Rethinking Guidelines for VTE Risk Among Nursing Home Residents

A Population-Based Study Merging Medical Record Detail With Standardized Nursing Home Assessments

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BACKGROUND: Nursing home (NH) residents are at increased risk for both VTE and bleeding from pharmacologic prophylaxis. Construction of prophylaxis guidelines is hampered by NH-specific limitations with VTE case identification and characterization of risk. We addressed these limitations by merging detailed provider-linked Rochester Epidemiology Project (REP) medical records with Centers for Medicare and Medicaid Services Minimum Data Set (MDS) NH assessments.

METHODS: This population-based nested case-control study identified all Olmsted County, Minnesota, residents with first-lifetime VTE October 1, 1998, through December 31, 2005, while a resident of an NH (N = 91) and one to two age-, sex-, and calendar year-matched NH non-VTE control subjects. For each NH case without hospitalization 3 months before VTE (n = 23), we additionally identified three to four nonhospitalized NH control subjects. REP and MDS records were reviewed before index date (VTE date for cases; respective REP encounter date for control subjects) for numerous characteristics previously associated with VTE in non-NH populations. Data were modeled using conditional logistic regression.

RESULTS: The multivariate model consisting of all cases and control subjects identified only three characteristics independently associated with VTE: respiratory infection vs no infection (OR, 5.9; 95% CI, 2.6-13.1), extensive or total assistance with walking in room (5.6, 2.5-12.6), and general surgery (3.3, 1.0-10.8). In analyses limited to nonhospitalized cases and control subjects, only nonrespiratory infection vs no infection was independently associated with VTE (8.8, 2.7-29.2).

CONCLUSIONS: Contrary to previous assumptions, most VTE risk factors identified in non-NH populations do not apply to the NH population. NH residents with infection, substantial mobility limitations, or recent general surgery should be considered potential candidates for VTE prophylaxis.

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ABBREVIATIONS: CMS = Centers for Medicare and Medicaid Services; MDS = Minimum Data Set; NH = nursing home; PE = pulmonary embolism; REP = Rochester Epidemiology Project

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VTE, including DVT and pulmonary embolism (PE), is relatively common, potentially life threatening, and costly.¹⁻⁴ VTE incidence can be reduced with appropriate prophylaxis. However, risk stratification is required to avoid unnecessary, costly therapy and potentially serious consequences.⁵ Risk stratification is especially critical within the nursing home (NH) setting. Using Rochester Epidemiology Project (REP) records-linkage resources, we previously reported that odds of VTE among NH residents were 5.6 times those for non-NH residents, even adjusted for other established risk factors.⁶ Furthermore, NH residency accounted for 13% of all incident VTE cases within the population.⁷ Thus, reducing VTE incidence among NH residents would contribute to reductions within the population generally. Importantly, however, NH residents exhibit several characteristics (eg, advanced age, low body weight, hypertension, stroke, and polypharmacy) associated with adverse consequences from anticoagulant thromboprophylaxis.^{8,9}

Despite growing recognition of the importance of risk assessment and appropriate targeting of prophylaxis within the NH setting,⁸⁻¹⁴ evidence needed to inform NH-specific recommendations is lacking. The very few population-based studies typically identified NH VTE using diagnosis codes from administrative data.^{15,16} Limitations of this approach were demonstrated in a previous study among Olmsted County, Minnesota, NH residents.¹⁶ Using REP resources, 161 cases were identified; only 53 were identified using NH administrative data. Other differences between REP and administrative data (ie, proportions with PE [62% vs 21%] and 1-year sur-

vival [45% vs 76%]) suggest that NH administrative data are biased against case subjects who died before next assessment.

Because of difficulties with NH VTE case ascertainment, recommendations for VTE risk stratification within the NH, including American College of Chest Physicians (CHEST) guidelines,^{5,9,16-20} have been largely restricted to extrapolation from general population or hospital studies. Such extrapolation was challenged with another REP study, published as a brief report.²¹ That study was limited to three factors known to account for the majority of VTE events among the general Olmsted County population (ie, recent hospitalization, recent trauma, and active cancer).⁷ These factors failed to sufficiently characterize VTE risk among Olmsted County NH residents.²¹ However, we did not explore other clinical characteristics or functional status and mobility limitations, two measures not routinely documented in REP resources but of potential relevance for NH residents.^{17,22}

The current study addresses the recognized need for data on VTE risk among NH residents.⁸⁻¹⁴ Previous limitations are minimized by using REP resources to identify both NH VTE cases and control subjects and comprehensively explore clinical factors and then by merging with Centers of Medicare and Medicare Services (CMS) Minimum Data Set (MDS) NH assessments²³ to obtain standardized measures of functional status and mobility. Combining data from both sources will help inform practice guidelines for reducing VTE and its adverse consequences within the NH setting.

Materials and Methods

This population-based case-control study was conducted in Olmsted County, Minnesota (2010 census population = 144,248). Rochester, the county seat, is geographically isolated from other urban centers and home to Mayo Clinic, one of the world's largest medical centers. Thus, county residents receive medical care from very few providers, primarily Mayo Clinic and another group practice, Olmsted Medical Center, and affiliated hospitals.²⁴ Since 1907, every patient at Mayo is assigned a unique identifier. All information (medical history, clinical assessments, consultations, dismissal summaries, surgical procedures, laboratory/radiology/pathology/autopsy results, correspondence, and death certificates) from every contact (eg, office, NH, ED, hospital) is contained within a unit medical record. Under auspices of the REP, this

records linkage was expanded to include non-Mayo providers of care to county residents.²⁴

Study Sample

REP resources were used to identify all Olmsted County residents with symptomatic objectively diagnosed VTE.^{7,25,26} Cases included all county residents, regardless of age, sex, or symptom-onset location (eg, community, hospital, NH). Explicit case criteria were applied following medical record review from date first seen until earliest of death or last REP encounter by trained experienced nurse abstractors under direction of a board-certified vascular medicine specialist (J. A. H.). Variables abstracted included diagnostic method, symptom-onset location, and event type (DVT, PE, or both; chronic thromboembolic pulmonary hypertension). DVT was considered objectively diagnosed when acute symptoms/signs were present and confirmed using venography, compression venous duplex ultrasonography, impedance plethysmography, CT venography, MRI, pathology examination of surgically removed thrombus, or autopsy. PE was considered objectively diagnosed when acute symptoms/signs were present and confirmed using pulmonary angiography, ventilation and perfusion lung scan interpreted as high probability for PE, CT pulmonary angiography, MRI, pathology examination of surgically removed thrombus, or autopsy.^{7,25,26}

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For this NH study, VTE cases included all county residents with first-lifetime objectively diagnosed VTE between NH admission and discharge, regardless of symptom-onset location. Because NH residents may experience lower rates of symptom reporting, diagnostic testing, and autopsy compared with the general population,²⁷ we also included events that only met possible VTE criteria (physician-diagnosed DVT/PE plus signs/symptoms consistent with DVT/PE and anticoagulant treatment or surgical procedure for DVT/PE).⁴

REP resources also afford enumeration of the entire Olmsted County population from which non-VTE control subjects can be sampled.²⁸ Similar to REP studies of VTE within the general population,^{25,26} for each NH case, all Olmsted County residents of same sex, similar birth year (± 1 year), and an REP encounter within ± 1 year of case subject's VTE were identified as potential control subjects.

Information on NH residency of potential control subjects was facilitated with access to Minnesota CMS MDS NH assessments.²³ MDS was developed following the Omnibus Budget Reconciliation Act requirement that all Medicare- and Medicaid-certified long-term care facilities assess each resident (regardless of payer status) at specified times throughout their stay. Each individual is assigned an anonymous identifier that is maintained for all admissions across all facilities. Assessments include resident and NH identifiers, admission/discharge/assessment dates, admission source, discharge disposition, and reason for assessment. From the list of all potential control subjects for each case, REP and MDS data on sex, birth date, death date, Social Security number, and other information were used to select two individuals who were local NH residents. For each NH case without hospitalization 3 months before index, we additionally identified three to four nonhospitalized NH control subjects. The study period was October 1, 1998 (date MDS files became available for research) through December 31, 2005.

This study was approved by Mayo Clinic (PR07-006750-06) and Olmsted Medical Center (011-OMC-08) institutional review boards. Informed consent was obtained from individuals for medical data use; those who declined authorization for use of medical records in research were excluded (typically $< 6\%$ in REP studies).^{29,30}

VTE Risk Factors

Each subject was assigned an index date (VTE date for cases, REP encounter date for matched control subjects). Using definitions and abstraction protocols used in REP general population studies,^{6,7,26} nurse abstractors reviewed REP medical records for demographic and clinical characteristics to be investigated as potential VTE risk factors (e-Appendix 1). REP data were supplemented with CMS MDS data. MDS assessments include standardized information on demographics/cognition/communication/hearing/vision/mood/behavior/and activity, physical functioning and structural problems, psychosocial well-being, continence, selected diagnoses/health conditions, oral/nutritional/dental status, skin condition, medications, special treatments/procedures, discharge potential, and overall status.²² Our use of MDS benefitted from previous experience using NH assessment data.^{16,21,31-34}

MDS includes > 400 variables; $> 90\%$ were excluded from consideration because (1) they were of limited relevance for VTE risk, (2) REP afforded better information,¹⁶ or (3) $> 20\%$ of subjects were missing data. Availability of information varies by assessment type. We considered all assessment types, preferring admission, annual, or quarterly assessments; those conducted for significant change in status; or those required by Medicare within 100 days following NH admission/readmission. We selected closest assessment before index for cases and before or after index for control subjects.

Statistical Analysis

REP and MDS characteristics were summarized using descriptive statistics. All variables under consideration were modeled univariately (ie, unadjusted for other variables) using conditional logistic regression. To identify a multivariable model including REP and MDS characteristics, we used stepwise conditional logistic modeling with P value $< .05$ to enter and leave the model (Score and Wald statistics, respectively). Interactions between remaining variables and age, sex, and calendar year were assessed. Diagnostics (eg, influence statistics) were used to assess model fit. Two analyses were conducted: first, considering all cases and matched control subjects; second, considering nonhospitalized cases and separately matched nonhospitalized control subjects.

TABLE 1 Selected Characteristics of Olmsted County Residents Who Experienced a First Lifetime VTE While a Resident of a Local NH (Cases) October 1, 1998, Through December 31, 2005, and Age- and Sex-Matched NH Residents Who Had Not Experienced a VTE (Control Subjects)

Resident Characteristics	Cases (n = 91)	Control Subjects (n = 180)	OR (95% CI)	Overall P Value ^a
Age, mean (SD), y	83.1 (9.4)	83.2 (9.2)	0.99 (0.60-1.64)	.98
Female sex	66 (72)	131 (73)	NA	NA
Race/ethnicity (non-Hispanic white, yes)	91 (100)	176 (98)	NA	.16
Education level				.46
Did not graduate high school	25 (27)	50 (28)	Reference	
High school graduate	33 (36)	56 (31)	1.17 (0.57-2.41)	
Some college	22 (24)	34 (19)	1.25 (0.57-2.73)	
Bachelor's degree	4 (4.4)	20 (11)	0.44 (0.14-1.43)	
Graduate degree	5 (5.5)	6 (3.3)	1.60 (0.46-5.51)	
Type of VTE ^b				NA
DVT alone	63 (69)	NA	NA	
PE alone	20 (22)	NA	NA	
DVT and PE	8 (8.8)	NA	NA	

Data are presented as No. (%) unless otherwise noted. NA = not applicable; NH = nursing home; PE = pulmonary embolism.

^aP value from Score test.

^bOf 71 DVT events, six were proximal arm DVT, and all remaining were proximal or distal leg DVT. There were no abdominal or cerebral vein thromboses.

TABLE 2] CMS MDS Data: Univariate Analyses (ie, Unadjusted for Other Variables) of Selected Baseline NH Characteristics as Potential Risk Factors for DVT or PE Among Olmsted County Residents of Local NHs October 1, 1998, Through December 31, 2005

Selected NH Characteristics	Cases (n = 91)	Control Subjects (n = 180)	OR (95% CI)	Overall P Value ^a
Admission source ^b				.59
Private home	4 (4.4)	10 (5.6)	...	
Board and care/assisted living/group home	4 (4.4)	11 (6.1)	...	
NH	6 (6.6)	10 (5.6)	...	
Hospital	74 (81)	135 (75)	...	
Other or unknown	3 (3.3)	14 (7.8)	...	
Days in NH, ^c median (25th-75th %)	63 (19-420)	16 (2-126)	1.02 (1.00-1.05)	.021
Short-term memory problem, ^d yes	48 (53)	83 (46)	1.35 (0.80-2.30)	.26
Long-term memory problem, ^d yes	31 (34)	62 (34)	0.99 (0.58-1.69)	.96
Bed mobility ^d				.006
Independent or supervision only	20 (22)	65 (36)	Reference	
Limited assistance	17 (19)	45 (25)	1.22 (0.57-2.62)	
Extensive or total assistance	54 (59)	70 (39)	2.50 (1.33-4.70)	
Transfer ^d				.0002
Independent or supervision only	16 (18)	57 (32)	Reference	
Limited assistance	13 (14)	48 (27)	1.01 (0.43-2.34)	
Extensive or total assistance	62 (68)	75 (42)	3.25 (1.60-6.59)	
Walk-in room ^d				< .0001
Independent or supervision only	14 (15)	62 (34)	Reference	
Limited assistance	15 (16)	44 (24)	1.56 (0.67-3.65)	
Extensive or total assistance or did not occur	62 (68)	74 (41)	4.75 (2.23-10.14)	
Walk-in corridor on unit ^d				.0004
Independent or supervision only	14 (15)	55 (31)	Reference	
Limited assistance	8 (8.8)	31 (17)	1.03 (0.37-2.84)	
Extensive or total assistance or did not occur	69 (76)	94 (52)	3.63 (1.69-7.80)	
Locomotion on unit ^{d,e}				.059
Independent or supervision only	17 (19)	58 (32)	Reference	
Limited assistance	18 (20)	29 (16)	2.07 (0.92-4.62)	
Extensive or total assistance or did not occur	56 (62)	93 (52)	2.13 (1.11-4.08)	
Locomotion off unit ^{d,e}				.023
Independent or supervision only	13 (14)	48 (27)	Reference	
Limited assistance	9 (9.9)	26 (14)	1.30 (0.49-3.42)	
Extensive or total assistance or did not occur	69 (76)	106 (59)	2.40 (1.20-4.80)	
Leg voluntary movement				.022
No limitation	51 (56)	127 (71)	Reference	
Limitation on one side	29 (32)	46 (26)	1.55 (0.85-2.85)	
Limitation on both sides	10 (11)	6 (3.3)	3.35 (1.21-9.29)	
Foot range of motion				.037
No limitation	65 (71)	152 (84)	Reference	
Limitation on one side	17 (19)	15 (8.3)	2.46 (1.19-5.11)	

(Continued)

TABLE 2] (continued)

Selected NH Characteristics	Cases (n = 91)	Control Subjects (n = 180)	OR (95% CI)	Overall P Value ^a
Limitation on both sides	8 (8.8)	12 (6.7)	1.44 (0.59-3.55)	.012
Foot voluntary movement				
No limitation	63 (69)	154 (86)	Reference	
Limitation on one side	18 (20)	16 (8.9)	2.42 (1.19-4.92)	.012
Limitation on both sides	9 (10)	9 (5.0)	2.31 (0.88-6.03)	
Change in care needs ^f				
No change	51 (56)	70 (39)	Reference	.012
Improved	14 (15)	25 (14)	0.71 (0.33-1.52)	
Deteriorated	25 (28)	84 (47)	0.42 (0.24-0.75)	

Data are presented as No. (%) unless otherwise noted. For cases, baseline was defined as date of the assessment that was closest to but before index. For control subjects, baseline was defined as date of the assessment that was closest to index. CMS = Centers for Medicare and Medicaid Services; MDS = Minimum Data Set. See Table 1 legend for expansion of other abbreviations.

^aP value from Score test.

^bSource of admission for most recent NH admission. As is apparent from interquartile range for number of NH days and, as suggested here, date of index minus date of most recent admission could be far greater than 3 mo before index.

^cDays were calculated as index date minus most recent NH admission date. For NH residents whose most recent admission was before study start date of October 1, 1998, days were calculated as index date minus October 1, 1998. OR values are for each 30-d increase in stay.

^dFrom baseline MDS assessment; data represent activity within the prior 7 d.

^eWalking or self-sufficient wheeling.

^fFrom variable Q2 on baseline MDS assessment; data represent comparison of baseline care needs to those 90 d prior (or to those at last assessment if <90 d ago).

Results

Ninety-nine Olmsted County residents experienced first-lifetime symptomatic VTE from October 1, 1998, through December 31, 2005, after admission to and before discharge from any of nine NHs within or bordering Olmsted County. Analyses were limited to matched sets where the case and at least one control subject had an MDS assessment of the preferred types within 6 months of index (91 cases, 180 control subjects). Twenty-eight cases (31%) were PE $\pm$ DVT; 63 (69%) were DVT alone. Eighty-seven cases (96%) met criteria for objectively diagnosed VTE. Case subjects and control subjects exhibited similar age and sex distributions, because of matching; race/ethnicity and education were also similar (Table 1).

Table 2 provides univariate analyses results for selected characteristics obtained from MDS. All results for which case subjects differed significantly from control subjects are provided; some nonsignificant characteristics associated with VTE in other NH studies are included.^{16,17,22} Source of most recent NH admission appeared similar. Number of NH days (ie, index date minus most recent admission date) was significantly higher for case vs control subjects. Of multiple MDS mobility measures, several differed significantly between case and control subjects. Case subjects also exhibited a nonsignificant trend for

greater need for assistance with locomotion on unit. None of the other 38 MDS characteristics considered in univariate analyses differed significantly between case and control subjects (data upon request).

Table 3 provides univariate analyses results for characteristics obtained from REP record review. Of all characteristics included in e-Appendix 1, Table 3 includes all those for which case subjects differed significantly from control subjects plus selected others frequently implicated as VTE risk factors in community or hospital studies. Hospitalization was not significant; P values with and without surgery were .38 and .61, respectively. Significant differences were limited to superficial vein thrombosis, varicose veins, neurologic disease with leg paresis, β -blockers, central venous catheter, general surgery, and infection. For 66% of cases and 78% of control subjects with pharmacologic prophylaxis, hospitalization was determined by nurse abstractors to be the indication for prophylaxis. Thus, the remaining 34% of cases and 22% of control subjects represented chronic anticoagulation for another indication (eg, atrial fibrillation, mechanical heart valve, and so forth). The median durations of heparin (7.0 days vs 4.0 days) and warfarin (13.5 days vs 7.5 days) prophylaxis were longer for case subjects than control subjects. However, the time from prophylaxis stop date to index

TABLE 3] REP Data: Univariate Analyses (ie, Unadjusted for Other Variables) of Selected Baseline Clinical Characteristics as Potential Risk Factors for DVT or PE Among Olmsted County Residents of Local NHs October 1, 1998, Through December 31, 2005

Selected Clinical Characteristics	Cases (n = 91)	Control Subjects (n = 180)	OR (95% CI)	Overall P Value ^a
BMI, mean (SD)				
5-unit increase	26.4 (5.0)	25.7 (7.0)	1.10 (0.89-1.36)	.37
Weight groups (BMI category)				.14
Normal, ≥ 18.5 and < 25	38 (42)	80 (44)	Reference	
Underweight, < 18.5	3 (3.3)	18 (10)	0.33 (0.09-1.25)	
Overweight, ≥ 25 and < 30	31 (34)	46 (26)	1.40 (0.74-2.63)	
Obese, ≥ 30	19 (21)	36 (20)	1.14 (0.55-2.34)	
Superficial thrombosis, yes	18 (20)	14 (7.8)	2.94 (1.34-6.46)	.005
Diabetes mellitus, yes	20 (22)	35 (19)	1.17 (0.62-2.18)	.63
Varicose vein groups				.03
No clinical diagnosis, no treatment	56 (62)	130 (72)	Reference	
Clinical diagnosis	23 (25)	41 (23)	1.35 (0.73-2.50)	
Treatment	12 (13)	9 (5.0)	3.35 (1.27-8.79)	
Neurologic disease (leg paresis), yes	10 (11)	4 (2.2)	4.79 (1.50-15.33)	.004
Systemic lupus erythematosus, yes	1 (1.1)	0 (0.0)	NA	NA
Trauma/fracture, ^b yes	28 (31)	41 (23)	1.52 (0.85-2.74)	.16
Any prophylaxis, ^c yes	55 (60)	106 (59)	1.06 (0.63-1.80)	.82
Estrogen/progesterone, yes	8 (8.8)	20 (11)	0.74 (0.30-1.81)	.51
Lipid-lowering drugs, ^d yes	20 (22)	39 (22)	1.02 (0.56-1.86)	.96
β-Blocker group				.02
No β -blocker	43 (47)	101 (56)	Reference	
β -Blocker only	43 (47)	56 (31)	1.87 (1.08-3.27)	
β -Blocker plus thiazide	5 (5.5)	23 (13)	0.54 (0.19-1.52)	
Central venous catheter, yes	17 (19)	18 (10)	2.11 (0.99, 4.53)	.05
Chronic lung disease	30 (33)	56 (31)	1.06 (0.63-1.80)	.82
Congestive heart failure	34 (37)	59 (33)	1.22 (0.72-2.08)	.46
Infection groups				<.001
No infection, no fever, no antibiotic	19 (21)	81 (45)	Reference	
Nonrespiratory infection or fever or antibiotic	35 (38)	69 (38)	2.01 (1.04-3.91)	
Respiratory infection ^e	37 (41)	30 (17)	4.85 (2.39-9.86)	
Active malignancy, yes	10 (11)	15 (8.3)	1.29 (0.52-3.20)	.58
General surgery, yes	12 (13)	10 (5.6)	2.78 (1.07-7.20)	.03
Orthopedic surgery, yes	20 (22)	35 (19)	1.19 (0.64-2.22)	.59
Any major surgery ^f or anesthesia, ^g yes	45 (50)	74 (41)	1.45 (0.85-2.47)	.18
Hospitalization groups				.27
No hospitalization	23 (25)	46 (26)	Reference	

(Continued)

TABLE 3] (continued)

Selected Clinical Characteristics	Cases (n = 91)	Control Subjects (n = 180)	OR (95% CI)	Overall P Value ^a
Hospitalization without surgery	35 (38)	84 (47)	0.84 (0.43-1.63)	
Hospitalization with surgery	33 (36)	50 (28)	1.40 (0.67-2.93)	

Data are presented as No. (%) unless otherwise noted. For each variable, information had to be documented in the medical records within 3 mo before index, except for diabetes, superficial vein thrombosis, and varicose veins (any time before index) and active malignancy ($\pm$ 3 mo of index). REP = Rochester Epidemiology Project. See Table 1 legend for expansion of other abbreviations.

^aP value from Score test.

^bFracture defined as radiologic confirmed major fracture (skull, mandible, ribs, spine, pelvis, long bones) or fracture of lower extremity bones (ankle, metatarsals, phalanges) requiring immobilization by casting/boot; trauma defined as any of the following resulting in hospital admission: fracture as defined previously or multiple rib fractures or severe soft tissue injury or suspected internal injuries.

^cHeparin, warfarin, or mechanical.

^dIncludes statin and nonstatin.

^eRespiratory infection includes clinical diagnoses of influenza, pneumonia, lower respiratory infection (including bronchitis), and upper respiratory infection (including sinusitis).

^fIncludes general surgery, orthopedic surgery, neurosurgery, gynecologic surgery, cardiac surgery, or anesthesia.

^gAnesthesia includes general anesthesia and epidural/spinal anesthesia, as well as conscious sedation, nerve block, and other regional anesthesia (eg, for biopsy, upper and lower GI endoscopy, bronchoscopy, transesophageal echocardiography, cystoscopy, and so forth).

date was longer for case subjects (16.5 days) compared with control subjects (4.0 days).

Multivariate analyses included all REP characteristics listed in e-Appendix 1 and 12 MDS mobility variables. The final model consisted of only three characteristics that were independently associated with VTE risk (Table 4). With “infection groups” categorized as shown, the OR (95% CI) for “respiratory infection” was 5.86 (2.62-13.09). To investigate whether this association resulted from misclassification of PE

symptoms as “respiratory infection,” medical records of all 16 PE events with relevant diagnoses were reviewed; respiratory infection was confirmed by radiograph or culture for 15. Moreover, “respiratory infection” was significantly associated with both PE and DVT (data upon request). The second variable to enter the model was “walking in room”; categorized as shown, the OR (95% CI) for “extensive or total assistance” was 5.57 (2.46-12.61). General surgery was the last variable in the final model; OR (95% CI) was 3.32 (1.02-10.84).

TABLE 4] Combined REP and CMS MDS Data: Final Results From Multivariate Analyses of Clinical Plus NH Characteristics as Potential Risk Factors for DVT or PE Among Olmsted County Residents of Local NHs October 1, 1998, Through December 31, 2005, Including All 91 NH VTE Cases and 180 NH Non-VTE Control Subjects

Baseline ^a Characteristics	OR (95% CI)	P Value
Infection groups		< .0001 ^b
No infection, no fever, no antibiotic	Reference	
Nonrespiratory infection or fever or antibiotic	2.01 (0.97-4.17)	.06 ^c
Respiratory infection	5.86 (2.62-13.09)	< .0001 ^c
Walk-in room ^d		< .0001 ^b
Independent or supervision only	Reference	
Limited assistance	1.34 (0.51-3.53)	.55 ^c
Extensive or total assistance or did not occur	5.57 (2.46-12.61)	< .0001 ^c
General surgery, yes	3.32 (1.02-10.84)	.04 ^b

See Table 1-3 legends for expansion of abbreviations.

^aBaseline was defined differently for clinical and NH characteristics. For clinical characteristics, baseline information had to be documented in REP medical records within 3 mo before index, except for diabetes, superficial vein thrombosis, varicose veins (any time before index), and active malignancy ($\pm$ 3 mo of index). For NH characteristics, baseline for cases was date of the MDS assessment that was closest to but before index, and baseline for control subjects was date of the assessment that was closest to index.

^bP value from Score test.

^cP value from Wald test.

^dFrom baseline MDS assessment; data represent activity within the prior 7 d.

TABLE 5] Combined REP and CMS MDS Data: Final Results From Multivariate Analyses of Clinical Plus NH Characteristics as Potential Risk Factors for DVT or PE Among Olmsted County Residents of Local NHs October 1, 1998, Through December 31, 2005, Limited to the 23 NH VTE Cases and Respective 92 NH Non-VTE Control Subjects Not Hospitalized Within 3 Mo Before Index

Baseline ^a Characteristics	OR (95% CI)	P Value
Infection groups		.0002 ^b
No infection, no fever, no antibiotic	Reference	
Nonrespiratory infection or fever or antibiotic	8.83 (2.66-29.24)	.0004 ^c
Respiratory infection	3.27 (0.78-13.63)	.10 ^c

See Table 1-3 legends for expansion of abbreviations.

^aBaseline was defined differently for clinical and NH characteristics. For clinical characteristics, baseline information had to be documented in REP medical records within 3 mo before index, except for diabetes, superficial vein thrombosis, varicose veins (any time before index) and active malignancy (± 3 mo of index). For NH characteristics, baseline for cases was date of the MDS assessment that was closest to but before index, and baseline for control subjects was date of the assessment that was closest to index.

^bP value from Score test.

^cP value from Wald test.

To consider lower rates of diagnostic testing and/or autopsy among NH residents compared with community-dwelling individuals,²⁷ this study included possible as well as objectively diagnosed VTE events. Results were essentially unchanged after excluding the four possible cases and respective control subjects (data upon request).

There were 23 NH VTE cases without hospitalization 3 months before index and 91 age-, sex-, and calendar year-matched nonhospitalized NH control subjects. Table 5 provides multivariate analyses results. Infection was the only variable to enter and remain in the model. Need for assistance with self-transfer, indicative of substantial immobility, reached borderline significance only, likely because of insufficient sample size.

Discussion

This population-based study provides some of the first reliable data, to our knowledge, on characteristics associated with VTE risk among NH residents. Of numerous characteristics examined, the only independent risk factors were infection, marked immobility, and general surgery. Although these factors have been independently associated with VTE risk in some general population or hospital studies,^{1,35-38} we found higher OR values for infection and immobility among NH residents. Importantly, we did not find independent associations between VTE risk and most risk factors identified in community and hospital studies. These findings reinforce our previous report that three characteristics known to account for a substantial proportion of VTE events in the general population (ie, recent hospitalization, recent trauma,

active cancer) exhibited markedly lower OR values within the NH population.²¹

VTE prophylaxis recommendations for nonsurgical NH residents, typically, distinguish acute from chronic, stable illness.^{5,9,18} Such distinction may be questioned by our observations that, compared with matched control subjects, NH case subjects exhibited (1) a lower percentage with change in care needs at their baseline assessment, and (2) similar percentages with recent hospitalization, and that infection was an independent risk factor, both overall and for nonhospitalized NH residents.

Study strengths include the complete spectrum of recognized NH VTE, including fatal and nonhospitalized events. VTE was defined using strict criteria following review of detailed provider-linked medical records (including imaging/surgical/autopsy reports). Incident VTE was distinguished from recurrent events and sequelae. NH control subjects were drawn from the same community; individuals with prior VTE were excluded as control subjects. Subjects were followed across acute and long-term care settings, permitting investigation of simultaneous contributions of clinical and NH assessment data to VTE risk. To our knowledge, no other studies have accessed both clinical and NH sources to carefully identify and fully characterize NH VTE.

Estimates are for a single geographic population, which in 2010 was 86% white. Olmsted County is similar to all Upper Midwest states with respect to age, sex, and racial distributions, as well as chronic disease prevalence and medical care use; however, median income and education are higher.^{24,39,40} Of note, VTE risk factors

identified for all Olmsted County residents^{6,26} are similar to those for other population-based studies that carefully ascertained VTE.^{1,35} Although no single geographic area is representative of all others, the underrepresentation of minorities and relatively few providers compromises the generalizability of study findings to racial/ethnic groups and health-care environments different from those represented. Some PE events are only identified at autopsy. Recognized low autopsy rates for NH residents²⁷ may have resulted in missing events. NH residency as of index was required for all subjects; however, cases and control subjects were not matched on length of NH exposure (defined as index minus most recent admission). By definition, residents with more NH person-days at risk have greater (cumulative) probability of experiencing VTE as an NH resident. Thus, the greater NH days for case subjects compared with control subjects was likely attributable to study design, and number of NH days was not allowed to compete in the multivariate model. To address concerns regarding differential exposure, a separate analysis was conducted in which NH days were added to the final model. Findings were essentially unchanged (data upon request).

In conclusion, study findings caution against using results from non-NH populations to inform practice guidelines for NH residents. Findings also suggest that NH residents with infection, substantial mobility limitations, or recent general surgery should be considered potential candidates for VTE prophylaxis. Of concern, however, is that although we previously showed that pharmacologic thromboprophylaxis rates within 3 months before index appeared higher for NH VTE cases and control subjects compared with the elderly population generally, the prophylaxis failure rate among NH residents was disturbingly high.²¹ Moreover, decisions regarding which NH residents to prophylax involve multiple considerations separate from VTE risk (eg, clinical contraindications, reduced life expectancy, patient/caregiver wishes, quality-of-life issues). These concerns emphasize the need for further investigation regarding costs and benefits of pharmacologic prophylaxis within the NH population. Only a clinical trial can answer questions regarding the efficacy and safety of such prophylaxis. Our goal is to inform such a trial by identifying those high VTE-risk NH residents who would potentially benefit most from thromboprophylaxis.

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