

# Risk and Outcomes of Substance Use Disorder among Anesthesiology Residents

## A Matched Cohort Analysis

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### ABSTRACT

**Background:** The goal of this work is to evaluate selected risk factors and outcomes for substance use disorder (SUD) in physicians enrolled in anesthesiology residencies approved by the Accreditation Council for Graduate Medical Education.

**Methods:** For each of 384 individuals with evidence of SUD while in primary residency training in anesthesiology from 1975 to 2009, two controls ( $n = 768$ ) who did not develop SUD were identified and matched for sex, age, primary residency program, and program start date. Risk factors evaluated included location of medical school training (United States *vs.* other) and anesthesia knowledge as assessed by In-Training Examination performance. Outcomes (assessed to December 31, 2013, with a median follow-up time of 12.2 and 15.1 yr for cases and controls, respectively) included mortality and profession-related outcomes.

**Results:** Receiving medical education within the United States, but not performance on the first in-training examination, was associated with an increased risk of developing SUD as a resident. Cases demonstrated a marked increase in the risk of death after training (hazard ratio, 7.9; 95% CI, 3.1 to 20.5), adverse training outcomes including failure to complete residency (odds ratio, 14.9; 95% CI, 9.0 to 24.6) or become board certified (odds ratio, 10.4; 95% CI, 7.0 to 15.5), and adverse medical licensure actions subsequent to residency (hazard ratio, 6.8; 95% CI, 3.8 to 12.2). As of the end of follow-up, 54 cases (14.1%) were deceased compared with 10 controls (1.3%); 28 cases and no controls died during residency.

**Conclusion:** The attributable risk of SUD to several adverse outcomes during and after residency training, including death and adverse medical license actions, is substantial. (*ANESTHESIOLOGY* 2015; 123:929-36)

THE potential consequences of substance use disorder (SUD) among physicians are serious for both the physicians and their patients.<sup>1</sup> Anesthesiologists are thought to be particularly susceptible to SUD, perhaps due to their ready access to drugs such as potent opioids, although it remains to be established whether the incidence of SUD is higher in anesthesiologists compared with other physician specialties.<sup>2-5</sup> In prior work, we used an extensive array of data resources to describe the incidence and selected outcomes of SUD in anesthesiology residents in the United States from 1975 to 2009.<sup>6</sup> This initial analysis demonstrated that the incidence of SUD in this population continues to increase and that adverse outcomes such as death are not uncommon. However, comparisons were not made with residents who did not develop SUD, precluding direct quantification of how much SUD may increase the risk of adverse outcomes, such as failure to complete residency and achieve board certification, and the exploration of risk factors associated with SUD. Further quantification of relative risk and outcomes may help guide both individual treatment decisions and the development and implementation of policy.

### What We Already Know about This Topic

- The risk factors and outcomes for substance use disorder among anesthesia residents are poorly understood.

### What This Article Tells Us That Is New

- In a nested, matched case-cohort design of 384 anesthesia residents who developed substance use disorder (SUD) and 768 controls who did not, receiving medical education in the United States, but not anesthesia knowledge early in residency, was associated with risk of developing SUD.
- By the end of follow-up, 54 anesthesiology residents (14.1%) with SUD and 10 controls (1.3%) were dead. Those with SUD were 15-, 10-, and 7-fold more likely to not complete residency, to not become board certified, or have adverse medical licensure actions, respectively.

The goal of this work is to evaluate available risk factors and outcomes for SUD in physicians enrolled in anesthesiology residencies approved by the Accreditation Council for Graduate Medical Education. Using a comparator group of anesthesiology residents who did not develop SUD, this

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nested matched cohort study aimed to test the hypotheses that (1) mortality, both during and after residency (if surviving initial episode), is increased in residents with evidence of SUD during training; (2) the location of medical training (U.S. *vs.* non-U.S. medical schools) and medical knowledge as assessed by In-Training Examination (ITE) scores are risk factors for developing SUD; and (3) surviving residents with evidence of SUD during training are less likely to complete residency and fellowship training, less likely to achieve board certification, and more likely to have later disciplinary actions against their medical licenses.

## Materials and Methods

The Mayo Clinic Institutional Review Board (Rochester, Minnesota) determined that this study protocol, which involved the analysis of deidentified data, was exempt from review and thus waived requirements for consent.

### Identification of Residents with SUD

Prior work identified 384 individuals with evidence of SUD (referred to hereafter as “cases”) while in primary residency training in anesthesiology.<sup>6</sup> To summarize, the primary data sources for this ascertainment process included the training records of the American Board of Anesthesiology (ABA), the National Death Index, and the Disciplinary Action Notification Service (DANS) of the Federation of State Medical Boards (more information regarding the latter two sources is provided in subsequent sections). A staged procedure was used to determine whether there was definite evidence of SUD during primary residency training as previously described in detail.<sup>6</sup> Beginning with the ABA training records, other data sources were used to seek confirmatory evidence of SUD or to identify cases (*e.g.*, individuals with cause of death information related to SUD) who had not been previously in the ABA records.

### Identification of Controls

For each case, two controls who did not develop SUD were identified from the training records of the ABA. The design for the current study was proposed at the same time as the original study and the decision to use 2:1 matching was made without a formal power analysis. It was rather based on the estimated resources that would be required to manually abstract all study data for both cases and controls given the number of SUD cases anticipated. Matching criteria included the following: (1) sex, (2) age ( $\pm 5$  yr old), (3) primary residency program, and (4) program start date ( $\pm 2$  yr). For all cases, it was possible to identify exact matches for all criteria except age. For age, 277 cases had two controls with exact matches, an additional 71 cases had two controls matched within 1 yr of age, and an additional 28 cases had two controls matched within 2 to 5 yr of age. For eight cases, at least one control differed in age from the case by greater than 5 yr. Sex was included as a matching factor because prior analysis had already revealed that the

proportion of males among those with SUD (92%) exceeded the proportion of males in the overall resident population (74%) during the study period, such that the incidence of SUD was considerably greater in males than females (2.68 and 0.65 per 1,000 resident-years in male and female residents, respectively).<sup>6</sup> Matching procedures were performed using the FUZZY Extension command for SPSS Statistics, Version 23 (IBM, USA).

### Risk Factors

Although the availability of information regarding the potential risk factors for SUD was limited in the datasets, three potential risk factors related to training characteristics were available. The level of medical knowledge regarding anesthesiology was assessed using individual scores on the annual ITE administered during the spring of each year to anesthesiology residents. Before 1998, these scores were not permanently maintained with the ABA training records, so this analysis could be performed for only the most recent subset of study subjects. The location of medical school education before starting anesthesiology residency training was noted for each subject as occurring within the United States or outside of the United States. Finally, as an exploratory analysis, the primary residency training program that each subject attended was also noted.

### Outcomes

Outcomes were assessed up to December 31, 2013.

**Mortality.** As previously described,<sup>6</sup> the Social Security Administration Death Master File was used to identify individuals who are deceased. The National Death Index, an index of death record information on file in state vital statistics offices, was used to determine the cause of death for these individuals if available. The cause was classified as either related or unrelated to SUD according to the definitions of the Centers for Disease Control.<sup>7</sup>

**Training Outcomes.** These outcomes included whether primary residency training was completed, the duration of primary training, whether primary ABA certification was achieved, whether accredited subspecialty training in Critical Care or Pain Medicine was begun or completed, and whether subspecialty certification from the ABA in Critical Care or Pain Medicine was achieved.

**DANS Notifications.** This system aggregates information from all U.S. state medical boards regarding actions taken that resulted in loss of medical license or restrictions from the practice of medicine. This information is forwarded to the ABA for all individuals who have entered Accreditation Council for Graduate Medical Education–accredited anesthesiology residencies, regardless of whether they have completed their training or achieved board certification. DANS notifications are coded according to the basis for the license action and the specific action taken against the medical license. The action codes are classified according to severity, including (from most to least severe) loss of license or license

privileges, restriction of license or license privileges, other prejudicial action, or nonprejudicial actions (e.g., lifting of probation). A few actions were unclassified as to severity. An individual can have multiple separate actions against his or her license. For purposes of this study, the basis codes were classified as either related or unrelated to SUD, and basis codes indicating nonprejudicial actions were not considered. The list of basis codes and descriptions defined as related to SUD are provided in the appendix. Because license actions described by codes that themselves were unrelated to SUD may have been a consequence of SUD, for purposes of this analysis, individuals were considered to have at least one license action unrelated to SUD *only if none* of the actions against their licenses were related to SUD.

### Data Handling/Analysis

American Board of Anesthesiology personnel performed the original data abstraction and coordinated the search through the National Death Index. Data capture was achieved using the Research Electronic Data Capture (REDCap) system (Version 3.6.7; Vanderbilt University, Nashville, Tennessee), which also was used to export data for analysis. All identifying information was removed during the exporting. To deidentify dates, a random number of days between 1 and 365 were subtracted from each date for each individual during export (with the number constant within each individual) so that the exact dates could not be identified, but time intervals could be calculated. The deidentified dataset was used to conduct all analyses to preserve anonymity.

Conditional logistic regression, taking into account the 1:2 matched set study design, was used to assess whether the risk for SUD was associated with the location of medical school education (United States *vs.* non-United States). Test scores during the clinical base year of training, and during the first year of clinical anesthesiology (CA-1) training, were analyzed using mixed linear models with group (SUD *vs.* control) as the explanatory variable and location of medical training included as a covariate. Training outcomes, DANS reports, and survival after training were analyzed using logistic regression, or proportional hazards regression, with group (SUD *vs.* control) as the explanatory variable and medical school location as a covariate. Unless otherwise specified, stratified analyses were performed to take into account the matched set study design. Findings from these analyses are summarized using the odds ratio, or hazards ratio, along with 95% CIs. For the analysis of survival after training, cases that died during training and their matched controls were excluded. For the analysis of DANS reports not related to SUD during training, cases with a DANS report related to SUD during training were excluded along with their matched controls. The analysis of subspecialty training initiation was limited to those who completed anesthesia training, and the analysis of subspecialty training completion was limited to those who initiated subspecialty training. DANS alerts not related to SUD that occurred after training were

analyzed using proportional hazards regression analysis. For this analysis, only those who survived training and did not have any DANS alerts during training were included with data censored at death, last follow-up, or the first DANS alert related to SUD after training. Because matched sets could not be maintained consistently, the subgroup analyses assessing subspecialty outcomes and DANS alerts after training were performed with age and sex included as covariates rather than using stratified analyses.

To calculate program-specific incidence rates of SUD, cases were allocated to the program they were enrolled in at their date of first use. For this analysis, individuals were counted as incidence cases for each program in which substance use was identified (*i.e.*, an individual could be counted as an incidence case in more than one program if they used substances in multiple programs). Program-specific incidence rates of SUD were calculated using these SUD counts as the numerators and program-specific resident-years during the study period as the denominators. Small programs with less than 90 resident-years during the study period were excluded from subsequent analyses. To assess whether incidence rates differed according to program size, programs were grouped into quartiles according to total resident-years with incidence compared across quartiles using Poisson regression. Poisson regression was also used to compare the incidence of SUD across program types (Military, Community based, and University). In all cases, two-tailed tests were used with *P* values 0.05 or less considered statistically significant. With the exception of the matching procedures, all analyses were performed using SAS Version 9.3 (SAS Institute Inc., USA).

### Results

Cases and controls were exactly matched on sex, and mean ages were nearly identical in the two groups (table 1).

#### Risk Factors

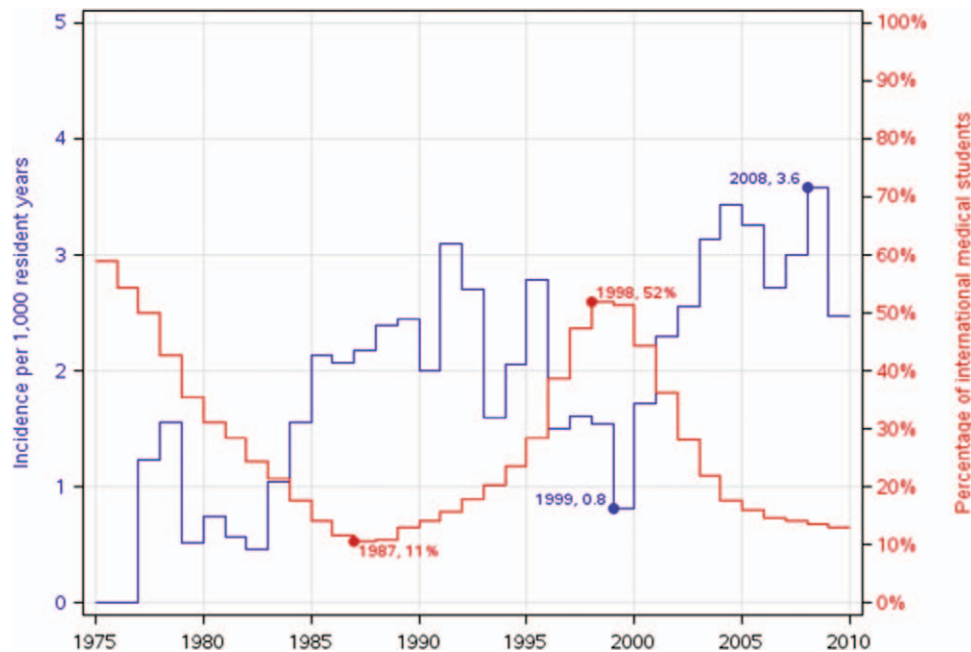
Regarding location of medical school education, cases were significantly more likely to have received their medical education in the United States (table 1; odds ratio, 2.4; 95% CI, 1.6 to 3.7). During the period of study (1975–2009), the proportion of residents who received their medical school training within the United States varied considerably (fig. 1). We had previously reported<sup>6</sup> that the incidence of SUD also varied considerably during the years studied, with a period of lower rates observed in approximately 1996 to 2002 that interrupted an overall trend toward increases during these years (fig. 1). This period of lower incidence rates corresponded to the time when the proportion of individuals receiving medical school education outside of the United States who were enrolled in residency programs peaked (fig. 1).

Regarding medical knowledge as assessed by performance on early ITEs, scores for the tests administered in the clinical base year of training were available for both a case and at least one of the controls for that case in 134 cases (with 229 corresponding controls). The mean (SD) score for cases was

**Table 1.** Resident Characteristics

Characteristics	Controls (N = 768)	SUD Cases (n = 384)	P Value
Age at residency entry (mean $\pm$ SD)	29.8 $\pm$ 3.6	29.9 $\pm$ 4.1	—
Sex (female, %)	60 (8)	30 (8)	—
Medical school location (n, %)			<0.001
United States	607 (79)	337 (88)	
Other	161 (21)	47 (12)	

SUD = substance use disorder.



**Fig. 1.** Incidence of substance use disorder according to year of first substance use for residents entering anesthesiology training from 1975 to 2009 (blue line) and proportion of residents enrolled in anesthesiology training who received their medical school education outside of the United States (red line). Highest and lowest values since 1980 are noted as annotated circles, with the year in which they occurred.

18.4 (5.1) compared with 18.5 (5.5) for controls. In a mixed model adjusted for location of medical training (United States *vs.* non-United States), the difference was  $-0.1$  (95% CI,  $-1.1$  to  $0.9$ ;  $P = 0.85$ ). Scores for the tests administered in the CA-1 year of training were available for both a case and at least one of the controls for that case in 136 cases (corresponding to 255 controls). The mean (SD) score for cases was 24.1 (5.8) compared with 25.4 (6.4) for controls. In a mixed model adjusted for the location of training, the difference was  $-1.3$  (95% CI,  $-2.5$  to  $-0.2$ ;  $P = 0.027$ ). Thus, ITE scores were not different in the clinical base year but were significantly less in cases by the CA-1 year.

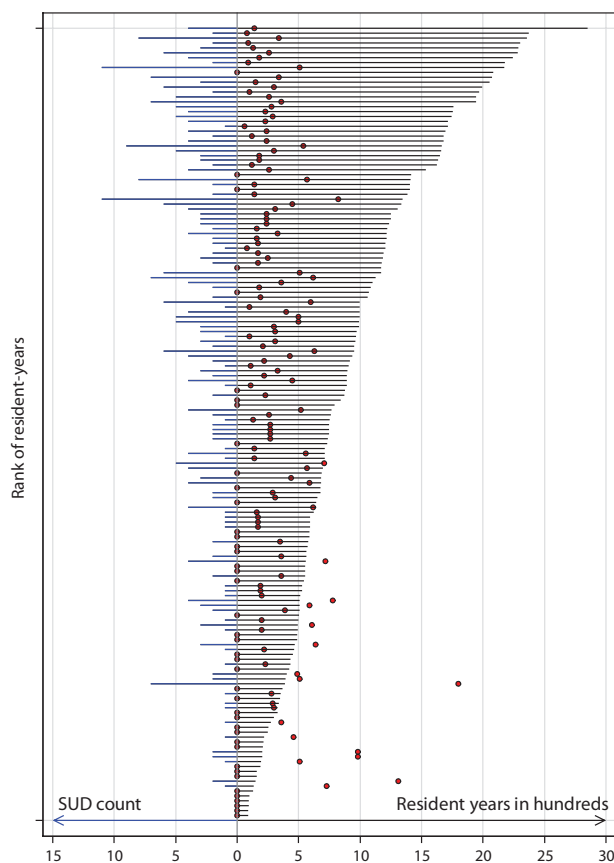
In exploratory analysis, incidence rates for SUD varied considerably among individual training programs, which may reflect in part the small overall number of events in relation to the total number of programs (fig. 2). For programs with greater than a total of 90 resident-years of experience ( $n = 162$ ), 42 (25.9%) had no resident develop SUD. Although visual inspection of the data suggests a trend toward higher incidence rates in smaller programs, this may again reflect the relatively

small number of cases. When rates were analyzed according to quartiles of programs classified according to number of resident-years of training, rates were similar across these quartiles, suggesting that program size was not consistently associated with incidence rates (table 2). Incidence rates also did not significantly differ among university, military, or community-based residency programs (data not shown).

### Outcomes

Cases were more likely than controls to die during training; 28 cases (7.3%) and no controls died before the completion of training (table 3 and fig. 3). Those cases who survived the training period were more likely to die after training (table 3), with a median follow-up time of 12.2 and 15.1 yr for cases and controls, respectively. Overall, 54 of the 384 cases (14.1%) were deceased as of December 31, 2013 compared with 10 of the 768 controls (1.3%,  $P < 0.001$ ). Examination of the survival curve (fig. 3) suggests that much of the excess mortality in the cases occurs within approximately the first 10 yr after training.





**Fig. 2.** Histogram of the incidence of substance use disorder (SUD) in individual residency programs, depicting (1) total resident-years of training provided from 1975 to 2009 (black lines, with programs ordered according to this value), (2) absolute number of SUD cases during this period (blue lines), and (3) incidence rate for each program (per 1,000 resident-years, red dots). Data were analyzed for 162 programs; programs with <90 resident-years ( $n = 17$ ) were not included in the analysis.

**Table 2.** Incidence of SUD within Individual Residency Programs According to Program Size

Quartile of Program Resident-years*	Estimates (95% CI)†
1st (smallest)	2.84 (2.02 to 4.00)
2nd	2.57 (2.01 to 3.27)
3rd	2.59 (2.13 to 3.13)
4th	2.30 (1.98 to 2.68)

\* Quartiles were based on total resident-years of training provided from 1975 to 2009. Data were analyzed for 162 programs; programs with <90 resident-years ( $n = 19$ ) were not included in the analysis. Estimates and CIs were obtained from a Poisson regression analysis. Rates did not differ significantly across program sizes ( $P = 0.619$ ). † Per 1,000 resident-years. SUD = substance use disorder.

Cases were less likely to complete residency training (table 3) and required significantly more months of training to do so. Cases were also less likely to achieve primary board certification. A similar proportion of cases and controls who finished residency training pursued subspecialty

training (approximately one in five residents), but cases were less likely to finish this training and to achieve subspecialty certification.

In the analysis of disciplinary actions, only DANS reports not related to SUD are considered; cases with DANS reports related to SUD during training ( $n = 27$ ) and their respective controls ( $n = 54$ ) were excluded from the analyses. Of the remaining cases and controls, cases were more likely to have a DANS alert during training (table 3). For the remaining cases and their controls who survived training, cases were more likely to have a DANS alert after completion of training. For those cases and controls with DANS alerts, the severity of alerts was greater in cases. Thus, cases were more likely to have actions against their medical licenses that were not related to SUD both during and after training, and the license actions reported *via* these alerts were more severe.

## Discussion

The major findings of this analysis are that (1) receiving medical education within the United States, but not anesthesia knowledge early in residency training, is associated with an increased risk of developing SUD as a resident and (2) SUD among anesthesiology residents in primary training is associated with a marked increase in the risk of death, adverse training outcomes (including failure to complete training or become board certified), and adverse medical licensure actions subsequent to residency training. These results extend our prior report of residents who developed evidence of SUD during primary residency training from 1975 to 2009<sup>6</sup> by including a matched control group of residents who did not develop SUD and by extending follow-up for the outcomes reported by 3 yr (to December 31, 2013). The focus of the prior report<sup>6</sup> was on secular trends in SUD incidence and outcomes during the study period; the inclusion of an appropriate comparator group in the current analysis allows for additional analysis of risk factors and places the risk of these outcomes into perspective.

## Risk Factors

Our prior analysis had already established male sex as a strong risk factor for SUD (with an approximately four-fold increase in incidence compared with female sex), so that this was included as a matched variable.<sup>6</sup> The other potential risk factors that may be associated with SUD in the general population are both numerous and complex,<sup>8</sup> and the ability to examine other risk factors was limited by the information available in the underlying datasets. However, we did have access to two training-related factors that we hypothesized *a priori* could be potentially relevant: location of prior medical training and performance on ITEs as a measure of academic ability and achievement.

Regarding the location of training, our prior analysis noted a marked decline in the incidence of SUD at the end of the 20th century, a period in which enrollment in anesthesiology residency training programs also declined.<sup>6</sup> The

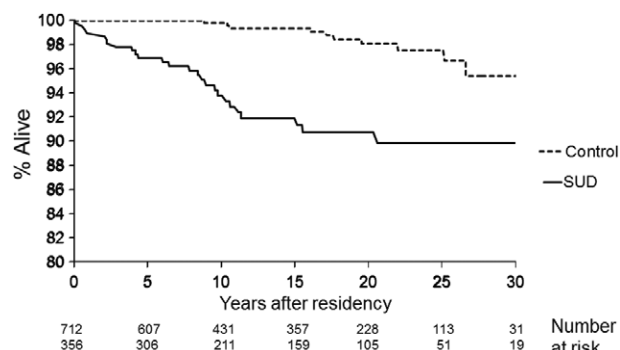
**Table 3.** Survival, Training, and License Action Outcomes

Variables*	Controls (N = 768)	SUD Cases (N = 384)	P Value	Hazard or Odds Ratio (95% CI)
<b>Survival outcomes</b>				
Deceased (overall)	10 (1%)	54 (14%)	<0.001†	
Deceased during training	0 (0%)	28 (7%)	<0.001†	
Deceased after training‡	10 (1%)	26 (7%)	<0.001	7.9 (3.1 to 20.5)
<b>Training outcomes§</b>				
Residency training completed	730 (95%)	236 (61%)	<0.001	14.9 (9.0 to 24.6)
Months of residency training	36 (35 to 47)	44 (36, 54)	<0.001	
Board certification achieved	665 (87%)	183 (48%)	<0.001	10.4 (7.0 to 15.5)
Subspecialty training began	137 (19%)	43 (18%)	0.929	1.0 (0.7 to 1.4)
Subspecialty training completed	131 (96%)	27 (63%)	<0.001	12.9 (4.5 to 37.2)
Subspecialty certification achieved	109 (80%)	5 (12%)	<0.001	34.6 (12.0 to 100.0)
<b>License action outcomes (DANS alerts)  </b>				
Any DANS alert during training	4 (1%)	12 (3%)	0.002	7.5 (2.1 to 26.6)
DANS alert after end of training	18 (2%)	33 (10%)	<0.001	6.8 (3.8 to 12.2)
Highest severity alert after end of training			0.038	
Loss of license	0 (0%)	2 (6%)		
Restriction of license	3 (17%)	13 (39%)		
Other prejudicial action	14 (78%)	17 (52%)		
Unclassified	1 (6%)	1 (3%)		

\* Categorical variables are summarized as n (%), and months of residency training are summarized as median (25th, 75th). † Chi-square tests. ‡ Analysis was performed using proportional hazards regression including those cases and their controls who survived training (n = 1,124), adjusted for location of medical training (United States vs. other). Findings are summarized using the hazard ratio for SUD cases relative to controls, with estimates >1 representing an increased hazard of experiencing death. Median follow-up time was 14.0 and 15.0 yr for censored (surviving) cases and controls, respectively. § Analysis was performed using stratified logistic regression, adjusted for location of medical training (United States vs. other). Findings are summarized using the odds ratio for SUD cases relative to controls, with estimates >1 representing an increased likelihood of not achieving the given outcome. Analysis of months of residency training and subspecialty training began was limited to subjects who completed training (n = 966). Analyses of subspecialty completed and certification achieved were limited to subjects who began subspecialty training (n = 180). || For disciplinary actions, only DANS reports not related to SUD are considered, and cases with DANS reports related to SUD during training (n = 27) and their respective controls (n = 54) were excluded from the analyses. Only subjects who survived training and did not have a DANS alert during training (n = 1,081) were included in the analysis of DANS alerts after training. Subjects were censored at first DANS alert related to SUD after training. The highest severity DANS alert after end of training was only summarized for subjects who had DANS events. Because matched sets were not retained consistently, these subset analyses were performed with age and sex included as additional covariates rather than using a matched analysis.

DANS = Disciplinary Action Notification Service; SUD = substance use disorder.

current analysis revealed that this period also corresponded to a marked increase in proportion of non-U.S. medical school graduates enrolled in residency programs (peaking at 52% in 1998) and that as this proportion subsequently declined, the incidence of SUD again increased. This is just an association, but it is striking, and is consistent with the greater proportion of controls who were not U.S. trained (table 1). It is not clear whether the risk of SUD is less in



**Fig. 3.** Kaplan-Meier survival curves for cases and controls who survived residency training (n = 356 and n = 768 for cases and controls, respectively), including number at risk. SUD = substance use disorder.

physicians not trained in the United States in general or whether this reflects characteristics of the particular physicians recruited to fill anesthesiology residency programs during this period. We are not aware of prior data regarding the incidence or prevalence of SUD in U.S. *versus* non-U.S. trained physicians. There is certainly marked heterogeneity among cultures in rates of substance use,<sup>9</sup> but in the absence of more information regarding the characteristics of non-U.S. trained physicians, it is impossible to further speculate.

Regarding medical knowledge, a prior report from the ABA found that performance on the ITE at the completion of the CA-1 year predicted the achievement of board certification in the shortest possible time.<sup>10</sup> Thus, the lower certification rates in residents with SUD could reflect in part knowledge deficits apparent earlier in training. Given that SUD can interfere with learning, this is perhaps not surprising at the time of training completion, but we wondered whether there was any evidence of differences test performance before the detection of SUD. In other words, are those with lesser ability or achievement at risk for SUD? We did not have access to measures of ability or achievement such as U.S. Medical Licensing Examination scores, but rather used ITE performance as a surrogate measure,

finding no evidence of differences between groups at the first administration in the clinical base year. This is consistent with findings in the general population. Lower intelligence assessed in childhood is associated with SUD; however, after adjustment for behavioral problems and family situation, this association disappears.<sup>11</sup> However, performance started to diverge in the CA-1 year. In prior analysis, we noted that median time to first use (when known) in those manifesting SUD was 29.5 months (interquartile range 20.7 to 36.8 months). The CA-1 ITE is administered at approximately 21 months of training, which may suggest that performance was already starting to be impaired in those who had already started using or contemplating use. However, this does not appear to reflect the baseline differences between groups in performance on a standardized test of anesthesia knowledge. We did not extend this analysis to the CA-2 and CA-3 years, as by this time, these measures were either not available or were considerably delayed in cases compared with their controls.

In an exploratory *post hoc* analysis, incidence within individual residency programs was analyzed to determine whether there was any evidence of clustering of cases within programs according to size or type. Although there was considerable heterogeneity in incidence at the program levels, there was little evidence for clustering of cases according to these factors. However, this exploratory analysis is limited by a relatively few number of cases distributed among a large number of programs.

### Outcomes

The prior analysis identified residents with SUD who experienced adverse outcomes, but the current analysis quantifies the attributable risk conferred by SUD. This additional risk is considerable, with hazard and odds ratio estimates for survival and adverse training outcomes ranging from 7.9 to 34.6, indicating that developing SUD has profound consequences for both personal safety and for further training. For example, even those who survive an episode of SUD during residency training are almost eight times as likely to die after training. They are also less likely to complete training and achieve primary certification in anesthesiology. Those who complete training are just as likely to pursue subspecialty training but are less likely to complete it and obtain subspecialty certification. We are not aware of comparable data for other groups of physicians.

The current analysis also examined the implications of developing SUD to subsequent clinical practice. Although the tools to evaluate practice are limited, actions by state licensing boards are readily available to specialty boards *via* the DANS alert system and thus represent an attractive surveillance system for physician performance issues. There are limitations of using license actions as a measure of clinical performance, including potentially different standards and thresholds that differing licensing boards have for license actions, and that license actions likely reflect only more

extreme deficits in physician performance (and also do not reflect excellent performance). However, license actions have been associated with factors such as poor clinical performance as a resident and lack of board certification,<sup>12,13</sup> providing some evidence for validity. The analysis complicated by the fact that, as demonstrated in our prior analysis,<sup>6</sup> SUD itself is a basis for license actions, and license actions that themselves are not noted as directly related to SUD (as defined in the appendix) may be in fact the consequence of an SUD episode. Thus, we conservatively analyzed only those individuals with *non*-SUD-related DANS reports, which may bias against finding differences between groups. Nonetheless, cases were almost seven times as likely to have a DANS alert not related to SUD subsequent to training, and those alerts indicated license actions of higher severity, indicative of practice-related difficulties that rose to the level of state medical board action. Thus, physicians with SUD who finish training and enter practice are more likely to run afoul of state licensing boards.

### Limitations

In addition to the limitations already mentioned, as discussed in the previous report using this dataset,<sup>6</sup> there is no doubt that the initial ascertainment missed cases of SUD. The implication of these missing cases for the current analysis is the potential for misclassification bias. However, there was no evidence that controls had developed SUD, and given the relatively low absolute incidence of SUD, this is unlikely to affect our results. Also, limitations of the underlying datasets do not permit other analyses of potential relevance. For example, there is insufficient information about any treatment that these residents received for SUD to determine how treatment, or what features of treatment, might affect the relative risk for adverse outcomes. Also, the National Death Index process does not provide more granular information on cause of death that could be of interest.

### Conclusion

Risk factors for developing SUD during residency include male sex and attending medical school in the United States; performance on the anesthesiology ITE during the clinical base year is not associated with risk. The attributable risk of SUD to several adverse outcomes during and after residency training, including death and adverse medical license actions, is substantial. These results should not be interpreted as implying that individuals who develop SUD as residents cannot be treated and enjoy successful careers, as case series and anecdotes provide evidence that favorable outcomes are possible.<sup>5,14-17</sup> However, both the prior analysis from this dataset demonstrating an estimated 43% 30-yr risk of relapse to SUD,<sup>6</sup> and the current analysis show that risks of adverse outcomes are considerable. This information may be useful to guide both policy and the difficult individual choices faced by anesthesiology residents who develop SUD and those who supervise and treat them.

## Acknowledgments

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## Competing Interests

The authors declare no competing interests.

## Correspondence

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## Appendix: Disciplinary Action Notification System Basis Codes Associated with Substance Use Disorder

- B0001 Alcohol abuse
- B0002 Alcoholism
- B0003 Intemperate use of alcohol
- B0004 Excessive/inappropriate use of alcohol
- B0005 Substance abuse
- B0006 Controlled substance abuse
- B0007 Chemical abuse
- B0008 Practicing medicine while under the influence
- B0098 DUI/DWI (driving under the influence/driving while intoxicated)
- B0151 Conviction relating to controlled substances
- B0170 Chemical dependency
- B0198 Unlawful possession of controlled substances