	20	2731	149227	2720	2690	2740	
Subgroup of studies according to geographic region							
Asia	8	235	13000	3230	1470	7100	
Europe	10	2554	75634	2340	1170	4680	
United States	6	346	87376	1030	450	2380	
United Kingdom, Australia and Canada	5	416	46535	2020	630	6490	
† one study failed to converge							

Table 3. Suicide rates in the week month post discharge from psychiatric settings

	N Studies	Suicides	Patient years	Pooled estimate	Lower Limit	Upper Limit	
One week	24	1928	60880	2950	1740	5000	
Subgroup of studies according to data source							
Extracted directly	16	1429	12605	5090	2930	8840	
Personally communicated	8	499	48257	1400	740	2680	
Subgroups of studies according to study quality							
Higher Quality	5	246	26370	3950	3910	3990	
Lower Quality	19	1682	34492	1400	1380	1410	

Figures 1-3

Figure 1. Prisma Flow Chart

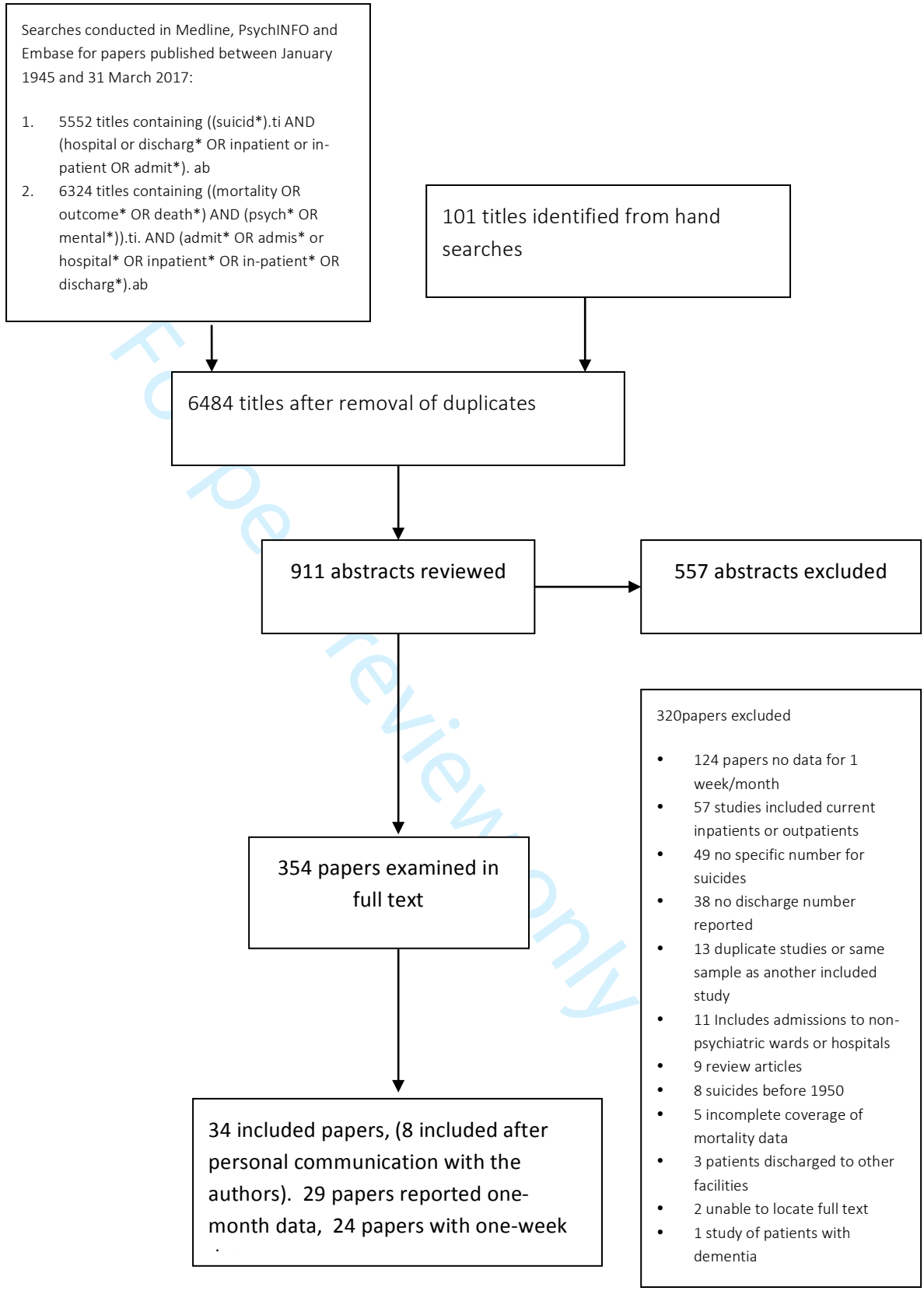
Figure 2. Forrest Plot of suicide rates in one month following discharge from psychiatric hospitalisation

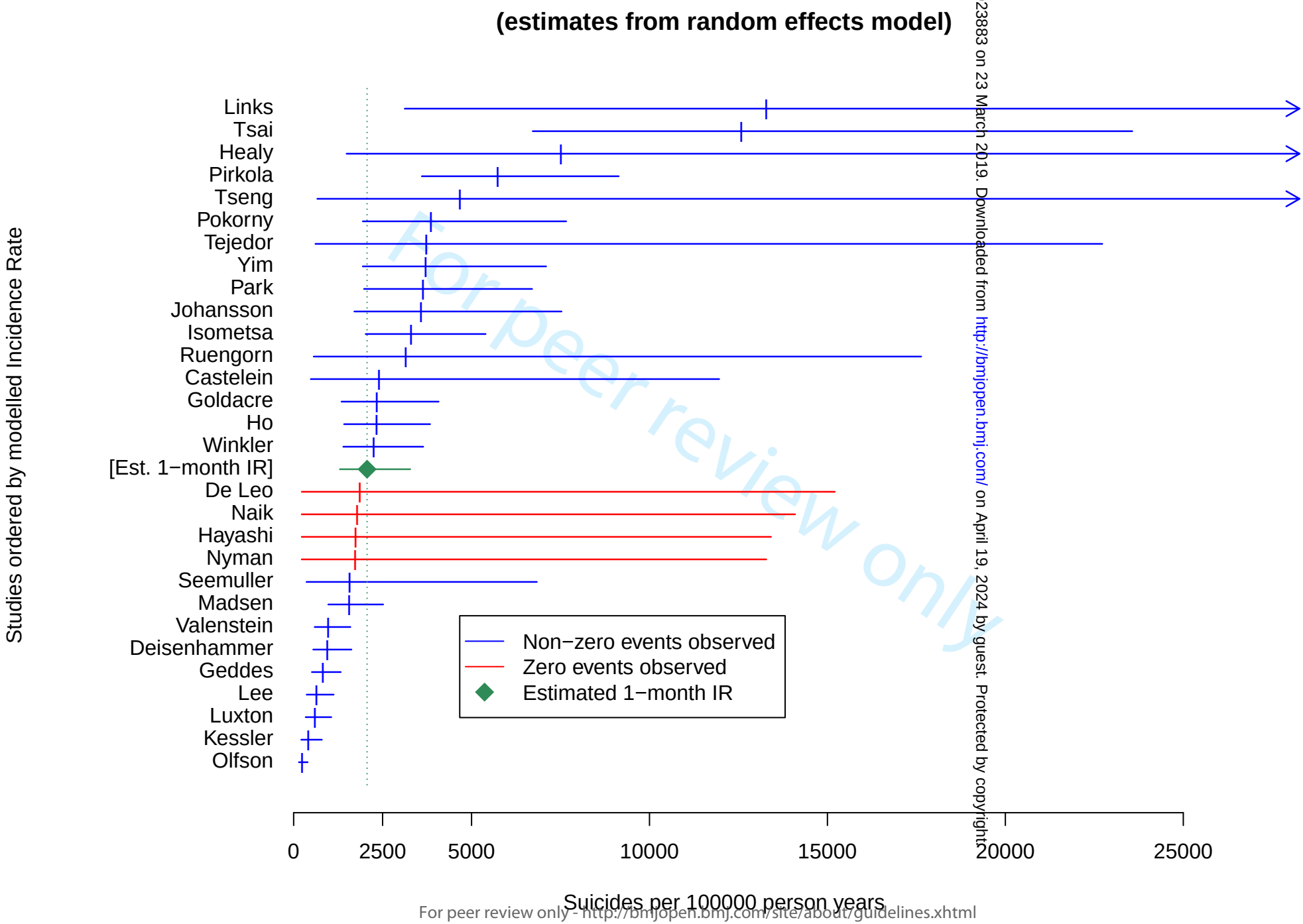
Figure 3. Forrest Plot of suicide rates in one week following discharge from psychiatric hospitalisation

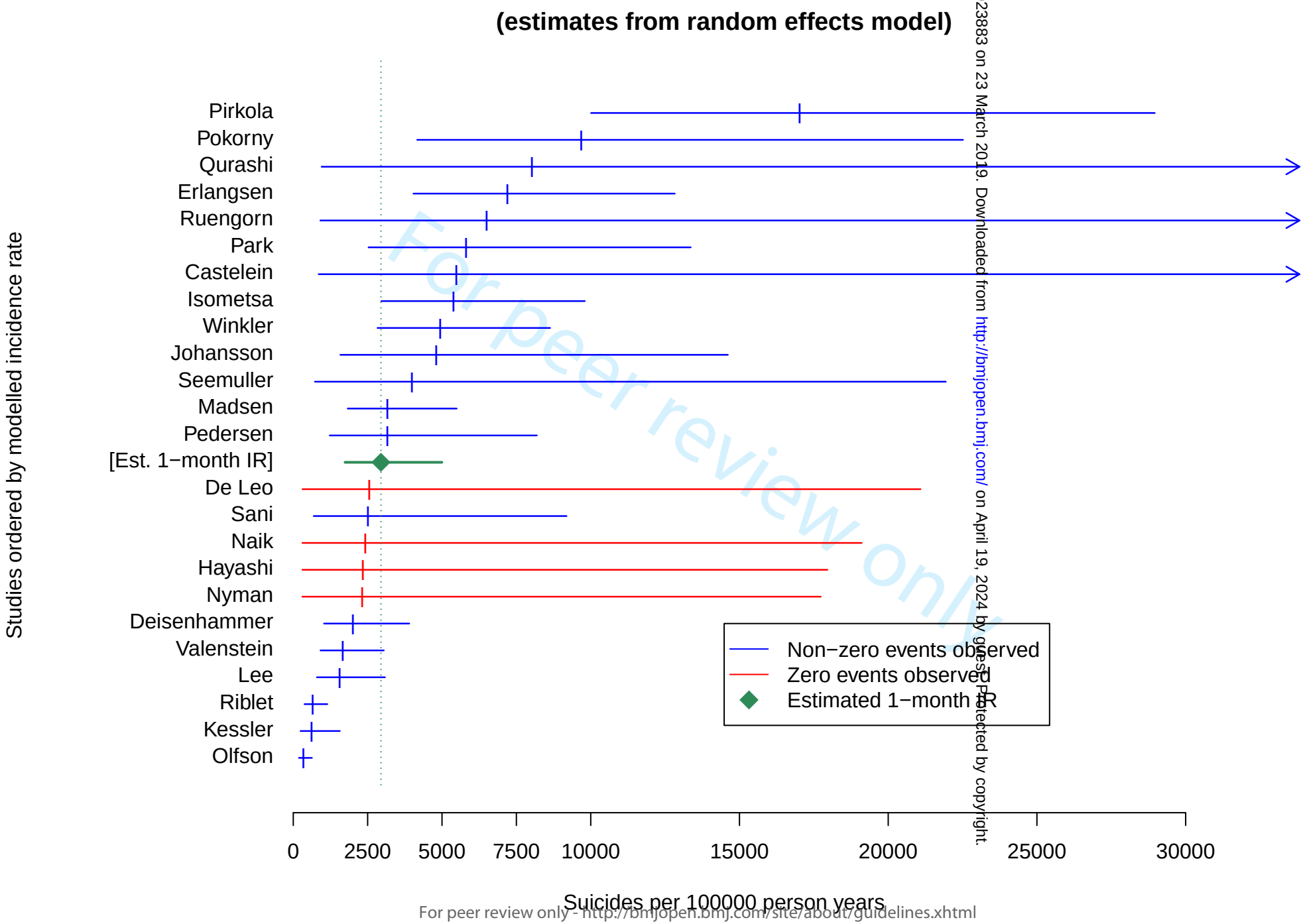
eSupplements 1-10

1. Search stategy
2. Strength of reporting items of included studies
3. Suicide rates in one month following discharge from psychiatric hospitalisation
4. Suicide rates in one week following discharge from psychiatric hospitalisation
5. Suicide rates in one month following discharge from psychiatric hospitalisation with gender subgroups.
6. Forest Plot of studies reporting suicides by men and women in one month following discharge from psychiatric hospitalisation
7. Suicide rates in one week and two-four weeks following discharge from psychiatric hospitalisation
8. Forrest Plot Suicide rates in one week and two-four weeks following discharge from psychiatric hospitalisation
9. Funnel Plot of Suicide rates in one month following discharge from psychiatric hospitalisation
10. Funnel Plot of Suicide rates in one week following discharge from psychiatric hospitalisation

Figure 1. Prisma Flow Chart







eSupplement 1. Search Strategy

Data bases Medline, PsychINFO and Embase

Dates January 1945 and 31 March 2017:

Limits. English Language

Search Terms 1. ((suicid*).ti AND (hospital or discharg* OR inpatient or in-patient OR admit*). ab

Search Terms 2. ((mortality OR outcome* OR death*) AND (psych* OR mental*)).ti. AND (admit* OR admis* or hospital* OR inpatient* OR in-patient* OR discharg*).ab

eSupplement 2. Strength of reporting items of included studies

Study name	Coronial Verdicts	Counts admissions	Defined Population	Includes Undetermined deaths	Strength of Reporting Score
Castelein 2015	0	0	1	0	1
De Leo 2007	0	0	0	0	1
Erlangsen 2006	1	0	1	0	2
Deisenhammer 2016	1	1	1	0	3
Geddes 1997	1	0	1	1	3
Goldacre 1993	1	1	1	1	4
Hayashi 2012	0	0	0	0	0
Healy 2006	1	0	1	0	2
Ho 2003	1	0	1	1	3
Isometsa 2014	1	1	1	0	3
Johansson 1996	1	0	0	1	2
Kessler 2015	1	1	1	0	3
Lee 2009	1	1	1	0	3
Links 2012	0	0	0	0	0
Luxton 2013	1	0	1	0	2
Madsen 2013	1	0	1	0	2
Naik 1997	1	0	0	0	1
Nyman 1986	1	1	0	0	2
Olfson 2016	1	0	1	0	2
Park 2013	1	0	0	0	1

Pedersen	1	0	1	0	2
Pirkola 2007	1	0	1	0	2
Pokorny 1983	1	0	0	0	1
Qurashi 2006	0	0	0	0	0
Riblet 2017	1	1	1	0	3
Ruengorn 2011	0	0	0	0	0
Sani 2011	1	0	0	0	1
Seemuller 2014	0	0	0	0	0
Tejedor 1999	0	0	0	0	0
Tsai 2002	0	0	0	0	0
Tseng 2006	0	0	0	0	0
Valenstein 2009	1	0	1	0	2
Winkler 2015	1	0	1	0	2
Yim2004	1	0	1	1	3

eSupplement 3 – Suicide rates in one month following discharge from psychiatric hospitalisation

Study	Person years	Suicides	Observed	Fitted	LL	UL
Castelein	36.01	1	0.0278	0.0240	0.0048	0.1796
De Leo	5.00	0	0.0000	0.0186	0.0023	0.1521
Deisenhammer	5471.00	51	0.0093	0.0095	0.0055	0.0362
Geddes	44634.20	367	0.0082	0.0082	0.0051	0.0332
Goldacre	1875.00	44	0.0235	0.0234	0.0134	0.0407
Hayashi	8.83	0	0.0000	0.017	0.0023	0.1342

				4		
Healy	11.08	2	0.1805	0.0751	0.0149	0.3395
Ho	5314.00	124	0.0233	0.0233	0.0142	0.0383
Isometsa	4769.00	158	0.0331	0.0330	0.0202	0.0540
Johansson	321.00	12	0.0374	0.0358	0.0171	0.0753
Kessler	4480.75	17	0.0038	0.0041	0.0021	0.0079
Lee	6250.00	39	0.0062	0.0064	0.0037	0.0112
Links	9.92	3	0.3025	0.1329	0.0312	0.5653
Luxton	6050.13	35	0.0058	0.0060	0.0034	0.0106
Madsen	23911.92	374	0.0156	0.0157	0.0097	0.0252
Naik	7.25	0	0.0000	0.0179	0.0023	0.1709
Nyman	9.17	0	0.0000	0.0173	0.0023	0.1628
Olfson	63288.60	151	0.0024	0.0024	0.0015	0.0039
Park	700.25	26	0.0371	0.0364	0.0198	0.0670
Pirkola	29583.33	1698	0.0574	0.0574	0.0360	0.0914
Pokorny	400.00	16	0.0400	0.0386	0.0194	0.0766
Ruengorn	19.58	1	0.0511	0.0315	0.0056	0.1663
Seemuller	79.25	1	0.0126	0.0157	0.0036	0.0683

Tejedor	12.50	1	0.0800	0.0373	0.0061	0.2372
Tsai	177.75	24	0.1350	0.1258	0.0672	0.2357
Tseng	5.58	1	0.1791	0.0468	0.0066	0.3389
Valenstein	13149.47	127	0.0097	0.0097	0.0059	0.0160
Winkler	11440.83	258	0.0226	0.0225	0.0140	0.0364
Yim	524.33	20	0.0381	0.0371	0.0194	0.0710

eSupplement 4. Suicide rates in one week following discharge from psychiatric hospitalisation						
Study	Person years	Observed	Observed	Fitted	LL	UL
Castelein	8.14	1	0.1229	0.0548	0.0085	0.3523
DeLeo	5.00	0	0.0000	0.0255	0.0031	0.2109
Deisenhammer	1262.54	25	0.0198	0.0201	0.0103	0.0390
Erlangsen	1058.72	77	0.0727	0.0720	0.0404	0.1283
Hayashi	8.83	0	0.0000	0.0234	0.0030	0.1796
Isometsa	974.00	53	0.0544	0.0539	0.0296	0.0980
Johansson	74.08	4	0.0540	0.0481	0.0158	0.1461
Kessler	1034.00	5	0.0048	0.0062	0.0024	0.0157
Lee	1442.00	22	0.0153	0.0156	0.0079	0.0308
Madsen	5518.13	175	0.0317	0.0317	0.0183	0.0550
Naik	7.25	0	0.0000	0.0242	0.0031	0.1911
Nyman	9.17	0	0.0000	0.0232	0.0030	0.1773
Olfson	14776.80	49	0.0033	0.0034	0.0019	0.0063
Park	161.60	10	0.0619	0.0581	0.0253	0.1336
Pedersen	187.40	6	0.0320	0.0317	0.0123	0.0819
Pirkola	6826.92	1164	0.1705	0.1703	0.1001	0.2896
Pokorny	92.30	10	0.1083	0.0968	0.0417	0.2252
Qurashi	1.33	1	0.7536	0.0803	0.0095	0.6766

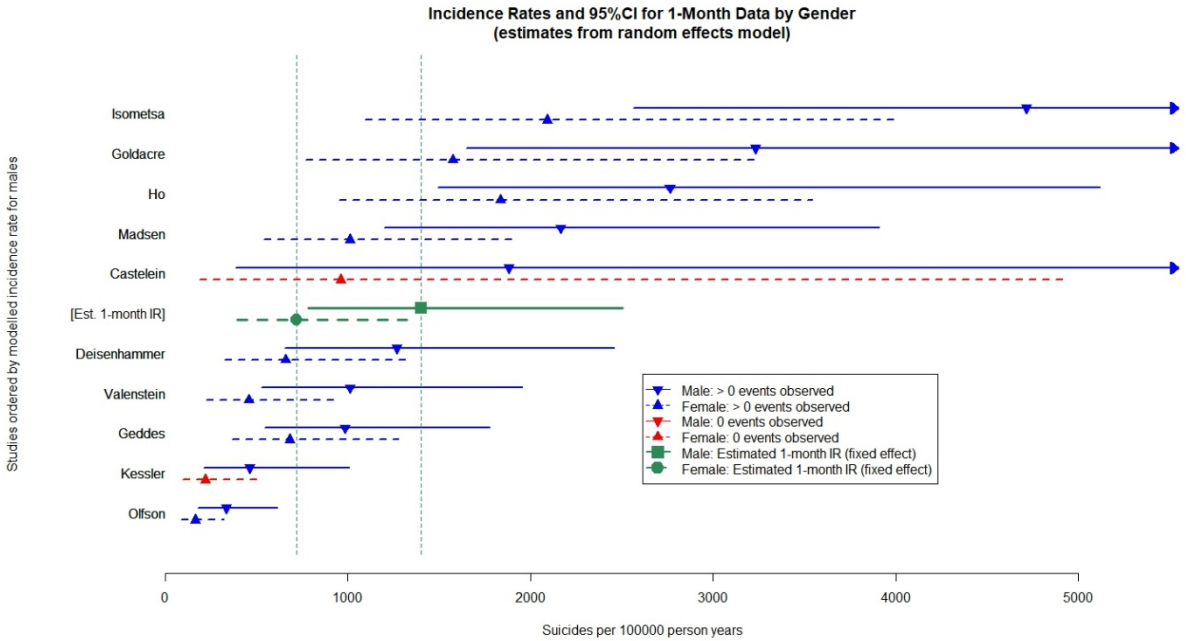
Riblet	21657.30	141	0.0065	0.0066	0.0038	0.0115
Ruengorn	4.52	1	0.2212	0.0650	0.0091	0.4651
Sani	85.31	2	0.0234	0.0251	0.0069	0.0919
Seemuller	18.29	1	0.0547	0.0399	0.0073	0.2194
Valenstein	3026.18	50	0.0165	0.0167	0.0091	0.0304
Winkler	2640.19	131	0.0496	0.0494	0.0283	0.0863

eSupplement 5 – Suicide rates in one month following discharge from psychiatric hospitalisation with gender subgroups.

Study	Sex	Person years	Suicides	Residual	Observed	Fitted	LL	UL
Castelein	F	10.36	0	-0.447	0.0000	0.0096	0.0019	0.0491
Castelein	M	25.65	1	0.646	0.0390	0.0188	0.0039	0.0921
Deisenhammer	F	3006.00	20	0.026	0.0067	0.0066	0.0033	0.0133
Deisenhammer	M	2465.00	31	-0.045	0.0126	0.0127	0.0066	0.0246
Geddes	F	24113.30	171	0.477	0.0071	0.0068	0.0037	0.0128
Geddes	M	20520.90	196	-0.456	0.0096	0.0099	0.0055	0.0178
Goldacre	F	1072.00	16	-0.205	0.0149	0.0158	0.0077	0.0322
Goldacre	M	803.00	28	0.383	0.0349	0.0323	0.0165	0.0633
Ho	F	2582.00	53	0.830	0.0205	0.0184	0.0095	0.0354
Ho	M	2732.00	71	-0.543	0.0260	0.0276	0.0149	0.0512
Isometsa	F	2614.00	52	-0.352	0.0199	0.0209	0.0110	0.0400
Isometsa	M	2155.00	106	0.413	0.0492	0.0471	0.0256	0.0867
Kessler	F	887.64	0	-2.004	0.0000	0.0022	0.0010	0.0050
Kessler	M	3593.11	17	0.096	0.0047	0.0046	0.0021	0.0101
Madsen	F	12533.41	125	-0.171	0.0100	0.0101	0.0054	0.0189

Madsen	M	11378.51	249	0.157	0.0219	0.0217	0.0120	0.0391
Olfson	F	35113.50	58	-0.181	0.0017	0.0017	0.0009	0.0032
Olfson	M	28175.10	93	-0.069	0.0033	0.0033	0.0018	0.0061
Valenstein	F	1065.11	2	-1.504	0.0019	0.0046	0.0023	0.0092
Valenstein	M	12084.36	125	0.215	0.0103	0.0101	0.0053	0.0196

eSupplement 6. Forest Plot of studies reporting suicides by men and women in one month following discharge from psychiatric hospitalisation

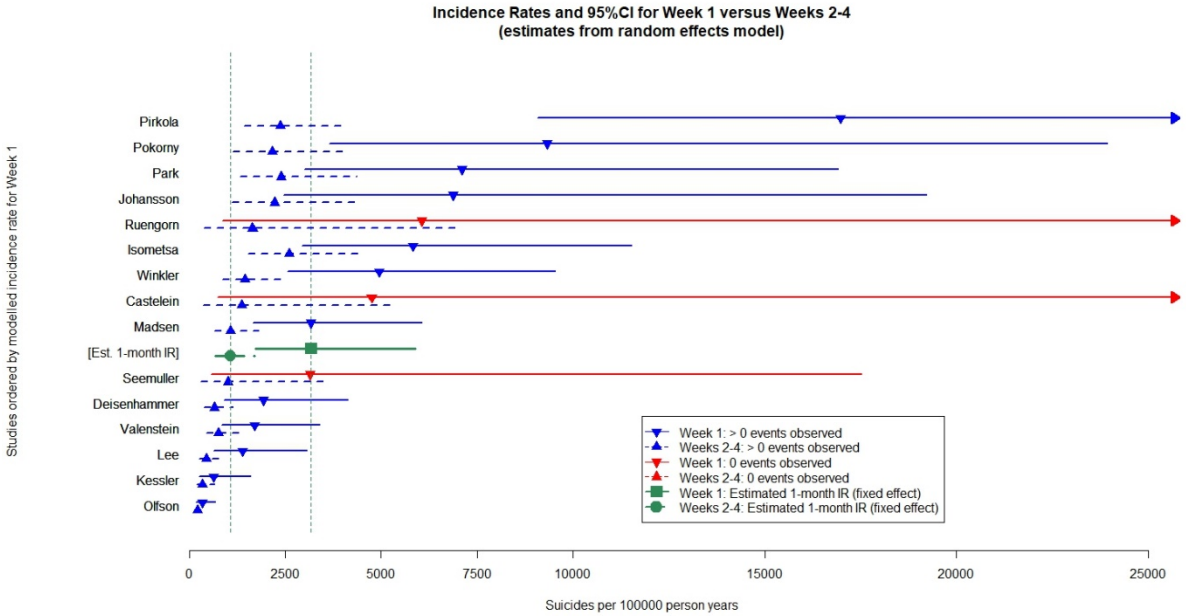


eSupplement 7. Suicide rates in one week and two-four weeks following discharge from psychiatric hospitalisation							
Study	Week	Person years	Observed	IR Observed	IR Fitted	LL	UL

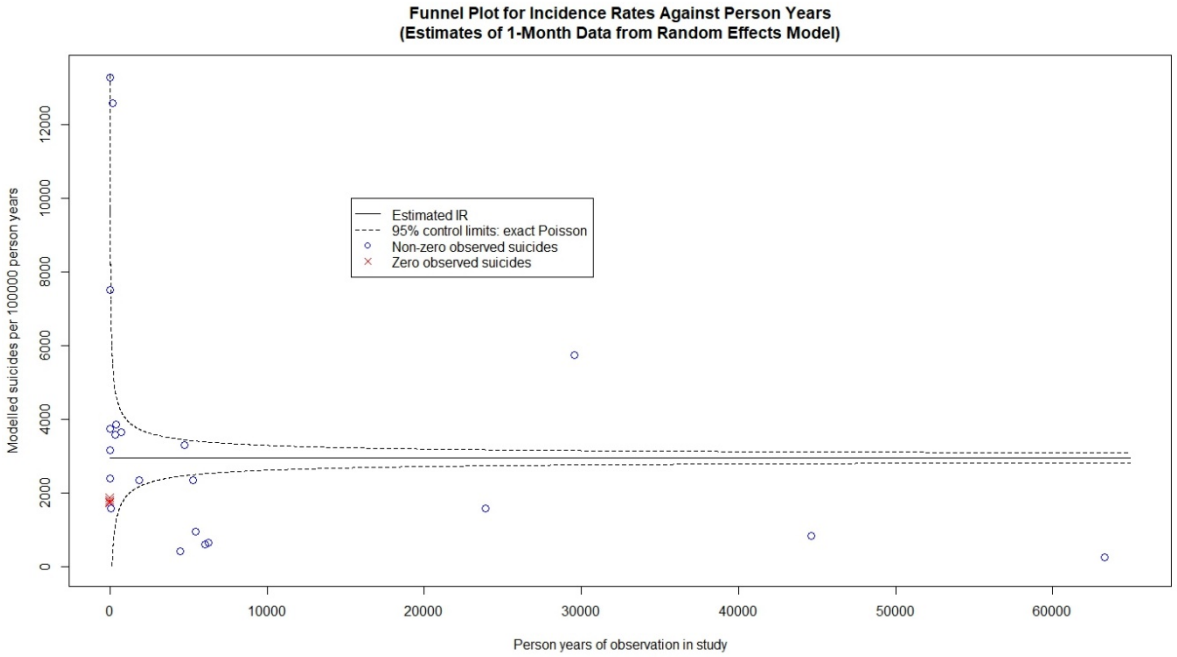
Castelein	1	8.14	1	0.1229	0.0475	0.0074	0.3028
Castelein	2-4	27.88	0	0.0000	0.0137	0.0035	0.0532
Deisenhammer	1	1262.54	25	0.0198	0.0192	0.0089	0.0413
Deisenhammer	2-4	4208.46	26	0.0062	0.0066	0.0038	0.0114
Isometsa	1	974.00	53	0.0544	0.0582	0.0294	0.1153
Isometsa	2-4	3795.00	105	0.0277	0.0261	0.0154	0.0443
Johansson	1	74.08	4	0.0540	0.0688	0.0246	0.1923
Johansson	2-4	246.92	8	0.0324	0.0223	0.0112	0.0444
Kessler	1	1034.00	5	0.0048	0.0063	0.0025	0.0160
Kessler	2-4	3446.75	12	0.0035	0.0034	0.0018	0.0064
Lee	1	1442.00	22	0.0153	0.0138	0.0063	0.0305
Lee	2-4	4808.00	17	0.0035	0.0043	0.0025	0.0076
Madsen	1	5518.13	175	0.0317	0.0317	0.0166	0.0605
Madsen	2-4	18393.79	199	0.0108	0.0108	0.0064	0.0181
Olfson	1	14776.80	49	0.0033	0.0034	0.0017	0.0068
Olfson	2-4	48511.80	102	0.0021	0.0021	0.0012	0.0036
Park	1	161.60	10	0.0619	0.0711	0.0299	0.1691
Park	2-4	538.65	16	0.0297	0.0240	0.0132	0.0435
Pirkola	1	6826.92	1164	0.1705	0.1698	0.0909	0.3173
Pirkola	2-4	22756.41	534	0.0235	0.0237	0.0142	0.0395
Pokorny	1	92.30	10	0.1083	0.0934	0.0364	0.2393
Pokorny	2-4	307.70	6	0.0195	0.0216	0.0114	0.0409
Ruengorn	1	4.52	1	0.2212	0.0606	0.0086	0.4286
Ruengorn	2-4	15.06	0	0.0000	0.0165	0.0039	0.0699
Seemuller	1	18.29	1	0.0547	0.0314	0.0056	0.1751
Seemuller	2-4	60.96	0	0.0000	0.0101	0.0029	0.0347
Valenstein	1	3026.18	50	0.0165	0.0170	0.0085	0.0339

Valenstein	2-4	10123.29	77	0.0076	0.0075	0.0044	0.0127
Winkler	1	2640.19	131	0.0496	0.0495	0.0258	0.0954
Winkler	2-4	8800.64	127	0.0144	0.0144	0.0083	0.0243

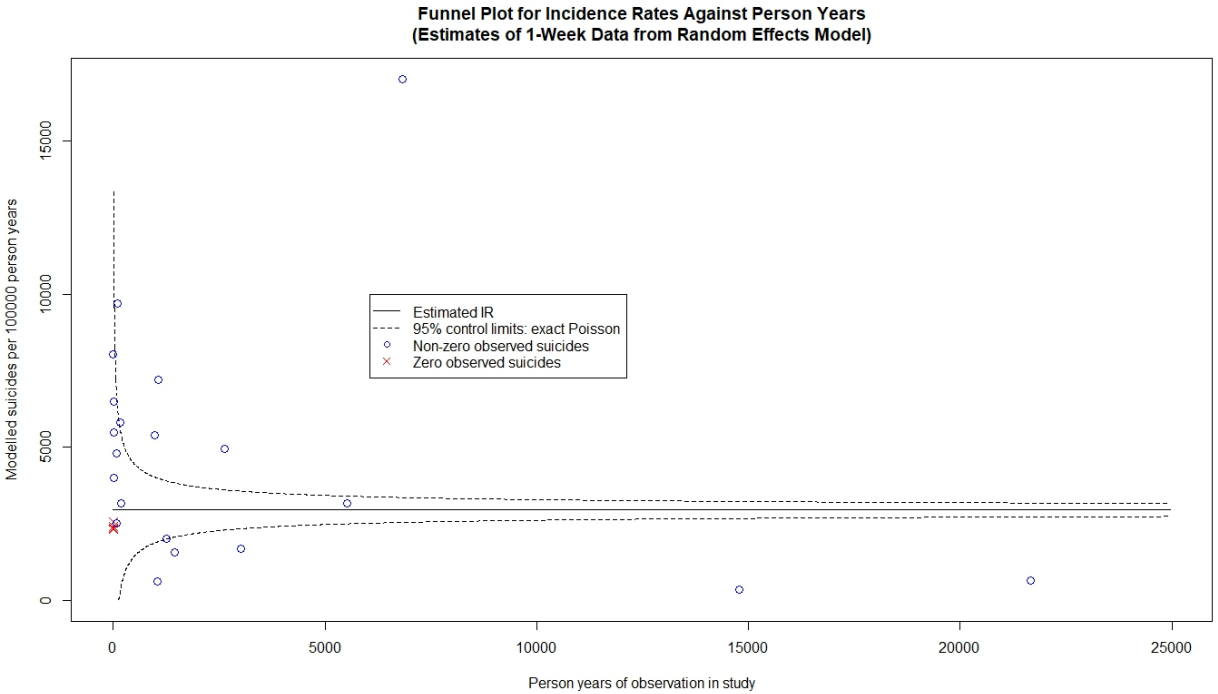
eSupplement 8. Forrest Plot Suicide rates in one week and two-four weeks following discharge from psychiatric hospitalisation



eSupplement 9. Funnel Plot of Suicide rates in one month following discharge from psychiatric hospitalisation



eSupplement 10. Funnel Plot of Suicide rates in one week following discharge from psychiatric hospitalisation



PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	1
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	4
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	4
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	4
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	4
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	4
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	4
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	5
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.	5
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	5
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	5

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	5
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	5
RESULTS			
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.	28
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	table 1
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).	data supplement
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	29
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	7-9, 29
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	9
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	9
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	10
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	11-12
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	12
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	13

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

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BMJ Open

Meta-analysis of suicide rates in the first week and first month after psychiatric hospitalisation

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Meta-analysis of suicide rates in the first week and first month after psychiatric hospitalisation

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ABSTRACT

Objective

To assess the magnitude of suicide rates in the first week and first month post-discharge following psychiatric hospitalisation.

Design

Meta-analysis of relevant English-language, peer-reviewed papers published in Medline, PsychINFO or Embase between 1 January 1945 and 31 March 2017 and supplemented by hand searching and by personal communication. A generalised linear effects model was fitted to the number of suicides, with a Poisson distribution, log link, and log of person years as an offset. A random effects model was used to calculate the over all pooled rates and within subgroups in sensitivity analyses.

Outcome Measures

Suicides per 100,000 person years in the week and first month after discharge from psychiatric hospitalisation.

Results

34 included papers comprised 29 studies reported suicides in the first month post-discharge (3,551 suicides during 222,546 patient years) and 24 studies reported suicides in the first week post-discharge (1,928 suicides during 60,880 patient years). The pooled estimate of the suicide rate in the first month post-discharge suicide was 2,060 per 100,000 person years (95% confidence interval (CI) = 1,300 – 3,280, I^2=90). The pooled estimate of the suicide rate in the first week post-discharge suicide was 2,950 suicides per 100,000 person years (95% CI = 1,740–5,000, I^2 = 88). Eight studies that were included after personal communication had lower pooled rates of suicide than studies included after data extraction and there was evidence of publication bias towards papers reporting a higher rate of post discharge suicide.

Conclusion

Acknowledging the presence of marked heterogeneity between studies and the likelihood of bias towards publication of studies reporting a higher post discharge suicide rate, the first week and month post-discharge following psychiatric hospitalisation are periods of extraordinary suicide risk. Short-term follow-up of discharged patients should be augmented with greater focus on safe transition from hospital to community care.

Registration

Prospero registration CRD42016038169

Funding

No funding source involved.

Strengths and limitations of this study

- Published and previously unavailable data were synthesised to estimate rates of suicide in the first week and first month post discharge following psychiatric hospitalisation
- Pooled rates of suicide were about 3000 and 2000 per 100,000 person years respectively in the first week and first month post discharge
- Published studies reported higher suicide rates than data obtained by personal communication
- High between study heterogeneity and the likelihood of publication bias towards studies with higher suicide rates may impact the generalizability of our estimated rates
- The period immediately following discharge from psychiatric hospitalisation should be regarded as a distinct phase of care associated with an extraordinary suicide risk.

Data Sharing

All Individual study data is available in the supplementary material.

Introduction

A recent meta-analysis of suicide mortality after discharge from psychiatric facilities estimated a rate of 484 per 100,000 person years among 100 studies reporting on suicides after any period of follow up and 1132 suicides per 100,000 person years among 18 studies reporting on suicides in the first three months. [1] These alarming figures suggest that the suicide rate among this vulnerable patient group is about 100 times global suicide rate and that being a recently discharged patient confers a higher risk of suicide death than any other risk factor. [2] However, the earlier meta-analysis did not report estimates over periods shorter than three months[1] because the methods used excluded the duplicated patient samples with smaller number of patient years and because no steps were taken to obtain further data by personal communication. As a result, the earlier study included only two studies that reported suicide rates in the first month post hospital discharge.[1] Although several primary studies have reported on suicide in the immediate post-discharge period [3-5] expected rates of suicide in the first week and month of transition from the hospital to the community remain uncertain. Knowledge of the extent and trajectory of the suicide risk in the weeks following hospital discharge would inform the timing and duration of interventions aimed at reducing these tragic events.

The primary aim of this study was to calculate a pooled estimate and statistical dispersion (range, median and quartile values) of one-week and one-month post-discharge suicide rates. The secondary aim was to examine the possible moderators of the suicide rates over these two periods of follow up according to the characteristics of the primary research.

Methods

The meta-analysis was registered with PROSPERO [6] (Registration CRD42016038169) and conducted according to PRISMA[7] and MOOSE[8] guidelines.

Search Strategy and Selection Criteria

We included longitudinal studies that reported the number of person years and the number of suicides in the first week (one-week) and first month (or 28 days) post-discharge (one-month) after discharge from acute adult psychiatric hospitalisation. We defined acute adult psychiatric hospitalisation broadly so as to include hospitalisations, patients admitted with specific psychiatric diagnoses, psychiatric discharges of older people and after psychiatric hospitalisation in military settings. We excluded studies of post-discharge suicide after release from child and adolescent psychiatric wards, long-stay mental health wards, forensic psychiatric facilities, and patients who were admitted to non-psychiatric settings (such as emergency departments or the medical or surgical wards of general hospitals). Studies were excluded if the number of suicides and number of person years were not reported, could not be calculated, or could not be obtained by email from the authors.

Two authors (DC and ML) independently searched Medline, PsychINFO and Embase for relevant papers published in English between 1 January 1945 and 31 March 2017 (See Figure 1, eSupplement 1). Electronic searches were supplemented by hand searches of the relevant review articles and the full text papers located in the searches conducted for a related meta-analysis [1] were re-examined. Grey literature was not considered. DC and ML independently winnowed titles, abstracts, and full text papers. The authors of studies that met inclusion criteria except for reporting post-discharge suicide rates over periods of longer than a month were contacted by email for data regarding suicides in the one-week and one-month periods. Authors of papers that reported post-

discharge suicide in one-month but not report one-week and the converse were also contacted. A total of 27 authors were contacted.

Data extraction

SS and MW independently extracted the data and ML and DC performed a further check of the data. The number of person years was calculated using the number of discharges and the period of follow-up of 28 or 31 days when it was not directly reported in the paper. Where the follow up was specified to be 'one-month' the length of follow up was assumed to be 365/12 = 30.4 days. Separate figures were extracted for men and women and for the first and subsequent weeks of follow up where possible.

A predetermined list of effect size and moderator variables was extracted. The variables collected were i) number of suicides and number of patient years, ii) period of follow up (one-month versus one week), iii) sex (where specified), iv) diagnostic group (where specified), v) whether the primary study only included people admitted for suicidal thoughts and behaviours, vii) country in which the study was conducted, vii) whether the data were obtained by personal communication with the authors, and viii) study quality items.

We assessed study quality using a 0-4 point scale derived from the Newcastle-Ottawa Scale for assessing the quality of nonrandomised studies[9] and used in a previous meta-analysis of post-discharge suicide rates.[1] One point was awarded if the study: i) identified suicides using coroners' records or a national mortality database (rather than using hospital records), ii) included all the post-discharge suicides in a defined geographic region (rather than suicides from a particular care setting), iii) included open verdicts in suicide numbers; iv) reported the number of discharges (rather than the number of individuals). Studies with a total quality score of 3 or 4 were regarded as being of higher quality.

Data analysis

The effect sizes of interest were the incidence rate (IR), expressed as suicides per 100,000 person years and the incidence rate ratio (IRR). In all analyses a generalized linear mixed effects model was fitted to a count response (number of suicides), with a Poisson distribution, log link, and log of person years as an offset allowing the inclusion of fitted values for zero suicide studies. All models included a random effect (intercept) for study. Confidence intervals were based on t-distribution with df equal to the number of studies. All models were fitted with the R package lme4. Standard errors were calculated using the delta method from the R package car. Pre-specified subgroup analyses were conducted according to the period of follow up, source of the data (published or obtained by personal communication), country of publication, sex, and study quality using a mixed effects model. Publication bias was examined directly by i) comparing extracted data to that obtained by personal communication, ii) examination of Funnel Plots and iii) Egger's regression tests based on the fitted values.

Patient and Public Involvement

The results of this study were discussed with Easter Suburbs Mental Health Service, Consumer Advisory Group for their views on suicide prevention in the suicide in the post discharge period.

Results

Search results and data extraction

Independent searches (DC and ML) both identified 24 of 26 papers reporting on suicides occurring in the first week or first month after discharge. A further 8 studies were included after data were provided by personal communication with the authors, such that either one-week or one-month data or both periods was available from 34 papers (Table 1, eSupplement 2.). The earliest study was published in 1983, the median year of publication was 2009 and the most recent was published in 2017. Twenty-nine papers contained data pertaining to the first month post-discharge (eSupplement 3). Twenty-four papers reported on suicides in the first week post-discharge (eSupplement 4).

There were disagreements concerning 6 of the 68 data points relating to either the number of suicides or number of patient years. All disagreements were resolved by a second examination of the data by DC and ML.

Suicides within a month of discharge

Twenty-nine studies (inclusive of 4 studies with no suicides) reported 3,551 suicides in the first month after discharge during 222,546 person years. The mean number of suicides per study was 122 (SD 443) and the mean number of person years per study was 7,674 (SD 22,581). The median sample suicide rate was 2,333 per 100,000 person years with a range of 0 to 30,252 per 100,000 person years. The first and third quartiles were 601 and 4,555 per 100,000 person years, respectively (see Figure 2. Forrest Plot of suicide rates in one month following discharge from psychiatric hospitalisation). The pooled rate of one-month post-discharge suicide was 2,060 per 100,000 person years (95% CI 1,300–3,280) with very high between-sample heterogeneity (Q = 266.8, $p < 0.001$, $I^2 = 90$) (Table 2).

Separate data for men and women were available for 10 studies reporting one-month post-discharge suicides including 6 studies obtained by personal communication. Men had almost twice the pooled rate of suicide of women (IRR 1.94 95%, CI 1.54 – 2.44; See Table 2, eSupplement 5 & 6).

Studies of patients admitted for suicidal thoughts or behaviours had over three times the rate of suicide than studies of psychiatric patients who were not selected in this way (IRR 3.56, 95% CI 1.29-7.63) but this result was based on a small number of studies and suicides among patients presenting with suicidal thoughts or behaviours. The analysis of suicide rates according to diagnostic group was also limited by a small number of studies but suggested that groups of patients with a mood disorder might have higher rates of one-month post discharge suicide than groups of patients that were not selected by diagnosis (Table 2).

The eight studies deemed to be of low quality had a higher pooled suicide rate compared to the studies deemed to be of higher quality (IRR 1.99 95% CI 1.98–2.01). The eight studies from Asian countries had the highest pooled suicide rate of suicide, followed by the 10 studies from European countries; the five studies from the UK, Canada, and Australia; while the 6 US studies had the lowest rate (Table 2).

Excluding four studies that reported no suicides, fifteen studies reported one-month and one-week suicides allowing a direct comparison of the suicide rates over the first week post-discharge to the remaining 8-31 days. Among these studies, the one-week pooled suicide rate was almost three times the rate in the 8-31 day period (IRR 2.99 95% CI 2.24- 3.97; See Table 2, eSupplement 7 & 8).

Data obtained direct extraction from published papers had a significantly higher one-month post-discharge suicide than data obtained by personal communication (IRR 3.14, 95% CI 1.29 – 7.63). The Funnel Plot was characterised by 8 studies with lower

suicide rates than the pooled estimate and 5 studies with higher suicide rates than the pooled estimate lying outside the Funnel (eSupplement 9). An Eggers test confirmed the likelihood of publication bias towards studies with a higher post discharge suicide rate (Eggers Bias = 4.94, 95% CI 1.38-8.50, df = 27, P<.004)

Suicide rates in the first week post discharge

24 studies were included in a meta-analysis of one-week post-discharge suicide rates. These comprised 15 studies reporting suicides at both one-month and one-week (as above, Table 2), five studies reporting suicides in one-week but not one month and four studies with no suicides. The 24 studies reported a total of 1,928 suicides (mean = 80.3 per study, SD= 315.5, median = 8) during 60,880 person years (mean = 2,536.7 per study, SD = 7783, median = 174.5). The median sample suicide rate was 3,186 per 100,000 person years (range 0–75,000 per 100,000, first quartile = 567, third quartile = 6,730).

The pooled one-month post-discharge suicide rate was 2,950 suicides per 100,000 person years (95% CI 1,740-5,000) with very high between study heterogeneity (Q = 186.4, $p < 0.0001$), $I^2 = 88$). (Table 3., Figure 3. Forrest Plot of suicide rates in one week following discharge from psychiatric hospitalisation).

Data extracted from published papers had a significantly higher rate of suicide than personally communicated data (IRR 3.63, 95% CI 1.55 – 8.49). The Funnel Plot was characterised by 5 studies with lower suicide rates than the pooled estimate and there were 4 studies with higher suicide rates than the pooled estimate lying outside the Funnel (eSupplement 10). An Eggers test confirmed the likelihood of publication bias towards studies with a higher post discharge suicide rate (Eggers Bias = 4.31, 95% CI .85-7.78, df = 22, p <.008).

Studies considered to have a lower quality had a higher rate of suicide than those assessed to have a lower quality (IRR 2.83 95% CI 2.80-2.85).

Discussion

This study synthesised over thirty years of research on suicide risk during the period immediately following psychiatric hospitalisation. The study builds on a previous meta-analysis of post psychiatric discharge suicide rates [1] by including unpublished data and data that were excluded from an earlier meta-analysis of suicide rates post discharge [1] to estimate suicide rates over the first week and first month post discharge. One-week post-discharge suicide rates were approximately 3,000 suicides per 100,000 person years while one-month rates were approximately 2,000 per 100,000 person years. Rates from the beginning of the second week to the end of the fourth week or one-month post-discharge were approximately 1,000 per 100,000 person years. Rates of 2,000 to 3,000 per 100,000 person years are respectively about 200–300 times the global suicide rate.[10] Our results also compare with a recent meta-analysis that estimated 1,132 suicides per 100,000 person years among 18 studies of the first three months and 484 per 100,000 person years among 100 studies of any period of follow up. [1] This suggests a six-fold risk of suicide in the first week post-discharge compared to the long-term rates of suicide after psychiatric discharge of about 500 per 100,000 person years. It further suggests that length of time since discharge is at least as important as clinical risk factors for suicide (odds ratio =1.50) [11] and high-risk models for suicide (odds ratio = 4.84) [12] reported in longitudinal studies.[13]

Our finding of higher rates of suicides by men in the immediate post-discharge period is unsurprising because of the preponderance of men among all suicide deaths [10] but is in contrast with less clear gender effects on inpatient suicide rates. [14 15]

The main limitation or our study is uncertainty about the extent to which our pooled estimates can be generalised. We observed very high between-study heterogeneity that may be partially explained by publication bias towards studies with high suicide rates and aspects of study quality. However, in all likelihood there are real differences

in post discharge suicide rates between settings that cannot be examined using the existing literature. Most importantly, this study was not able to ascertain the role of the availability and quality of post-discharge care in determining post discharge suicide rates.

Our findings emphasise the importance of post-discharge follow up. Currently in the United States only around half of commercially insured patients and a third of Medicare patients in the US received a psychiatric follow-up visit within 7 days of hospital discharge for a mental illness.[16] In the United Kingdom, the NICE guidelines suggest that people discharged from mental health settings should be followed up within seven days. [17] While the introduction of a seven day follow period is one of a suite of measures that do seem to be associated lower suicide rates in the UK,[18] it is sobering to consider that some patients who are scheduled to be followed up at the seven day mark will die before they are ever reassessed.

Very high rates of suicide in the immediate post-discharge period should encourage clinicians to think carefully about the patient's transition from hospital to the community. Qualitative research suggests that the transition from hospital to home is associated with re-emergence of pre-existing social stresses and new stresses associated with hospitalisation.[19-21] Clinicians should consider strategies that might improve this transition, including pre- and post-discharge patient psycho-education, formal needs based assessments, use of transitional care teams, improved communication between the inpatient team, and greater involvement of the patient's outpatient team and family.[22]

The high risk of suicide during the period immediately following hospital discharge provides a clinical rationale for conceptualizing the first post-discharge month as a distinct phase of recovery and treatment, especially in the context of pervasive gaps in treatment following psychiatric hospitalization. Traditional case management approaches to continuity of care following psychiatric hospitalisation have not consistently yielded promising results. In one review, two of seven studies of telephone follow-up

and one of five studies that involved facilitating communication between inpatient and outpatient clinicians resulted in a significant increase in continuity of care [22]. Intensive interventions that involve home visits, social support, motivational interviewing, and accompanying patients to outpatient appointments have yielded more encouraging results.[23 24]

Other limitations relate to the representativeness of the included studies. All of the research came from high-income economies of Asia, Australasia, North America, and Europe and our results might not be representative of post-discharge suicide in low and middle-income countries. Moreover, there were an insufficient number of studies to determine whether apparent differences in suicide rates between regions were real or were simply the result of available studies. Differences between rates of post-discharge suicide between countries are plausible because of differences in national suicide rates, [10] progress towards deinstitutionalisation, [25] and likely national differences in the quality of mental health care systems [26]

Although it has been argued that one way of combatting post-discharge suicide is to focus on individual patients with clinical characteristics that signify a high suicide risk,[27 28] the very high suicide rates calculated in this study and the known limitations of suicide risk assessment [29] suggest that a narrow focus on clinical risk assessment might mislead clinicians into thinking that some recently discharged psychiatric inpatients can be regarded as being at low risk post-discharge.[30] Our findings support an approach to suicide prevention focussed on whole cohorts of discharged patients.[31]

Role of the funding source

There was no funding source for this study.

Conflicts of Interest

Dr. Olfson reports grants from Janssen Scientific Affairs, outside the submitted work.

Author Contribution Statement

Study Design; DC, ML

Data Collection; DC, ML, MO, SS, MW

Data Analysis; DH-P, ML

Interpretation and Critical Review; ML, MO, DH-P

Manuscript Preparation: DC, DH-P, ML, MO, SS, MW

Dr Large has full access to all the data in the study and takes responsibility for the integrity of the data and accuracy of the analysis

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Tables

Table 1. List of included studies

Study	Location	Period	Suicide Ascertainment	Type of Patient	Discharges	Suicides in the first week	Suicides on the first month
Castelein et al., (2015) [32]	Psychiatric hospitals in Groningen, the Netherlands	2000-2011	Regional psychiatric case register	Recent onset psychosis	424	1	-
De Leo & Heller (2007) [33]	Gold Coast Hospital, Queensland, Australia	2002-2005	Not specified	Previous suicide attempters	60	0	0
Deisenhammer et al. (2016) [34]	Three psychiatric hospitals, Tyrol, Austria	2004-2011	Not specified	Unselected adults	65,652	25	51
Erlangsen (2006) [35]	All psychiatric hospitals, Denmark	1990-2001	Coronial records	Adults aged >60 years	72,701	77	-
Geddes et al. (1997) [36]	All psychiatric hospitals, Scotland, UK	1968-1993	Coronial records	Unselected adults	338,013	-	367
Goldacre et al. (1993) [37]	Hospitals within the Oxford Regional Health Authority, UK	1979-1986	Coronial records	Unselected adults	26,864	-	44
Hayashi et al. (2012) [38]	Tokyo Metropolitan Matsuzawa	2006-2009	Not specified	Admitted suicidal patients	3,450	-	0

	Hospital, Japan						
Healy et al. (2006) [39]	Unspecified hospitals, North Wales UK	1994-2003	Coronial records	Psychotic patients	133	-	2
Ho (2003) [3]	All psychiatric wards and hospitals in Hong Kong, China	1997-2000	Coronial records	Unselected adults	21,921	-	124
Isometsa (2014) [40]	All psychiatric wards and hospitals, Finland	1987-2004	Coronial records	Adults with bipolar disorder	52,747	53	158
Johansson (1996) [41]	All psychiatric inpatients in southern Stockholm, Sweden	1984-1985	Coronial records	Unselected adults	3,862	4	12
Kessler et al. (2015) [42]	US Army psychiatric hospitals and wards, USA	2004-2009	Coronial records	US army psychiatric patients	53,769	5	17
Lee & Lin (2009) [43]	All psychiatric wards and hospitals in Taiwan	2001-2005	Coronial records	Patients with schizophrenia	435	22	39
Links et al. (2012) [44]	St Michael's Hospital, Toronto, Canada	2007-2009	Not specified	Patients with previous suicidal behaviour or ideation	120	-	3
Luxton et al. (2013) [45]	US Military treatment facilities, USA	2001-2011	Coronial records	US service members	68,947	-	35
Madsen &	All psychiatric	1998-	Coronial	Unselected	287,866	175	374

Nordentoft (2013) [46]	wards and hospitals in Denmark	2006	records	adults			
Naik et al. (1997) [47]	Saxondale Hospital, Nottinghamshire, England, UK	1974-1992	Local registers and NHS central register	Unselected adults	86	-	0
Nyman (1986) [48]	Unspecified psychiatric hospital, Sweden	1964-1968	Coronial records	Patients with schizophrenia	110		0
Olfson (2016) [49]	Psychiatric patients from 45 American states	2001-2008	Coronial records	Unselected adults	770,643	49	151
Park et al. (2013) [50]	Asan Medical Center, Seoul, South Korea	1989-2006	Coronial records	Unselected adults	8,403	10	26
Pedersen et al. (2014) [51]	All psychiatric hospitals and wards in Denmark	2005-2010	Coronial records	Patients with schizophrenia	7,107	6	-
Pirkola et al. (2007) [52]	All psychiatric hospitals and wards in Finland	1985-2001	Coronial records	Unselected adults	355,000	1,164	1,698
Pokorny (1983)[53]	Houston Veterans Administration Medical Centre, Texas, USA	Not specified	Coronial records	Veterans administration patients	4,800	10	16
Qurashi et al. (2006) [54]	Unspecified hospital, Manchester, England, UK	Not specified	Not specified	Unselected adults	69	1	-
Riblet (2017)	All American	2002-	Coronial	Unselected	1,126,17	141	-

[55]	Veteran Health mental health inpatient units	2015	records	American service-people	9		
Ruengorn et al. (2011) [56]	Suanprung Psychiatric Hospital, Chiang Mai, Thailand	2007-2010	Hospital records	Mood disorder patients admitted for suicide attempt	235	1	1
Sani et al. (2011) [57]	Belvedere Montello Hospital, Rome, Italy	1964-1998	Coronial records	Unselected adults	4,441	2	-
Seemuller et al. (2014) [58]	Twelve centres across Germany	Not specified	Study follow up	Patients with major depression	1,014	1	1
Tejedor et al. (1999) [59]	Psychiatric Department of Santa Cruz y San Pablo Hospital, Barcelona, Spain	1983-1997	Study follow up	Suicide attempters	150	0	1
Tsai (2002) [60]	Taipei City Psychiatric Center, Taiwan	1985-1997	Coronial Records	Patients with mood disorders	2,133	0	24
Tseng et al. (2006) [61]	Unspecified psychosomatic ward, Taiwan	2000-2002	Study follow up	Patients with major depression	67		2
Valenstein (2009)[62]	All US veteran psychiatric inpatient facilities	1999-2004	Coronial data	American veterans with mood disorders	184,093	50	127
Winkler et al. (2015) [63]	All psychiatric hospitals and psychiatric	2006-2012	Coronial records	Unselected adults	137,290	131	258

	wards, Czech Republic						
Yim (2004) [64]	Pamela Youde Nethersole Eastern Hospital, Hong Kong	1996-1999	Coronial records	Unselected adults	6,292	-	20

Table 2. Suicide rates in the first first month post discharge from psychiatric settings							
	N Studies	Suicides	Patient years	Pooled estimate	Lower Limit	Upper Limit	
One month	29	3551	222546	2060	1300	3280	
Subgroup of studies reporting follow up at 1 week and 2-4weeks							
One Week	15	1928	60854	3170	1710	5890	
Two to four weeks	15	1229	115858	1060	660	1070	
Subgroup of studies reporting suicides by men and women							
Male	10	917	83913	1400	780	2500	
Female	10	497	82989	720	390	1320	
Subgroup of studies according to data source							
Extracted directly	22	2672	107439	2880	1770	4670	
Personally communicated	7	879	115107	920	430	1930	
Subgroups of studies according to selection for suicidal thoughts or behaviours							
Admitted with suicidal thoughts or behaviours	5	5	56	6210	1550	24860	
Unselected by suicidally	24	3546	222490	1850	1170	2920	
Subgroups of studies according to selection by diagnosis							
Patients with a mood disorder	6	312	18201	3370	1240	9180	
Patients with a schizophrenia spectrum disorder	3	41	6270	1720	330	9110	

Unselected by diagnosis	20	3198	198075	1830	1080	3110	
Subgroups of studies according to study quality							
Higher Quality†	8	820	73318	1360	1350	1370	
Lower Quality	20	2731	149227	2720	2690	2740	
Subgroup of studies according to geographic region							
Asia	8	235	13000	3230	1470	7100	
Europe	10	2554	75634	2340	1170	4680	
United States	6	346	87376	1030	450	2380	
United Kingdom, Australia and Canada	5	416	46535	2020	630	6490	
† one study failed to converge							

Table 3. Suicide rates in the week month post discharge from psychiatric settings

	N Studies	Suicides	Patient years	Pooled estimate	Lower Limit	Upper Limit	
One week	24	1928	60880	2950	1740	5000	
Subgroup of studies according to data source							
Extracted directly	16	1429	12605	5090	2930	8840	
Personally communicated	8	499	48257	1400	740	2680	
Subgroups of studies according to study quality							
Higher Quality	5	246	26370	3950	3910	3990	
Lower Quality	19	1682	34492	1400	1380	1410	

Figures 1-3

Figure 1. Prisma Flow Chart

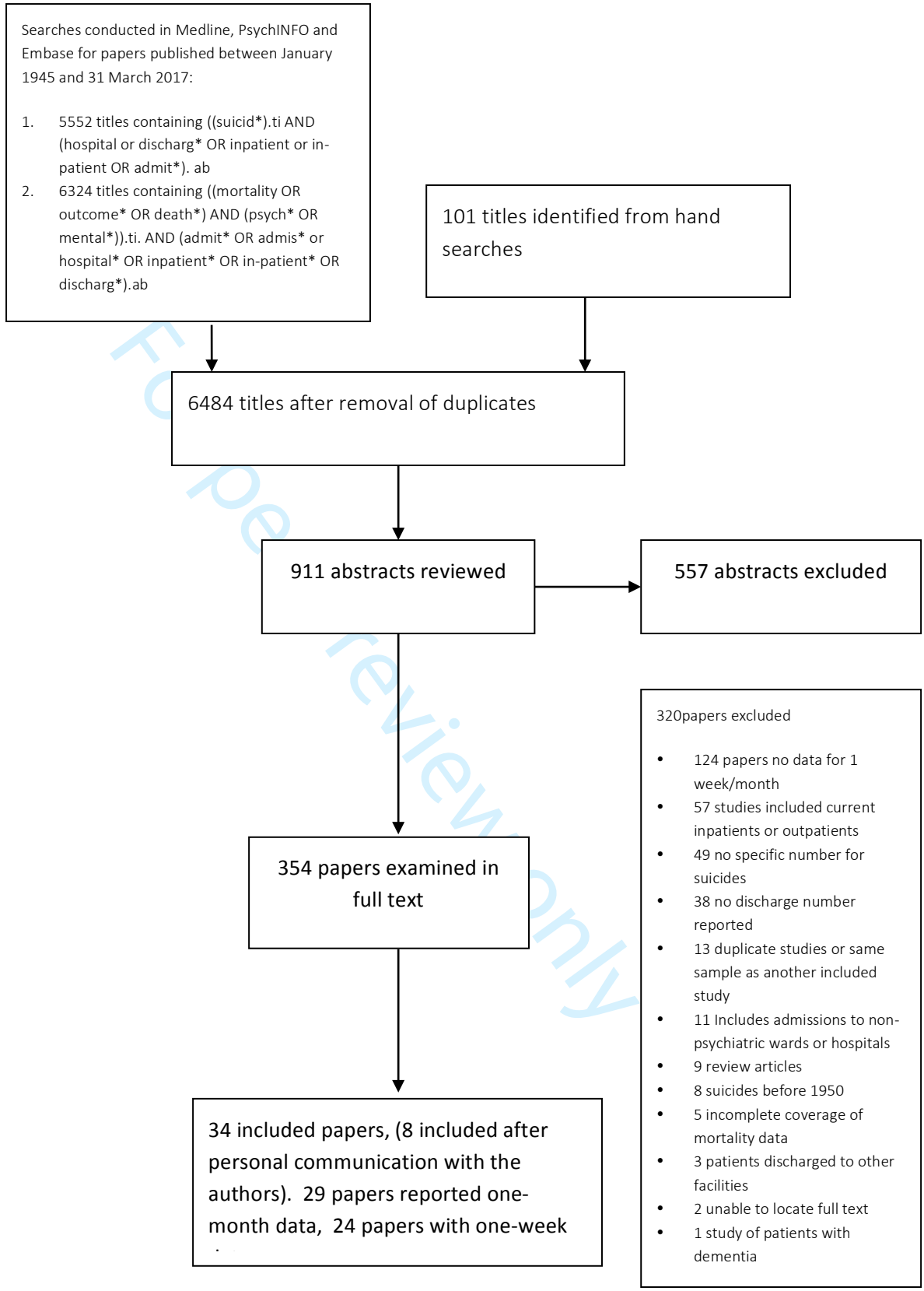
Figure 2. Forrest Plot of suicide rates in one month following discharge from psychiatric hospitalisation

Figure 3. Forrest Plot of suicide rates in one week following discharge from psychiatric hospitalisation

eSupplements 1-10

1. Search stategy
2. Strength of reporting items of included studies
3. Suicide rates in one month following discharge from psychiatric hospitalisation
4. Suicide rates in one week following discharge from psychiatric hospitalisation
5. Suicide rates in one month following discharge from psychiatric hospitalisation with gender subgroups.
6. Forest Plot of studies reporting suicides by men and women in one month following discharge from psychiatric hospitalisation
7. Suicide rates in one week and two-four weeks following discharge from psychiatric hospitalisation
8. Forrest Plot Suicide rates in one week and two-four weeks following discharge from psychiatric hospitalisation
9. Funnel Plot of Suicide rates in one month following discharge from psychiatric hospitalisation
10. Funnel Plot of Suicide rates in one week following discharge from psychiatric hospitalisation

Figure 1. Prisma Flow Chart



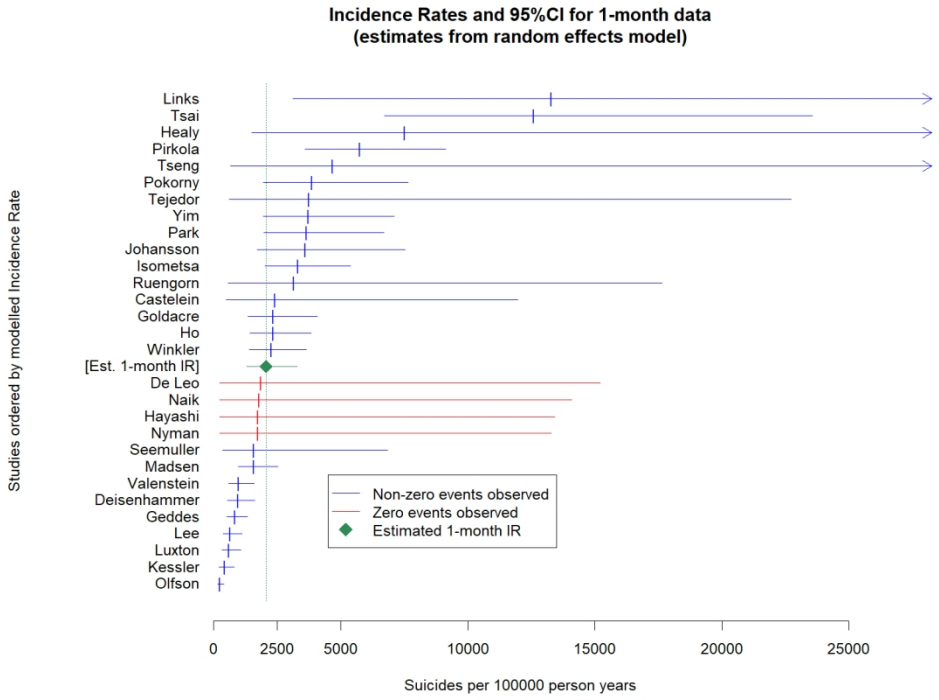


Figure 2. Forest plot of studies reporting suicide rates in the first-month post discharge

279x203mm (150 x 150 DPI)

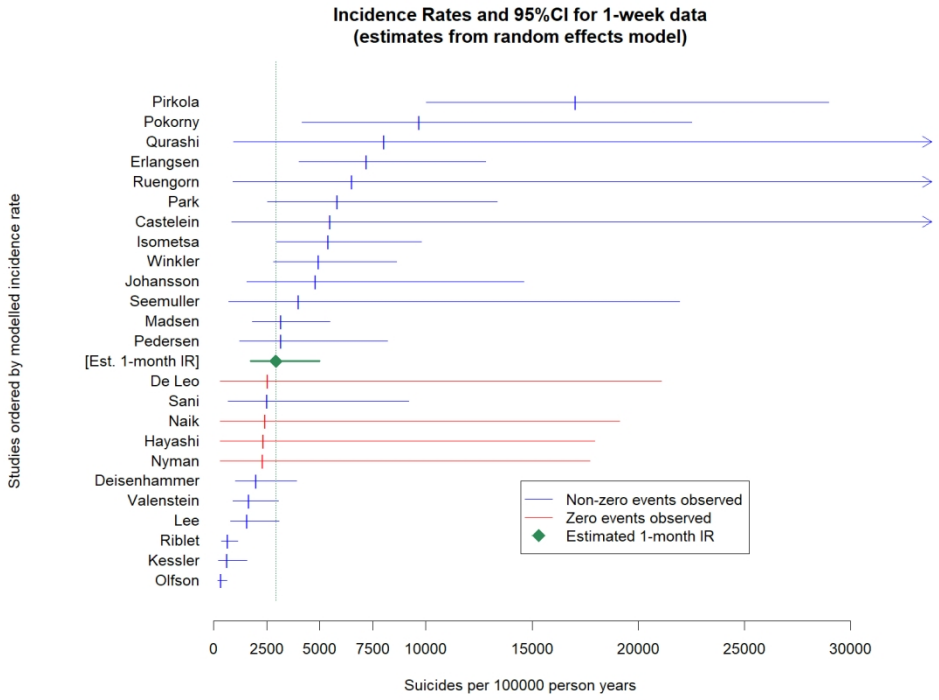


Figure 3. Forest plot of studies reporting suicide rates in the first-week post discharge

279x203mm (150 x 150 DPI)

eSupplement 1. Search Strategy

Data bases Medline, PsychINFO and Embase

Dates January 1945 and 31 March 2017:

Limits. English Language

Search Terms 1. ((suicid*).ti AND (hospital or discharg* OR inpatient or in-patient OR admit*). ab

Search Terms 2. ((mortality OR outcome* OR death*) AND (psych* OR mental*)).ti. AND (admit* OR admis* or hospital* OR inpatient* OR in-patient* OR discharg*).ab

eSupplement 2. Strength of reporting items of included studies

Study name	Coronial Verdicts	Counts admissions	Defined Population	Includes Undetermined deaths	Strength of Reporting Score
Castelein 2015	0	0	1	0	1
De Leo 2007	0	0	0	0	0
Erlangsen 2006	1	0	1	0	2
Deisenhammer 2016	1	1	1	0	3
Geddes 1997	1	0	1	1	3
Goldacre 1993	1	1	1	1	4
Hayashi 2012	0	0	0	0	0
Healy 2006	1	0	1	0	2
Ho 2003	1	0	1	1	3
Isometsa 2014	1	1	1	0	3
Johansson 1996	1	0	0	1	2
Kessler 2015	1	1	1	0	3
Lee 2009	1	1	1	0	3
Links 2012	0	0	0	0	0
Luxton 2013	1	0	1	0	2
Madsen 2013	1	0	1	0	2
Naik 1997	1	0	0	0	1
Nyman 1986	1	1	0	0	2
Olfson 2016	1	0	1	0	2
Park 2013	1	0	0	0	1

Pedersen	1	0	1	0	2
Pirkola 2007	1	0	1	0	2
Pokorny 1983	1	0	0	0	1
Qurashi 2006	0	0	0	0	0
Riblet 2017	1	1	1	0	3
Ruengorn 2011	0	0	0	0	0
Sani 2011	1	0	0	0	1
Seemuller 2014	0	0	0	0	0
Tejedor 1999	0	0	0	0	0
Tsai 2002	0	0	0	0	0
Tseng 2006	0	0	0	0	0
Valenstein 2009	1	0	1	0	2
Winkler 2015	1	0	1	0	2
Yim2004	1	0	1	1	3

eSupplement 3 – Suicide rates in one month following discharge from psychiatric hospitalisation

Study	Person years	Suicides	Observed	Fitted	LL	UL
Castelein	36.01	1	0.0278	0.0240	0.0048	0.1796
De Leo	5.00	0	0.0000	0.0186	0.0023	0.1521
Deisenhammer	5471.00	51	0.0093	0.0095	0.0055	0.0362
Geddes	44634.20	367	0.0082	0.0082	0.0051	0.0332
Goldacre	1875.00	44	0.0235	0.0234	0.0134	0.0407
Hayashi	8.83	0	0.0000	0.017	0.0023	0.1342

				4		
Healy	11.08	2	0.1805	0.0751	0.0149	0.3395
Ho	5314.00	124	0.0233	0.0233	0.0142	0.0383
Isometsa	4769.00	158	0.0331	0.0330	0.0202	0.0540
Johansson	321.00	12	0.0374	0.0358	0.0171	0.0753
Kessler	4480.75	17	0.0038	0.0041	0.0021	0.0079
Lee	6250.00	39	0.0062	0.0064	0.0037	0.0112
Links	9.92	3	0.3025	0.1329	0.0312	0.5653
Luxton	6050.13	35	0.0058	0.0060	0.0034	0.0106
Madsen	23911.92	374	0.0156	0.0157	0.0097	0.0252
Naik	7.25	0	0.0000	0.0179	0.0023	0.1709
Nyman	9.17	0	0.0000	0.0173	0.0023	0.1628
Olfson	63288.60	151	0.0024	0.0024	0.0015	0.0039
Park	700.25	26	0.0371	0.0364	0.0198	0.0670
Pirkola	29583.33	1698	0.0574	0.0574	0.0360	0.0914
Pokorny	400.00	16	0.0400	0.0386	0.0194	0.0766
Ruengorn	19.58	1	0.0511	0.0315	0.0056	0.1663
Seemuller	79.25	1	0.0126	0.0157	0.0036	0.0683

Tejedor	12.50	1	0.0800	0.0373	0.0061	0.2372
Tsai	177.75	24	0.1350	0.1258	0.0672	0.2357
Tseng	5.58	1	0.1791	0.0468	0.0066	0.3389
Valenstein	13149.47	127	0.0097	0.0097	0.0059	0.0160
Winkler	11440.83	258	0.0226	0.0225	0.0140	0.0364
Yim	524.33	20	0.0381	0.0371	0.0194	0.0710

eSupplement 4. Suicide rates in one week following discharge from psychiatric hospitalisation						
Study	Person years	Observed	Observed	Fitted	LL	UL
Castelein	8.14	1	0.1229	0.0548	0.0085	0.3523
DeLeo	5.00	0	0.0000	0.0255	0.0031	0.2109
Deisenhammer	1262.54	25	0.0198	0.0201	0.0103	0.0390
Erlangsen	1058.72	77	0.0727	0.0720	0.0404	0.1283
Hayashi	8.83	0	0.0000	0.0234	0.0030	0.1796
Isometsa	974.00	53	0.0544	0.0539	0.0296	0.0980
Johansson	74.08	4	0.0540	0.0481	0.0158	0.1461
Kessler	1034.00	5	0.0048	0.0062	0.0024	0.0157
Lee	1442.00	22	0.0153	0.0156	0.0079	0.0308
Madsen	5518.13	175	0.0317	0.0317	0.0183	0.0550
Naik	7.25	0	0.0000	0.0242	0.0031	0.1911
Nyman	9.17	0	0.0000	0.0232	0.0030	0.1773
Olfson	14776.80	49	0.0033	0.0034	0.0019	0.0063
Park	161.60	10	0.0619	0.0581	0.0253	0.1336
Pedersen	187.40	6	0.0320	0.0317	0.0123	0.0819
Pirkola	6826.92	1164	0.1705	0.1703	0.1001	0.2896
Pokorny	92.30	10	0.1083	0.0968	0.0417	0.2252
Qurashi	1.33	1	0.7536	0.0803	0.0095	0.6766

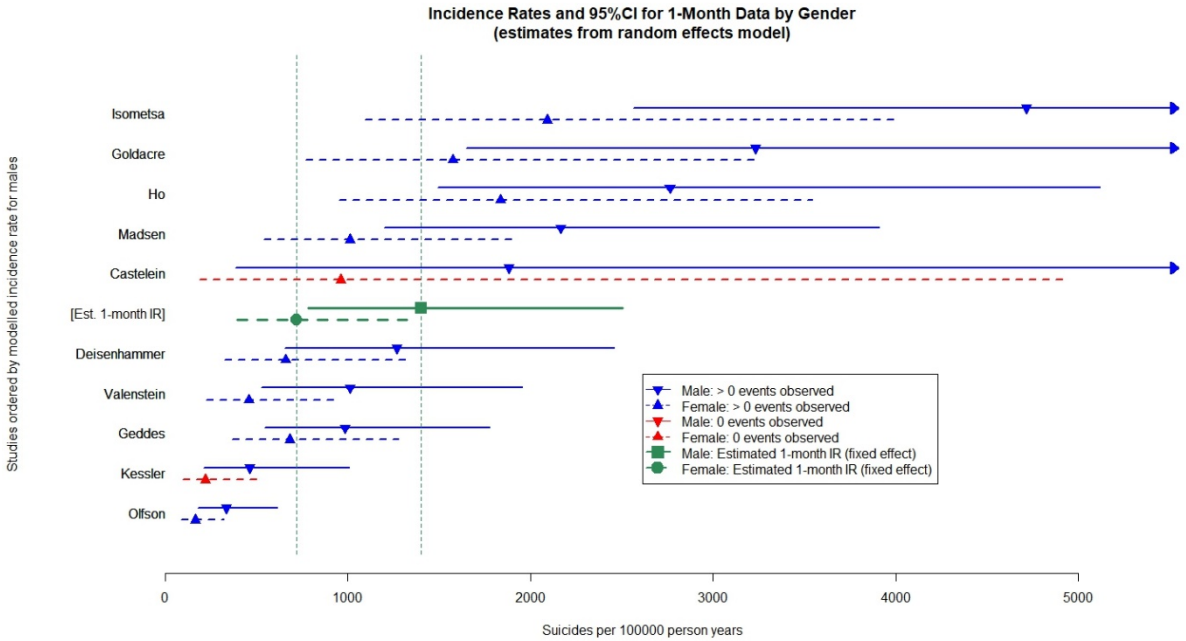
Riblet	21657.30	141	0.0065	0.0066	0.0038	0.0115
Ruengorn	4.52	1	0.2212	0.0650	0.0091	0.4651
Sani	85.31	2	0.0234	0.0251	0.0069	0.0919
Seemuller	18.29	1	0.0547	0.0399	0.0073	0.2194
Valenstein	3026.18	50	0.0165	0.0167	0.0091	0.0304
Winkler	2640.19	131	0.0496	0.0494	0.0283	0.0863

eSupplement 5 – Suicide rates in one month following discharge from psychiatric hospitalisation with gender subgroups.

Study	Sex	Person years	Suicides	Residual	Observed	Fitted	LL	UL
Castelein	F	10.36	0	-0.447	0.0000	0.0096	0.0019	0.0491
Castelein	M	25.65	1	0.646	0.0390	0.0188	0.0039	0.0921
Deisenhammer	F	3006.00	20	0.026	0.0067	0.0066	0.0033	0.0133
Deisenhammer	M	2465.00	31	-0.045	0.0126	0.0127	0.0066	0.0246
Geddes	F	24113.30	171	0.477	0.0071	0.0068	0.0037	0.0128
Geddes	M	20520.90	196	-0.456	0.0096	0.0099	0.0055	0.0178
Goldacre	F	1072.00	16	-0.205	0.0149	0.0158	0.0077	0.0322
Goldacre	M	803.00	28	0.383	0.0349	0.0323	0.0165	0.0633
Ho	F	2582.00	53	0.830	0.0205	0.0184	0.0095	0.0354
Ho	M	2732.00	71	-0.543	0.0260	0.0276	0.0149	0.0512
Isometsa	F	2614.00	52	-0.352	0.0199	0.0209	0.0110	0.0400
Isometsa	M	2155.00	106	0.413	0.0492	0.0471	0.0256	0.0867
Kessler	F	887.64	0	-2.004	0.0000	0.0022	0.0010	0.0050
Kessler	M	3593.11	17	0.096	0.0047	0.0046	0.0021	0.0101
Madsen	F	12533.41	125	-0.171	0.0100	0.0101	0.0054	0.0189

Madsen	M	11378.51	249	0.157	0.0219	0.0217	0.0120	0.0391
Olfson	F	35113.50	58	-0.181	0.0017	0.0017	0.0009	0.0032
Olfson	M	28175.10	93	-0.069	0.0033	0.0033	0.0018	0.0061
Valenstein	F	1065.11	2	-1.504	0.0019	0.0046	0.0023	0.0092
Valenstein	M	12084.36	125	0.215	0.0103	0.0101	0.0053	0.0196

eSupplement 6. Forest Plot of studies reporting suicides by men and women in one month following discharge from psychiatric hospitalisation

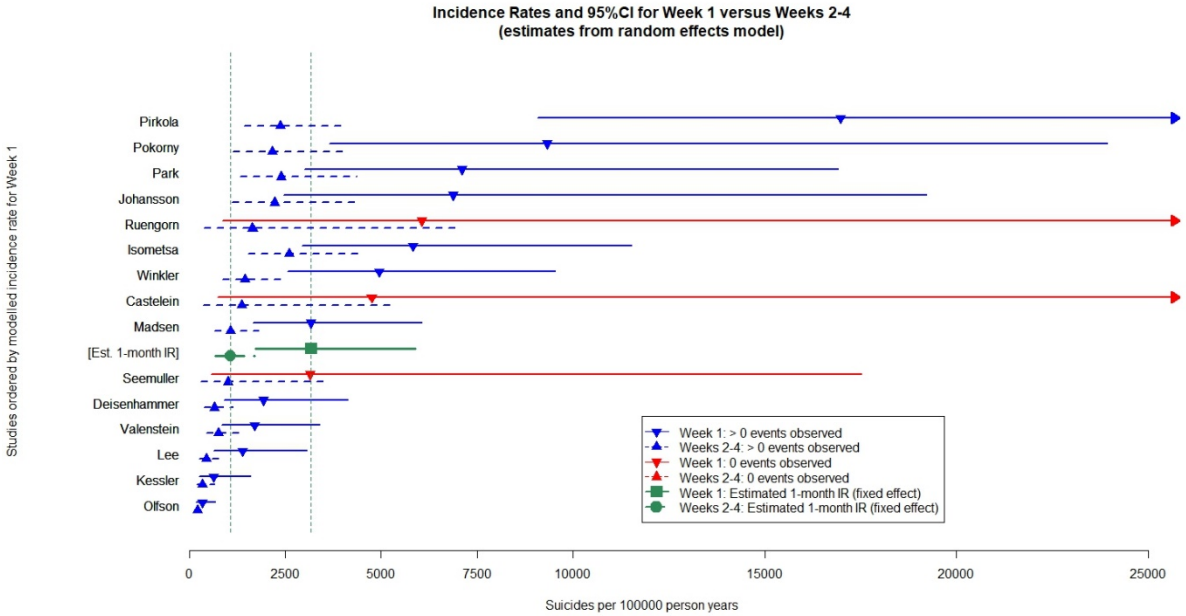


eSupplement 7. Suicide rates in one week and two-four weeks following discharge from psychiatric hospitalisation							
Study	Week	Person years	Observed	IR Observed	IR Fitted	LL	UL

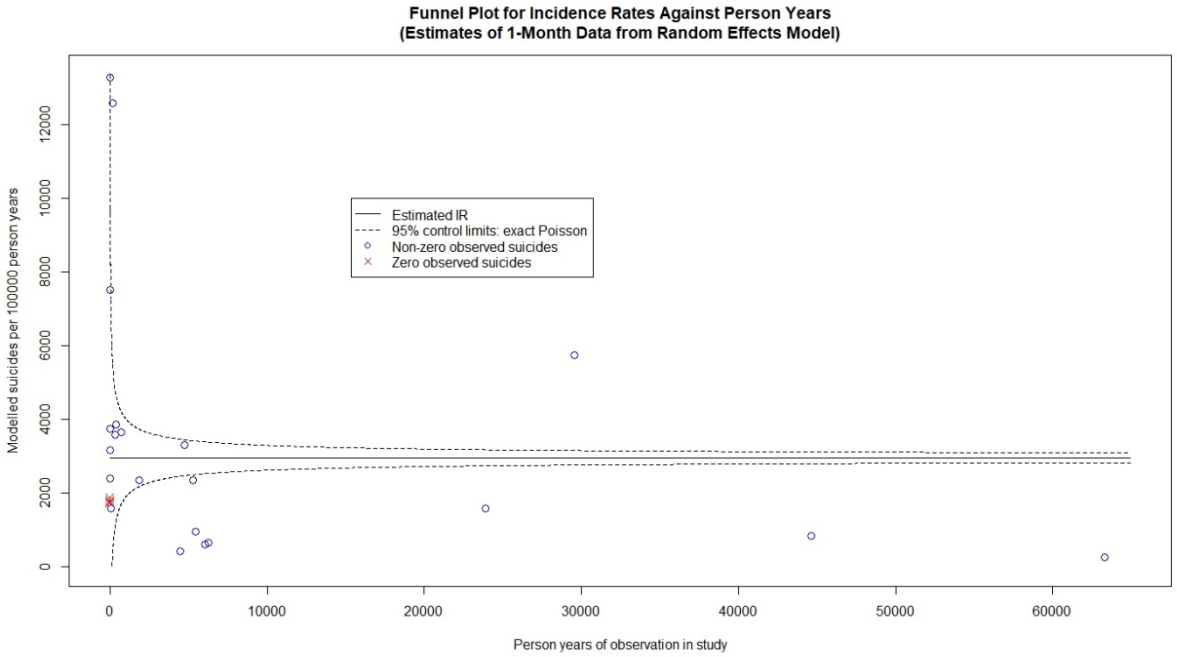
Castelein	1	8.14	1	0.1229	0.0475	0.0074	0.3028
Castelein	2-4	27.88	0	0.0000	0.0137	0.0035	0.0532
Deisenhammer	1	1262.54	25	0.0198	0.0192	0.0089	0.0413
Deisenhammer	2-4	4208.46	26	0.0062	0.0066	0.0038	0.0114
Isometsa	1	974.00	53	0.0544	0.0582	0.0294	0.1153
Isometsa	2-4	3795.00	105	0.0277	0.0261	0.0154	0.0443
Johansson	1	74.08	4	0.0540	0.0688	0.0246	0.1923
Johansson	2-4	246.92	8	0.0324	0.0223	0.0112	0.0444
Kessler	1	1034.00	5	0.0048	0.0063	0.0025	0.0160
Kessler	2-4	3446.75	12	0.0035	0.0034	0.0018	0.0064
Lee	1	1442.00	22	0.0153	0.0138	0.0063	0.0305
Lee	2-4	4808.00	17	0.0035	0.0043	0.0025	0.0076
Madsen	1	5518.13	175	0.0317	0.0317	0.0166	0.0605
Madsen	2-4	18393.79	199	0.0108	0.0108	0.0064	0.0181
Olfson	1	14776.80	49	0.0033	0.0034	0.0017	0.0068
Olfson	2-4	48511.80	102	0.0021	0.0021	0.0012	0.0036
Park	1	161.60	10	0.0619	0.0711	0.0299	0.1691
Park	2-4	538.65	16	0.0297	0.0240	0.0132	0.0435
Pirkola	1	6826.92	1164	0.1705	0.1698	0.0909	0.3173
Pirkola	2-4	22756.41	534	0.0235	0.0237	0.0142	0.0395
Pokorny	1	92.30	10	0.1083	0.0934	0.0364	0.2393
Pokorny	2-4	307.70	6	0.0195	0.0216	0.0114	0.0409
Ruengorn	1	4.52	1	0.2212	0.0606	0.0086	0.4286
Ruengorn	2-4	15.06	0	0.0000	0.0165	0.0039	0.0699
Seemuller	1	18.29	1	0.0547	0.0314	0.0056	0.1751
Seemuller	2-4	60.96	0	0.0000	0.0101	0.0029	0.0347
Valenstein	1	3026.18	50	0.0165	0.0170	0.0085	0.0339

Valenstein	2-4	10123.29	77	0.0076	0.0075	0.0044	0.0127
Winkler	1	2640.19	131	0.0496	0.0495	0.0258	0.0954
Winkler	2-4	8800.64	127	0.0144	0.0144	0.0083	0.0243

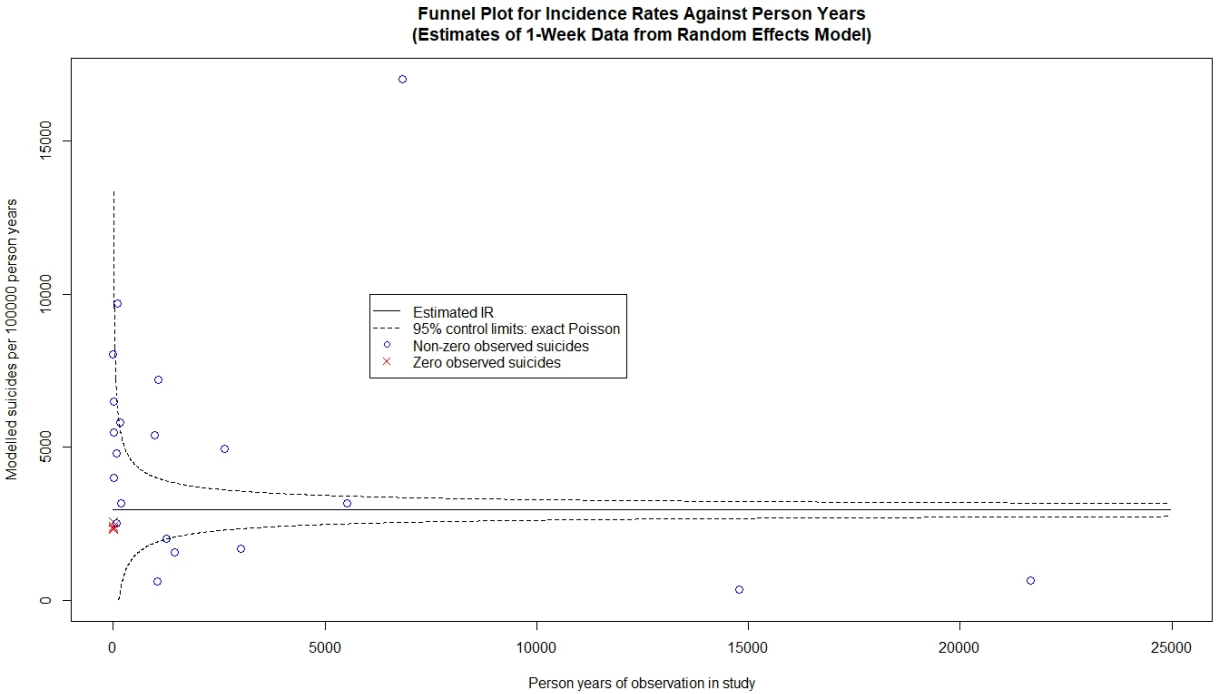
eSupplement 8. Forrest Plot Suicide rates in one week and two-four weeks following discharge from psychiatric hospitalisation



eSupplement 9. Funnel Plot of Suicide rates in one month following discharge from psychiatric hospitalisation



eSupplement 10. Funnel Plot of Suicide rates in one week following discharge from psychiatric hospitalisation



PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	1
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	4
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	4
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	4
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	4
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	4
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	4
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	5
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.	5
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	5
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	5

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	5
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	5
RESULTS			
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.	28
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	table 1
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).	data supplement
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	29
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	7-9, 29
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	9
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	9
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	10
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	11-12
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	12
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	13

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

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