Incidence of Diagnosed Deep Vein Thrombosis in the General Population: Systematic Review

F. J. I. Fowkes, J. F. Price and F. G. R. Fowkes*

Wolfson Unit for Prevention of Peripheral Vascular Diseases, Public Health Sciences, University of Edinburgh, Teviot Place, Edinburgh EH8 9AG, Scotland

Objective: to determine the incidence of deep vein thrombosis (DVT) in the general population by pooling results from all studies of adequate quality.

Design: systematic review including meta-analysis.

Material and Methods: MEDLINE (1966–2001) and EMBASE (1950–2001) were searched for studies on the incidence of DVT and thromboembolism in the general population. Studies had to attain minimum inclusion and quality criteria to be accepted for the review, including adequate specification of the diagnosis of DVT and the age range of the population. The appraisal of studies for inclusion and abstraction of data were carried out independently by each author. Incidence rates were adjusted to standardise for differences between studies in categories of DVT and population age structures. Weighted and unweighted means of incidence per 10 000 person years were estimated.

Results: nine studies were identified which fulfilled the inclusion and quality criteria. Most were conducted in Sweden or U.S.A. between 1976 and 2000. The weighted mean incidence of first DVT in the whole general population was 5.04 (95% CI 4.70, 5.38) per 10 000 person years. The incidence was similar in males and females and increased dramatically with age from about 2–3 per 10 000 person years at age 30–49 to 20 per 10 000 person years at age 70–79. Around 40% of cases of DVT were idiopathic.

Conclusion: this study provides the most comprehensive estimate to date of the incidence of DVT in the whole general population – around 5 per 10 000 per annum – and is a useful background figure for comparison with incidence in high risk groups.

Key Words: Incidence; Deep vein thrombosis; Population; Systematic review.

Introduction

Recent medical and public interest in the risks of deep vein thrombosis (DVT) associated with long distance air travel has highlighted the need for more accurate data on the incidence in travellers. In the general population, the incidence of traveller related venous thromboembolism was estimated to be around 0.4 to 3 per 10 000 population per annum and the incidence of DVT associated with flying to be about 1 to 2.5 per 10 000 travellers. These figures were however estimated and greater precision is required.

In calculating the size of an increased risk among travellers, the incidence among a non travelling comparable group is required. Knowledge of the background risk in the general population is also helpful in putting travel associated risks in context. Reviews of the epidemiology of venous thromboembolism have emphasised the importance of general population surveys in providing a true picture of the occurrence of disease in the community. But, since DVT cannot be diagnosed solely by history and physical examination alone and requires specialist investigation, incidence cannot be measured easily in such population surveys. Most of the evidence on incidence is available from the detection of cases diagnosed in health care facilities serving a defined population. We performed a systematic review of relevant studies in order to provide a comprehensive estimate of the incidence of DVT in the general population.

Material and Methods

MEDLINE (1966–2001) and EMBASE (1950–2001) were searched for studies on the incidence of
DVT and thromboembolism. The criterion for inclusion of studies was the reporting of all diagnosed patients with DVT in a defined general population in a developed country. The reference lists of selected papers were searched for further studies. The minimum quality criteria for inclusion in the review were that: DVT diagnoses were confirmed by clinical tests (phlebography, duplex scan) or a satisfactory validation study confirming the accuracy of the diagnoses had been performed; the age range of a defined catchment population was specified; and incidence rates could be estimated per 10 000 person years.

The studies which met the initial inclusion criteria were assessed independently by each of the authors to ascertain that each fulfilled the criteria and furthermore attained the minimum quality criteria for inclusion in the review. The final list of included papers was agreed by discussion. Each author then independently abstracted data from each of the studies and calculated crude incidence rates. The final rates to be included were then agreed by discussion between the authors. Also, all authors confirmed the subsequent calculations by one author (FGRF) of adjusted incidence rates as described below. Mean incidence rates were calculated by one author (FJIF) and checked by the others.

The studies were not consistent in their inclusion or exclusion of DVTs which were recurrent, DVTs which were combined with pulmonary embolism, and DVTs due to all causes. The age ranges of the reference populations also differed. These differences would lead to inconsistencies in the crude incidence rates between studies and would not permit meaningful pooling of the incidence rates. We decided to define incidence rates for the purpose of this meta-analysis according to the most frequently reported, that is, only new DVT cases which were not combined with pulmonary embolism, and DVTs due to any cause. We therefore had to make adjustments derived from the published evidence to those incidence rates not defined as above and to those based on restricted age ranges. These adjustments were pre-specified and were not changed following calculation of the adjusted incidence rates. The adjustments comprised: ×0.75 for studies including new and recurrent DVTs because in such studies approximately 75% would be new DVTs, ×0.8 for those including DVTs with pulmonary embolism because in such studies approximately 80% would have a DVT but no detectable pulmonary embolism, and ×2.5 for those including only “idiopathic” DVT because around 40% of all DVTs are “idiopathic”. Age adjustments were based on age specific distributions of incidence detailed in two studies and incidence rates in studies with a restricted age range recalculated for a population of all ages.

In pooling the incidence rates from each study to produce an overall rate, means of the incidence rates were estimated unweighted and weighted by person years of follow up in each study. In the unweighted method, the means were simply added and divided by the number of studies. In the weighted method, each incidence rate was multiplied by the number of person years of observation in the study; this result was then summed for all the studies, and then divided by the sum of the weights.

### Results

The search identified 19 possible studies according to the title of the paper and information in the abstract. On detailed examination of the 19 papers, only 11 fulfilled the initial inclusion criteria. Two of these 11 studies did not meet the additional quality criterion of adequate diagnostic confirmation and were excluded. The remaining nine studies were published between 1976 and 2000 and comprised analyses of DVTs which were identified: (a) in hospitals with defined populations, (b) in national discharge data sets, or (c) in a population cohort study. The characteristics of the studies are shown in Table 1. Most were conducted in Sweden or the U.S.A. The diagnosis of deep vein thrombosis was made in most studies using phlebography or in three studies a satisfactory validation study of discharge diagnoses was performed. This comprised detailed review of samples of medical records confirming that in most cases the discharge diagnosis was correct. In most studies, the population denominator was derived from a census and comprised all age ranges, except for three studies in which the age ranges were restricted.

Table 2 shows that the adjusted incidence rates derived from the nine studies encompassed a narrow range with the incidence in seven studies clustering around 5.0 per 10 000 person years and the remaining two studies having incidences of 8.7 and 9.5 per 10 000 person years. The unweighted mean was 5.97 (95% CI 4.78, 7.16) and the weighted mean was 5.04 (95% CI 4.70, 5.38) per 10 000 person years. This weighted mean was influenced substantially by two studies which were very much larger than the others.

DVT occurred rarely below 20 years of age but, above 20 years, the incidence increased markedly with age. The annual incidence rates by age group were approximately: 2–3 per 10 000 (30–49 years), 5 per 10 000 (50–59 years), 10 per 10 000 (60–69 years), 20 per 10 000 (70–79 years), and 30 per 10 000 (80–89 years).
<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>Location</th>
<th>Cases of deep vein thrombosis</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authors</td>
<td>Cases of deep vein thrombosis</td>
<td>New only or new &amp; recurrent</td>
<td>Pulmonary embolism included</td>
<td></td>
</tr>
<tr>
<td>Nylander + Ollvera</td>
<td>1976</td>
<td>Malmo, Sweden</td>
<td>1 hospital</td>
<td>Phlebography</td>
</tr>
<tr>
<td>Kierkegaard</td>
<td>1980</td>
<td>2 districts, Sweden</td>
<td>1 hospital</td>
<td>Phlebography</td>
</tr>
<tr>
<td>Anderson et al.</td>
<td>1991</td>
<td>Worcester, U.S.A.</td>
<td>16 hospitals</td>
<td>Case record diagnosis; validation study</td>
</tr>
<tr>
<td>Nordström et al.</td>
<td>1992</td>
<td>Malmo, Sweden</td>
<td>1 hospital</td>
<td>Phlebography</td>
</tr>
<tr>
<td>Kniffen et al.</td>
<td>1994</td>
<td>U.S.A.</td>
<td>Insurance claims (Medicare)</td>
<td>Discharge diagnosis; validation study</td>
</tr>
<tr>
<td>Hansson et al.</td>
<td>1997</td>
<td>Goteburg, Sweden</td>
<td>Repeated clinical exams of cohort</td>
<td>Discharge diagnosis + phlebography or anticoagulants</td>
</tr>
<tr>
<td>White et al.</td>
<td>1998</td>
<td>California, U.S.A.</td>
<td>Discharge data set</td>
<td>Discharge diagnosis; validation study</td>
</tr>
<tr>
<td>Silverstein et al.</td>
<td>1998</td>
<td>Olmsted Co., U.S.A.</td>
<td>1 hospital</td>
<td>Data set diagnosis + medical record with confirmatory criteria</td>
</tr>
<tr>
<td>Oger</td>
<td>2000</td>
<td>Brest, France</td>
<td>3 hospitals + specialist referrals</td>
<td>Phlebography or duplex</td>
</tr>
</tbody>
</table>

* Information derived from study methods but not stated precisely in paper.
The incidence was similar in males and females as indicated by the male:female ratios (Table 2); there was some suggestion of a higher rate in women than in men during the reproductive years which was reversed after the menopause\(^6,9,14,15\) but this was not a consistent finding.\(^8,14,15\) The causes of DVT were attributed mostly to cancer or previous hospitalisation (around one quarter to one third of causes in each case\(^8-10\)), and around 40% were idiopathic.\(^9,10\)

### Discussion

This systematic review provides the best available evidence of the incidence of newly diagnosed DVT in the general population (but does not include individuals with asymptomatic DVT or those with symptoms who were not investigated). Newly diagnosed DVT appears to occur in around 5 per 10,000 of the whole population per annum (i.e. 1 per 2000) of whom 2 per 10,000 are idiopathic. An additional 1–2 per 10,000 have a new DVT combined with pulmonary embolism. The incidence of DVT is very strongly age related and in the population as a whole is comparable in men and women.

The increased risks of DVT within subgroups of the general population may be substantial. For example, in a population based study in the U.S.A.,\(^4\) institutionalisation was associated with an 8 fold increase in risk of DVT or pulmonary embolism, and this rose to 22 fold if accompanied by surgery. Trauma was associated with a 13-fold increase and malignancy with a 5-fold increase in risk. The relative risks of thromboembolism among women using oral contraceptives or hormone replacement therapy is around 2–4 compared to non-users.\(^10,19\) Inherited or acquired thrombophilia, such as those associated with activated protein C resistance and Factor V Leiden mutation, may increase risk very substantially such that it has been suggested that “an acquired or familial thrombophilia may underlie all episodes of venous thromboembolism”.\(^4\)

In estimating the typical background incidence in a group of individuals exposed to a potentially high risk situation, such as prolonged air travel, consideration must be given to the age distribution of the group and the presence of other risk factors such as thrombophilia, malignancy and recent hospitalisation. The same diagnostic category of DVT and an appropriate comparison population must be used. These methodological requirements are not always followed. For example, in a recent report of the risk of thromboembolism in airline pilots,\(^20\) the diagnostic category was not defined and the incidence in the pilots was compared with that in only one small population study in Sweden.\(^6\) While this present systematic review provides useful summary data which can be used for approximate comparison purposes, the increased risks in long distance air travellers can only be estimated with precision by means of studies using properly matched control groups.

### References


---

### Table 2. Incidence of newly diagnosed deep vein thrombosis in the total general population.

<table>
<thead>
<tr>
<th>Author</th>
<th>Cases of deep vein thrombosis (DVT)</th>
<th>Population size</th>
<th>Crude incidence of DVT per 10000 person years</th>
<th>Adjusted incidence(^a) of DVT per 10000 person years (95% CI)</th>
<th>Male:female ratio of incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nylander + Olivecrona(^13)</td>
<td>231</td>
<td>263 144</td>
<td>8.8</td>
<td>5.3 (4.6, 6.0)</td>
<td>1.3 : 1</td>
</tr>
<tr>
<td>Kierkegaard(^14)</td>
<td>344</td>
<td>125 761</td>
<td>7.6</td>
<td>4.6 (4.1, 5.1)</td>
<td>1.3 : 1</td>
</tr>
<tr>
<td>Anderson et al.(^8)</td>
<td>274</td>
<td>379 593</td>
<td>4.8</td>
<td>4.8 (4.2, 5.4)</td>
<td>1.4 : 1</td>
</tr>
<tr>
<td>Nordström et al.(^10)</td>
<td>366</td>
<td>230 835</td>
<td>15.9</td>
<td>9.5 (8.5, 10.5)</td>
<td>1.1 : 1</td>
</tr>
<tr>
<td>Kniffen et al.(^9)</td>
<td>8923</td>
<td>1,650,000</td>
<td>18.0</td>
<td>5.2 (5.1, 5.3)</td>
<td>1.0 : 1</td>
</tr>
<tr>
<td>Hansson et al.(^6)</td>
<td>29</td>
<td>855</td>
<td>13.8</td>
<td>5.8 (5.7, 5.9)</td>
<td>n.a.</td>
</tr>
<tr>
<td>White et al.(^7)</td>
<td>17 991</td>
<td>15,780,000</td>
<td>2.3</td>
<td>4.9 (4.8, 5.0)</td>
<td>n.a.</td>
</tr>
<tr>
<td>Silverstein et al.(^11)</td>
<td>230</td>
<td>469 388</td>
<td>4.9</td>
<td>4.9 (4.3, 5.5)</td>
<td>0.9 : 1</td>
</tr>
<tr>
<td>Oger(^15)</td>
<td>296</td>
<td>342 017</td>
<td>8.7</td>
<td>8.7 (7.7, 9.7)</td>
<td>0.8 : 1</td>
</tr>
</tbody>
</table>

\(^a\) Incidence rates are adjusted to include only DVTs which were new, not combined with pulmonary embolism, due to all causes and for all ages in the population.

n.a. Not available.
Population Incidence of DVT


Accepted 29 August 2002

Eur J Vasc Endovasc Surg Vol 25, January 2003