Reducing the Incidence of Substance Use Disorders in Anesthesiology Residents

13 Years of Comprehensive Urine Drug Screening

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ABSTRACT

Background: The incidence of substance use disorders in the United States among residents in anesthesiology is between 1% and 2%. A recent study reported that the incidence of substance use disorders in U.S. anesthesiology residents has been increasing. There are no reports of effective methods to prevent substance use disorder in residents. A comprehensive drug testing program including a random component may reduce the incidence of substance use disorders.

Methods: The authors initiated a comprehensive urine drug screening program of residents, fellows, faculty physicians, and certified nurse anesthetists. The authors performed 3,190 tests over 13 yr. The authors determined the incidence of substance use disorders among residents in our large anesthesiology residency program during the decade before (January 1, 1994, to December 31, 2003) and for the 13 yr after (January 1, 2004 to December 31, 2016) instituting a random urine drug testing program. A total of 628 residents trained in the program over these 23 yr; they contributed a total of 1,721 resident years for analysis. Fewer faculty and certified nurse anesthetists were studied, so we do not include them in our analysis.

Results: The incidence of substance use disorders among trainees in our department during the 10 yr before initiation of urine drug screening was four incidents in 719 resident years or 0.0056 incidents per resident-year. In the 13 yr after the introduction of urine drug screening, there have been zero incidents in 1,002 resident years in our residency program ($P = 0.0305$).

Conclusions: This single-center, comprehensive program including preplacement and random drug testing was associated with a reduction of the incidence of substance use disorders among our residents in anesthesiology. There were no instances of substance use disorders in our residents over the recent 13 yr. A large, multicenter trial of a more diverse sample of academic, government, and community institutions is needed to determine if such a program can predictably reduce the incidence of substance use disorders in a larger group of anesthesiology residents. (ANESTHESIOLOGY 2018; 129:821-8)

THE incidence of substance use disorders among trainees as well as practicing physicians in anesthesiology has ranged between 1% and 2%.[1–4] It appears that the U.S. incidence of substance use disorder has increased in anesthesiology residents in recent years.[5] Data obtained from the American Board of Anesthesiology between the years 1995 and 2009 showed an overall incidence of substance use disorder of 2.16 (95% CI, 1.95 to 2.39) per 1,000 resident years. There was a decrease in substance use disorder incidences in the years from 1996 to 2002, but the incidence rose thereafter; the highest incidence occurred between 2003 and 2009 when it was 2.87 (95% CI, 2.42 to 3.39) per 1,000 resident years. This increase appears to parallel the national increase in prescription opioid overdose deaths in the U.S. population.[6] Efforts to reduce the frequency of substance use disorders in anesthesiology residents have included education about the effect of substance use disorder on the health and career of anesthesiologists, increased control of drugs used in the operating room, and study of factors that potentially lead to substance use disorder. These efforts have not reduced the

Editor's Perspective

What We Already Know about This Topic

- Substance abuse remains common among anesthesia clinicians
- Whether routine, random drug testing deters use remains unknown

What This Article Tells Us That Is New

- The Massachusetts General Hospital randomly tested residents over a period of 13 yr
- There was no detected substance abuse among residents during the testing period in 1,002 resident years, *versus* four incidents in the previous 719 resident years
- This intriguing, but statistically fragile, result needs to be confirmed in other settings and other anesthesia clinicians

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incidence of substance use disorder among U.S. residents in anesthesiology.[3] Substance use disorders among healthcare providers have long been considered a problem limited to the individual provider. However, healthcare providers impaired by substance use disorders have harmed patients.[7,8] Mandatory testing of physicians for impairment by substances has been suggested by some authors.[9–11] In 2008, we described our nascent random drug testing program and reported that urine drug screening of resident physicians in anesthesiology was feasible.[12]

Random urine and alcohol screening has been shown to detect substance use disorder in individuals in positions where the safety of the public is at risk.[13–15] It has been estimated that implementation of drug testing programs has resulted in a 9 to 10% reduction in truck accident fatalities.[15] Therefore, we sought to determine whether a comprehensive random drug screening would be similarly effective in reducing the rate of substance use disorders in anesthesiology resident physicians.

The purpose of the current study was to describe our experience over the years and determine if a program including random urine drug screening in our large population of residents could reduce the incidence of substance use disorders. For completeness, we include the data for our faculty and recently expanded certified nurse anesthetist cohort, but our smaller numbers preclude meaningful quantitative analysis.

Materials and Methods

In 2004, we initiated a program of preplacement and random urine drug testing as a condition for employment as an anesthesia resident at Massachusetts General Hospital. Physician faculty and certified nurse anesthetists were also included in the program. This new program was in addition to our already existing for-cause drug testing program. The physician director of the Massachusetts General Hospital Institutional Review Board (Boston, Massachusetts) documented that this work was considered exempted and did not require Institutional Review Board approval.

The development and implementation of our program was previously reported.[12] We appointed a substance abuse committee consisting of the department chairperson, residency program director, director of critical care, volunteer faculty members, chief residents, a legal representative from the Office of General Counsel, and the director of the Occupational Health Clinic to oversee the program. The hospital administration reviewed and approved the testing program.

Urine testing protocols were based upon guidelines of the U.S. Department of Transportation including collection, maintenance of specimen integrity, storage, testing in a certified laboratory, and review by a certified medical review officer.[16] The medical review officer is a licensed physician trained to the workplace drug testing guidelines of the Department of Health and Human Services Substance Abuse and Mental Health Services Administration. The medical review officer provides independent and impartial interpretation of drug testing results. The medical review officer is hired by the testing facility and is fully independent of our program. The medical review officer is thus responsible for determining whether there is a legitimate medical reason for a result that is positive, dilute, adulterated, substituted, or invalid. The Mandatory Guidelines for Federal Workplace Drug Testing Programs define the responsibilities in detail.[17]

Substances selected for preplacement screening were based upon drugs that would suggest the likelihood of illicit use if used without a prescription (table 1). Substances selected for subsequent random drug testing were those primarily used in our hospital operating rooms, although other substances are included as they are part of the available panel. Urine tests were obtained when behaviors, performance, or other actions raised a concern for impairment and are referred to as for-cause or reasonable suspicion tests. For-cause testing includes a broader panel of substances that cause physician impairment and is not limited to the panel shown. We have the capacity to expand our panel to include another substance if it could be the cause of impairment and we had a high level of suspicion.

When we introduced the program, urine testing was voluntary for residents who were already enrolled in the residency program. Thereafter all trainees entering on July 1, 2005, and later were informed and required to participate in the urine testing program. In addition, all trainees entering in July 2005 or later underwent preplacement urine drug testing during orientation. Our plan for the frequency and timing of random drug testing was to test residents early in their training more frequently because based on previous reports, they were more likely to develop substance use disorders. These "most at risk" physicians are those in the first 5 yr after medical school.[18] We designed our program with a goal that residents in their first year of clinical anesthesia training would receive two random tests, with a third random test in at least 20% of these residents. Residents in their second or third year of anesthesia training were targeted to undergo one random test per year, with an additional random test for at least 30% of these residents. For-cause testing was initiated when attending anesthesiologists believed poor performance could be consistent with a substance use disorder (*e.g.*, tardiness, poor vigilance, or incorrect drug accounting).

A positive urine drug test on the initial test (enzyme-linked immunosorbent assay) triggered subsequent chemical confirmation by gas chromatography–mass spectroscopy and was reviewed by the medical review officer. Our program is structured so that results are communicated to the leadership of the Anesthesiology Department only if the medical review officer cannot find a plausible reason for a positive result. If an individual claims to have a prescription for the detected substance, it must be presented to the medical review officer within 48 h. Whenever a positive result is confirmed by the medical review officer, our department conducts a structured intervention to present our findings to the resident.

Statistical analyses were performed with Stata 13.0 (StataCorp, USA). We determined the upper bound of the 97.5%

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Table 1. Drug Testing Panels

Preplacement	Random Testing	"For-cause"	Screening Threshold (ELISA), ng/ml	Confirmation Threshold (GC/MS), ng/ml	Typical Detection "Window," Days[20–22]*
Amphetamines†	Amphetamines	Amphetamines	1,000	500	2–5
Barbiturates‡	Barbiturates	Barbiturates	300	200	3–15
Benzodiazepines§	Benzodiazepines	Benzodiazepines	300	100–200	2–10
Cocaine metabolites	Cocaine metabolites	Cocaine metabolites	300	150	< 1 to 5
Opiates‖	Opiates	Opiates	2,000	2,000	1–3
Oxycodone#	Oxycodone	Oxycodone	100	100	3
Phencyclidine	Phencyclidine	Phencyclidine	25	25	8
Methadone	Methadone	Methadone	300	200	7
Propoxyphene	Propoxyphene	Propoxyphene	300	200	1.5–5
Meperidine	Meperidine	Meperidine	200	100	0.5–1
Fentanyl	Fentanyl	Fentanyl	0.75	0.5	3
		Ketamine Norketamine	100	200	2
		Marijuana** metabolite	50	15	3 to > 30
		Others as indicated by concern††			

*Detection times will depend upon testing threshold, frequency of use, doses, and individual metabolism. †Amphetamines include amphetamine and methamphetamine. ‡Barbiturates include butalbital, amobarbital, pentobarbital, secobarbital, phenobarbital, and butabarbital. §Benzodiazepines includes diazepam, desmethyldiazepam, oxazepam, temazepam, alprazolam, alpha-OH-alprazolam, hydroxyethylflurazepam, alpha-hydroxymidazolam, 7-aminoclonazepam, 7-aminoflunitrazepam. (We are in the process of determining a single threshold for benzodiazepine confirmation.) ‖Opiates includes codeine, morphine, hydrocodone, hydromorphone. #Oxycodone includes oxycodone and oxymorphone. **Marijuana includes tetrahydrocannabinol. ††Other substances may be added depending upon situational circumstances, including propofol.

ELISA, enzyme-linked immunosorbent assay; GC/MS, gas chromatography–mass spectrometry.

CI for the incident rate, which has zero for its lower bound. When bounded by zero at the lower end, a one-tailed analysis with level of significance (α) of 0.025 is used and is analogous to a two-tailed analysis with $\alpha = 0.05$ for a symmetric distribution without lower bound. The frequency of substance use disorders of the residents was compared between the decade before we added preplacement and random testing and the 13 yr after commencing urine screening by use of Fisher exact test.

Faculty physicians and certified nurse anesthetists were included in our testing program. Initially, faculty and certified nurse anesthetists were subject to one random drug test within their reappointment period (typically once every 2 yr). We did not perform quantitative analysis because of the lower number of total faculty members and fellows and because we had only a small number of certified nurse anesthetists when we started our comprehensive testing program.

Results

Since beginning our comprehensive testing program in January 2004, we have obtained and analyzed a total of 3,190 urine drug screens among all department members. Testing among residents accounted for 1,285 urine tests (table 2). Nearly all 302 preplacement tests were obtained from residents entering our program in their first year (99%). In addition, during this period three trainees entered our residency during their second year of clinical training, and no resident entered during their third year. During the 13-yr period of our testing program, 302 of 336 trainees completed preplacement urine screening (91%). The total number of random drug tests was 971. On first-year residents, 374 random drug tests were performed; 332 were performed on second-year residents, and 265 were performed on third-year residents. During this 13-yr period, 12 for-cause tests were obtained on 12 different residents. These for-cause tests were conducted primarily because of altered behavioral cues (table 3). The results of the for-cause tests were known between 5 and 7 days after samples were submitted. None of our preplacement, random, or for-cause urine tests on residents was positive during this 13-yr period.

We estimated our baseline substance use disorders rate by examining the 10 yr before beginning our drug testing program. Between 1994 and 2003 there were four episodes of substance use disorders in 292 Massachusetts General Hospital anesthesiology residents (1.4%) or 0.0056 incidents per resident-year. Of these four positive results, three were accompanied by an explicit acknowledgment of substance abuse by the individual before test results were returned as positive, and one individual admitted to substance abuse after the return of the positive test result. Beginning in 2004 all our positive test results were adjudicated by a medical review officer and confirmed by our departmental review process. We compared this rate to the rate during the subsequent 13 yr (2004 to 2016). In the 13 yr since establishment of our comprehensive drug testing program, there were zero episodes of substance use disorders in 387 anesthesiology residents (0%) or an incidence of zero incidents per resident-year. The 97.5% CI for zero incidents per resident-year lies between 0 and 0.00368 incidents per resident-year. Comparing these two periods (the decade before and 13 yr after

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Table 2. Total Resident Drug Screens

Status		Years													
		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
First-year clinical anesthesia resident	Preplacement	25	25	18	15	24	23	24	24	30	23	26	22	20	299
	Random	12	5	11	22	51	41	25	36	27	34	39	29	42	374
	For cause	0	1	0	0	1	0	0	0	1	0	0	0	2	5
Second-year clinical anesthesia resident	Preplacement	1	0	0	0	0	0	0	0	1	0	1	0	0	3
	Random	6	15	16	24	53	29	24	33	29	23	27	29	24	332
	For cause	0	0	1	0	0	0	1	0	0	1	0	1	2	6
Third-year clinical anesthesia resident	Preplacement	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Random	2	9	19	9	28	34	30	13	26	16	25	24	30	265
	For cause	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Total		46	55	65	70	157	127	104	106	114	97	118	106	120	1285

Table 3. Drug Screen Fellows, Certified Nurse Anesthetists, Staff

Status		Years													
		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Fellows	Preplacement	5	5	7	10	9	5	9	11	8	16	14	15	15	129
	Random	1	2	6	4	19	8	9	12	17	13	15	11	24	141
	For cause	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Certified nurse anesthetists	Preplacement	0	0	0	0	0	7	20	16	22	43	20	9	17	154
	Random	0	12	2	1	7	9	9	25	47	56	63	60	59	350
	For cause	0	0	0	0	0	0	0	0	1	0	1	1	0	3
Faculty	Preplacement	2	2	2	3	5	2	2	11	7	12	4	3	11	66
	Random	36	50	34	24	71	74	68	97	79	146	124	135	121	1059
	For cause	0	0	0	0	0	0	0	0	1	0	1	0	0	2
		44	71	51	42	111	105	117	172	182	286	243	234	247	1905

commencing preplacement and random urine testing) with Fisher exact test, we determined that the incidence of substance use disorders between the two periods (four positive in 719 resident years *vs.* 0 positives in 1,002 resident years) was significantly different and the incidence was lower after we instituted random urine testing ($P = 0.0305$).

We obtained a total of 1,905 tests among faculty physicians (n = 1,127 tests), fellows in training (n = 271 tests), and certified nurse anesthetists (n = 507 tests). Six individuals in this cadre were required to undergo for-cause testing (table 3). One random test and one for-cause test were confirmed as positive and determined to be due to a substance use disorder. The smaller number of individuals in each role group, combined with the lack of a "before" group of certified nurse anesthetists, infrequent testing (every 2 yr for faculty and certified nurse anesthetists), and the incomplete records pertaining to faculty substance use disorders before introducing our comprehensive drug testing program precludes not only a comparison before and after but also a reliable rate determination.

Discussion

We instituted a preplacement and random urine testing system to augment our existing for-cause drug testing program to try to reduce the incidence of substance use disorders in our residency program. In 2004, we began our program of drug testing including preplacement and random urine screening. All department members including faculty physicians, trainees, and certified nurse anesthetists were subject to testing. We view the random testing component as the most important aspect of the program. Data suggest that the increased frequency of testing may have a greater deterrent effect than infrequent testing, which allowed us to quantitatively analyze our resident substance use disorder rates before and after.[19] Available data for trainees were more accurate than for other department members. In our anesthesiology residency program, we had four substance use disorder events in the 10 yr before initiation of our urine drug testing program. Over the 13 yr since implementing preplacement and random testing, we have had zero events among our residents. This is a statistically significant decrease in incidence. This is all the more impressive since over a very similar time period (2003 to 2009), the national rate of substance use disorders among U.S. anesthesiology residents increased.[5] Although our program had a decrease in rate at the same time that the national rate increased, our study design does not allow us to attribute our decrease solely to our urine testing program. Concurrent with the initiation of our program, we implemented enhanced educational annual lectures to incoming residents and we implemented an annual lecture to our entire staff. Furthermore, since beginning our testing program other measures were initiated including

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the addition of automated medication dispensing machines, required witnessing of medication waste, and periodic surveillance of medical records for discrepancies between medications obtained and administered. We also believe that the presence of our program increased the vigilance for substance use disorders as a potential cause for performance problems. Our policy for dealing with potential substance use disorders is written and distributed to all incoming department members. All personnel are aware that this process exists. It is also possible that resident applicants who experiment with drugs and who are at risk for developing a substance use disorder may have decided not to rank our residency program because we inform all applicants of our drug testing policy during the residency interview process.

Our program includes a protocol for performing an intervention when a test is found to be positive or when performance problems could potentially indicate a substance use disorder. Members of the intervention team include the substance use disorders prevention program director, the residency program director, the department chairperson or designee, the resident's mentor, and a psychiatrist familiar with our testing program. Subjective performance problems such as interpersonal interactions, lack of vigilance, or abnormal behavior may be identified by a colleague in anesthesia or other operating room personnel (surgeon, nurse). These concerns may be brought to the attention of any departmental leader and are then directed to the substance use disorders prevention leadership. Repeated or unexplained medical record discrepancies trigger notification of the respective group leaders (program director for residents or fellows, head certified nurse anesthetist for certified nurse anesthetists, or compliance officer for the faculty) by the pharmacy. Resident academic issues that could indicate potential impairment and are identified through the Clinical Competency Committee may be cause for testing. A tested individual is removed from clinical duty as confidentially as possible. The individual is presented with the facts that led to our concerns for a substance use disorder. A medical leave of absence is mandated while awaiting the results, and confirmatory substance use disorder testing is performed at our Occupational Health Clinic when necessary. If issues other than a substance use disorder are responsible for the poor performance (such as depression, fatigue, or illness), we begin addressing these while we await the results of the drug test. We performed 12 interventions as part of for-cause urine screening because of performance problems among resident trainees since 2004. The most common Accreditation Council for Graduate Medical Education core competency associated with performance concerns has been patient care (six interventions) (table 4). Patient care issues have included sleeping on duty, poor clinical vigilance, and general abnormal behavior. Professionalism was the competency domain for four interventions, and behaviors included recurrent tardiness as well as suspicious behavior. Systems-based practice indicators for potential impairment included recurrent substance accounting problems. No patient harm occurred in relation to any of our for-cause incidents, and all urine screens were negative. All residents were returned to clinical practice after counseling to address the particular performance issues in the identified competency.

There are limitations to our program. There are several limitations that potentially bias our program to underestimate the detection of positive urine-screening tests. Residents within the program in 2004 or committed to our program through the National Residency Matching Program were initially allowed to choose to be included in the test program. Of these trainees, 32 (43%) participated while 35 (47%) did not, and 7 (10%) did not respond.[12] We did not reach the testing frequency for random urine testing that we targeted at the beginning of our program. Randomization is done through our Occupational Health Clinic, and an individual may miss a test after having gone home after an overnight call or they may be unable to arrive for testing because they are caring for a critically ill patient, are ill themselves, or on vacation requiring rerandomization and testing on another day after we confirm there was a valid reason for delaying the test. We have implemented an online scheduling system and allowed access to the system by our Occupational Health Clinic colleagues. This has increased the frequency of testing by improving coordination of schedules. Testing timing has proven difficult because early morning testing occurs during times when cases are starting and most staff are clinically very busy. Testing later in the day may conflict with more complicated cases. The pharmacokinetics of substances in the body and the timing of drug testing remains a challenge. Most substances can be detectable in urine for 24 to 72 h, although factors such as the expected duration of action of the agent (short *vs*. long acting), use frequency, and potency will impact elimination (table 1).[20,21] Individuals who use substances on a Friday may test negative by Monday. Drug testing will not detect when a substance is diverted for use by another person outside of the program. Last, the deterrent effect of drug testing may be reduced for individuals that have had the expected one to two tests a year and may feel less concerned about being tested again or testing positive.

Urine collection is done at our facility, but analytical testing of the sample is performed by a laboratory accredited by the Substance Abuse and Mental Health Services Administration outside of our institution. Results are reported to the Occupational Health Clinic but are not reported in the individuals' electronic medical record. We rely upon a medical review officer to confirm any positive results. If an individual produces a valid prescription for a detected substance, the medical review officer may be satisfied with this explanation and the positive result is not reported and it is considered a negative result. A urine test that reveals the presence of a controlled substance does not prove substance use disorder as an individual may have a legitimate use for the substance. The presence of a controlled substance does not define diversion from a work facility since the substance could have come from an outside source.

Various concerns have been raised about random drug testing programs. These include the risk of false-positive test

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Table 4. Total Resident Interventions

Clinical Level	Competency	Specifics	Result
CA-2	Professionalism	Interpersonal and communication skills	Negative
	Practice-based learning	Rigidity	
CA-1	Professionalism	Arriving late	Negative
	Systems-based practice	Distracted	
		Accounting errors	
CA-3	Professionalism	Acting strange	Negative
		Calling in sick frequently	
CA-2	Patient care	Falling asleep	Negative
	Interpersonal and communication skills	Poor engagement	
CA-1	Patient care	Drop in performance	Negative
	Practice-based learning	Lack of engagement	
		Frequently call in sick	
CA-2	Systems-based practice	Recurrent substance accounting errors	Negative
CA-2	Patient care	Vigilance	Negative
CA-1	Patient care	Vigilance	Negative
CA-2	Professionalism interpersonal	Tardiness	Negative
		Potential impairment	
CA-1	Systems-based practice	Recurrent substance accounting errors	Negative
CA-2	Patient care	Sleeping on duty	Negative
CA-1	Patient care	Vigilance	Negative

CA-1, first-year clinical anesthesia resident; CA-2, second-year clinical anesthesia resident; CA-3, third-year clinical anesthesia resident.

results, the integrity of the testing process, privacy, and effectiveness. We have encountered and reported two tests that we consider "false positives." One false positive was a urine sample that tested positive for opioids, but upon confirmatory evaluation, we determined that this was most likely due to ingestion of poppy seeds on a bagel. Our testing threshold at the time was set extremely low and could be triggered by poppy seeds. We subsequently raised our opioid testing threshold to the federal concentration (2,000 ng/ml).[12] A second "false positive" occurred when an initial urine enzyme-linked immunosorbent assay screening test was reported positive for ketamine, but the confirmatory gas chromatography–mass spectroscopy result was "indeterminate."[23] Our testing protocol includes "split-sample testing." Split-sample testing is the practice of dividing the collected urine sample into two separate containers, which are individually sealed and labeled. This practice provides a second sample to be tested by another laboratory at the request of the tested person. A second sample is thus available to be analyzed at a second independent and certified laboratory. In our second false-positive case, the result was reported as negative by the second laboratory. We view this as an example of a successful system. The likelihood of a false-positive result from two different labs with gas chromatography–mass spectroscopy sample analysis capacity is exceedingly small. Among other nonresident clinicians, we have had five tests that were reported as positive by the medical review officer but upon further investigation were determined to have plausible explanations after formal intervention. In two of these circumstances individuals admitted to consumption of a substance but were not able to produce the prescriptions within the 48-h time frame. The prescriptions were subsequently produced, and the test results were changed to negative per our policy. One test was positive due to consumption of an antidiarrheal agent containing a barbiturate. Another test was determined to be inadvertent consumption of an amphetamine.

Concerns about the integrity of the testing process are largely related to the ability of the individual to adulterate the urine and mask the presence of an illicit substance. Household substances such as bleach, table salt, laundry detergent, lemon juice, and eye drops have been used to impair the integrity of the sample.[24] Other adulterants are reported on the internet. Most of these can be detected by tests such as pH, temperature, urine creatinine, specific gravity, and so on. Adulteration detection devices have been developed to test the adulterating substances in urine samples.[23] Attempts to invalidate samples by individuals with substance use disorders will remain a challenge for testing programs. Direct observation of urine collection may reduce the likelihood of adulteration; however, we did not employ this strategy.

The effect of substance use disorders on the health and welfare of medical providers as well as the safety of their patients is an important public health issue. Several recent reports of drug-impaired providers harming patients under their care established the need for drug testing to protect patients from injury by impaired physicians.[9–11,25,26] Pilots and bus drivers who may harm their passengers when driving or flying when intoxicated are drug tested. Thus, it seems appropriate that physicians at high risk of practicing while under the influence of drugs should be randomly tested. Anesthesiology is considered the physician specialty most likely to produce practitioners who abuse substances on the basis of their representation in rehabilitation programs.[27,28] The incidence of substance use

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disorders is highest during the residency training period, which occurs in the first 5 yr after medical school. Death or near death is the presenting problem in approximately 18% of reports of physician impairment.[3] Substance use disorders contribute to the shortened life expectancy of anesthesiologists as compared to physicians practicing internal medicine.[17]

We do not believe that random drug testing alone will decrease the incidence of substance use disorders among residents. We also acknowledge that our program may simply push individuals prone to substance use disorder to another program that does not randomly test practitioners. This is important since Gallegos *et al.*, has postulated that certain individuals choose the field of anesthesiology for its access to drugs.[29] A substance use disorders prevention program comprising enhanced education about the effects of substance use disorder on patients and care providers, stricter substance control and dispensing practices with consequences for violations, an organized system for staging an intervention when a substance use disorder is suspected, as well as preplacement, random, and for-cause testing may combine to reduce substance use disorders among physicians. Our results over the past 13 yr demonstrate that a program including preplacement and random urine testing can reduce the incidence of substance use disorders in anesthesia residents, a group at high risk of developing substance use disorders.[5] A larger prospective, randomized, controlled trial is necessary to determine whether drug testing prevents or acts as a deterrent to resident substance use disorders. In the future, a large national trial of random urine testing in a diverse sample of academic, community, and government programs should be carried out with residents in anesthesiology since they remain at high risk for substance use disorders.[5]

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Competing Interests

The authors declare no competing interests.

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ANESTHESIOLOGY REFLECTIONS FROM THE WOOD LIBRARY-MUSEUM

Haunted Anesthesia? Spirited Herbs in Mayo's Vegetable Vapor

Frustrated by his failure to find a balanced combination of sedative herbs to extend the duration of nitrous-oxide anesthesia, Urial K. Mayo, D.D.S. (1816 to 1900), sought advice from a neighboring Boston spiritualist. From Mayo's self-described "spiritual revelation" sprang the "vegetable vapor" anesthetic that the dentist patented in 1885. Regarding both his nitrous oxide and the "spirit" (the ethyl alcohol dissolving his herbs) as stimulants, Mayo balanced their effects with herbal depressants, such as *Humulus lupulus* ("hops" or H on the grinning jack-o'-lantern, *above*) and *Datura stramonium* (D S or jimsonweed). Similarly, Mayo sought to offset the hypoxic jactitations, spasms, or even seizures caused by his spasmodic gas (unoxygenated nitrous oxide) with antispasmodic herbs, such as *Valeriana officinalis* (V or Valerian), *Cypripedium* sp. (C or Lady's slipper), and/or *Scutellaria lateriflora* (S L or Blue scullcap). (Copyright © the American Society of Anesthesiologists' Wood Library-Museum of Anesthesiology.)

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