Smoking, Surgery, and Venous Thromboembolism Risk in Women:

UK Cohort Study

Running title: Sweetland et al.; Smoking, surgery, venous thromboembolism

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Abstract:

**Background**—Evidence about the effect of smoking on venous thromboembolism risk, generally and in the post-operative period, is limited and inconsistent. We examined the incidence of venous thromboembolism in relation to smoking habits, both in the absence of surgery and in the first 12 post-operative weeks in a large prospective study of UK women.

**Methods and Results**—During 6 years’ follow-up of 1,162,718 women, mean age 56 years, 4630 were admitted to hospital for or died from venous thromboembolism. In the absence of surgery, current smokers had a significantly increased incidence of venous thromboembolism compared to never smokers (adjusted relative risk [RR]=1.38 [95% confidence interval 1.28-1.48]), with significantly greater risks in heavier than lighter smokers (RRs 1.47 [1.34-1.62] and 1.29 [1.17-1.42] for 15+ versus <15 cigarettes/day). Current smokers were also more likely to have surgery than never smokers (1.12 [1.12-1.13]). Among women who had surgery, the incidence of venous thromboembolism in the first 12 post-operative weeks was significantly greater in current than never smokers (1.16 [1.02-1.30]).

**Conclusions**—Venous thromboembolism incidence was increased in current smokers, both in the absence of surgery and in the 12 weeks following surgery. Smoking is another factor to consider when assessing venous thromboembolism risk in patients undergoing surgery.

**Key words**: smoking, surgery, deep vein thrombosis, pulmonary embolism, cohort study
Introduction

Venous thromboembolism (deep vein thrombosis and/or pulmonary embolism) is the third most common vascular disease\textsuperscript{1} and causes large numbers of potentially avoidable deaths.\textsuperscript{2} The incidence of venous thromboembolism increases considerably in the first 12 weeks following surgery,\textsuperscript{3} with a greater incidence in overweight and obese than in lean patients.\textsuperscript{4} Smoking is a well-established risk factor for arterial thrombosis,\textsuperscript{5} but the evidence for its role in venous thrombosis is inconsistent, with some reporting a higher risk in current than never smokers\textsuperscript{6-11} and others reporting no difference in risk.\textsuperscript{12-17} Moreover, few studies have reported on the association between smoking and post-operative venous thromboembolism risk and those that did have found inconclusive results.\textsuperscript{18-22}

In a large prospective study, the Million Women Study, we linked women’s reported smoking history with hospital admission and death records. The aim was to investigate the relationship between smoking and venous thromboembolism risk in the absence of surgery and in the first 12 weeks following surgery. We also examined whether smokers were more likely to undergo surgery than never smokers, as might be expected (given the established relationships between smoking and conditions such as cancer and cardiovascular disease).\textsuperscript{5}

Methods

Study Population

The Million Women Study has been described in detail elsewhere.\textsuperscript{3, 23} In brief, this prospective cohort study recruited 1.3 million women through the National Health Service (NHS) Breast Screening Programme in England and Scotland between 1996 and 2001, by sending out a recruitment questionnaire (available at www.millionwomenstudy.org) which asked about
smoking status and amount currently smoked, as well as use of hormone replacement therapy, height and weight, physical activity, alcohol consumption, medical and reproductive history, use of oral contraceptives, education and other factors.

All study participants are followed up through linkage to NHS Central Registers for deaths, cancer registrations and emigrations. Additionally, each woman’s unique NHS identification number, together with other personal information, was used to link to cause-specific information on NHS hospital admission databases (including inpatient (i.e. overnight) and day-case (i.e. not overnight) admissions): Hospital Episodes Statistics for England, and Scottish Morbidity Records in Scotland. Information on the date of admission and discharge and on diagnoses and procedures associated with each hospital admission were provided, coded to the World Health Organization’s International Classification of Diseases, 10th revision (ICD-10) for diagnoses and the Office of Population Censuses and Surveys Classification of Surgical Operations and Procedures, fourth revision (OPCS-4) for procedures.

Women were classified as having a venous thromboembolism event if they had either a hospital admission record or death registration with an ICD code as listed in the Appendix. Women were classed as never, past or current smokers as reported at recruitment; current smokers were further classified according to the average number (<15, 15+) of cigarettes smoked per day. Women were classified as having had surgery during follow-up if the hospital data included one or more operative codes (see Appendix for non-operative OPCS-4 codes excluded from this definition).

**Statistical Analysis**

Women were excluded from the analyses if they reported a history of blood clots or treatment for clotting problems at recruitment; or if, before recruitment, they had a hospital admission for
venous thromboembolism (see Appendix), had surgery in the previous 12 weeks, or had a previous cancer registration (excluding non-melanoma skin cancer); or if they had no smoking information at recruitment.

Relative risks of undergoing surgery during follow-up, and of a venous thromboembolism admission or death (as an inpatient or in the community) according to smoking status at recruitment were estimated from hazard ratios with use of Cox regression models, with attained age as the underlying time variable. In the model, age was measured in days and was incremented over time during follow-up so that age at each point in time, rather than age at recruitment, was taken into account in the analyses. The proportional hazards assumption was assessed by using tests based on Schoenfeld residuals; no evidence of a violation of the assumption was found for any of the analyses. All analyses were adjusted for region of recruitment (10 regions), socioeconomic group (quintiles of Townsend deprivation index), frequency of strenuous exercise (rarely/never, ≤once a week, >once a week), use of hormone replacement therapy (never, past, current), body mass index (<25, 25-29, 30-34, 35+ kg/m²), weekly alcohol consumption (<7, 7-<14, 14+ units), history of hypertension, and history of diabetes, as reported at recruitment. For each adjustment variable, an “unknown” category was created to deal with missing values (data missing for ≤5% women per covariate).

The association between smoking and the risk of venous thromboembolism was explored separately in two circumstances: in the absence of surgery and post-operatively in the first 12 weeks after surgery, as described in our previous paper. In the analyses relating to time without surgery, women were followed from their date of recruitment (or from 1st April 1997 for the 5% of women recruited in England in the year before the Hospital Episode Statistics data were available), and censored at the earliest of the following: any day or inpatient surgery; cancer
registration; emigration, death or other loss to follow-up in the NHS Central Registers; or the end of hospital record follow-up (the latest date for which complete hospital discharge data were available – 31st March 2008 in England and 31st December 2008 in Scotland). In the analyses relating to the post-operative period, women who had at least one operation during follow-up were followed from the date of the first recorded surgery and censored at the earliest of the following: emigration, death, or other loss to follow-up; the end of hospital record follow-up; or 12 weeks since the first surgery. Operations were classified as day surgery (if admitted and discharged on same day) or inpatient surgery (at least one overnight stay).

STATA version 11.1 was used for all analyses.

Ethical Approval

The Million Women Study has been approved by the Cambridge South Research Ethics Committee (formerly Oxford and Anglia Multi-Centre Research Ethics Committee) and is sponsored by the University of Oxford. Access and linkage to hospital records was approved by the Information Centre for Health and Social Care in England and the Information and Statistics Division of the NHS in Scotland. All participants gave written consent for inclusion and follow-up.

Results

A total of 1,162,718 women were included in this study after excluding 129,274 with previous venous thromboembolism, clotting disorder, cancer, surgery in the 12 weeks before recruitment or loss to NHS follow-up before study entry, and 72,282 who did not report smoking information at recruitment. Table 1 shows the characteristics of these women in relation to smoking status and amount smoked at recruitment. The mean age at recruitment was 56.1 years. Half the
cohort had never smoked (51%), whilst 28% were past smokers and 20% were current smokers at recruitment, with similar proportions smoking <15 and 15+ cigarettes per day. The proportion of women in the lowest socioeconomic tertile increased from 27% in never smokers to 51% in current heavy smokers. Smokers (past and current) were more likely to be current users of hormone replacement therapy than never smokers, but current smokers were less likely to exercise regularly or to have a history of hypertension at recruitment.

During 7.28 million person-years of follow-up in the absence of surgery (an average of 6 years of follow-up per woman), 4630 women had a hospital admission with, or died from, venous thromboembolism. Overall 636,549 women underwent at least one operation during follow-up and 1852 of these were diagnosed with venous thromboembolism within the first 12 weeks after surgery. The operation was done as day surgery for 364,482 women, of whom 235 had post-operative venous thromboembolism, and as inpatient surgery for 271,300 women, of whom 1617 had post-operative venous thromboembolism. For a very small number (767) the type of operation was unknown and no venous thrombosis occurred among them in the 12 weeks after surgery. The most common types of surgery (classified as described previously) were for gastrointestinal (23%), orthopaedic (13%), gynaecological (9%), cancer (8%) or vascular disease (7%) – each of these conditions was associated with an increased risk of venous thromboembolism in the first 12 post-operative weeks.

Table 2 shows the analyses for risk of venous thromboembolism by smoking status in the absence of surgery. There was a small increase in the risk of venous thromboembolism in past compared to never smokers (relative risk (RR) 1.08 [95% CI 1.01-1.16]). Current smokers had about a 40% greater incidence of venous thromboembolism than never smokers (1.38 [95% CI 1.28-1.48]). Dividing current smokers by amount smoked suggested that heavier smokers (15+...
cigarettes per day) were more likely to develop venous thromboembolism than lighter smokers (RRs 1.47 [1.34-1.62] and 1.29 [1.17-1.42]; \( P_{\text{heterogeneity}} = 0.03 \)). 2054 of the 4630 women with venous thromboembolism were diagnosed with pulmonary embolism (with or without deep vein thrombosis), whilst the remaining 2576 cases were diagnosed with deep vein thrombosis alone; similar patterns of increased risk for current smokers were seen for each of these two subgroups (Table 2).

We also investigated the relative risk of being admitted to hospital for surgery in relation to smoking status, and the effect of smoking status on the risk of venous thromboembolism in the first 12 weeks after an operation (Table 3). There was a significantly increased relative risk of surgery for both past and current smokers compared to never smokers (RRs 1.12 [95% CI 1.12-1.13] for both categories), with heavier smokers having a significantly greater increased relative risk than lighter smokers (RRs 1.15 [1.14-1.16] and 1.10 [1.09-1.11] respectively; \( P_{\text{heterogeneity}} < 0.0001 \)). Among women who underwent surgery, those who were current smokers at recruitment were more likely to be diagnosed with venous thromboembolism in the first 12 weeks after surgery than never smokers (RR 1.16 [1.02-1.30]), with a suggestion of increasing risk with increasing amount smoked for current smokers, although this difference is not statistically significant (RRs 1.10 [0.94-1.29] and 1.21 [1.04-1.41] for <15 and 15+ cigarettes per day respectively; \( P_{\text{heterogeneity}} = 0.4 \)). The relative risks of venous thromboembolism for current compared to never smokers after day case and inpatient surgery separately were similar to the overall relative risk for current smokers after any type of surgery, although there were fewer cases and these risks were not statistically significantly increased (RRs 0.94 [0.65-1.35] and 1.11 [0.98-1.26] for day case and inpatient surgery respectively).
Discussion

In this large prospective study of middle-aged women in the United Kingdom, we found that current smokers had about a 40% greater risk of a hospital admission with, or death from, venous thromboembolism than never smokers (adjusted RR 1.38 [95% CI 1.28-1.48]). Moreover, venous thromboembolism incidence was greater in heavier than lighter smokers. We also found that current smokers were more likely to be admitted to hospital for surgery than never smokers, and were more likely to develop post-operative venous thromboembolism than never smokers.

Findings in relation to previous studies

Our finding that women who smoke are at an increased risk of venous thromboembolism is consistent with some, but not all, previous studies. A 2008 meta-analysis found no overall effect of smoking on venous thromboembolism risk in men and women combined (odds ratio, 1.15 [95% CI 0.92 1.44]), however there was significant heterogeneity by study and the relationship by amount smoked was not examined. Subsequent reports from cohort studies involving women are mixed: the Iowa Women’s Health Study found an increased risk of venous thromboembolism in smokers only for those with cancer; conversely, results from three other cohort studies are consistent with our findings, although these investigations had limited power to detect an association. A recent report from a large population-based case-control study also noted a relationship between smoking and venous thromboembolism in women: the odds ratio for current versus never smokers was 1.55 (95% CI 1.33–1.82).

Our study is the first to explore the relationship between smoking and the risk of post-operative venous thromboembolism in women. Moreover, the few investigations which have examined the independent effects of smoking on venous thromboembolism following surgery involved far fewer patients than the present study and smoking was not the key exposure of
interest. In these studies, no association was observed following elective hip replacement, hip or knee arthroplasty, colorectal surgery, or outpatient surgery.

Our observation that current and past smokers were more likely to undergo surgery during follow-up than never smokers was not unexpected, given that smoking increases the risk of conditions, such as cancer and cardiovascular disease, which are frequently treated surgically. However, to our knowledge, the relationship has not been directly explored previously.

The biological mechanism by which smoking might increase the risk of venous thromboembolism has not been confirmed, however it has been postulated that activation of monocytes, granulocytes, and endothelial inflammation is the likely mechanism.

The relationship between smoking and venous thromboembolism is important. First, despite a general downward trend of smoking prevalence among women in many high-income countries, smoking is still relatively common. Second, it has been reported that smoking interacts with other inherited and acquired risk factors for venous thromboembolism, including thrombophilic mutations, oral contraceptive use, and pregnancy.

Strengths and limitations
This study has several strengths, including the large number of participants and the linkage of questionnaire data with hospital admission, cancer registration, and death and emigration records. The linked data permitted the exclusion of women with a history of venous thromboembolism, cancer, or recent surgery at recruitment; provided information on a broad range of potential confounders; and ensured virtually complete follow-up for both hospital admission and deaths. As discussed previously, high accuracy rates have been reported for the coding of diagnoses and operations in NHS admissions data, the linkage between NHS data sets, and the identification of Million Women Study participants within those data sets. In addition,
an underlying cause of death was recorded for 99.9% of cohort members who died during follow-up. Only 6% of eligible women did not provide information about smoking at recruitment and their exclusion from the study is unlikely to explain our findings.

There are several aspects of this study which merit further consideration. The large majority of women with pulmonary embolism would have been admitted to hospital, but some with venous thrombosis alone may not have been (currently available NHS databases do not permit reliable estimation of how frequent this is) Smoking-associated relative risks are similar for women with and without pulmonary embolism, so our conclusions are unlikely to be altered by some women with venous thrombosis not having been admitted to hospital. Smoking-associated relative risks are similar for women with and without pulmonary embolism, so our conclusions are unlikely to be altered by some with venous thrombosis not having been admitted to hospital. Smoking status was based on self-report at recruitment, which if anything, would result in underestimation of the risk of venous thromboembolism in current smokers. Validation studies show that self-report of smoking is reliable39 40, but the prevalence of smoking in this cohort has decreased substantially over the study period, causing smoking-related risks to be underestimated.41

As in our previous investigation,4 in this analysis we were able to minimize the potential for confounding by major risk factors for venous thromboembolism: women with a history of venous thromboembolism, cancer, or recent surgery at recruitment were excluded, age was accounted for, and we adjusted for body mass index, hormone replacement therapy, physical activity, hypertension, diabetes, alcohol consumption, socioeconomic group, and region of recruitment; in the absence of surgery analysis, follow-up was censored at any cancer diagnosis or surgery (which included procedures to treat fractures and other trauma); and oral
contraceptive use and pregnancy are improbable exposures in our study of middle-aged women. We cannot, of course, exclude the possibility that there are unmeasured confounders.

Study participants were not tested for inherited prothrombotic mutations, however there is no reason to suppose that smokers are more likely to have thrombophilic disorders than never smokers; indeed, the observation that venous thromboembolism risk was only marginally increased in past smokers argues against confounding by thrombophilia status as an explanation for our findings of a higher risk of venous thromboembolism in current smokers.

We were able to adjust for physical activity at recruitment and censor follow-up at surgery, but we had no information about other periods of immobility during follow-up. Nor did we have information about the use of post-operative anticoagulation, however in order to explain the excess risk of post-operative venous thromboembolism in current smokers, never smokers would need to have been preferentially treated with anticoagulants. This seems unlikely, especially since never smokers had a similar mean body mass index to smokers, and were more physically active and less likely to take hormone replacement therapy than smokers.

Our exploration of the relationship between smoking and venous thromboembolism was restricted to women. As with the investigations which provided results for women, cohort studies which included men have produced inconsistent findings.\textsuperscript{10-11, 15-17}

Implications

Our finding of a higher risk of venous thromboembolism in current smokers reinforces the importance of tobacco control strategies and their vital role in the prevention of disease and premature mortality. While the 40\% increase in venous thromboembolism incidence in smokers found here is not as great as the smoking-related increases in arterial diseases,\textsuperscript{42} in 2009 about 20\% of UK women aged 50 – 59 years were smokers.\textsuperscript{41} Hence a considerable proportion of
venous thromboembolic events in women could be attributed to smoking. Our results also highlight the benefits of smoking cessation, as the risk of venous thromboembolism in past smokers was only marginally higher than that of never smokers. Current clinical guidelines do not specify smoking as an additional risk factor for post-operative venous thromboembolism.43–46 Our findings suggest that smoking might also be considered when assessing venous thromboembolism risk in patients undergoing surgery.

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Conflict of Interest Disclosures: Valerie Beral is the Principal Investigator of the Million Women Study (Research Grant ≥ $10,000).

Million Women Study Collaborators: Steering Committee: Emily Banks, Valerie Beral, Ruth English, Jane Green, Julietta Patnick, Richard Peto, Gillian Reeves, Martin Vessey and Matthew Wallis. Million Women Study Coordinating Centre Staff: Simon Abbott, Naomi Allen, Miranda Armstrong, Angela Balkwill, Emily Banks, Vicky Benson, Valerie Beral, Judith Black, Anna Brown, Diana Bull, Benjamin Cairns, Kathy Callaghan, Karen Canfell, Dexter Canoy, James Chivenga, Barbara Crossley, Francesca Crowe, Dave Ewart, Sarah Ewart, Lee Fletcher, Toral Gathani, Laura Gerrard, Adrian Goodill, Jane Green, Lynden Guiver, Elizabeth Hilton, Michal Hozak, Sau Wan Kan, Carol Keene, Oksana Kirichek, Mary Kroll, Nicky Langston, Isobel Lingard, Bette Liu, Maria-Jose Luque, Lynn Pank, Kirstin Pirie, Gillian Reeves, Andrew Roddam, Keith Shaw, Emma Sherman, Evie Sherry-Starmer, Helena Strange, Siân Sweetland, Alison Timadjer, Sarah Tipper, Ruth Travis, Xiaosi Wang, Joanna Watson, Lucy Wright, Tienyu Yang, Heather Young. NHS Breast Screening Centres collaborating in the Million Women Study: Avon, Aylesbury, Barnsley, Basingstoke, Bedfordshire and Hertfordshire, Cambridge and Huntingdon, Chelmsford and Colchester, Chester, Cornwall, Crewe, Cumbria, Doncaster, Dorset, East Berkshire, East Cheshire, East Devon, East of Scotland, East Suffolk, East Sussex,

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Table 1. Baseline characteristics and follow-up of women included in the analyses, by smoking status at recruitment.

<table>
<thead>
<tr>
<th>Characteristics and Follow-Up</th>
<th>All women (n=1 162 718)</th>
<th>Smoking status (cigarettes/day) at recruitment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All women</td>
<td>Never (n=596 860)</td>
</tr>
<tr>
<td><strong>Baseline characteristics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, y, mean (SD)</td>
<td>56.1 (4.8)</td>
<td>56.3 (4.9)</td>
</tr>
<tr>
<td>Body mass index, kg/m², mean (SD)</td>
<td>26.1 (4.6)</td>
<td>26.1 (4.6)</td>
</tr>
<tr>
<td>Alcohol consumption, units/wk, mean (SD)</td>
<td>4.2 (5.3)</td>
<td>3.5 (4.6)</td>
</tr>
<tr>
<td>Lowest socioeconomic tertile, %</td>
<td>32.8</td>
<td>27.2</td>
</tr>
<tr>
<td>Current user of hormone replacement therapy, %</td>
<td>34.0</td>
<td>31.4</td>
</tr>
<tr>
<td>Strenuous physical activity &gt;1 time per week, %</td>
<td>21.1</td>
<td>21.8</td>
</tr>
<tr>
<td>History of diabetes, %</td>
<td>2.6</td>
<td>2.4</td>
</tr>
<tr>
<td>History of hypertension, %</td>
<td>23.9</td>
<td>24.8</td>
</tr>
<tr>
<td><strong>Follow-up: without surgery</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of women</td>
<td>1 162 718</td>
<td>596 860</td>
</tr>
<tr>
<td>Person-years of follow-up</td>
<td>7 282 214</td>
<td>3 849 413</td>
</tr>
<tr>
<td>No. of incident venous thromboembolism cases</td>
<td>4630</td>
<td>2226</td>
</tr>
<tr>
<td><strong>Follow-up: after surgery</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of women with ≥1 hospital admissions for surgery</td>
<td>636 549</td>
<td>313 466</td>
</tr>
<tr>
<td>Person-years of follow-up during 12 wks after first operation</td>
<td>144 438</td>
<td>71 189</td>
</tr>
<tr>
<td>No. of incident venous thromboembolism cases during 12 wks after first operation</td>
<td>1852</td>
<td>893</td>
</tr>
</tbody>
</table>

Includes person-years at risk and incident cases for women who did not have surgery during the entire follow-up period and person-years and incident cases before the first operation for women who had surgery.
Table 2. In the Absence of Surgery, Adjusted Relative Risks by Smoking Status of Hospital Admission With, or Death From, Venous Thromboembolism (and Separately for Pulmonary Embolism and for Venous Thrombosis Without Pulmonary Embolism).

<table>
<thead>
<tr>
<th>Smoking Status</th>
<th>Venous thromboembolism*</th>
<th>Venous thrombosis with pulmonary embolism†</th>
<th>Venous thrombosis without pulmonary embolism</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of cases</td>
<td>Adjusted Relative Risks (95% CI)</td>
<td>No. of cases</td>
</tr>
<tr>
<td>Never</td>
<td>2226</td>
<td>1.00</td>
<td>977</td>
</tr>
<tr>
<td>Past</td>
<td>1296</td>
<td>1.08 (1.01-1.16)</td>
<td>576</td>
</tr>
<tr>
<td>Current</td>
<td>1108</td>
<td>1.38 (1.28-1.48)</td>
<td>501</td>
</tr>
<tr>
<td>Current &lt;15 cigarettes per day</td>
<td>531</td>
<td>1.29 (1.17-1.42)</td>
<td>243</td>
</tr>
<tr>
<td>Current 15+ cigarettes per day</td>
<td>577</td>
<td>1.47 (1.34-1.62)</td>
<td>258</td>
</tr>
</tbody>
</table>

Population at risk = 1,162,718 women. Relative risks are adjusted for region of recruitment, socioeconomic group, age, frequency of strenuous exercise, use of hormone replacement therapy, body mass index, alcohol consumption, history of hypertension, and history of diabetes.

* Diagnosis of deep vein thrombosis and/or pulmonary embolism.
† Pulmonary embolism with or without a recorded diagnosis of concurrent deep vein thrombosis.

Table 3. Relative Risks of Hospital Admission for Surgery During Follow-Up, by Smoking Status; and, Among Women Admitted to Hospital, Relative Risks of Subsequent Hospital Admission With, or Death From, Venous Thromboembolism in the 12 weeks Following Surgery, by Smoking Status.

<table>
<thead>
<tr>
<th>Smoking Status</th>
<th>Relative Risk of Hospital Admission for Surgery During Follow-Up</th>
<th>Relative Risk of Venous Thromboembolism in 12 wk Period Following Surgery*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Population at Risk (n=1,162,718)</td>
<td>No. of Women Admitted for Surgery (n=636,549)</td>
</tr>
<tr>
<td>Never</td>
<td>596,860</td>
<td>313,466</td>
</tr>
<tr>
<td>Past</td>
<td>327,839</td>
<td>187,031</td>
</tr>
<tr>
<td>Current</td>
<td>238,019</td>
<td>136,052</td>
</tr>
<tr>
<td>Current &lt;15 cigarettes per day</td>
<td>122,214</td>
<td>68,320</td>
</tr>
<tr>
<td>Current 15+ cigarettes per day</td>
<td>115,805</td>
<td>67,732</td>
</tr>
</tbody>
</table>

Relative risks are adjusted for region of recruitment, socioeconomic group, age, frequency of strenuous exercise, use of hormone replacement therapy, body mass index, alcohol consumption, history of hypertension, and history of diabetes.

* Diagnosis of deep vein thrombosis and/or pulmonary embolism.
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SUPPLEMENTAL MATERIAL

Sweetland et al.; Smoking, Surgery, Venous Thromboembolism

Appendix

ICD codes used to identify venous thromboembolism before study entry and during follow-up:
ICD-9: 415.1, 451, 452, 453, 997.2, 671.3, 671.4, 671.9, 673.2, 634.6, 635.6, 636.6, 637.6, 638.6, and 639.6.
ICD-10: I26, I80, I81, I82, I97.8, I97.9, O22.3, O22.9, O87.1, O87.9, O88.2, O08.7, O08.2.

OPCS-4 codes excluded from definition of surgery:
All U codes, X28-X39, X44, X48-X58, X60-X62, X66, X70-X97