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# Surgery as a Teachable Moment for Smoking Cessation

Yu Shi, M.D., M.P.H.,* David O. Warner, M.D.†


## ABSTRACT

**Background:** A "teachable moment" is an event that motivates spontaneous behavior change. Some evidence suggests that major surgery for a smoking-related illness can serve as a teachable moment for smoking cessation. This study tested the hypotheses that surgery increases the likelihood of smoking cessation and that cessation is more likely after major surgical procedures compared with outpatient surgery.

**Methods:** Secondary analyses were performed of longitudinal biennial survey data (1992–2004) from the nationally representative Health and Retirement Study of U.S. adults older than 50 yr, determining the relationship between the incidence of smoking cessation and the occurrence of surgery.

**Results:** Five thousand four hundred ninety-eight individuals reported current smoking at enrollment, and 2,444 of them (44.5%) quit smoking during the period of examination. The incidence of quitting in smokers undergoing major surgery was 20.6/100 person-years of follow-up and 10.2/100 person-years in those undergoing outpatient surgery. In a multivariate negative binomial regression model, the incidence rate ratio of quitting associated with major surgery was 2.02 (95% CI: 1.67–2.44) and that of those associated with outpatient surgery was 1.28 (95% CI: 1.09–1.50). Estimates derived from national surgical utilization data show that approximately 8% of all quit events in the United States annually can be attributed to the surgical procedures analyzed.

**Conclusions:** Undergoing surgery is associated with an increased likelihood of smoking cessation in the older U.S. population. Cessation is more likely in association with major procedures compared with outpatient surgery. These data support the concept that surgery is a teachable moment for smoking cessation.


### What We Already Know about This Topic

- Millions of smokers undergo surgery each year, which may provide a good opportunity for them to quit smoking

### What This Article Tells Us That Is New

- In this analysis of a large nationally representative longitudinal study, undergoing major surgery approximately doubled the chances that a smoker would quit
- Approximately 1 in 10 of all successful quit attempts in older U.S. citizens is associated with surgery

SMOKING is the leading preventable cause of premature death.[1] Despite intensive efforts to reduce tobacco use, 19.8% of Americans still smoke cigarettes,[2] a prevalence that has remained relatively stable for several years. Even though most smokers report that they want to quit and efficacious intervention services such as telephone quitlines are now widely available, success rates in the absence of interventions are modest (~3–4% annually) and the utilization of available interventions remains relatively low.[3,4]

The term "teachable moment" refers to an event that "motivates individuals to spontaneously adopt risk-reducing health behaviors."[5] Because smoking cessation is so difficult for individuals to achieve, there is considerable interest in understanding the application of the teachable moment concept to smoking behavior. Current evidence suggests that the new diagnosis of a serious medical condition may serve as a teachable moment for smoking cessation. Using data from a large longitudinal health survey of older Americans, Keenan[6] showed that adults with recent diagnoses of stroke, cancer, lung disease, heart disease, or diabetes mellitus were 3.2 times more likely to quit smoking than were individuals without new diagnoses. Surgery is another health-related event that may represent a teachable moment for smoking cessation. Studies suggest that abstinence rates are high after a major surgical procedure directly related to a smoking-induced illness, such as coronary artery bypass grafting or lung resection for cancer, and that the rates may be proportional to the intensity of the procedure.[7–11] However, it is not known whether this effect is observed for surgery not related to a smoking-induced disease (such as orthopedic surgery) or for more minor outpatient procedures, which constitute the majority of surgeries in the United States. Furthermore, there are no estimates of the potential significance of surgery as a teachable moment for smoking cessation on a population level. Given that approximately 10 million procedures are performed each year on U.S. residents who smoke,[10,12,13] the public health impact of even a small increase in abstinence rates prompted by surgery could be significant.

* Research Fellow, † Professor of Anesthesiology, Department of Anesthesiology and Nicotine Research Center, Mayo Clinic.

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Address correspondence to Dr. Warner: Department of Anesthesiology, Mayo Clinic, 200 First Street Southwest, Rochester, Minnesota 55905. warner.david@mayo.edu. 

The overall goal of this study was to determine the association between undergoing selected surgical procedures and smoking cessation by secondary analysis of data obtained in large longitudinal health survey of older U.S. residents.[14] We hypothesized that surgery would be associated with an increased likelihood of smoking cessation and that the magnitude of this effect would be greater after major surgical procedures compared with outpatient surgery. Using these data, the potential impact of this effect on the U.S. population was also estimated.

## Materials and Methods

### Study Population

The Health and Retirement Study (HRS) surveys a national representative sample of adults older than 50 yr.[14] The study enrolled its first cohort in 1992 and conducts follow-up interviews every 2 yr. A nationally representative sample of U.S. residents aged 70 yr and older was enrolled in 1993 and reinterviewed in 1995 and 1998. In 1998, a group of people in the age group that fall between the original two cohorts and a "refresher" cohort consisting of people in their early 50s were enrolled. Since 1998, all living individuals in the study continue to be interviewed biennially. Survey response rates (70–81%) and retention rates (86–90%) were good. The dataset provides rich information on American older adults' physical and mental health, insurance coverage, financial situations, family support systems, work status, and retirement planning, and it was the source for the analysis performed by Keenan,[6] demonstrating that recent diagnosis of a major illness was associated with smoking cessation. The HRS is approved by the University of Michigan Health Sciences Human Subjects Committee. Data collected from 1992 to 2004 were used in this analysis. Because this study used publicly available deindentified data, it was exempted from review by the Mayo Clinic Institutional Review Board.

### Data Analyzed

During each cycle of interviews, participants were asked whether they were a current cigarette smoker. All those reporting current smoking at the time of study enrollment were included in this analysis. A quit event was defined as the first report of no current smoking at a subsequent interview. At each interview, participants also answered questions about new diagnoses of chronic diseases (including cancer, heart disease, diabetes, stroke, or lung disease) and whether they had undergone surgery in the interval since the last interview (cancer surgery, heart surgery, joint replacement surgery, or outpatient surgery—the four surgical categories available in the HRS dataset). Demographic information was also analyzed.

To estimate the potential impact of surgery on smoking cessation on population level, annual numbers of major surgical procedures in the United States were obtained from the 2000 data on inpatient procedures from Healthcare Cost and Utilization Project.[15] Numbers of heart surgeries (coronary artery bypass graft and valve replacement), joint replacement (hip and knee), and cancer surgeries (colectomy, mastectomy, lung resection, radical prostatectomy, and radical nephrectomy) in patients older than 45 yr were obtained. This age range was chosen because it was available from the 2000 data and inclusive of the subjects in the HRS dataset. The estimated annual number of outpatient procedures in patients older than 45 yr was obtained from the 1996 report on ambulatory and inpatient procedures in the United States.[16]

### Statistical Analysis

Person-time methods were used to calculate the incidence of smoking cessation up to 2004. Participants were considered to be at risk for this event on their enrollment and to exit at the first occurrence of this event or when they were reported to be deceased. The exact time of the event within the 2-yr interval between interviews was unknown and thus was arbitrarily considered to be the midpoint between two consecutive interviews. Each individual contributed to person-years from enrollment through exit.

Because only counts of events are available in the time intervals analyzed and incidence rate is a measure of interest, negative binomial regression was used to evaluate the effect of various variables on the incidence of smoking cessation. A negative binomial regression model was chosen because the assumption of a Poisson distribution of the dependent variable may not be fulfilled, which is required for a Poisson regression model. Variables included age (in 10-yr intervals), sex, race (white *vs.* nonwhite), new medical diagnoses (at least one new diagnosis of diabetes mellitus, heart disease, stroke, cancer, or lung disease), major surgery (heart surgery, cancer surgery, and joint replacement surgery), and outpatient surgery. Incidence was calculated as the number of new quitters in a given time interval divided by the size of population at risk. The log of the smoking cessation incidence rate was assumed to be linearly associated with the variables. Relative incidence was calculated by exponentiation of the model parameters. New medical diagnoses, recent major surgery, and outpatient surgery were entered into the models as time-dependent variables. In a multivariate negative binomial regression model, the independent contribution of covariates of interest was determined after adjustment for the effects of other covariates. Adjusted relative incidence rate was reported. The separate effects of heart surgery, cancer surgery, and joint replacement were also estimated using an additional multivariate analysis.

All estimates of prevalence were adjusted for the sampling weights used in the HRS data collection procedures. In the estimation of annual number of individuals who quit smoking, the annual number of procedures was obtained from published national data as described above,[14,15] whereas the prevalence of smoking among surgical patients, the incidence of smoking cessation, and incidence rate ratio were calculated from the HRS dataset. The estimated number of quit events that could be attributed to a specific surgical procedure was calculated as number of quitters undergoing a procedure multiplied by (incidence rate ratio − 1)/incidence rate ratio.

**Table 1.** Incidence of Quit Events and Relative Incidence in Multivariate Analysis

| Variables | No. Person-Years | No. Quitters | Incidence per 100 Person-Years | Adjusted* Relative Incidence (95% CI) | *P* Value |
|---|---|---|---|---|---|
| Age in 1992, yr | | | | | |
| < 50 | 6,864 | 359 | 5.23 | 1.00 | |
| 50–60 | 20,712 | 1,200 | 5.79 | 1.16 (0.94–1.42) | 0.165 |
| 60–70 | 7,505 | 546 | 7.28 | 1.38 (1.11–1.72) | 0.004 |
| 70–80 | 3,393 | 288 | 8.49 | 1.50 (1.18–1.90) | 0.001 |
| > 80 | 487 | 51 | 10.47 | 2.15 (1.49–3.10) | < 0.001 |
| Sex | | | | | |
| Male | 18,107 | 1,155 | 6.38 | 1.00 | |
| Female | 20,840 | 1,286 | 6.17 | 0.95 (0.82–1.10) | 0.468 |
| Race: white | | | | | |
| No | 8,240 | 555 | 6.74 | 1.00 | |
| Yes | 30,721 | 1,889 | 6.15 | 0.93 (0.79–1.09) | 0.352 |
| New diagnoses | | | | | |
| No | 28,363 | 1,213 | 4.28 | 1.00 | |
| Yes | 10,599 | 1,231 | 11.61 | 2.13 (1.82–2.50) | < 0.001 |
| New major surgery | | | | | |
| No | 37,784 | 2,202 | 5.83 | 1.00 | |
| Yes | 1,177 | 242 | 20.56 | 2.02 (1.67–2.44) | < 0.001 |
| New outpatient surgery | | | | | |
| No | 35,027 | 2,041 | 5.83 | 1.00 | |
| Yes | 3,934 | 403 | 10.24 | 1.28 (1.09–1.50) | 0.003 |

* Each relative incidence was adjusted for the other factors in the table as a part of multivariate negative binomial regression.

Analysis was performed using Stata, Version 10.0 (College Station, TX), and $P < 0.05$ was considered to be statistically significant.

## Results

Of the subjects available for analysis, 5,498 subjects reported current smoking at the time of enrollment in the HRS study: 2,659 (48.4%) were men, and 2,839 (51.6%) were women. Of these subjects, 4,276 (77.8%) were white. The age of the cohort members in 1992 was 57 ± 10 yr (mean ± SD). A total of 2,444 (44% of those smoking at enrollment) individuals quit smoking during 38,961 person-years of observation, an incidence of 6.27/100 person-years (95% CI: 6.03–6.53).

Table 1 shows the association between the incidence of quit events and the variables of age, sex, race, new medical diagnosis, recent major surgery, and recent outpatient surgery as determined by multivariate negative binomial regression The incidence increased with age, was similar among men and women, and was also similar for whites and nonwhites. The incidence for subjects who had at least one major surgery was higher than those who did not have any major surgery (adjusted rate ratio = 2.02, 95% CI: 1.67–2.44), similar to the incidence for participants who had outpatient surgery compared with those who did not have outpatient surgery (adjusted rate ratio = 1.28, 95% CI: 1.09–1.50). The incidence for participants who had at least one new medical diagnosis was higher than those who did not have any new diagnosis (adjusted rate ratio = 2.13, 95% CI: 1.82–2.50).

Table 2 presents the relationship between the three different types of major surgery and incidence of quit events as

**Table 2.** Multivariate Analysis of Relative Incidence by the Three Types of Major Surgery*

| Variables | No. Person-Years | No. Quitters | Incidence per 100 Person-Years | Adjusted Relative Incidence (95% CI) | *P* |
|---|---|---|---|---|---|
| Heart surgery | | | | | |
| No | 38,493 | 2,310 | 6.00 | 1.00 | |
| Yes | 468 | 134 | 28.63 | 2.58 (2.06–3.24) | < 0.001 |
| Cancer surgery | | | | | |
| No | 38,656 | 2,389 | 6.18 | 1.00 | |
| Yes | 305 | 55 | 18.03 | 1.57 (1.16–2.12) | 0.004 |
| Joint replacement | | | | | |
| No | 38,538 | 2,386 | 6.19 | 1.00 | |
| Yes | 423 | 58 | 13.71 | 1.59 (1.20–2.12) | 0.001 |

* Each relative incidence was adjusted for age, race, sex, new outpatient surgery, and new medical diagnosis.

**Table 3.** Estimation of Annual Number of Smokers Who Quit Smoking ("Quitters") Related to Surgical Procedures in the U.S. Population

| | Annual No. Procedures in the United States* | Smoking Prevalence† | Annual No. Smokers Undergoing Procedure in the United States | Incidence of Cessation Associated with Procedure† | Annual No. Quitters in the United States Associated with Procedure | Annual No. Quitters in the United States Attributable to Procedure |
|---|---|---|---|---|---|---|
| Heart surgery | 399,492 | 0.16 | 63,919 | 0.29 | 18,536 | 11,407 |
| Cancer surgery | 411,270 | 0.21 | 86,367 | 0.18 | 15,546 | 5,830 |
| Joint replacement | 587,879 | 0.15 | 88,182 | 0.14 | 12,345 | 4,630 |
| Outpatient surgery | 19,565,000 | 0.18 | 3,521,700 | 0.10 | 352,170 | 81,270 |

* Estimations for outpatient surgery were based on 1996 data,[16] and estimations for other procedures were based on 2000 data[15]; both included only those adults aged older than 45 yr. † Data for smoking prevalence and cessation incidence were obtained from the Health and Retirement Study dataset.

calculated by multivariate analysis. The incidence was highest for heart surgery, followed by cancer surgery and joint replacement (28.6/100 person-years, 18.0/100 person-years, and 13.7/100 person-years, respectively).

Using the incidence of cessation associated with a given procedure from the HRS data and the estimate of the annual number of smokers undergoing that procedure in the United States from the HRS data and Healthcare Cost and Utilization Project data, the relationship between undergoing surgery and smoking cessation was estimated in the U.S. population aged 45 yr and older (table 3). This analysis estimates that 103,137 additional smokers in this population quit each year attributable to undergoing heart surgery, cancer surgery, joint replacement surgery, or outpatient surgery. The greatest number is related to outpatient surgery; although the incidence of quit events is the lowest among procedures, the number of outpatient procedures is far greater.

## Discussion

The main finding of this study is that in this nationally representative longitudinal study, undergoing a surgical procedure was associated with increased incidence of quitting smoking. The results of the study support the concept that surgery is a teachable moment for smoking cessation.

The proportion of individuals who quit during the study years of examination (44% of those who reported current smoking at enrollment) is comparable with other studies on smoking cessation based on representative national U.S. samples. For example, in a study that followed up smokers from 1988 to 2001, 50% of smokers aged 45–54 yr and 54% aged 55–64 yr quit.[17] A study based on National Health Interview Surveys showed that 4.1% of those aged 35–50 yr quit in 1990.[18] Another study based on the 2003 Tobacco Use Supplement to the Current Population Survey showed that annual quit rate in those aged 35–64 yr was 5.0%.[19] These findings are consistent with our observations at comparable ages (table 1). We found that the rate of smoking cessation increased with age, a finding again consistent with other representative national U.S. samples.[17,20–23] These concordances support the validity of smoking status data in the HRS survey.

The term "teachable moment" has been applied to indicate that health events can motivate people to spontaneously change health behaviors.[5,24–27] Many health events can serve as teachable moments, including clinical visits, notification of abnormal test results, pregnancy, and disease diagnosis with or without hospitalization.[28] McBride *et al.*[5] proposed a heuristic to explain the mechanism of the teachable moment. They posited that three key constructs determine whether a cueing event represents a teachable moment, including the extent to which the event (1) increases perceptions of risk and negative outcome expectancies related to smoking, (2) prompts strong affective or emotional responses, and (3) redefines self-concept or social role. These cognitive responses precede motivation, skills acquisition, and self-efficacy, which in turn increase the likelihood of health behavior change.[5] Evidence suggests that diagnosis of a serious medical condition can serve as a teachable moment for smoking cessation, including the study of Keenan,[6,29,30] which used a similar methodology applied to the HRS survey. Patient confrontation with a serious illness might be expected to affect all the three constructs of McBride *et al.*, although this heuristic has not yet been validated directly.

Previous studies have suggested that surgery may also serve as a teachable moment for smoking cessation, because quit rates are high after major procedures related directly to conditions caused by smoking. For example, in a study of patients receiving cardiac procedures, smoking cessation rates at 1 yr were 55% for those who had coronary artery bypass graft surgery, when compared with 25% for angioplasty patients and 14% for angiography patients, suggesting that for a given medical condition, the intensity of treatment influences quit rates.[8] Simon *et al.*[31] reported that 13% of smokers who underwent major noncardiac inpatient surgeries and received a brief intervention were abstinent at 12 months, suggesting that abstinence rates may be lower in patients who are undergoing surgery not necessarily related to smoking. There are few data regarding whether more minor surgical procedures also serve as teachable moments. In a small observational study of surgical patients, Warner *et al.*[10] observed that the proportion of smokers who were abstinent

30 days after surgery was low after outpatient procedures (4%), especially when compared with the rate after major inpatient surgery (21%).

Our analysis provides the first information regarding the incidence of smoking cessation among a population of smokers undergoing a variety of surgical procedures and is consistent with these previous studies. A major surgery approximately doubled the likelihood of quitting smoking, an effect that was independent of the previously noted effect of major medical diagnosis in multivariate analysis.[6] Only three types of major surgery were analyzed in this study, because information about other types of major surgery is not available in the HRS data. Thus, the effect of all major surgery on smoking cessation rates is likely to be underestimated. Among patients undergoing major surgery, it seems that those patients undergoing surgery for diseases clearly related to smoking (cancer and heart disease) were more likely to quit than those having joint replacement surgery (an indication not obviously related to smoking). Rates associated with more minor outpatient procedures were lower, although having an outpatient surgery was still independently associated with a 28% increase in smoking cessation rate. These data are consistent with the concept that the intensity of the surgical intervention is correlated with its power as a teachable moment.[9–11]

With this incidence information obtained in a sample from the U.S. population, we explored the effect of surgery as a teachable moment on smoking in the population as the estimated number of quit events in smokers aged 45 yr and older in the United States that can be attributed to smokers undergoing one of the four surgical procedures examined (table 3). We can further estimate what proportion this represents of the total quit events in the U.S. population. The 2000 U.S. census indicates that there were 96,944,389 U.S. residents aged 45 yr and older. Using the population smoking prevalence estimate calculated from the HRS data (20.6%), there are then 19,970,544 smokers aged 45 yr and older. The HRS data indicate that the annual incidence of cessation in the overall population is 6.3%, so that 1,252,153 quit each year. Thus, in the U.S. population aged 45 yr and older, we estimate that 8.0% of all quit events (103,137/1,252,153) can be attributed to smokers undergoing one of the four types of surgical procedures. If all surgical procedures were available for analysis, this proportion would be higher. This evidence suggests that surgery as a teachable moment has a major impact on smoking cessation in the United States. Most of the impact is produced by outpatient surgery, which has a more modest effect on incidence, but is highly used by the population. We emphasize that there are inherent limitations of both the HRS and Healthcare Cost and Utilization Project datasets, so that these data indeed provide only an estimate.

This study has several other limitations. First, an inherent limitation of the HRS dataset is that it relies on self-reported health events and smoking status, although studies suggest that self-reported smoking status is usually reliable.[32] Second, information is not available on the exact dates of both health events such as surgery and the quit event. Rather, it can be known only that both the surgery and the quit event took place at the same 2-yr interval. Thus, it is possible that in some patients cessation was not directly related to the surgery itself. Third, only four categories of surgical procedures were available for analysis, so that the total impact of all surgical procedures on incidence is underestimated. Fourth, the HRS enrolled adults older than 50 yr, so that these results may not reflect those in younger patients. Fifth, smoking cessation was defined as a single quit event, meaning that those who reported no current smoking no longer received a followed up after this assessment. However, they could have resumed smoking. Further analysis showed that 574 individuals (24% of those who reported quitting) indeed resumed smoking after their initial quitting event (*i.e.*, reported status as current smoker in subsequent assessment). Women were more likely to relapse compared with men, which has also been reported in other studies (data not shown).[33,34] Relapse rates were similar in those who did and did not undergo surgery. If participants who reported relapse were excluded from analysis, the overall incidence of quitting was 5.15/100 person-years. However, excluding these patients from the multivariate analysis had very little effect on the results (data not shown). Sixth, other confounding variables not analyzed could also affect the incidence of smoking cessation. We did not conduct an exhaustive search for such variables but included in the model basic demographic variables and new medical diagnosis, shown to be a strong independent predictor of cessation in previous work using the HRS dataset.[6] Seventh, some patients may have received tobacco interventions, so that likely not all quit events were spontaneous. Current evidence suggests that very few surgical patients receive tobacco interventions in the United States.[35] Nonetheless, rehabilitation programs after cardiac surgery commonly include tobacco interventions, which may have contributed to the higher rates of cessation observed in this group. Finally, this analysis does not suggest which element of the surgical experience may increase the likelihood of quitting. For example, the greater numbers of preoperative and postoperative visits, which may be associated with major inpatient surgery compared with minor surgery, provide more opportunities for healthcare professionals to provide stop smoking messages.

In conclusion, undergoing surgery is associated with an increased likelihood of smoking cessation in the older U.S. population. Cessation is more likely in association with more major procedures compared with outpatient surgery. These data support the concept that surgery is a teachable moment for smoking cessation. In addition to beneficial effects on long-term health, smoking cessation also has immediate benefits to surgical patients by reducing the risk of perioperative complications.[36–39] Although few surgical patients currently receive tobacco interventions,[35] the evident power of the surgery as a teachable moment suggests that this is an opportune time to intervene and further increases cessation rates.

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