Patients undergoing trauma surgery are at significant risk for developing thromboembolism. Venous thromboembolism rates, especially after less common surgical procedures are unknown. The purpose of this study is to establish data on the incidence of venous thromboembolism in trauma practice following a surgical procedure.

All surgical trauma procedures between 2006 and 2011 were identified within the Achmea Health Database. This database records medical care to persons insured at the Achmea health insurance company. This is the largest health insurance company in the Netherlands.

In the year following the surgical procedure we analyzed if a claim was filed concerning a deep venous thrombosis or pulmonary embolism.

56,884 surgical trauma procedures were included in the analysis and followed for one year thereafter. Venous thromboembolism development was raised most markedly until 100 days after the surgical procedure. Relatively high incidences of venous thromboembolism were found after surgical lower extremity and pelvic procedures.

The present large database study provides a comprehensive view on the epidemiology of venous thromboembolism after different traumatic injuries requiring a surgical procedure.

Keywords: Trauma surgery ; thromboembolism.

INTRODUCTION

After trauma surgery there is a significant risk for the development of deep vein thrombosis (DVT) and pulmonary embolism (PE) (12,6). PE is the third most common cause of death in patients that survive the first 24 hours after trauma (4,5,11). Furthermore, post-thrombotic syndrome is a long term complication of DVT and accounts for 25% of leg ulcers (10).

The actual risk of venous thromboembolism (VTE) after trauma surgery might be dependent on the fracture type. Although the incidence of VTE after some common fractures such as femoral neck fractures is well documented, little is known about the incidence of VTE after less common fracture types (3,14). Because the trauma itself seems to be a major risk factor for the development of VTE, a better understanding of the risk for VTE after specific fractures can be used to better identify patients that might benefit from thromboprophylaxis. For a reliable estimate of thromboembolic events large numbers of patients are needed. This paper...
aims to establish data on the incidence of venous thromboembolism in the skeletal trauma practice following a surgical procedure from a large population based database.

MATERIALS AND METHODS

The retrospective cohort consisted of 3.7 million persons insured between 2006 and 2012 with ‘Achmea’, the largest health care insurance company in the Netherlands. Every resident of the Netherlands is compulsorily insured. All claims are routinely recorded in a database, the Achmea Health Database. Background information on those insured like age and death are also recorded in the database.

Third parties can request anonymized data for scientific research in accordance with the Dutch privacy legislation.

We identified patients to be eligible based on insurance claims for a surgical procedure related to a fracture, ligament injury, dislocation or other trauma. In the Netherlands these claims are filed according to a national diagnosis-treatment classification (DTC) system based on a combination of the hospital registration of diagnosis (international classification of diseases, 9th revision, clinical modification (ICD-9-CM) codes) and applied therapeutic interventions. Patients were only included if they were insured with Achmea for a 365-day period from surgery. In the year following the fracture we analyzed if a claim was filed concerning a deep venous thrombosis or pulmonary embolism.

Data was retrospectively extracted from the Achmea database to IBM SPSS statistics version 21 (SPSS Inc, Chicago, Illinois, USA) and then analyzed for frequency, percentage and 95% confidence intervals.

RESULTS

56,884 surgical procedures performed between 2006 and 2011 were included in the analysis and followed for 1 year thereafter. (Fig 1) The mean age of the patient was 55 (SD 25.5) years at the time of the procedure. 6815 patients were 17 years and younger.

Fig. 1. — Flow chart of eligible subjects

Fig. 2. — Cumulative percentage VTE in the cohort, in the year after surgery.

Fig. 3. — Venous thrombotic event rate following injury requiring a surgical procedure, injuries are grouped to anatomical region.
Table I. — Venous thrombotic event rates following injury requiring a surgical procedure

<table>
<thead>
<tr>
<th>Injury Description</th>
<th>No. of surgical procedures</th>
<th>No. of VTE (%)</th>
<th>No. of DVT (%)</th>
<th>No. of PE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PELVIS/PROXIMAL FEMUR</td>
<td>17005</td>
<td>149 (0.9;0.8-1.0)</td>
<td>75 (0.4;0.4-0.6)</td>
<td>74 (0.4;0.4-0.6)</td>
</tr>
<tr>
<td>Femur proximal and neck fracture</td>
<td>16653</td>
<td>147 (0.8;0.7-1.0)</td>
<td>74 (0.4;0.3-0.6)</td>
<td>73 (0.4;0.3-0.5)</td>
</tr>
<tr>
<td>Pelvic fracture</td>
<td>242</td>
<td>2 (0.8;0.3-2.0)</td>
<td>1 (0.4;0.4-1.2)</td>
<td>1 (0.4;0.4-1.2)</td>
</tr>
<tr>
<td>Hip traumatic dislocation</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Acetabulum fracture</td>
<td>98</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>FEMUR FRACTURE (DIAPHYSEAL/DISTAL)</td>
<td>2010</td>
<td>21 (0.9;0.5-1.6)</td>
<td>8 (0.4;0.1-0.7)</td>
<td>13 (0.6;0.3-1.0)</td>
</tr>
<tr>
<td>KNEE</td>
<td>2308</td>
<td>29 (1.3;0.9-1.8)</td>
<td>10 (0.4;0.2-0.8)</td>
<td>19 (0.8;0.5-1.3)</td>
</tr>
<tr>
<td>Knee ligament rupture</td>
<td>138</td>
<td>6 (4.3;0.9-7.8)</td>
<td>1 (0.7;0.7-2.2)</td>
<td>5 (3.6;0.5-6.8)</td>
</tr>
<tr>
<td>Patella fracture</td>
<td>670</td>
<td>8 (1.2;0.4-2.0)</td>
<td>1 (0.1;0.1-0.4)</td>
<td>7 (1.0;0.3-1.8)</td>
</tr>
<tr>
<td>Tibial plateau fracture</td>
<td>1334</td>
<td>14 (1.0;0.5-1.6)</td>
<td>7 (0.5;0.1-0.9)</td>
<td>7 (0.5;0.1-0.9)</td>
</tr>
<tr>
<td>Patella dislocation</td>
<td>127</td>
<td>1 (0.8;-0.8-2.4)</td>
<td>1 (0.8;-0.8-2.4)</td>
<td>0</td>
</tr>
<tr>
<td>Knee dislocation</td>
<td>39</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TIBIA (DIAPHYSEAL)</td>
<td>3204</td>
<td>26 (0.8;0.6-1.2)</td>
<td>14 (0.4;0.3-0.7)</td>
<td>12 (0.4;0.2-0.7)</td>
</tr>
<tr>
<td>Tibia fracture</td>
<td>3137</td>
<td>26 (0.8;0.5-1.2)</td>
<td>14 (0.4;0.2-0.7)</td>
<td>12 (0.4;0.2-0.7)</td>
</tr>
<tr>
<td>Fibula fracture</td>
<td>67</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>ANKLE FRACTURE</td>
<td>7300</td>
<td>58 (0.8;0.6-1.0)</td>
<td>35 (0.5;0.3-0.6)</td>
<td>25 (0.3;0.2-0.5)</td>
</tr>
<tr>
<td>FOOT</td>
<td>2517</td>
<td>18 (0.7;0.5-1.1)</td>
<td>15 (0.6;0.4-1.0)</td>
<td>3 (0.1;0.0-0.4)</td>
</tr>
<tr>
<td>Achilles tendon rupture</td>
<td>758</td>
<td>11 (1.5;0.6-2.3)</td>
<td>10 (1.3;0.5-2.1)</td>
<td>1 (0.1;0.1-0.4)</td>
</tr>
<tr>
<td>Tarsus fracture</td>
<td>157</td>
<td>1 (0.6;-0.6-1.9)</td>
<td>1 (0.6;-0.6-1.9)</td>
<td>0</td>
</tr>
<tr>
<td>Phalanx fracture</td>
<td>410</td>
<td>2 (0.5;-0.2-1.2)</td>
<td>1 (0.2;-0.2-0.7)</td>
<td>1 (0.2;-0.2-0.7)</td>
</tr>
<tr>
<td>Metatarsus fracture</td>
<td>628</td>
<td>3 (0.5;-0.0-1.0)</td>
<td>3 (0.5;-0.0-1.0)</td>
<td>0</td>
</tr>
<tr>
<td>Calcaneus fracture</td>
<td>437</td>
<td>1 (0.2;-0.2-0.7)</td>
<td>0</td>
<td>1 (0.2;-0.2-0.7)</td>
</tr>
<tr>
<td>Talus fracture</td>
<td>88</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ankle/Foot Luxation</td>
<td>28</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Toe luxation</td>
<td>11</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>HUMERUS</td>
<td>3573</td>
<td>18 (0.5;0.3-0.8)</td>
<td>8 (0.2;0.1-0.4)</td>
<td>10 (0.3;0.2-0.5)</td>
</tr>
<tr>
<td>Biceps tendon rupture</td>
<td>64</td>
<td>1 (1.6;1.6-4.7)</td>
<td>0</td>
<td>1 (1.6;1.6-4.7)</td>
</tr>
<tr>
<td>Humerus proximal and shaft fracture</td>
<td>3364</td>
<td>17 (0.5;0.3-0.8)</td>
<td>8 (0.2;0.1-0.4)</td>
<td>9 (0.3;0.1-0.4)</td>
</tr>
<tr>
<td>Shoulder luxation</td>
<td>145</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>ELBOW</td>
<td>4558</td>
<td>6 (0.1;0.0-0.3)</td>
<td>6 (0.1;0.0-0.3)</td>
<td>0</td>
</tr>
<tr>
<td>Humerus; distal, (epi)condyle fracture</td>
<td>2014</td>
<td>4 (0.2;0.0-0.4)</td>
<td>4 (0.2;0.0-0.4)</td>
<td>0</td>
</tr>
<tr>
<td>Olecranon fracture</td>
<td>1777</td>
<td>2 (0.1;0.0-0.2)</td>
<td>2 (0.1;0.0-0.2)</td>
<td>0</td>
</tr>
<tr>
<td>Radial head fracture</td>
<td>715</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Elbow luxation</td>
<td>52</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
The present large database study provides a comprehensive view on the epidemiology of VTE after different traumatic injuries requiring a surgical procedure. We found the largest risk for the development of VTE after trauma to the pelvis, spine and lower extremity. The relatively high risk occurs despite many of these patients receiving some form of pharmacological thromboprophylaxis.

The main strength of our study is that we were able to analyze a very large group of patients contributing to more accurate results. Potential limitations of our study include the fact that the data were collected for administrative (reimbursement) purposes, rather

A total of 178 DVT and 179 LE was recorded in the year following surgery. The median time in days for DVT and LE to develop was 72 and 59 days respectively. The 25\textsuperscript{th} percentile was at 30 and 24 days, the 75\textsuperscript{th} percentile was at 149 and 130 days. Overall VTE development seemed to decrease around 100 days after trauma but afterwards still one third of the VTE’s occurred (Fig 2).

Both LE and DVT occurred in 7 patients. Table I represents a comprehensive list of DVT and PE following different procedures. In Figure 3 thromboembolic events are presented with injuries grouped to anatomical region.

VTE incidence rate is higher after lower extremity and pelvic trauma requiring a surgical procedure compared to upper extremity trauma (chi-square $P < 0.05$).
that scientific research. Also because of changes in
the reimbursement system in 2006 and 2012, our
dataset was restricted to this time period. Because
17% of patients were not continuously covered after
surgery for 1 year they were “lost to follow up”
and excluded from the study. The database lacks
detail in terms of the diagnosis, not accounting for;
concomitant injury, extent of soft tissue
damage and trauma mechanism. Also, treatment
information regarding thromboprophylaxis, anes-
thesia, hospital stay and weight bearing were not
available. It is therefore, impossible to define very
specific high risk groups for the development of
VTE from this study. However, registration of the
data is complete, accurate, subject to extensive
control and comprehensive auditing because of
the economic function of the data (13). Finally
despite the very large cohort of patients the absolute
number of procedures for some specific traumatic
injuries remains low and the accuracy of these
data accordingly. Grouping of surgical procedures
to anatomical region is debatable but it allows for
more reliable event rates and subsequently better
shows the regions are at risk.

An observational study on 45,968 orthopedic
procedures between 1996 and 2005 with a relatively
short follow up of six weeks after internal fixation
of proximal femur fractures and hemiarthroplasty
surgery following hip fracture found VTE incidence
rates of 1.1% (95% CI, 0.9-1.4) and 0.9% (95%
CI, 0.4-2.0) respectively. Thromboprophylaxis
(not further specified) was used for 7-10 days (9).
We found the VTE rate of 0.8% (95% CI, 0.7-1.0)
after proximal femur and neck fracture surgery to
be slightly lower, although follow up was 1 year
and we found that the thromboembolic risk to
persists well after 6 weeks. These finding can be
explained through an increasing emphasis on early
mobilization of patients in recent years and advances
in surgical technique. Furthermore, Dutch national
guideline advised 4-5 weeks thromboprophylaxis
after hip fracture surgery in this time period and
adherence to this guideline has been shown to be
very high (1,2). Our results are also in line with a
recent large randomized trial which compared
standard of care thromboprophylaxis with rivaro-
xaban after major orthopedic surgery (elective
total hip and knee arthroplasty). The standard of
care thromboprophylaxis showed a symptomatic
venous thromboembolic event rate of 1.02% in
8,635 patients (14). Furthermore, we found our data
to be comparable to a large recent study including
57,619 patients, determining symptomatic venous
thromboembolism after surgery for a lower leg
fracture ; they found an overall event rate of 1.0%
(15). We found that the risk after spinal cord injury
is high and this is confirmed in several studies
(3). Development of VTE after upper extremity
fracture surgery was relatively uncommon. A
study to internal fixation of upper limb fractures or
dislocation also found a low incidence of VTE, 1 in
637 procedures (7). The comparable rates of VTE of
these selected fractures in other studies support the
reliability of the database used for this study and
provide further evidence for the reliability of the
reported incidences of VTE for the less documented
trauma procedures.

There was no documentation available on how
VTE was diagnosed. The applicable Dutch guideline
advised compressive ultrasound for diagnosing
DVT and Multidetector Computed Tomography
(CT) angiography for pulmonary embolism if
indicated after clinical analyses. This is in line with
accepted international guidelines (3,8).

To the best of our knowledge the present database
study provides the largest and most recent analysis
of the epidemiology of VTE after trauma surgery
to the human body. Consensus statement advice is
usually based on well-studied trauma procedures
and it is often hard to extrapolate such advice to
less well studied traumatic injuries. This study at
least provides an indication for the rates of VTE
after very common and less common procedures
and therefore can be a valuable aid in deciding for
thromboprophylaxis in specific patients and aid in
the extrapolation of consensus statement advice to
specific procedures. Furthermore it may provide a
base for the need of further research for the need of
thromboprophylaxis after traumatic injuries.

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