E. Plunkett,

Anaesthetics Department, Theatre Corridor (2nd Floor),

Queen Elizabeth Hospital Birmingham,

Mindelsohn Way, Edgbaston

Birmingham, B15 2GW

Suicide in anaesthetists: a systematic review

E. Plunkett,[1] A. Costello,[2] S.M. Yentis[3] and K. Hawton[4,5]

1 Consultant Anaesthetist, University Hospitals Birmingham, UK @emmaplunkett

2 Consultant Anaesthetist, Milton Keynes University Hospitals, UK

3 Consultant Anaesthetist, Chelsea and Westminster Hospital, London, UK; Honorary Reader, Imperial College London, UK

4 Professor of Psychiatry and Director, Centre for Suicide Research, University Department of Psychiatry, Warneford Hospital, Oxford, UK

5 Consultant Psychiatrist, Oxford Health NHS Foundation Trust, Warneford Hospital, Oxford, UK

Correspondence to: Dr E. Plunkett; emma.plunkett@nhs.net

Short title: Suicide in anaesthetists

Key words: anaesthetists; suicide; suicidal ideation, suicidal behaviour

Summary

Evidence suggests that healthcare professionals are at an increased risk of dying by suicide, with anaesthetists at particularly high risk. However, much of the data on which this is based are historical. We conducted a systematic review of evidence regarding suicide and suicidal behaviour amongst anaesthetists, with a focus on the epidemiology and methods used, in order to provide a more contemporary summary. The systematic review process was adapted from a previous, similar study in veterinary surgeons and was consistent with recommended guidance. We identified 54 articles published in or after 1990 that had anaesthetist-specific data and met the inclusion criteria. Seven of these articles reported epidemiological data, of which four were published after 2000. Although none of the more recent studies reported standardised mortality rates specific to suicide in anaesthetists, the proportion of anaesthetists dying by suicide was increased with respect to comparator groups, which is consistent with previous findings. Eleven studies that included information on suicidal behaviour reported suicidal ideation in 3.2-25% of individuals (6 studies) and suicide attempts in 0.5-2% (4 studies). Studies reporting methods of suicide highlighted the use of anaesthetic drugs, particularly propofol, supporting the suggestion that the increased risk of suicide in anaesthetists may be related to the availability of the means. We discuss our findings in relation to other recently published data and guidance concerning mental health problems in anaesthetists.

Introduction

Many reports in the literature suggest that medicine is a profession associated with a higher likelihood of death by suicide than the general population [1-6]. A report published in 2010 by the Australian mental health organisation Beyond Blue summarised the profession-specific literature available at that time [7]. It references the 'good quality' meta-analysis published by Schernhammer and Colditz in 2004, which compared suicide rates in male and female physicians with those in the general population [2]. The meta-analysis included 22 studies and concluded that both male and female doctors had a higher rate of suicide (standardised mortality rate (SMR) for male doctors 1.26 (95% CI 1.09-1.44); $p = 0.001$; SMR for female doctors 2.46 (95% CI 1.93-3.13); $p < 0.0001$).

The Beyond Blue report included three studies specific to anaesthetists [8-10], all of which included data from before 2000. Bruce et al. compared the causes of death in members of the American Society of Anesthesiologists (ASA) with those in non-medical life insurance policy holders between 1967 and 1971 and found that the death rate from suicide in the former was 2.97 times that of policy holders [8]. Neil et al. followed a cohort of male anaesthetists in the UK between 1957 and 1983 and compared them with the general population [9]. As in the study by Bruce et al., the overall mortality was lower in the doctors, but there was a significantly higher rate of suicide (SMR 2.02 (95%CI 1.15-3.28)) compared with the general population. However, anaesthetists were not at greater risk than other doctors (SMR 1.13 (95% CI 0.65-1.86)). The third of these anaesthetist-specific studies compared a cohort of US anesthesiologists between 1979 and 1995 with a cohort of internists and the general population [10]. The investigators found a lower suicide rate in male anesthesiologists compared with internists (SMR 0.8 (95% CI 0.64-0.98)), a non-significantly higher rate in females (SMR 1.68 (95%CI 0.82-3.00)). However, the authors reported a "*nearly 50% excess risk of suicide*" for anaesthesiologists compared with internists (RR 1.45 (95%CI 1.07-1.97)), with the rate ratio for drug-related suicide being more than doubled (RR 2.21 (95%CI 1.33-3.66)).

A narrative review of suicide in anaesthetists, published in 2003, serves as the most recent specialty-specific summary [11], although much of the literature reviewed referred to doctors in general. Four further studies with epidemiological data specific to anaesthetists are cited in the review [12-15]; all of these presented data from before 2000 and used a range of metrics (relative risk, SMR and crude annual rates). In each study the risk or rate of suicide was higher in anaesthetists than in a comparison group of other specialty doctors.

Recent Office of National Statistics (ONS) data on suicide by occupation in England for 2011-2015 suggest that this historical trend for increased suicide rates in doctors may be no longer evident [16]. While the ONS data for

1991-2000 showed doctors, dentists and nurses to be at increased risk of suicide [17], the most recent report indicated a 24% increased rate in female health professionals, which was mostly attributed to a high suicide rate in female nurses. At least part of this discrepancy may arise from the use of different measures of mortality rate, the older publication reporting proportional mortality rates (PMR) and the more recent one reporting SMRs. A PMR is likely to exaggerate levels of suicide relative to other causes of death (especially natural causes) compared with an SMR, as doctors are generally healthier than the general population (i.e. the proportion dying from natural causes will be lower than in the general population and, therefore, the PMRs for suicide will be greater).

In addition to the published literature and ONS data, there continue to be reports of anaesthetist suicides in the media [18-20], whilst anecdotal reports continue to suggest that anaesthetists may be a particularly high-risk group for suicide [21]. A plausible reason for this relates to relatively easy access to powerful drugs and the knowledge of how to use them [6, 11, 18].

The aim of this review is to provide a contemporary summary of the evidence regarding suicide and suicidal behaviour in anaesthetists, with a particular focus on the epidemiology and methods of suicide. Due to the overlap of suicide and suicidal behaviour with mental health conditions, information regarding the epidemiology of these is included in order to describe the prevalence of some possible contributory factors. This review has been conducted alongside other work on this topic [22, 23] which, together, are intended to raise awareness of this issue and guide possible interventions to mitigate the risk of suicide in anaesthetists.

Methods

We conducted a literature search of the following electronic literature databases: Medline; EMBASE; PsycINFO; British Nursing Index; and Web of Science, using the search strategy shown in Table S1, based on that used for a similar review of veterinary surgeons [24]. No restrictions were applied as to the type of studies included in the review and no language restriction was applied to the search. We conducted the search on 04/09/2016 and updated it on 08/03/20.

Identified articles were subjected to a title screening process by a single reviewer (EP) in order to exclude irrelevant articles. Following this, abstracts were screened and categorised into one of three groups (Table 1a) by a single reviewer (EP), with any queries verified by a second reviewer (SY). Articles in group 1 that were published in or after 1990 were included in the final review and categorised according to the type of research (Table 1b), with those in the other categories drawn upon for background information as appropriate. Where papers were written in a language other than English, these were translated where possible, and if not, data extraction was performed on the information available, with this limitation highlighted. The references of all the articles were checked by hand in order to identify any papers not identified by the original search strategy.

Data were extracted from the final group of articles using a standardised form based on that used previously [24]. Articles in the two main categories for data extraction (Categories A and B) were rated according to the quality of the study and the risk of bias. The rating system for epidemiological studies (A) was taken from a similar previous review [24] and the one used for surveys (B) was adapted from ones used previously [25, 26] (Supplementary Tables S2 and S3).

Results

The total number of articles identified through the database searches was 1409, with a further 23 additional papers identified from the references of the full text articles screened. After screening the titles of the articles, 222 articles remained and when duplicates were removed this fell to 175 (duplicates were auto-removed from the Medline / EMBASE search during the search process). The total number of articles selected for full-text review was 54. One article reported two studies and one study was reported in two articles. A flowchart of the search and screening process results is shown in Fig. 1 [27]. Six articles were not in English (French (n = 2; both translated); German (n = 3; two fully translated and one abstract translated); Turkish (n = 1; abstract translated)), but all were included as sufficient data were obtained.

Epidemiological data (Category A)

Seven studies (six primary studies and one meta-analysis and review) were included in this category and are summarised in Table 2. The six primary studies had quality rating scores of 7-12 (out of 12, where 12 is the highest quality) and risk of bias 4-5 (out of 6, where 6 is the lowest risk). Three of these studies presented data from 1995 or earlier and these all showed an increased age adjusted SMR for suicide in female anaesthetists (1.68-2.15), but a decreased age adjusted SMR for suicide in male anaesthetists (0.67-0.96) [10, 12, 13]. There were no SMR data specifically for deaths by suicide in the three reports describing more recent data, which presented findings from Finland [28, 30] and The Netherlands [29]. All these more recent studies presented the proportions of anaesthetists' deaths that were due to suicide, which ranged from 7.2% to 17% and were noted to be higher than the proportions observed in the general population (2-4%) [28-30]. The meta-analysis by Dutheil and colleagues reported SMR data relating to all physicians as well as some anaesthetist-specific results [31]. It was based on 25 studies, only two of which involved a period of observation extending into the 21st century. These two papers were analysed separately by the authors resulting in an SMR of 1.19 (95% CI -0.92-3.29), compared with the SMR of 1.44 (95% CI 1.16-1.72) when all 25 studies were included. The authors also conducted sub-analyses for gender, epochs of time and geographical area as well as meta-regressions for specialities (see Table 2), concluding that "*…some specialties were at higher risk such as anaesthesiologists…*" [31].

Suicidal behaviour surveys (Category B)

Eleven studies surveying suicidal behaviour were included in our review. The findings are summarised in Table 3 (one study was reported in two separate articles, therefore 12 articles are listed). Only five of these had a quality rating score ≥ 7 (out of 10); these studies also had a lower risk of bias [29, 34, 36-38] than the other reports. In seven of the studies the samples of anaesthetists or intensivists were contacted directly, in one the request went via the anaesthetic department and in the remaining three it was sent to heads of departments or training schemes to disseminate further.

The types of behaviour reported were suicidal ideation (six studies), suicide attempts (four studies) and suicides in the context of substance abuse (three studies). The proportion of respondents who had experienced suicidal ideation (in the six studies that reported this) ranged from 3.2% to 25%. One study only reported this for the subgroup of respondents who had screened positive for depression (22% of their total sample), in whom the proportion who had thought of suicide in the last two weeks was 23% [38]. In the other studies, definitions for severity in the time period during which the ideation occurred varied from "*moderately to extremely often within the last month*" (3.2%) [34], "*sustained suicidal thoughts*" (16%) [39], to having 'thought of' suicide with no specified time period (22.4%) [37]. In the four studies where respondents were asked about previous suicidal attempts, 0.5-2.0% of respondents reported that they had attempted suicide [29, 39, 41, 42].

In addition to suicidal behaviour, other mental health conditions investigated in these surveys were: substance abuse (six papers) [29, 32, 35, 39-41]; depression (six papers) [29, 34, 37, 38, 41, 42]; psychological distress or mild psychiatric disorders (five papers) [29, 33, 34, 39, 41]; burnout (five papers) [29, 37, 38, 41, 42]; and occupational stress or harassment (three papers) [34, 37, 41]. Reported proportions of individuals with burnout ranged widely (4-75%) [29, 41]; depression was reported in 12-28.9% of respondents [34, 42] and psychiatric distress or disorders in 13-34% [39, 33]. Again, definitions and screening tools varied.

Surveys related to other mental health conditions (Category C)

Fourteen studies met the criteria for category C. Eleven were surveys of anaesthetists and three of other anaesthesia professionals (anaesthesia assistants or nurse anaesthetists). Five were presented only as conference abstracts and two were letters. The topics covered were burnout (n = 8) [43-50]; depression (n = 2) [51, 52]; occupational stress (n = 3) [53-55]; substance abuse (n = 1) [51]; and wellbeing (n = 1) [56]. The studies that gave a prevalence for burnout in samples of anaesthetists reported proportions of 44% [44] to 78% [50]. One survey broke down the elements of

burnout into emotional exhaustion (61.3%), depersonalisation (35.6%) and decreased professional achievement (42.6%) [45]. A survey of over 12,000 anaesthetists in China found that 34% of respondents self-reported depression and 1.8% drug addiction [51]. In terms of occupational stress, 84% of respondents in a survey of ASA members reported experiencing a catastrophe at work, with over 70% acknowledging feeling guilt and anxiety relating to the event, the vast majority (88%) needing time to recover and almost 1 in 5 (19%) feeling they had never fully recovered [55]. None of these studies included data directly related to suicide.

Review articles (Category D)

There were three review articles that presented data related to suicide, in addition to the meta-analysis and review included in Category A [31] The review by Swanson et al., published in 2003 [11], included all the category A papers we identified in our search that had been published at that time. It also included three studies published before 1990 with epidemiological data from 1957-1983, that were identified in our search but excluded owing to their age. The authors of the review discussed aetiological factors, but mostly with respect to suicide amongst physicians in general. Two further review articles were identified, but we did not identify any additional data to include in this review [57, 58].

Studies related to mode of death (Category E)

Five articles that described the suicide methods of physicians in Germany [59], the UK [60], Australia [61], Japan [62] and China [63] were included, and these are summarised in Table 4. All five studies suggested an association between the method of suicide and the doctor's specialty. For example, the odds ratio for death by overdose of anaesthetic agent for anaesthetists compared with other doctors was 21.30 (95% CI 6.47-72.77) [60], and 80% (4/5) of suicides by Japanese anaesthetists were by poisoning compared with 5% of the general population [62].

In addition, the search identified 12 case reports that described the suicides or suicide attempts of 14 anaesthesia providers (and one cardiologist). The age of the individuals ranged from 25 to 64 years [64-75]. Five of the reports were of females, one of whom was a nurse anaesthetist. All the deaths involved injection of intravenous drugs, including neuromuscular blocking agents (n = 7), anaesthetic induction agents (n = 8), anxiolytics (n = 3) and others (n = 4). There was one case report describing a suicide attempt by an anaesthetist blowing air into a heparin lock that had been inserted for rapid intravenous access after a drug overdose [65].

Finally, in this category the search identified one study investigating deaths by propofol. This was a survey of forensic medical institutions in Germany to investigate the numbers of deaths by suicide over a 10-year period (2002-2012) involving propofol [76]. Of 39 autopsies performed for death related to drug abuse reported from 32 institutions (67% response rate), 22 were in physicians and 15 of these were anaesthetists. Thirteen of the deaths were thought to be suicides.

Other papers (Category F)

Whilst not reporting suicidal behaviour per se, nor providing any prevalence data regarding death by suicide, a recently conducted survey of anaesthetists' experiences of suicide highlights the impact of suicide on the anaesthetic community [22]. Thirty-nine percent (n = 1397) of the 3610 respondents had first-hand experience of a colleague's suicide, the majority of which were reported to involve anaesthetic drugs, and one third of respondents had experienced more than one suicide. Most were unaware of any hospital or departmental guideline around suicide and only half (53%) reported knowing where to access help, should they experience suicidal ideation. The proportion of survey respondents who had any experience of a death by suicide was much higher; most (86%, n = 3112) respondents reported experiencing a death by suicide either through work or outside work.

Discussion

Our search strategy identified 54 articles related to suicide in anaesthetists, 40 of which were published after 2003, when the most recent speciality-specific review was published [11]. None of these newer studies presented data on relative rates (SMRs) specific to anaesthetists and the majority were surveys of behaviour or mental illness, or case reports of deaths by suicide. The lack of published data on relative risk of suicide in the academic literature extending into the 21st century is a limitation of work in this area. Nevertheless, the newer data do add to our knowledge about the prevalence of suicide and suicidal behaviour, as well as the methods used.

Epidemiology

The notion that both physicians in general, and anaesthetists in particular, have a higher rate of suicide is not new. Our review has not revealed further standardised data about suicide in anaesthetists to add to that from previous studies, with the more recent epidemiological studies comparing proportions and not SMRs, or only providing data

for physicians in general. However, in each of these more recent studies, a higher proportion of deaths was by suicide in anaesthetists than in comparator groups. In their meta-analysis, Dutheil et al acknowledged that anaesthetists were a higher-risk group and, therefore, we have found no evidence to contradict the evidence already published [31].

Looking at suicide rates according to gender, a slightly different picture emerges. The three epidemiological studies published in or before 2001 (Table 2) highlight the gender difference in risk of suicide, with an increased risk in females only [10, 12, 13]. The Dutheil et al meta-analysis showed a significantly higher SMR in both male and female physicians, but a larger increase in females. The increased risk of suicide in females but not males is consistent with both recent ONS data reporting deaths by suicide according to occupational groups [16] and an Australian study comparing deaths by suicide in health professionals with other occupations [77]. It is likely, therefore, that the risk of suicide in male anaesthetists, and doctors generally, may no longer be elevated compared with the general population. However, it must be remembered that the actual numbers of suicides in male doctors are still greater than those in female doctors, in view of a higher rate of suicides in males generally and the overall male preponderance in the profession [78].

Several theories have been proposed for an increased risk of suicide in physicians, and in female physicians particularly. These include an increased rate of psychiatric illness and alcohol and substance abuse (considered further below); the professional burden; a reluctance to access healthcare; gender bias in healthcare; being single and having no children; and an increased proportion of suicide attempts that result in death [79]. Many of these factors may be particularly pronounced in anaesthetists, who often work in isolation in high-stress environments and, significantly, have detailed knowledge of, and ready access to, potentially lethal drugs and the means of administering them.

Suicidal behaviour

Our search identified seven studies reporting data related to suicidal behaviour in anaesthetists, with considerable variation in the proportion of anaesthetists experiencing suicidal ideation (3.2-25%) and a more uniform range for proportions attempting suicide (0.5-2.0%). Both are consistent with those seen in previously studies of physicians, with some suggestion that higher proportions of anaesthetists than other specialties experience suicidal ideation

[80, 81]. The range in those experiencing suicidal ideation is likely to relate to variation in the definitions of both ideation itself and the timescale for experiencing it.

Comparison data for suicidal ideation in the general population can be found in the UK Adult Psychiatric Morbidity Survey. In 2014, 5.4% of 16-74 year olds reported suicidal thoughts within the last year, which had significantly increased since 2000 [82]. The data from our review, therefore, suggest that suicidal ideation is experienced by significant numbers of anaesthetists, consistent with that of physicians generally and at least equal to that in the general population.

Suicidal ideation is a predictor for subsequent suicide attempts [83] and should always be taken seriously. In the 1980s, the American Medical Association / American Psychological Association Physician Mortality Project conducted interviews with the family, relatives and colleagues of a group of physicians who had died by suicide and a control group who died from other causes and found that an increased proportion of those who died by suicide had discussed it (29% vs 8%) [84]. However, it is important to remember that not all ideation is disclosed, nor will all ideation proceed to a suicide attempt. A recent meta-analysis investigating the association between suicidal ideation and subsequent suicide found that approximately 40% of people who died by suicide had expressed suicidal ideation to others beforehand [83]. This meta-analysis is a reminder that the non-disclosure of suicidal ideation cannot reassure – as at least 60% of those who go on to die by suicide have not previously expressed it but almost certainly will have experienced it.

Association with mental health disorders, occupational stress and burnout

Our search was not specifically designed to identify papers related to mental health disorders and occupational stress in anaesthetists but, due to the overlap with suicide, many of the studies we reviewed also or primarily investigated these factors. The link between mental illness and suicide is well established and it has been postulated that the qualities that lead to successful selection for medical school (high-achieving, self-critical, perfectionist, conscientious) may also be the same characteristics that predispose to mental illness [85]. It is interesting, however, that in a Danish study of suicide in medical and related occupational groups, an excess of mental health problems (as defined by psychiatric service contact) was not seen [6]. This contradictory evidence may relate to the significant stigma associated with mental illness and seeking help for psychiatric problems, which may be especially true for physicians, and is a reminder that reported rates of mental health disorders may well be underestimates.

In addition to mental health disorders, occupational demands of working in healthcare in terms of funding stresses, external scrutiny and whistleblowing pressures, can impact on mental wellness [85, 86]. Recently,the number of doctors dying by suicide whilst under investigation by the General Medical Council prompted an internal investigation [87, 88]. A narrative review from 2017 explored the relationship between burnout, depression and suicide amongst physicians, with a focus on anaesthetists [89]. The review cited the risks of burnout as 41-50%, quoting a study of anaesthesia trainees also identified in our search [38]. It reported a risk of depression of 28.8% (in US residents and not specifically in anaesthesia). These rates are slightly higher than those identified in the recent UK-based Satisfaction and Wellbeing in Anaesthetic Training (SWEAT) study, which found a prevalence of high perceived stress in 37% (95% CI 32-42%), burnout in 25% (95% CI 21-29%) and depression in 18% (95% CI 15-23%) [90]. Thus, the rates of burnout and depression identified in our review seem similar to those reported by others.

Both the narrative review and the SWEAT study mention associated factors for negative psychological outcomes – some of which are individual e.g., lack of exercise and limited social support, while others are systemic (e.g. clinical and non-clinical work demands and lack of control). The authors concluded that solutions must be similarly focussed on multiple levels: "*anesthesiologists must actively engage in self-care*", "*organisations should evaluate the balance between demands… and resources provided*" and "*national efforts must be rallied to support physicians*", with which we concur. This multi-level strategy for developing solutions is echoed in the recently published guideline for suicide amongst anaesthetists, developed by an Association of Anaesthetists Working Party, of which three of this review's authors were members [23]. Our findings support the need for creation of mentally healthy workplaces, where mental ill-health is not stigmatised and everyone working in healthcare recognises the importance of supporting each other. This has been highlighted by the extraordinary stresses resulting from the COVID-19 pandemic [91] with anaesthetists at the forefront of the response. A Royal College of Anaesthetists' (RCoA) survey of members after the first wave of the pandemic revealed that 64% of respondents had suffered mental distress due to the work-related stress caused by the pandemic [92]. The longer-term implications of this are not yet known.

Methods of suicide

All of the studies mentioning methods of suicide in anaesthetists highlight the frequency of self-poisoning, giving weight to the 'availability of means' hypothesis for increased suicide in anaesthetists (and in some cases, in

healthcare professionals generally). This is also seen in data from the ONS in that in the period 2001-2015, 86% of anaesthetists' suicides were due to poisoning compared with 39% of all physician suicides [78]. In the general population in 2019, 33% of all deaths by suicide were due to poisoning [93]. Our search revealed one study specifically relating to deaths due to propofol use. Whilst our review was not designed specifically to investigate drug addiction and abuse in anaesthetists, it remains notable that propofol has been singled out as a drug of abuse implicated in suicide in anaesthetists – no other papers specifically related to a class of drugs or single drug were identified. Indeed, an internet search of deaths due to fatal propofol abuse identified 21 fatal cases, of which 18 (86%) occurred in healthcare workers, most of whom were medical or nurse anaesthetists (n = 14, 67%) [94].

The association of anaesthetists' suicide with anaesthetic drugs raises the question of what preventative measures could be introduced to address this, as there is evidence outside healthcare that restricting access to means, especially at high-risk periods, can successfully reduce deaths by suicide [95]. Potential options include restricting access to medications that are known to be abused, in a similar manner to the controlled drug management systems, or random urine drug screening for healthcare workers [96]. Such processes may act as a deterrent or enable identification of substance abuse, a potential risk factor for suicide. However, both options would be controversial and difficult. Restricting access to such a widely used and vital drug as propofol could adversely affect service provision and compromise patient safety, whilst the logistical and financial issues around urine screening are compounded by the potentially catastrophic consequences of a false positive test [97].

Limitations

There are limitations to our review, many of which reflect difficulties in this area of work in general. These include a lack of recent papers reporting age-standardised epidemiological data; problems with accurate reporting of deaths by suicide; variations in the definitions of suicidal ideation; and inability to be certain about the causes and contributory factors for any death by suicide. Much of the data related to suicide are historical and we chose to constrain our results by excluding papers earlier than 1990 in order to reflect more accurately the current situation. We did not exclude papers published in languages other than English, but there were some difficulties in translation. The papers included cover a wide spread of countries, with data from Europe, North America, South America, Asia and Australia. There is no way of knowing how translatable findings are from one country to another but it is likely that geographical and cultural factors make direct comparison difficult, along with differences in reporting accuracy.

Many of the papers we included were surveys, and more than half of these had low (poor) scores for quality and risk of bias. Thus, our conclusions must be interpreted with due caution. Finally, there is likely to be publication bias for the case reports of anaesthetists' deaths using anaesthetic drugs, as deaths by suicide due to other methods are less likely to be reported in academic literature.

Conclusions

The last two years (2018 and 2019) of ONS data suggest that deaths by suicide in the general population in the UK are on the increase [92, 98], whilst global rates are relatively static [99]. This comes at the same time as a lowering of the standard of proof for suicide used by coroners in England and Wales, which may have partly contributed to this increase, although the change in verdicts only came part way through 2018 [100]. The impact of the COVID-19 pandemic on suicide rates is uncertain. While there has been no indication of a rise in suicides during the early part of the pandemic, an increase in rates in the longer term is anticipated [101].

Our paper presents an updated review of the academic literature related to suicide in anaesthetists. There remains a worrying incidence of suicidal ideation in anaesthetists, with no evidence to refute the postulated excess risk of suicide in this group of medical practitioners. Nevertheless, this is an evolving issue that is likely to change over time and ongoing work is required to monitor trends. Improving the accuracy of recording and reporting of deaths by suicide in the healthcare profession and within subspecialties is fundamental to enabling more reliable conclusions to be drawn and also to support ongoing work to reduce the risk of suicide.

There is currently a great deal of investment in raising the awareness of mental illness generally. The recently launched 'Every Mind Matters' campaign by the UK National Health Service (NHS) gives easily accessible information to the general public about how to manage their mental health and to help look after that of others [102]. Anaesthetists should also be encouraged to access such resources. Within the NHS, there is increasing recognition of the psychological impact of being a carer and the NHS Staff and Learners' Mental Wellbeing Commission was launched in February 2019, with principle 5 (of 9) stating that death by suicide of a member of staff or learner should be investigated and the results reported to the Health Trust board [103]. There has also been considerable work done by the Association of Anaesthetists to raise awareness of this issue within the specialty, together with the survey of anaesthetists' experience of suicide included in this review [22] and production of recent guidelines on suicide amongst anaesthetists [23]. The Association is one of many organisations signed up to the Zero

Suicide Alliance, a collaborative of NHS Trusts, businesses and organisations that seeks to improve the support available for people contemplating suicide by raising awareness and providing free suicide prevention training [104]. Every suicide is a tragedy and all work being done to raise awareness and to identify and reduce risk factors is welcomed. It must continue if we are to see a sustained downward trend in suicide in anaesthetists, other healthcare workers and the population generally.

Competing interests

SY was co-chair, and EP and KH members, of the Association of Anaesthetists Working Party on Suicide. KH is a member of the National Suicide Prevention Strategy for England Advisory Group. No other competing interests or external funding declared.

References

1. Lindeman S, Laara E, Hakko H, Lonnqvist J. A systematic review on gender-specific suicide mortality in medical doctors. *British Journal of Psychiatry* 1996; **168**: 274-9.
2. Schernhammer ES, Colditz GA. Suicide rates among physicians: a quantitative and gender assessment (meta-analysis). *American Journal of Psychiatry* 2004; **161**: 2295-302.
3. Hem E, Haldorsen T, Aasland OG, Tyssen R, Vaglum P, Ekeberg O. Suicide rates according to education with a particular focus on physicians in Norway 1960-2000. *Psychological Medicine* 2005; **35**: 873-80.
4. Torre DM, Wany NY, MeoniLA, Young JH, Klag MJ, Ford DE. Suicide compared to other causes of mortality in physicians. *Suicide and Life-Threatening Behavior* 2005; **35:** 146-53.
5. Agerbo E, Gunnell D, Bonde JP, Mortensen PB, Nordentoft M. Suicide and occupation: the impact of socio-economic, demographic and psychiatric differences. *Psychological Medicine* 2007; **37**: 1131-40.
6. Hawton K, Agerbo E, Simkin S, Platt B, Mellanby RJ. Risk of suicide in medical and related occupational groups: a national study based on Danish case population-based registers. *Journal of Affective Disorders* 2011; **134**: 320-6.
7. Elliott L, Tan J, Norris S. The mental health of doctors: a systematic literature review. Beyond Blue 2010. Available at http://resources.beyondblue.org.au/prism/file?token=BL/0823 (accessed 29/03/21).
8. Bruce DL, Eide KA, Smith NJ, et al. A prospective survey of anaesthesiologist mortality, 1967-1971. *Anaesthesiology* 1974; **42**: 71-4.
9. Neil HAW, Fairer JG, Coleman MP, et al. Mortality among male anaesthetists in the United Kingdom, 1957-83. *British Medical Journal* 1987; **295**: 360-2.
10. Alexander BH, Checkoway H, Nagahama S, et al. Cause-specific mortality risks of anesthesiologists. *Anaesthesiology* 2000; **93**: 922-30.
11. Swanson SP, Roberts LJ, Chapman MD. Are anaesthetists prone to suicide? A review of rates and risk factors. *Anaesthesia and Intensive Care* 2003; **31**: 434-45.
12. Hawton K, Clements A, Sakarovitch C, et al. Suicide in doctors: a study of risk according to gender, seniority and specialty in medical practitioners in England and Wales, 1979-1995. *Journal of Epidemiology and Community Health* 2001; **55**: 296-300.

13. Carpenter LM, Swerdlow AJ, Fear NT. Mortality of doctors in different specialties: findings from a cohort of 20,000 NHS hospital consultants. *Occupational and Environmental Medicine* 1997; **54**: 388-95.

14. Ritchings JC, Khara GS, McDowell M. Suicide in young doctors. *British Journal of Psychiatry* 1986; **149**: 475-8.

15. DeSole DE, Singer P, Aronson S. Suicide and role strain among physicians. *International Journal of Social Psychiatry* 1969; **15**: 294-301.

16. Office of National Statistics. Suicide by occupation, England 2011-2015, 2017. https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/articles/suicidebyoccupation/england2011to2015 (accessed 29/03/21).

17. Office of National Statistics. Occupational mortality in England and Wales 1991-2000, 2009. https://webarchive.nationalarchives.gov.uk/20160128192054/http://www.ons.gov.uk/ons/rel/occupational-mortality/occupational-mortality-in-england-and-wales/occupational-mortality/occupational-mortality-in-england-and-wales--1991-2000.pdf (accessed 29/03/21).

18. Agency. Anaesthetist dies after overdosing on the drugs he used to treat patients. *The Telegraph*, 4 August 2015. https://www.telegraph.co.uk/news/health/news/11782640/Anaesthetist-dies-after-overdosing-on-the-drugs-he-used-to-treat-patients.html (accessed 29/03/21).

19. Harding K. 'I went on a walk and returned to find my husband dead'. *The Guardian*, 24 February 2018. https://www.theguardian.com/lifeandstyle/2018/feb/24/went-walk-returned-husband-suicide-depression (accessed 29/03/21).

20. Burke D. Heartbroken anaesthetist killed himself with cocktail of stolen drugs after realising his marriage was over. *The Mirror*, 6 February 2018. https://www.mirror.co.uk/news/uk-news/heartbroken-anaesthetist-killed-himself-cocktail-11977190 (accessed 29/03/21).

21. Wible P. Why are so many male anesthesiologists dying by suicide? 19 May 2018. http://www.idealmedicalcare.org/why-are-so-many-male-anesthesiologists-dying-by-suicide/ (accessed 29/03/21).

22. Yentis SM, Shinde S, Plunkett E, Mortimore A. Suicide amongst anaesthetists – an Association of Anaesthetists survey. *Anaesthesia* 2019; **74**: 1365-73.

23. Shinde S, Yentis SM, Asanati K, et al. Guidelines on suicide amongst anaesthetists 2019. *Anaesthesia* 2020*;* **75**: 96-108.

24. Platt B, Hawton K, Simkin S, Mellanby RJ. Systematic review of the prevalence of suicide in veterinary surgeons, *Occupational Medicine* 2010; **60**: 436-46.

25. National Institute of Health and Care Excellence (NICE). The guidelines manual. Process and methods **(**PMG6). Appendix H: Methodology checklist: qualitative studies. 2012. https://www.nice.org.uk/process/pmg6/resources/the-guidelines-manual-appendices-bi-2549703709/chapter/appendix-h-methodology-checklist-qualitative-studies (accessed 29/03/21).

26. Bruce J, Chambers WA. Questionnaire surveys. *Anaesthesia* 2002; **57**: 1049-51.

27. Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Medicine* 2009; **6(7)**: e1000097.

28. Ohtonen P, Alahuhta S. Mortality among Finnish anesthesiologists from 1984–2000. *Acta Anaesthesiologica Scandinavica 2*002; **46**: 1196–9.

29. Liem M, Liem AL, van Dongen EPA, Carels IC, van Egmond M, Kerkhof AJFM. Suicide mortality, suicidal ideation and psychological problems in Dutch anaesthesiologists. *Suicidology Online* 2016; **6**: 21-6.

30. Ohtonen P, Alahuhta S. Mortality rates for Finnish anaesthesiologists and paediatricians are lower than those for the general population. *Acta Anaesthesiologica Scandinavica* 2017; **61**: 880-4.

31. Dutheil F, Aubert C, Pereira B, et al. Suicide among physicians and health-care workers: a systematic review and meta-analysis. *PLoS ONE* 2019; **14**: e0226361.

32. Menk EM, Baumgarten RK, Kingsley CP, Culling RD, Middaugh R. Success of re-entry into anesthesiology training programs by residents with a history of substance abuse. *JAMA* 1990; **263**: 3060-2.

33. Blenkin H, Deary IJ, Wood RA, Zeally HE, Agius RM. Stress in NHS consultants. *British Medical Journal* 1995; **310**: 534.

34. Coomber S, Todd C, Park G, et al. Stress in UK intensive care unit doctors. *British Journal of Anaesthesia* 2002; **89**: 873-81.

35. Fry RA. Substance abuse by anaesthetists in Australia and New Zealand. *Anaesthesia and Intensive Care* 2005; **33**: 248-55.

36. Lindfors PM, Nurmi KE, Meretoja OA, et al. On-call stress among Finnish anaesthetists. *Anaesthesia* 2006; **61**: 856-66.

37. Lindfors PM, Meretoja OA, Luukkonen RA, et al. Suicidality among Finnish Anaesthesiologists. *Acta Anaesthesiologica Scandinavica* 2009; **53**: 1027-35.

38. De Oliveira GS, Chang R, Fitzgerald PC, et al. The prevalence of burnout and depression and their association with adherence to safety and practice standards: a survey of United States anesthesiology trainees. *Anesthesia and Analgesia* 2013; **117**: 182-93.

39. McDonnell NJ, Kaye RM, Hood S, et al. Mental health and welfare in Australian anaesthetists. *Anaesthesia and Intensive Care* 2013; **41**: 641-7.

40. Fry RA, Fry LE, Castanelli DJ. A retrospective survey of substance abuse in anaesthetists in Australia and New Zealand from 2004-2013. *Anaesthesia and Intensive Care* 2015; **43**: 111-7.

41. Aykut G, Efe M, Bayraktar S, et al. Mobbing exposure of anaesthesiology residents in Turkey. *Turkish Journal of Anaesthesiology and Reanimation* 2016; **44**: 177-89.

42. Beschoner P, Braun M, Schönfeldt-Lecuona C, Freudenmann RW, von Wietersheim J. Gender aspects in female and male physicians: Occupational and psychosocial stress. *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz.* 2016; **59**: 1343-50.

43. Mion G, Libert N, Journois D. Burnout-associated factors in anesthesia and intensive care medicine. 2009 survey of the French Society of anesthesiology and intensive care. *Annales Francaises d'Anesthesie et de Reanimation* 2013; **32**: 175-88.

44. Palmer Y, Gomez-Vera A, Cabrera- Pivaral C, et al. Organisational factors associated to burnout syndrome among anaesthesiologists. *Salud Mental* 2005; **28**: 82-91.

45. Kroll H, Jesse M, Jankowski M, et al. Job insecurity predicts burnout in pain medicine specialists. *Anesthesia and Analgesia* 2014; **118**: S-114.

46. Gvozdenović L, Batak T, Ivanov D, Cvijanović R. A survey of professional satisfaction among anaesthesiologists in Serbia. *Archives of Industrial Hygiene and Toxicology* 2014; **65**: 423-4.

47. Kroll H, Jesse MT, Monroe KS, Davies N. Burnout in certified anesthesiologist assistants. *Anesthesia and Analgesia* 2018; **126 S1**: 468-70.

48. Kroll H, Jesse MT, Olson J. Burnout in certified registered nurse anesthetists. *Anesthesia and Analgesia* 2018; **126 S1**: 471-4.

49. Grinberg I, Aquino M, Adams D, Pisklakov S. Anesthesiology staff burnout, two-year study: causes and prevention. *Anesthesia and Analgesia* 2018; **126 S1**: 228-9.

50. Lofts A, Jeanes A, Elliott J. Feeling the burn? Check yourself before you wreck yourself. High risk of trainee burnout at Imperial School of Anaesthesia: Recognising the scale of the problem. *Anaesthesia* 2019; **74**: S38.

51. Zhang HF, Li FX, Lei HY, Xu SY. Rising sudden death among anaesthetists in China. *British Journal of Anaesthesia* 2017; **119**: 167-73.

52. Akinci SB, Rezaki M, Aypar Ü. Depression and anxiety in anesthesiologists. *Anestezi Dergisi* 2003; **11**: 34-9.

53. Chipas A, Cordrey D, Floyd D, et al. Stress: perceptions, manifestations, and coping mechanisms of student registered nurse anesthetists. *American Association of Nurse Anesthetists Journal* 2012; **80**: S49-55.

54. Neves BS, Pinheiro TMM. Epidemiological and occupational profile of anesthesiologists practicing in Belo Horizonte, Minas Gerais- Brazil, in 2010. *Revista Brasileira de Anestesiologia* 2012; **62**: 612-24.

55. Gazoni FM, Amato PE, Malik ZM, et al. The impact of perioperative catastrophes on anesthesiologists: results of a national survey. *Anesthesia and Analgesia* 2012; **114**: 596-603.

56. Adams PS, Gordon EKB, Berkeley A, et al. Academic faculty demonstrate higher well-being than residents: Pennsylvania anesthesiology programs' results of the 2017-2018 ACGME well-being survey. *Journal of Clinical Anesthesia* 2019; **56**: 60-4.

57. Paraschakis A, Michopoulos I. Suicide in physicians: an overview. *European Psychiatry* 2013; **28**: S1.

58. Maulen B. Every life counts. Suicide by anaesthetists. *Der Anaesthesist* 2010; **59**: 395-400.

59. Grellner W, Kukuk M, Glenewinkel F. About suicide methods of physicians, medical staff and related professions. *Archiv für Kriminologie* 1998; **201**: 65-72.

60. Hawton K, Clements A, Simkin S, et al. Doctors who kill themselves: a study of the methods used for suicide. *Quarterly Journal of Medicine* 2000; **93**: 351-7.

61. Austin AE, van der Heuval C, Byard RW. Physician Suicide. *Journal Forensic Science* 2013; **58**: S91-3.

62. Hikiji W, Fukunaga T. Suicide of physicians in the special wards of Tokyo Metropolitan area. *Journal of Forensic and Legal Medicine* 2014; **22**: 37-40.

63. Wang Y, Liu L, Xu H. Alarm bells ring: suicide among Chinese physicians: A STROBE compliant study. *Medicine (Baltimore)* 2017; **96**: e7790

64. Yashiki M, Miyazaki T, Iwasaki Y, Taniguchi T, Kojima T. A case of suicide by intravenous injection of pancuronium. *Nihon Hoigaku Zasshi* 1992; **46**: 282-5.

65. Yanowitch P, Rosenthal R. A suicide attempt by blowing air into a heparin lock. *Hospital and Community Psychiatry*. 1994; **45**: 382-3.

66. Klys M, Bialka J, Bujak-Gizycka B. A case of suicide by intravenous injection of pancuronium. *Legal Medicine* 2000; **2**: 93-100.

67. Hendin H, Maltsberger JT, Haas AP. A physician's suicide. *American Journal of Psychiatry* 2003; **160**: 2094-7.

68. Martinez MA, Ballesteros S, Almarza E. Anesthesiologist suicide with atracurium. *Journal of Analytical Toxicology* 2006; **30**: 120-4.

69. Kranioti EF, Mavroforou A, Mylonakis P, et al. Lethal self administration of propofol (Diprivan). A case report and review of the literature. *Forensic Science International* 2007; **167**: 56-8.

70. Colucci AP, Gagliano-Candela R, Aventaggiato L, et al. Suicide by self administration of a drug mixture (propofol, midazolam, and zolpidem) in an anesthesiologist: the first case report in Italy. *Journal of Forensic Science* 2013; **58**: 837-41.

71. Nau JY. Two female anesthesiologists, two tragic stories. *Revue Medicale Switzerland* 2014; 10: 1942-3.

72. Aknouche F, Guibert E, Tessier A, et al. Suicide of a nurse in a hospital environment involving anesthetic drugs. *Toxicologie Analytique et Clinique* 2016; **28**: 134-8.

73. Feola A, Cassandro P, Carfora A, et al. Suicides in physicians: two cases of poisoning involving fentanyl and phenobarbital. *Minerva Psychiatry* 2017; **58**: 103-9.

74. Stoykova S, Kiryakova T, Nikolov D, Nedzhib A, Pantcheva I, Atanasov V. Self-administrated propofol – a case report of a physician suicide. *Toxicologie Analytique et Clinique* 2018; **30**: 142-8.

75. Drevin G, Monoury L, Palayer M, et al. Lethal self administration of propofol and atracurium. *Toxicologie Analytique et Clinique* 2019; **31**: S62-3.

76. Maier C, Iwunna J, Tsokos M, Mußhoff F. Deaths from propofol abuse: survey of institutes of forensic medicine in Germany, Austria and Switzerland. *Anaesthesist* 2017; **66**: 109-14.

77. Milner AJ, Maheen H, Bismark MM, Spittal MJ. Suicide by health professionals: a retrospective mortality study in Australia, 2001-2012. *Medical Journal of Australia* 2016; **205**: 260-5.

78. Office of National Statistics. Suicide deaths among medical practitioners aged 20 to 64 years, by sex, deaths registered in England between 2001 and 2017, 2019. https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/adhocs/009831suicidedeathsamongmedicalpractitionersaged20to64yearsbysexdeathsregisteredinenglandbetween2001and2017 (accessed 29/03/21).

79. Schernhammer E. Taking their own lives – the high rate of physician suicide. *New England Journal of Medicine* 2005; **352**: 2473-6.

80. Hem E, Gronvold NT, Aasland OG, Ekeberg O. The prevalence of suicidal ideation and suicidal attempts among Norwegian physicians. Results from a cross-sectional survey of a nationwide sample *European Psychiatry* 2000; **15**: 183-9.

81. Beyond Blue. National Mental Health Survey of Doctors and Medical Students, October 2013 (updated February 2019). https://www.beyondblue.org.au/docs/default-source/research-project-files/bl1132-report---nmhdmss-full-report_web (accessed 29/03/21).

82. McManus S, Bebbington P, Jenkins R, Brugha T. (eds.) Mental health and wellbeing in England: Adult Psychiatric Morbidity Survey 2014. 2026. Leeds: NHS Digital. https://files.digital.nhs.uk/pdf/q/3/mental_health_and_wellbeing_in_england_full_report.pdf (accessed 29/03/21)

83. McHugh C, Corderoy A, Ryan C, Hickie I, Large M. Association between suicidal ideation and suicide: Meta-analyses of odds ratios, sensitivity, specificity and positive predictive value. 2019. *British Journal of Psychiatry Open* 2019; **5**: 1-12.

84. Council on Scientific Affairs. Results and implications of the AMA-APA Physician Mortality Project: Stage II. *Journal of the American Medical Association* 1987; **257**: 2949-53.

85. De Cates AN, Knott G, Cole-King A, Jones M. 'Dying to help': female doctor suicide and the NHS workforce crisis. *Journal of Holistic Healthcare* 2017; **14**: 30-7.

86. Bourne T, Wynants L, Peters M, et al. The impact of complaints procedures on the welfare, health and clinical practise of 7926 doctors in the UK: a cross-sectional survey. *BMJ Open* 2015; **5**: e006687.

87. Hawton K. Suicide in doctors while under fitness to practice investigation. *BMJ* 2015; **350**: h813.

88. General Medical Council. Doctors who commit suicide while under GMC fitness to practice investigation. 2014. https://www.gmc-uk.org/-/media/documents/Internal_review_into_suicide_in_FTP_processes.pdf_59088696.pdf (accessed 29/03/21).

89. Kuhn CM, Flanagan EM. Self-care as a professional imperative: physician burnout, depression and suicide. *Canadian Journal of Anesthesia* 2017; **64**: 158-68.

90. Looseley A, Wainwright E, Cook TM, et al. Stress, burnout, depression and work satisfaction among UK anaesthetic trainees; a quantitative analysis of the Satisfaction and Wellbeing in Anaesthetic Training study. *Anaesthesia* 2019; **74**: 1231-9.

91. Gerada C. Some good must come out of covid-19 *BMJ* 2020; **369**: m2043

92. Royal College of Anaesthetists. View from the frontline of anaesthesia during COVID-19. July 2020. View from the frontline of anaesthesia during COVID-19, July 2020 survey results | The Royal College of Anaesthetists (rcoa.ac.uk) (accessed 29/03/21)

93. Office of National Statistics. Suicides in England and Wales: 2019 registrations. 2020. https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/bulletins/suicidesintheunitedkingdom/2019registrations (accessed 29/03/21)

94. Diaz JH, Kaye AD. Death by propofol. *Journal of the Louisiana State Medical Society* 2017; **169**: 28-32.

95. Hawton K. Restricting access to methods of suicide. *Crisis: The Journal of Crisis Intervention and Suicide Prevention* 2007; **28**: 4-9.

96. Fitzsimons MG, Baker K, Malhotra R, Gottlieb A, Lowenstein E, Zapol WM. Reducing the incidence of substance use disorders in anesthesiology residents: 13 years of comprehensive urine drug screening. *Anesthesiology* 2018; **129**: 821-8.

97. Berge, KH, McGlinch, BP. The law of unintended consequences can never be repealed: the hazards of random urine drug screening of anesthesia providers. *Anesthesia and Analgesia* 2017; **124**: 1397-9.

98. Office of National Statistics. Suicides in England and Wales: 2018 registrations. 2019 https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/bulletins/suicidesintheunitedkingdom/2018registrations accessed 29/03/21.

99. Suicide rates estimate, crude. World Health Organisation, Global Health Observatory Data repository. https://apps.who.int/gho/data/view.main.MHSUICIDEREGv?lang=en (accessed 16/03/21)

100. Appleby L, Kapur N, Hawton K. New standard of proof for suicide at inquests in England and Wales. *British Medical Journal* 2019; **366**: l4745.

101. John A, Pirkis J, Gunnell D, Appleby L, Morrissey J. Trends in suicide during the covid-19 pandemic BMJ 2020; 371 :m4352 doi:10.1136/bmj.m4352

102. Every Mind Matters. https://www.nhs.uk/oneyou/every-mind-matters (accessed 29/03/21).

103. Health Education England. NHS Staff and Learners' Mental Wellbeing Commission. 2017. https://www.hee.nhs.uk/sites/default/files/documents/NHS%20%28HEE%29%20-%20Mental%20Wellbeing%20Commission%20Report.pdf (accessed 29/03/21).

104. Zero Suicide Alliance. https://www.zerosuicidealliance.com (accessed 29/03/21).

Table 1 Categorisation of a) abstracts related to suicide in anaesthetists and b) articles selected for full-text review (those classified into group 1).

a) Screening of abstracts	
1	Related to stress, mental health, psychological well-being or suicidal behaviour AND reporting primary empirical data related to these in anaesthetists or anaesthesiologists.
2	Related to stress, mental health, psychological well-being or suicidal behaviour AND discussing theoretical aspects such as possible causes, methods of prevention or models of the above in anaesthetists or anaesthesiologists OR personal perspectives but NOT presenting any primary empirical data.
3	Related to stress, mental health, psychological well-being or suicidal behaviour in anaesthetists or anaesthesiologists, but not fulfilling the above criteria, OR unrelated to stress, mental health, psychological wellbeing or suicidal behaviour in anaesthetists or anaesthesiologists.

b)	*Type of research*	*Description*
A	Suicide rates	Epidemiological studies based on mortality records of prevalence rates of suicide in anaesthetists
B	Suicidal behaviour survey	Questionnaires/surveys conducted to investigate the nature of suicidal thoughts and/or behaviour in anaesthetists
C	Other behaviour survey	Questionnaires/surveys conducted to investigate the nature of mental health issues/psychological wellbeing/stress in anaesthetists
D	Review	Systematic or narrative review of suicide and/or other mental health issues in anaesthetists
E	Models/theories	Reports that discuss causes of, modes of, methods of prevention for and / or models of suicide and other mental health issues in anaesthetists
F	Other	Type of research that meets inclusion criteria for the present review but which does not fall into one of the above categories

Table 2 Summary of articles categorised as 1A (see Table 1). Ranges in brackets are 95% CI.

Study and country	Quality rating (risk of bias)*	Time period	Data source	Methodology	Sample size	Number of suicides and prevalence	Other findings
Carpenter et al, 1997 [13] England & Wales	10 (4)	1962-1992	NHS Central Register Dept of Health records of NHS employees	Causes of death in NHS hospital consultants compared with that in the general population and between specialties	18,358 male, 2168 female hospital consultants aged 25-74	64 suicides overall (+ 19 accidental poisoning) Adjusted SMR for suicide for females 2.15 (0.93-4.23) and 0.96 (0.72-1.25) for males (corresponding figures for accidental poisoning 1.34 (0.03-7.47) and 2.27 (1.35-3.59), respectively)	No significant increase in RR for suicide amongst anaesthetists compared with all consultants, but the increased SMR for injury and accidental poisoning (including suicide) noted as possibly indicating a greater of risk of suicide, albeit not always identified as such Significant increase in cirrhosis in anaesthetists compared with all consultants (RR 2.22 (1.06-4.08)
Alexander et al., 2000 [10] USA	10 (4)	1979-1995	National Death Index American Medical Association Physician Master File records of self-designated specialties	Causes of death in anaesthesiologists compared with those in the general population and internists	40,242 anaesthesiologists, 40,211 matched internists	103 suicides in anaesthesiologists; 71 in internists Adjusted SMR for suicide for females 1.68 (0.82-3.00) and males 0.8 (0.64-0.98) Rate ratios (anaesthesiologists vs internists) 1.45 (1.07-1.97) overall: 1.50 (0.58-3.88) for females and 1.44 (1.05-1.98) for males	Anaesthesiologists had a greater number of lives lost before age 65 because of suicide, drug-related suicide and drug related deaths than internists. Suicide rate lower in anaesthesiologists than internists for the first 5 years after graduation, higher thereafter. Drug-related death rates higher than in internists throughout and highest in the first 5 years after graduation
Hawton et al., 2001 [12]	12 (5)	1979-1995	ONS death registry Medical Register	Suicide rates in medical practitioners compared	223 deaths by suicide in medical	13 suicides in anaesthetists	

England & Wales			Dept of Health records of NHS employees	with those in the general population; rates in different specialties compared with that in general medicine	practitioners (168 male; 55 female)	Adjusted overall SMR for suicide in female doctors 2.02 (1.00-3.04) and males 0.67 (0.47-0.87) Four specialties with increased risk compared with general medicine: community health RR 8.0 (2.3-28.0); anaesthetics RR 6.8 (2.2-20.8); psychiatry RR 4.8 (1.5-15.5); and general practice RR 3.6 (1.3-9.9)	
Ohtonen & Alahuhta, 2002 [28] Finland	9 (4)	1984-2000	Statistics Finland database Finnish Medical Association	Characteristics of deceased anaesthesiologists compared with other specialists	799 deaths including 18 anaesthesiologists	3 (17%) of the anaesthesiologists died by suicide + possibly one other recorded as 'accidental'. 2% of the general population died by suicide.	Lower mortality rate overall in anaesthesiologists than non-anaesthesiologists but limited conclusions due to small sample size
Liem et al, 2015 [29] Netherlands	7 (4)	1983-2007	Dutch Association of Anaesthetists membership database	Colleagues of deceased members individually contacted to seek details of deaths	117 deaths amongst anaesthesiologists	7 suicides (3 female, 4 male) in anaesthesiologists (7.2% overall. Comparable figures for the Dutch population ~4% for males and ~2.8% for females ≥ 35)	Limited conclusions due to sample size
Ohtonen & Alahuhta, 2017 [30]	10 (5)	1996-2014	Statistics Finland database	Causes of death in anaesthesiologists compared with those in	62 deaths among anaesthesiologists,	7 suicides in anaesthesiologists Suicide the 4th most common cause of death in	Overall SMR similar for anaesthesiologists (0.50 (0.39-0.64) and paediatricians (0.52 (0.42-0.64)

Finland		Finnish Medical Association	paediatricians and the general population	95 among paediatricians	anaesthesiologists (11.3%) compared with 3.2% in paediatricians and 2.1% in the general population	compared with the general population
Dutheil et al, 2019 [31]	No date restriction	Pubmed; Cochrane Library; Science Direct; Embase databases for articles presenting primary empirical data about suicide in healthcare workers	Meta-analysis and meta-regression for geography, epochs of time and medical specialty	55 papers related to physicians, 25 presented SMR data and 8 mentioned specialties. Data compared with "control group" for e.g. the general population	Overall SMR 1.44 (1.16-1.72); males 1.24 (1.05-1.43); females 1.94 (1.249-2.58). Six papers were included that presented data related to anaesthetists and from these papers the percentage of deaths by suicide in anaesthetists was 4%.	Geographical variation in SMR was seen with North America having highest SMR (1.63 (1.29-1.96). Reduction of suicide risk over time in Europe but not other areas. Meta-regression analysis showed a higher risk of suicide in anaesthetists than in radiologists, paediatricians, pathologists and dermatologists, but lower than internal medicine and psychiatry.

*see Table S2

ONS, Office of National Statistics (or its previous body, the Office for Population Censuses and Surveys); RR, relative risk; SMR, standardised mortality ratio (where reported as a percentage, converted to ratio).

Table 3 Summary of articles categorised as 1B (see Table 1). Ranges in brackets are 95% CI.

Study and country	Quality rating (risk of bias)*	Time period	Data source	Methodology†	Sample size (response rate)	Main results of relevance to suicide
Menk et al, 1990 [32] USA	4 (3)	1975-1989	US Anesthesiology Training Programmes	Questionnaire sent to all Directors of US anesthesiology training programmes	113/159 (71%) programmes responded, with details of 180 cases of substance abuse	Main focus on substance abuse 14 cases of suicide or lethal overdose in trainees allowed to re-enter a training programme
Blenkin et al, 1995 [33] Scotland	3 (3)	Not stated	Not stated	Questionnaire sent to randomly selected NHS consultants (method of randomisation not stated) General Health Questionnaire (GHQ) used	375/500 (75%)	5/41 anaesthetists (12.2%) had suicidal thoughts, the highest proportion of all specialties (psychiatry the second highest: (4/39; 10%)) 14/41 anaesthetists (34.1%) had a GHQ score > 5, the highest proportion of all specialties
Coomber et al, 2002 [34] UK	8 (5)	Not stated	Intensive Care Society	Questionnaire sent to all members General Health Questionnaire, Symptom Checklist Depression Sub-scale (SCL-D)	627/896 (70%)	20 doctors (3.2% (2.0-4.9%)) reported suicidal ideas moderately to extremely often in past month 136/610 (22% (19.0-25.6%)) had a GHQ score > 4 for psychiatric morbidity, and 78 (12% (9.9-15.0%)) had a SCL-D score > 1.5 for depression The three greatest stressors were: bed allocation when ICU was full; being overstretched; and effect on the family (for those with depression: effects on the family; lack of recognition; making the right decision alone)

Fry et al, 2005 [35] Australia/New Zealand	6 (4)	1994-2003	Australian and New Zealand College of Anaesthetists	Questionnaire sent to all supervisors of training and heads of department	100/128 (78%) progammes responded, with details of 44 cases of substance abuse	Main focus on substance abuse 18 case of suicide, all of them trainees (13 male, 5 female)
Lindfors et al, 2006 [36] & 2009 [37]‡ Finland	9 (4)	2004	Finnish Medical Association	Questionnaire sent to all working Finnish anaesthesiologists Occupational Stress Questionnaire, Maslach Burnout Inventory	328/550 (60%)	25% reported suicidal ideation - 73 (22.4%) had 'thought of' suicide; 7 (2.1%) had 'seriously planned' it. Respondents taking antidepressants (OR 9.1 (2.7-31.4)) and those with poor health (OR 11.2 (OR 3.8-32.9), low social support (OR 10.7 (3.6-31.4) and family problems (5.8 (2.9-11.7) had the highest risk of suicidality (all OR except health adjusted for age, gender and health) Positive correlation between stress symptoms and on-call workload: moderate burnout present in 18% vs 45% (p = 0.008) and exhaustion in 32% and 68% (p = 0.015), in the lowest vs highest workload category, respectively Stress symptoms significantly associated with stress, gender, perceived sleep deprivation, suicidal tendencies and sick leave
de Olivera et al, 2013 [38] USA	8 (4)	Not stated	American Society of Anesthesiologists	Anesthesiology residents invited by email to complete online survey (method of selection not stated)	1508/2773 (54%)	High risk of burnout found in 575/1417 respondents (41%); increased risk associated with working > 70 h/week, having > 5 drinks/week and female gender 298/1384 (22%) respondents screened positive for depression; increased risk associated with the same factors as above, plus smoking 68/298 (23%) who screened positive for depression reported they thought about taking or wanted to take their lives at least some of the time in the last two weeks

McDonnell et al, 2013 [39] Australia/New Zealand	6 (4)		Australian and New Zealand College of Anaesthetists	Randomly selected (method not stated) current or retired College members invited by email to complete online survey K10 Kessler Psychological Distress Scale	191/500 (38%)	13/186 (7.0%) reported high or very high levels of distress 16% reported sustained suicidal thoughts (actual number not provided); one had attempted suicide 13% had been diagnosed with a mental health illness; 17% reported sustained use of alcohol to manage stress; 25% self-prescribed (actual numbers not provided) 58% would not want to talk to a department welfare representative (actual number not provided)
Fry et al, 2015 [40] Australia/New Zealand	5 (3)	2004-2013	Australian and New Zealand College of Anaesthetists	Heads of anaesthetic departments invited by email to complete online survey	106/155 (57%) responded, with details of 61 cases of substance abuse	Main focus on substance abuse 19 cases of suicide: 8/9 males were consultants and 9/10 females were trainees Noted an increase in reported propofol and alcohol abuse and a decrease in reported opioid abuse, compared with previous survey (see above)
Liem et al, 2015 [29] Netherlands	7 (4)	1983-2007	Dutch Association of Anaesthetists	Questionnaire sent to all working Association members Symptom Checklist-90, Utrecht Burnout Scale	817/1132 (72%)	169 (21%) had seriously considered suicide in the past and 84 (10%) had been 'treated for suicidal ideation'. Eight (1.0%) had attempted suicide "At least" 32 (4%) suffered from burnout and 96 (12%) were at high risk for burnout 237 (28%) reported a history of depression; 151 (18%) had a period of depression and 84 (10%) more than one period. 13 (1.5%) reported substance (drug) abuse
Aykut et al, 2016 [41] Turkey	3 (1)	Not stated	Not stated	Questionnaires sent to the 25 largest training anaesthetic departments for dissemination	101 respondents from 7 departments; denominator and therefore response rate unknown	2 respondents reported a suicide attempt 69 respondents had experienced 'mobbing' (psychological harassment in the workplace), half by faculty members and half by 'speciality students' 16 respondents described alcohol/substance addiction, 18 severe depression, and 8 panic attacks

						75 respondents reported 'burnout' (n.b. in response to a broad description)
Beschoner et al, 2016 [42] Germany	5 (3)	Not stated	Interdisciplinary Congress of Intensive Care and Emergency Medicine	Questionnaire to delegates at the congress; Beck Depression Inventory, Maslach Burnout Inventory	1341 anaesthetists / intensivists responded; 55% response rate.	4 (0.5%) of male respondents and 9 (1.7%) of female respondents reported a suicide attempt 28.9% of female and 21.0% of male respondents scored for at least mild depression Male anaesthetists showed more depersonalisation than females, but females showed more emotional exhaustion than males

*see Table S3.

†validated assessment tools specified where described in the methods, otherwise unvalidated questions used.

‡the same study reported in two separate articles.

Table 4 Studies investigating suicide methods of anaesthetists.

Study and country	Sample	Details
Grellner et al, 1998 [59]* Germany	131 healthcare professionals (40% physicians) compared with 739 controls	Oral ingestion of medicines and infusion/injection were the two most common methods of suicide in the study group (29% and 18% respectively) compared with hanging and oral ingestion in controls (32% and 16%). Infusion/injection was over-represented in anaesthesiologists and the authors concluded that the tendency of a method of suicide to be associated with a profession rises with the degree of specialisation
Hawton et al, 2000 [60] UK	ONS data 1979-1995 of all deaths registered as suicide or undetermined in medical practitioners, n = 329	Poisoning and cutting and piercing were more commonly used methods in doctors compared with the general population (OR for poisoning 3.65 (95% CI 2.85-4.68); OR for cutting and piercing 3.18 (95% CI 1.85-5.40). Overdoses of anaesthetic agents were used in half of anaesthetists (10/20) compared with 4.5% of other doctors (OR 21.30 (95% CI 6.47 – 72.77)). There were no other specialty associations.
Austin et al, 2013 [61] Australia	Retrospective review of pathology files at Forensic Science South Australia from Jan 1997 - March 2011 for cases of physician suicide, n = 9	4 of the physicians were anaesthetists (44%). Poisoning was the most common method (n = 8, 89%) and most (n = 7, 78%) of these involved intravenous drugs with 5 using anaesthetic drugs. 33% had made a previous attempt, 33% had a history of substance abuse and 67% had a history of depression and / or suicidal ideation.
Hikiji et al, 2014 [62] Japan	All suicides in physicians in Tokyo (1996-2010), n = 87	Male: female ratio = 3.5. About half had a psychiatric illness and 1 in 5 used methods available to them via work. Five were anaesthetists (2.2-2.8% of population of physicians but 5.8% of suicides). Only psychiatrists had a relatively higher suicide risk (4.6-5.1% of population of physicians and 18.4% of suicides). A higher proportion of physicians used poisoning (14.9%) compared with the general population (4.6%). This was exaggerated in anaesthetists where 80% used poisoning.
Wang et al, 2019 [63] China	Reports from the Chinese Medical Doctor Association from 2004 – 2017.	18 cases of suicide. 1 anaesthetist (7 unknown specialty). The anaesthetist died by injection of narcotics. There were no other suicides by injection.

*Data from abstract included (article not translated).

Figure 1 Flowsheet of review process