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Original Study

Incidence of Venous Thromboembolism in Nursing Home Residents

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A B S T R A C T

Objective: Venous thromboembolism (VTE) is common in the elderly, but its epidemiology in nursing home residents remains unclear. This study estimated rates of VTE recorded on nursing home admission and incidence during residence.
Design: Retrospective analysis of AnalytiCare long term care (LTC) database for the period January 2007 to June 2009.
Setting: 181 nursing homes in 19 US states.
Participants: Eligible residents had 1 or more admission Minimum Data Set (MDS) 2.0 assessment(s) over the study period. All VTE cases were extracted if MDS indicated deep vein thrombosis or pulmonary embolism. The number of admissions and days at risk were estimated from a random sample (n = 1350) of all residents.
Measurements: The earliest admission was identified as the admission index date. VTE cases were classified as either "On Admission" (VTE coded on admission index date) or "During Residence" (coded afterward). Residents were followed from admission index date until censoring.
Results: A total of 2144 VTE admission cases (3.7% of all admissions) were identified. A further 757 cases of VTE occurring during residence were identified, yielding an incidence of 3.68 cases of VTE per 100 person-years of postadmission residence. VTE admission rates were highest for residents younger than 50 years (4.8%, confidence interval [CI]: 3.9%–5.9%) and 50 to 64 years (5.1%, CI: 4.6%–5.7%) but similar for those aged 65 to 74 (3.6%, CI: 3.3%–4.0%), 75 to 84 (3.6%, CI: 3.3%–3.9%), and 85 years or older (3.1%, CI: 2.9%–3.4%). The incidence of VTE during residence was similar among these age strata.
Conclusion: Approximately 1 in 25 nursing home admissions had a VTE diagnosis. VTE incidence during residence was higher than reported in earlier nursing home studies. These incidence rates merit further investigation because diagnostic improvements may be driving greater recognition of VTE in LTC.

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Deep vein thrombosis (DVT) and pulmonary embolism (PE) are separate but related aspects of the disease process of venous thromboembolism (VTE).[1] DVT of the lower extremities is the most-frequent manifestation,[2] whereas PE, the most urgent and serious, typically results from sudden occlusion of pulmonary arteries by a thrombus originating in the pelvis or calf.[1] VTE has been described

as a "silent killer"; most DVT cases are asymptomatic, and PE is often undetected until an autopsy is performed.[3] Postevent mortality rates of 7% and 13% have been reported at 1 month[4] and 11% and 15% at 6 months for DVT and PE, respectively.[5]

Acquired risk factors for VTE include previous VTE, frailty, cancer, hospitalization, surgery, advanced age, venous trauma, immobilization, estrogen therapy, inherited/acquired hypercoagulable state, acute medical illness, pregnancy, antiphospholipid antibodies, and several other implicated factors.[6–11] Silverstein et al[6] found that in the community, the incidence of VTE appears similar in magnitude to that of stroke: 0.117 per 100 person-years (PY). The incidence of DVT appears to increase markedly with age.[12] Heit et al[13] found that institutionalization (current or recent hospitalization or nursing home residence) was independently associated with 21.72 odds (among those with recent surgery) and 7.98 odds (without recent surgery) of having VTE. In another study, Heit et al[14] found that 59% of VTE cases in the community could be attributed to institutionalization: hospitalization for surgery accounted for 24%; hospitalization for medical illness 22%; and nursing home residence 13%. To facilitate risk assessment for the unique characteristics of nursing home residents, a literature-based long term care (LTC) risk stratification tool for VTE has recently been developed by Zarowitz et al.[15]

In the nursing home setting, 3 studies evaluated the incidence of VTE diagnosed during facility residence,[16–18] and 1 study evaluated prevalence of asymptomatic disease.[19] Using Minnesota Case Mix Review Program (MCMRP) data for the period 1988 to 1994, Liebson et al[16] found a crude incidence rate of 1.2 (95% confidence interval [CI]: 0.9–1.5) to 1.5 (95% CI: 1.1–1.9) cases per 100 PY. In the same study, analysis of a second database (Rochester Epidemiology Project of Olmstead County, MN, 1998–1994) revealed a crude incidence rate of 3.6 (95% CI: 3.0–4.2) cases per 100 PY.[16] Gomes et al,[17] compiling Minimum Data Set (MDS) and Medicare records for residents in Kansas for the period 1997 to 1998, found a crude VTE incidence rate of 1.30 events per 100 PY (95% CI: 1.10–1.51) when excluding warfarin users. Gatt et al[18] evaluated VTE incidence for residents with a length of stay (LOS) of 3 months or longer in a nursing home in Jerusalem, Israel, during the period 1991 to 2001. The crude incidence rate of VTE was similar in both chronically immobilized and mobile cohorts: 1.39 and 1.58 per 100 PY, respectively (P = .77).[18]

Arpaia et al[19] recently concluded that "[d]ata on the frequency of VTE among nonacute patients nursed at home or in long term care residential homes are still scarce." The current study updates earlier US research regarding the incidence of VTE events that occur during nursing home residence[16,17] and introduces an analysis of the proportion of nursing home admissions that were coded for VTE.

Methods

Data for this study were extracted for the data collection period January 1, 2007, to June 30, 2009, from the AnalytiCare longitudinal LTC database (www.analyticare.com). This database included MDS 2.0 assessments, pharmacy dispensing records, and resident characteristics from 181 nursing home facilities across 19 states (29% of facilities had 0–100 beds, 70% 101–200 beds, 1% >200 beds). All data provided by AnalytiCare were de-identified before release for research in accordance with Health Insurance Portability and Accountability Act safe-harbor provisions and were exempt from the requirement for institutional review board review.

AnalytiCare provided data for all residents who had available MDS and pharmacy data and who had been identified as having either DVT ("DVT" checkbox in Section I1 or ICD-9-CM codes of 451.1x, 451.2, 453.2, or 453.4x in Section I3) or PE (415.1x in Section I3) in any MDS assessment over the study period. To estimate the number of admissions and days at risk of the total resident population,

AnalytiCare separately provided a simple random sample of 1350 residents from the universe of residents (n = 74,019) who had available MDS and pharmacy data over the study period (reference sample).

Residents in both groups (census of those with VTE and reference sample) were considered eligible for analysis if they had 1 or more admission (or readmission) MDS assessment(s) over the study period; the earliest MDS admission (or readmission) over the study period was identified as the *admission index date*. Eligible residents were followed longitudinally from the admission index date until the end of follow-up (ie, censoring). Follow-up ended on the earliest occurrence of (1) an MDS assessment coded for VTE (follow-up equaled zero if VTE was coded on admission); (2) a postindex discharge that occurred wherein the resident was not readmitted to the facility within 30 days following discharge; (3) 90 days following the earliest MDS assessment for which a gap of 120 days or more occurred between successive MDS assessments; (4) date of death; or (5) the end of the data collection period.

Cases (eligible residents in the VTE census) were exclusively defined as either *VTE on admission* or *VTE during residence* depending on whether the date of the earliest VTE-coded MDS assessment occurred on or after the admission index date, respectively. Counts of cases were used to supply numerators for the rate of admissions coded for VTE and the incidence of postadmission VTE cases. The respective denominators—the total number of initial admissions and resident days at risk (sum of elapsed days from admission index date to end of follow-up)—were estimated from the reference sample.

Data for demographics were derived from the AnalytiCare resident characteristic data file. A set of 20 VTE risk factors was obtained from the risk stratification tool developed by Zarowitz et al[15] (5 other risk factors from this tool lacked available data for the current study: surgical resection of abdominal or pelvic cancer, central vein catheter, history of VTE, having first-degree relative with VTE, and treatment with erythroid-stimulating agents to hemoglobin greater than 12 g/dL). Comorbid and VTE risk factor data were obtained from the index admission MDS assessment and concurrent pharmacy records (≤45 days of the index date) for those residents with *VTE on admission* and was obtained from the index and all postindex MDS assessments and pharmacy records until censoring for those residents with *VTE during residence* and for the reference sample. As a proxy for the Zarowitz et al[15] immobility risk factor checklist (not derivable from the MDS), immobility was defined as having a score of 24 or higher (where 0 = total independence and 28 = total dependence) using a single global score from 7 items of activities of daily living in the index MDS Section G1A, applying the algorithm of Carpenter et al.[20]

Results

From the sampling universe, a total of 58,009 eligible residents were estimated to have 1 or more admissions (or readmissions) over the data collection period. The total number of years at risk for a postadmission VTE (from admission index date until end of follow-up) across all eligible residents was estimated at 20,586 PY.

A total of 2901 eligible VTE cases were identified. Of these, 2144 (74%) had VTE identified on the admission index date. These accounted for 3.7% of the 58,009 estimated admissions (Table 1). The remaining 757 (26%) of the 2901 VTE cases occurred during residence in study facilities. For these cases, mean time from admission until occurrence of the VTE event was 116 days (SD = 162). This yielded a crude incidence rate of 3.68 VTE cases per 100 PY of postadmission follow-up (Table 1). Table 1 also shows VTE admission rates and incidence rates during residence separately by age and gender strata. Residents younger than 50 and 50 to 64 years of age had disproportionately higher rates of VTE-coded admissions (4.8% and 5.1%)

Table 1
Rate of Admissions Coded for VTE and Incidence Rate of Postadmission VTE Cases

	No. Admissions Coded for VTE	Rate of Admissions Coded for VTE per Total No. Admissions (95% CI)	No. Residents Having Postadmission VTE Cases	Incidence Rate of Postadmission VTE Cases per 100 Person-Years of Postadmission Follow-up (95% CI)
All residents	2144	3.7% (3.5%–3.9%)	757	3.68 (3.42–3.95)
Age, y				
<50	98	4.8% (3.9%–5.9%)	21	4.03 (2.50–6.16)
50–64	357	5.1% (4.6%–5.7%)	92	4.51 (3.64–5.53)
65–74	435	3.6% (3.3%–4.0%)	133	3.84 (3.22–4.55)
75–84	720	3.6% (3.3%–3.9%)	259	3.15 (2.78–3.56)
≥85	534	3.1% (2.9%–3.4%)	252	3.97 (3.50–4.50)
Gender				
Male	822	3.6% (3.4%–3.9%)	266	3.65 (3.22–4.11)
Female	1322	3.7% (3.5%–3.9%)	491	3.69 (3.37–4.04)

CI, confidence interval; VTE, venous thromboembolism.
Residents with VTE (n = 2901) were assigned exclusively to either admission or postadmission cases. Only the earliest admission or postadmission VTE event was considered for this analysis. Rates and confidence intervals for the rate of admissions were derived from exact binomial estimates by dividing admission cases coded for VTE by total number of estimated admissions. Incidence rates and confidence intervals for postadmission VTE cases were derived from Poisson estimates by dividing number of post-admission VTE cases observed before censoring by the estimated total number of days from admission to censoring across all residents (exposure).

compared with the remaining age cohorts (3.1%–3.6%). VTE admission rates and incidence rates for the remaining age and gender cohorts were similar.

Table 2 shows admission rates (n = 1793 cases) and incidence rates (n = 615 cases) for residents with DVT only and admission rates (n = 270 cases) and incidence rates (n = 123 cases) for residents with PE only. The strata of DVT only and PE only, when combined, accounted for 97% of all VTE cases; 3% of cases were mixed DVT and PE. DVT only accounted for 6 admissions for every PE only–coded admission and for 5 incident cases for every PE only–coded incident case identified during residence. Patterns of findings were similar to those shown in Table 1 for VTE among age and gender strata, with the exception of a more homogeneous rate of admissions coded for PE only (shown by overlapping confidence intervals) across the age strata.

Among the cohort of residents developing VTE on admission, Table 3 shows the distribution of comorbid conditions and VTE risk factors by age category. Residents younger than 75 accounted for 42% of those residents who presented with VTE on admission. Rates of the comorbid conditions atherosclerotic heart disease, hypertension, atrial fibrillation, Alzheimer disease, non-Alzheimer dementia, and osteoarthritis generally increased among older residents ($P \leq .041$ for all distributions by age cohort), as did the VTE risk factors for lower limb fractures, congestive heart failure, and megestrol therapy ($P \leq .003$ for all age distributions). However, comorbid condition rates were higher among younger residents for diabetes, depression, hemiplegia or paralysis, cerebral palsy, multiple sclerosis, seizure disorders, and traumatic brain injury ($P \leq .024$ for all age distributions), as were rates for the VTE risk factors multiple trauma, obesity, and immobility ($P \leq .033$ for all age distributions). The VTE risk factors stroke, cancer, acute infectious disease, chronic obstructive pulmonary disease (COPD), congestive heart failure, obesity, and immobility were highly prevalent in 3 or more of the 5 age groups.

Table 4 shows the distribution of comorbid conditions and VTE risk factors by age category for the cohort of residents developing VTE during residence. The count of residents by age category was equivalent for those younger than 75 years, 75 to 84 years, and 85 years or older. As in the on admission cohort, similar age trends were observed: the comorbid conditions atherosclerotic heart disease, hypertension, atrial fibrillation, Alzheimer disease, and non-Alzheimer dementia generally increased among older residents ($P \leq .036$ for all distributions by age cohort), although only the risk factor congestive heart failure had a significant and consistent increase with age ($P = .010$ for age distribution). Similarly, comorbid condition rates were generally higher among younger residents having diabetes, hemiplegia or paralysis, cerebral palsy, multiple sclerosis, seizure disorders, and traumatic brain injury ($P \leq .002$ for all age distributions), whereas only the VTE risk factor obesity decreased significantly with age ($P < .001$ for age distribution). Similarly, the VTE risk factors stroke, cancer, acute infectious disease, COPD, congestive heart failure, obesity, and immobility were highly prevalent in 3 or more of the 5 age groups, whereas use of megestrol therapy was highly prevalent in all age cohorts.

Table 2
Rate of Admissions Coded for DVT and PE and Incidence Rate of Postadmission DVT and PE Cases

	Rate of Admissions Coded for DVT per Total No. of Admissions (95% CI)	Incidence Rate of Postadmission DVT Cases per 100 Person-Years of Postadmission Follow-Up (95% CI)	Rate of Admissions Coded for PE per Total No. of Admissions (95% CI)	Incidence Rate of Postadmission PE Cases per 100 Person-Years of Postadmission Follow-Up (95% CI)
All residents	3.1% (3.0%–3.2%)	2.99 (2.76–3.23)	0.5% (0.4%–0.5%)	0.60 (0.50–0.71)
Age, y				
<50	4.3% (3.5%–5.3%)	3.46 (2.05–5.46)	0.2% (0.1%–0.6%)	0.58 (0.12–1.68)
50–64	4.3% (3.9%–4.8%)	3.53 (2.76–4.44)	0.6% (0.5%–0.8%)	0.88 (0.52–1.39)
65–74	3.1% (2.8%–3.4%)	3.15 (2.58–3.80)	0.4% (0.3%–0.6%)	0.64 (0.40–0.96)
75–84	2.9% (2.7%–3.2%)	2.66 (2.32–3.04)	0.5% (0.4%–0.6%)	0.40 (0.28–0.56)
≥85	2.6% (2.4%–2.9%)	3.11 (2.69–3.57)	0.4% (0.3%–0.5%)	0.74 (0.54–0.99)
Gender				
Male	3.1% (2.9%–3.4%)	2.87 (2.49–3.28)	0.4% (0.3%–0.5%)	0.71 (0.53–0.93)
Female	3.1% (2.9%–3.2%)	3.05 (2.76–3.37)	0.5% (0.5%–0.6%)	0.53 (0.42–0.68)

CI, confidence interval; DVT, deep vein thrombosis; PE, pulmonary embolism; VTE, venous thromboembolism.
Residents with VTE were assigned exclusively to either DVT only or PE only and to either admission or postadmission cases. Only the earliest admission or postadmission VTE event was considered for this analysis. Combined DVT and PE (not shown in table) accounted for 3% of all VTE cases. DVT, n = 1793 admission cases and 615 incident cases; PE, n = 270 admission cases and n = 123 incident cases.

Table 3
Resident Comorbid Conditions and VTE Risk Factors for Admission VTE Cases by Age Strata

	<50 Years (n = 98), %	50–64 Years (n = 357), %	65–74 Years (n = 435), %	75–84 Years (n = 720), %	≥85 Years (n = 534), %	P Value
Conditions						
Arteriosclerotic heart disease	1	5	11	11	12	<.001
Hypertension	54	66	72	76	74	<.001
Atrial fibrillation	1	3	8	9	11	<.001
Peripheral vascular disease	6	11	12	11	13	.382
Alzheimer disease	0	0	3	6	9	<.001
Dementia other than Alzheimer	2	5	13	23	29	<.001
Transient ischemic attack	1	2	2	3	3	.244
Diabetes mellitus	42	45	46	40	27	<.001
Depression	47	43	36	29	26	<.001
Anemia	31	33	43	38	36	.026
Hemiplegia or paralysis	21	14	8	4	3	<.001
Osteoarthritis	0	4	5	6	6	.041
Cerebral palsy	1	1	0	0	0	.024
Huntington disease	0	0	0	0	0	.415
Multiple sclerosis	4	4	1	1	0	<.001
Parkinson's disease	0	2	2	4	3	.090
Seizure disorders	26	13	8	8	4	<.001
Traumatic brain injury	4	3	1	1	1	.004
VTE risk factors*						
Lower limb orthopedic surgery	0	2	4	2	1	.012
Hip, pelvis, or leg fracture	8	9	6	11	14	.001
Stroke[†]	16	20	21	16	15	.079
Spinal cord injury	1	1	1	0	1	.441
Multiple trauma	5	4	1	1	2	.016
Cancer	10	17	20	19	14	.040
Acute infectious disease	57	49	46	51	51	.330
COPD	13	23	27	23	19	.014
Dehydration	1	1	0	0	0	.252
Congestive heart failure	8	18	24	23	26	.001
Hypercoagulable state	1	0	0	0	0	.106
Inflammatory bowel disease	0	1	1	0	1	.551
Obesity (>30% above ideal body weight)	42	52	50	40	29	<.001
Rheumatoid arthritis	0	1	1	1	1	.756
Aromatase inhibitor therapy	0	0	1	1	1	.546
Hormone replacement therapy	0	1	1	1	1	.780
Megestrol acetate therapy	2	4	5	7	9	.003
Selective estrogen receptor modulator therapy	0	0	1	0	1	.231
Immobility[‡]	18	11	10	9	8	.033

COPD, chronic obstructive pulmonary disease; VTE, venous thromboembolism.

*VTE risk factors obtained from Zarowitz et al.[15]

†Includes hemorrhagic and nonhemorrhagic stroke; Zarowitz et al[15] list only ischemic (nonhemorrhagic) stroke as a VTE risk factor.

‡Immobility defined as having a score of ≥24 (where 0 = total independence and 28 = total dependence) using a single global score from 7 activity of daily living items in the index Minimum Data Set Section G1A, applying the algorithm of Carpenter et al.[20] Zarowitz et al[15] define immobility as either bedridden, bedridden except for bathroom privileges, unable to walk at least 10 feet, recent reduction in ability to walk at least 10 feet for at least 72 hours, or lower limb cast.

Using as a referent the sample of all residents in the facilities studied who did not have VTE on admission or during residence (n = 1011 after applying exclusion criteria), Table 5 shows, by VTE on admission and during residence cohorts, the odds ratios (ORs) for having each of the 20 VTE risk factors with occurrence of VTE. ORs are separately reported as univariate and adjusted (multivariate logistic regression of 20 VTE risk factors plus gender). Among the cohort of residents who developed VTE during residence, residents with the following risk factors had a significantly greater adjusted odds of having VTE during residence: stroke (OR = 1.51, P < .001), acute infectious disease (OR = 2.50, P < .001), congestive heart failure (OR = 1.69, P < .001), obesity (OR = 1.44, P = .001), hormone replacement therapy (OR = 2.08, P = .048), megestrol therapy (OR = 2.30, P < .001), and immobility (OR = 1.78, P < .001).

Discussion

Kroegel and Reissig[1] have described the complexity of assessing and treating VTE because it "is not a 'static disease' but must essentially be understood as a rapid dynamic condition with constantly changing features with respect to all clinical, radiological, functional, and laboratory findings." The current study provides evidence that a diagnosis of VTE is common among nursing home residents across all observed age and gender categories. VTE may be encountered as an existing condition noted on admission, likely originating outside of the nursing home, and separately, as an acute condition that originates in the nursing home setting. Regarding the latter group, a recent report evaluated a subset of residents who developed VTE during nursing home residence, obtained from the same database used in the current study.[21] Two-thirds of these residents received warfarin within 45 days of the VTE incident event. Patients who were underweight, had Alzheimer disease/dementia or cancer, or had independent physical functioning were less likely to receive warfarin. Nonpersistence of warfarin therapy was strongly related to antipsychotic use, presence of dementia, and peripheral vascular disease.

VTE on Admission

In our study, approximately 1 in 25 initial nursing home admissions had a contemporaneous MDS assessment listing VTE as a current diagnosis. This is a substantial finding given the serious nature of this disease, the potentially short hospital stays before

Table 4
Resident Comorbid Conditions and VTE Risk Factors for Postadmission VTE Cases During Residence by Age Strata

	<50 Years (n = 21), %	50–64 Years (n = 92), %	65–74 Years (n = 133), %	75–84 Years (n = 259), %	≥85 Years (n = 252), %	P Value
Conditions						
Arteriosclerotic heart disease	5	11	17	23	17	.036
Hypertension	71	67	83	81	79	.034
Atrial fibrillation	5	2	14	15	16	.009
Peripheral vascular disease	19	23	23	31	31	.206
Alzheimer disease	0	2	9	19	25	<.001
Dementia other than Alzheimer	10	16	25	36	40	<.001
Transient ischemic attack	0	1	2	3	4	.427
Diabetes mellitus	43	52	62	50	30	<.001
Depression	52	62	62	61	52	.157
Anemia	38	25	47	41	48	.003
Hemiplegia or paralysis	48	33	17	10	12	<.001
Osteoarthritis	5	8	11	12	13	.482
Cerebral palsy	0	3	0	0	0	<.001
Huntington disease	0	0	0	0	0	—
Multiple sclerosis	10	7	4	2	0	.002
Parkinson disease	0	1	6	10	3	.001
Seizure disorders	43	28	14	11	7	<.001
Traumatic brain injury	19	3	3	2	1	<.001
VTE risk factors						
Lower limb orthopedic surgery	5	2	2	2	0	.379
Hip, pelvis, or leg fracture	5	9	11	14	19	.051
Stroke	33	38	32	30	28	.503
Spinal cord injury	0	1	1	0	1	.857
Multiple trauma	10	4	3	4	6	.509
Cancer	5	5	17	9	13	.028
Acute infectious disease	81	65	82	83	81	.006
COPD	0	30	37	29	25	.005
Dehydration	0	0	2	1	2	.674
Congestive heart failure	14	26	39	41	42	.010
Hypercoagulable state	0	0	0	0	1	.196
Inflammatory bowel disease	0	0	0	1	0	.426
Obesity (>30% above ideal body weight)	38	61	47	42	30	<.001
Rheumatoid arthritis	0	2	2	3	1	.703
Aromatase inhibitor therapy	0	0	2	0	0	.230
Hormone replacement therapy	0	7	2	4	2	.201
Megestrol acetate therapy	10	9	13	15	16	.476
Selective estrogen receptor modulator therapy	0	0	1	0	1	.709
Immobility	38	12	16	20	18	.062

COPD, chronic obstructive pulmonary disease; VTE, venous thromboembolism.

nursing home entry, and concerns about continuity of care after hospital discharge. Little is known from published research regarding how VTE is managed in the nursing home. The VTE event would likely have originated in the hospital before nursing home transfer. On admission to the nursing home, a number of concerns are presented to clinical staff. Because of the lingering potential for sudden death either directly from existing PE or through the progression of DVT to PE, these residents would require adequate assessment to review, modify, and monitor hospital-initiated therapy. Because current consensus guidelines recommend at least 3 months of anticoagulant therapy from the start of VTE,[2,22] treatment would be expected to commence in the hospital setting and then continue after nursing home admission. One concern is whether warfarin is ever initiated on admission after bridging from short-term low-molecular-weight heparin or unfractionated heparin. For instance, Caprini et al[23] found that only 51% of patients having VTE in the hospital were discharged with a warfarin prescription, having an average hospital LOS of only 7.9 days.

VTE During Residence

Even after considering age, evidence suggests that VTE occurs at a far higher rate among nursing home residents than among community dwellers. In our study, the incidence rate of 3.68 VTE cases per 100 PY occurred among residents with a median age of 78

years. White et al[24] reported communitywide incidence rates of new VTE cases of only 0.45–0.60 per 100 PY among individuals aged ≥80 years. White et al[24] also found that early mortality after VTE is strongly associated with presentation of PE, advanced age, cancer, and underlying cardiovascular disease. As shown in Table 4, a large proportion of nursing home residents in our study had the latter 3 conditions.

The incidence of diagnosed VTE during residence in the current study was higher than reported in 3 earlier nursing home studies[16–18] but equivalent to that of a second of 2 databases in one of these studies.[16] Compared with the current study finding of 3.68 cases per 100 PY, VTE incidence rates in nursing home studies were 1.2 to 1.5 (MCMRP data/Minnesota),[16] 3.6 (Rochester Epidemiology Project data/Minnesota),[16] 1.3 (MDS and Medicare data/Kansas),[17] and 1.4 to 1.6 (medical chart data/Israel)[18] per 100 PY. The high incidence rate found in our study may be a consequence of differences in the pool of nursing homes studied (eg, a potentially greater number of residents receiving subacute care) or in the methods used, or it may be due to the later time period (2007–2009) than the earlier studies (1988–2001). The effect of changes in resident case-mix or a historic trend in the incidence of VTE remain unknown given the lack of details in the current and earlier studies regarding levels of resident acuity and changes in criteria to diagnose VTE. Findings from the Rochester Epidemiology Project[16] would suggest that the MDS might be undercounting the incidence of fatal

Table 5
Univariate and Adjusted Odds Ratios of Association of VTE Risk Factors With Occurrence of VTE (for Admission VTE Cases and Postadmission VTE Cases During Residence)

	Admissions Coded for VTE				Postadmission VTE Cases During Residence			
	Unadjusted		Adjusted		Unadjusted		Adjusted	
	Odds Ratio	P Value	Odds Ratio	P Value	Odds Ratio	P Value	Odds Ratio	P Value
VTE risk factors								
Lower limb orthopedic surgery	0.84	.461	0.69	.131	0.47	.042	0.70	.372
Hip, pelvis, or leg fracture	0.83	.118	0.84	.187	1.21	.179	1.27	.143
Stroke	0.76	.003	0.75	.003	1.58	<.001	1.51	<.001
Spinal cord injury	0.62	.146	0.57	.107	0.50	.146	0.57	.280
Multiple trauma	0.72	.167	0.79	.346	1.53	.090	1.53	.146
Age ≥60 years	0.74	.013	0.75	.023	1.09	.579	0.92	.625
Cancer	1.55	<.001	1.52	<.001	0.96	.807	1.06	.730
Acute infectious disease	0.74	<.001	0.71	<.001	2.93	<.001	2.50	<.001
COPD	0.86	.079	0.88	.174	1.17	.151	0.99	.919
Dehydration	1.26	.735	1.07	.926	3.59	.060	3.51	.075
Congestive heart failure	0.88	.138	0.88	.190	1.89	<.001	1.69	<.001
Hypercoagulable state	1.42	.764	1.36	.794	4.02	.229	3.34	.305
Inflammatory bowel disease	1.32	.593	1.11	.846	0.53	.453	0.46	.375
Obesity (>30% above ideal body weight)	1.41	<.001	1.44	<.001	1.40	<.001	1.44	.001
Rheumatoid arthritis	1.48	.337	1.31	.509	2.36	.054	2.11	.113
Aromatase inhibitor therapy	1.15	.762	0.90	.810	0.57	.417	0.64	.550
Hormone replacement therapy	0.61	.187	0.65	.249	2.51	.008	2.08	.048
Megestrol acetate therapy	1.01	.939	1.12	.496	2.46	<.001	2.30	<.001
Selective estrogen receptor modulator therapy	1.01	.982	0.85	.730	0.95	.936	1.31	.667
Immobility	0.97	.828	1.07	.631	1.95	<.001	1.78	<.001

COPD, chronic obstructive pulmonary disease; VTE, venous thromboembolism.
Odds ratios obtained from logistic regression. Adjusted odds ratios were obtained from a multivariate logistic regression of all 20 risk factors plus gender. Referent is the sample of all residents in the facilities studied not having VTE on admission or during residence (n = 1011 after applying exclusion criteria).

VTE, especially because residents who die in the hospital after nursing home discharge are less likely to have VTE recorded in the final MDS assessment. PE events may be especially undercounted. In a recent national study[25] of hospitalizations with a diagnosis of VTE, the ratio of DVT to PE was much lower than our findings: crude estimated average annual rates in that study were 0.152 (DVT) and 0.121 (PE) per 100 hospitalizations, respectively; the relative proportion due to PE declined with advancing age, although in an earlier community study,[6] the inverse relationship was observed.

The high incidence rate observed in our study might also be a consequence of the growth in associated risk factors among hospitalized patients admitted to nursing homes in recent years with high disease acuity, short hospital stays, and increased use of surgical and other interventional procedures. Improved diagnostics for recognizing asymptomatic VTE may be a key factor, although we have no means of describing how newer diagnostics, such as portable Doppler ultrasound, have affected incidence rates over time. Stein et al[26] found that the incidence of DVT in hospitalized patients increased from 0.8% to 1.3% of all hospital admissions over the period 1979 to 1999, yet the incidence of PE remained unchanged at 0.4%. These authors hypothesized that increased use of venous ultrasound may have increased DVT incidence, and early diagnosis and treatment of DVT may have prevented a concurrent rise in PE.[26] Our study found a 1:5 ratio of PE cases to DVT cases during residence. This is lower than the 1:3 ratio reported in 2 earlier nursing home studies[16,18] and raises the possibility, beyond potential undercounting of PE in the MDS, of earlier DVT diagnosis and treatment, thus preventing a concurrent growth in PE rates in the nursing home.

The rate of diagnosed VTE reported in this and earlier nursing home studies might underestimate the true extent of underlying disease. The reported prevalence of asymptomatic proximal DVT (measured through ultrasound screening) was 18% in a study of patients nursed at home or in nursing homes.[19] This rate is so substantial that if it approximates the true rate of underlying disease, diagnostic improvements might be expected to drive growth in DVT incidence for some time to come.

Risk Factors for VTE

Whereas residents who have VTE on admission must be managed therapeutically once they enter the nursing home, those who are at risk during residence can receive monitoring and possible interventions to prevent a VTE episode from occurring in the first place. Thus, a practical method for risk stratification, such as that proposed by Zarowitz et al,[15] might be especially beneficial for LTC clinicians. A recent study in this journal of 376 residents newly admitted or readmitted to 17 LTC facilities has shown that fully 85% of these residents met criteria for VTE prophylaxis (VTE-P) on admission.[27] In the current study, we provide evidence of strong and independent association with incidence of VTE for 7 of the 20 VTE risk factors that we evaluated: stroke, acute infectious disease, congestive heart failure, obesity, hormone replacement therapy, megestrol therapy, and immobility.

Although the risk for VTE has been found to increase with age, a surprising finding in the current study was the lack of evidence for age younger than 60 years as an independent predictor for VTE. Further, a large proportion of younger residents had VTE; admission and incidence rates during residence for these younger residents were as high as or higher than those of the older age groups. These findings are likely attributable to the unique case-mix of younger nursing home residents. A closer examination of residents younger than 50 and 50 to 64 years reveals severe levels of disability, apparent with high rates of neurological disease, cardiovascular disease, diabetes, and cancer, and high overall VTE risk (multiple trauma, obesity, immobility, stroke, cancer, acute infectious disease, COPD, congestive heart failure, and megestrol use), which collectively might be acting to overcome the potential age-related risk reduction that would otherwise be observed in younger patients outside of the nursing home setting.

Limitations

Our study had several limitations. First, the study design does not permit delineation between new VTE events and recurrences of earlier VTE events that occurred before the start of data collection.

Second, the MDS is a component of but does not encompass the full resident medical chart and may not have adequately captured emergent VTE, comorbid conditions, and VTE risk factors (eg, lower-limb orthopedic surgery). Although Poss et al[28] indicate that the validity and reliability of MDS measures can vary differentially by a given indicator, the MDS 2.0 has been reported to generally have moderate to moderate-high validity and reliability.[29] Wodchis et al[30] reported a high sensitivity of 0.80 for 6 of the 10 most-prevalent discharge diagnoses and moderate sensitivities in the range of 0.60 to 0.79 for another 12, including DVT. Kroegel and Reissig[1] have noted the difficulty associated with establishing a VTE diagnosis, thus illustrating the limitations of comparing studies without adequate consideration of the study methods used to determine VTE diagnosis. Finally, data for 5 of 25 VTE risk factors described by Zarowitz et al[15] were not available in the current study database. These factors may also have had an independent association with occurrence of VTE.

Conclusions

Further research should seek to test whether, as the possibility is suggested here, incidence rates of VTE during nursing home residence are increasing over time and whether such changes are related to changes in resident acuity or more widespread usage of advanced diagnostics. Appropriateness of assessment and therapy, dichotomized by cases of VTE on nursing home admission or during residence, should be evaluated in light of the high mortality risk linked to VTE.

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References

1. Kroegel C, Reissig A. Principle mechanisms underlying venous thromboembolism: Epidemiology, risk factors, pathophysiology and pathogenesis. Respiration 2003;70:7–30.
2. Snow V, Qaseem A, Barry P, et al. Management of venous thromboembolism: A clinical practice guideline from the American College of Physicians and the American Academy of Family Physicians. Ann Intern Med 2007;146:204–210.
3. Nutescu EA. Assessing, preventing, and treating venous thromboembolism: Evidence-based approaches. Am J Health Syst Pharm 2007;64:S5–13.
4. Lee CH, Cheng CL, Lin LJ, et al. Epidemiology and predictors of short-term mortality in symptomatic venous thromboembolism. Circ J 2011;75:1998–2004.
5. Murin S, Romano PS, White RH. Comparison of outcomes after hospitalization for deep venous thrombosis or pulmonary embolism. Thromb Haemost 2002;88:407–414.
6. Silverstein MD, Heit JA, Mohr DN, et al. Trends in the incidence of deep vein thrombosis and pulmonary embolism: A 25-year population-based study. Arch Intern Med 1998;158:585–593.
7. Kearon C. Epidemiology of venous thromboembolism. Semin Vasc Med 2001;1:7–26.
8. Folsom AR, Boland LL, Cushman M, et al. Frailty and risk of venous thromboembolism in older adults. J Gerontol A Biol Sci Med Sci 2007;62:79–82.
9. Imberti D, Agnelli G, Ageno W, et al. Clinical characteristics and management of cancer-associated acute venous thromboembolism: Findings from the MASTER Registry. Haematologica 2008;93:273–278.
10. Heit JA, Mohr DN, Silverstein MD, et al. Predictors of recurrence after deep vein thrombosis and pulmonary embolism: A population-based cohort study. Arch Intern Med 2000;160:761–768.
11. Geerts WH, Bergqvist D, Pineo GF, et al. Prevention of venous thromboembolism: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines (8th Edition). Chest 2008;133:381S–453S.
12. Fowkes FJ, Price JF, Fowkes FG. Incidence of diagnosed deep vein thrombosis in the general population: Systematic review. Eur J Vasc Endovasc Surg 2003;25:1–5.
13. Heit JA, Silverstein MD, Mohr DN, et al. Risk factors for deep vein thrombosis and pulmonary embolism: A population-based case-control study. Arch Intern Med 2000;160:809–815.
14. Heit JA, O'Fallon WM, Petterson TM, et al. Relative impact of risk factors for deep vein thrombosis and pulmonary embolism: A population-based study. Arch Intern Med 2002;162:1245–1248.
15. Zarowitz BJ, Tangalos E, Lefkovitz A, et al. Thrombotic risk and immobility in residents of long term care facilities. J Am Med Dir Assoc 2010;11:211–221.
16. Liebson CL, Petterson TM, Bailey KR, et al. Risk factors for venous thromboembolism in nursing home residents. Mayo Clin Proc 2008;83:151–157.
17. Gomes JP, Shaheen WH, Truong SV, et al. Incidence of venous thromboembolic events among nursing home residents. J Gen Intern Med 2003;18:934–936.
18. Gatt ME, Paltiel O, Bursztyn M. Is prolonged immobilization a risk factor for symptomatic venous thromboembolism in elderly bedridden patients? Results of a historical-cohort study. Thromb Haemost 2004;91:538–543.
19. Arpaia G, Ambrogi F, Penza M, et al. Risk of venous thromboembolism in patients nursed at home or in long-term care residential facilities. Int J Vasc Med 2011;2011:305027.
20. Carpenter GI, Hastie C, Morris J, et al. Measuring change in activities of daily living in nursing home residents with moderate to severe cognitive impairment. BMC Geriatrics 2006;6:7.
21. Reardon G, Pandya N, Nutescu EA, et al. Use of warfarin therapy among residents who developed venous thromboembolism in the nursing home. Am J Geriatr Pharmacother 2012;10:361–372.
22. Kearon C, Kahn SR, Agnelli G, et al. Antithrombotic therapy for venous thromboembolic disease: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines (8th Edition). Chest 2008;133:454S–545S.
23. Caprini JA, Tapson VF, Hyers TM, et al. Treatment of venous thromboembolism: Adherence to guidelines and impact of physician knowledge, attitudes, and beliefs. J Vasc Surg 2005;42:726–733.
24. White RH. The epidemiology of venous thromboembolism. Circulation 2003;107:I4–I8.
25. Venous thromboembolism in adult hospitalizations—United States, 2007–2009. MMWR Morb Mortal Wkly Rep 2012;61:401–404.
26. Stein PD, Beemath A, Olson RE. Trends in the incidence of pulmonary embolism and deep venous thrombosis in hospitalized patients. Am J Cardiol 2005;95:1525–1526.
27. Dharmarajan TS, Nanda A, Agarwal B, et al. Prevention of venous thromboembolism: Practice patterns in 17 geographically diverse long term care facilities in the United States: Part 1 of 2 (an AMDA Foundation project). J Am Med Dir Assoc 2012;13:298–302.
28. Poss JW, Jutan NM, Hirdes JP, et al. A review of evidence on the reliability and validity of Minimum Data Set data. Healthc Manage Forum 2008;21:33–39.
29. Shin JH, Scherer Y. Advantages and disadvantages of using MDS data in nursing research. J Gerontol Nurs 2009;35:7–17.
30. Wodchis WP, Naglie G, Teare GF. Validating diagnostic information on the Minimum Data Set in Ontario Hospital-based long-term care. Med Care 2008;46:882–887.