Low Rates of Bone Health Evaluation Before and After Primary Fragility Fractures

Diane Ghanem[1], Victoria E Bergstein, Henry Tout Shu[2], Bradley James Siler, William Green, Eve Rachel Glenn[3], Babar Shafiq[4], Alice Hughes, Rachel Beth Sotsky
[1]The Johns Hopkins Hospital, [2]The Johns Hopkins University, [3]The Johns Hopkins University School of Medicine, [4]Johns Hopkins University

INTRODUCTION:

Osteoporotic fractures pose a critical challenge in patient care, with earlier work pointing to a significant shortfall in preventing subsequent fractures. The purpose of this study is to determine the rate and predictors of bone health evaluations (BHE) before and after a first-time fragility fracture and assess the imminent risk of a subsequent fracture.

METHODS:

This is a retrospective cohort study at an academic Level I trauma center. Chart reviews of patients 60 years and older who underwent surgical treatment for hip, pelvis, wrist, humerus, or femur fractures resulting from low-energy mechanisms (such as a ground-level fall) between 2012 and 2022 were conducted. To ensure the study focused solely on fragility fractures, patients with a history of pathologic fractures, malignant neoplasms, or metabolic and autoimmune diseases affecting bone density were excluded. Demographic data, medical history, and details regarding BHE and fracture characteristics of patients with primary fragility fractures were collected. BHE was defined as a management/education session, with or without a DEXA scan, conducted by a specialist (Primary Care Physician, Physician Assistant, Endocrinologist, or Orthopaedic Surgeon).

RESULTS:

602 patients (71% female; median age 78 [IQR: 68-87]) with primary fragility fractures were identified. Within this cohort, only 13 (2.2%) had a documented BHE before fracture. Of the remaining 589 patients, 178 (30.2%) were referred for BHE after primary fragility fracture, but only 27 (4.6%) received it. Secondary fragility fractures were diagnosed in 69 patients (11.5%). Among this group, no statistically significant differences were found with respect to patient characteristics or demographics. The average time between primary and secondary fragility fractures was 2.2 years [IQR: 1.04-3.75]. When comparing patients with and without secondary fragility fractures, there was no statistically significant difference in the overall rate of BHEs. Younger patients (p=0.015) or those with a family history of osteoporosis (p<0.001) were more likely to seek BHE.

DISCUSSION AND CONCLUSION:

There is a marked scarcity of BHEs both before and after primary fragility fractures, despite the established risks. Much work needs to be done to improve referral and patient participation in bone health evaluations after first-time fragility fracture.

Supplemental Table 1. Multivariable Logistic Regression Model 1 for Risk of Secondary Fracture.
Primary Variable of interest: Bone health eval
Other variables chosen based on clinical relevance

Variable	Odds Ratio	95% Confidence Interval
Male gender	0.93	0.50-1.72
Age	1.02	0.99-1.04
Obese (BMI >30)	1.42	0.74-2.74
Physical activity	1.00	0.55-1.80
Previous Osteopenia treatment	**2.34**	**1.28-4.31**
Bone health **evaluation** AFTER primary fracture**	2.28	0.85-6.08

**Patients with previous bone health analysis before primary fragility fracture were excluded from this specific analysis.

Boldface indicates statistical significance.

Multivariable logistic regression performed with Stata Version 18.0
Patients with missing variables were excluded.
AUC:0.618
N=585

Table 1. Rates of Secondary Fracture and Bone Health Evaluations in patients with Primary Fragility Fractures

Variable	Number (N=602)
Bone health evaluation BEFORE primary fracture	13 (2.2%)
Bone health evaluation referral AFTER primary fracture	178 (30.2%)
Bone health evaluation AFTER primary fracture	27 (4.6%)
Secondary Fracture	69 (11.5%)

Table 2. Patient Characteristics and Demographics of patients with and without a secondary fragility fracture.

Variable	Overall (N=602)	No Secondary Fracture (N=533)	Secondary Fracture (N=69)	P-Value
Gender (Female)	429 (71%)	377 (71%)	52 (75%)	0.424
Age	78 [68-87]	78 [68–87]	80 [69-87]	0.370
BMI	24.1 [21.3-27.8]	24.0 [21.3-27.6]	24.4 [21.2-29.7]	0.420
LMP	49 [45-51]	49 [45-50]	50 [48-55]	0.200
Vitamin D level	32 [20-45]	32 [19-45]	38 [26-48]	0.254
Calcium Supplementation	185 (31%)	168 (32%)	17 (25%)	0.244
Vitamin D supplementation	297 (49%)	258 (48%)	39 (57%)	0.204
Type 2 diabetes mellitus	173 (29%)	152 (29%)	21 (30%)	0.741
Hypertension	466 (77%)	414 (78%)	52 (75%)	0.666
Self-reported physical activity	314 (52%)	272 (51%)	42 (61%)	0.124
Self-reported weightbearing exercise	325 (54%)	281 (53%)	44 (64%)	0.083
Any caffeine intake	117 (19%)	98 (18%)	19 (27%)	0.071
Any alcohol use	163 (27%)	147 (28%)	16 (23%)	0.440
Prior tobacco use	192 (32%)	175 (33%)	17 (25%)	0.172
Active tobacco use	57 (9%)	51 (10%)	6 (9%)	0.819
Active GCS use	111 (18%)	97 (18%)	14 (20%)	0.673
Seizure medication	72 (12%)	65 (12%)	7 (10%)	0.621
Drug use	31 (5%)	29 (5%)	2 (3%)	0.369
Family history of osteoporosis	27 (4%)	25 (5%)	2 (3%)	0.499

Values are reported as Median [Interquartile range] or N (Percent) as appropriate. Continuous variables were assessed for normality via Shapiro-Wilk's test. As no continuous variables were determined to be normally distributed, Mann-U Whitney testing was performed to determine P-values for continuous variables. P-values from categorical variables were obtained from Chi-squared testing.

Boldface indicates P<0.5.

BMI: Body mass index
LMP: Age of last menstrual period
GCS: Glucocorticosteroid

Table 3. Fracture characteristics and osteoporosis treatments of those with and without secondary fragility fractures.

Variable	Overall (N=602)	No Secondary Fracture (N=533)	Secondary Fracture (N=69)	P-Value
Previous osteopenia treatment	140 (23%)	114 (21%)	26 (38%)	**0.002**
Bisphosphonates	30 (5%)	22 (4%)	8 (12%)	**0.006**
Teriparatide	1 (0.2%)	1 (0.2%)	0 (0%)	0.721
SERM	1 (0.2%)	1 (0.2%)	0 (0%)	0.721
Calcitonin	3 (1%)	2 (0.4%)	1 (1%)	0.227
Denosumab	4 (1%)	4 (1%)	0 (0%)	0.474
Calcium supplementation	78 (13%)	67 (13%)	11 (16%)	0.405
Vitamin D	122 (20%)	99 (19%)	23 (34%)	**0.003**
Location of Primary fracture				
Spine	2 (0.3%)	2 (0.4%)	0 (0%)	0.610
Hip	325 (54%)	291 (55%)	34 (49%)	0.404
Wrist	80 (13%)	68 (13%)	12 (17%)	0.286
Humerus	41 (7%)	34 (6%)	7 (10%)	0.243
Pelvis	7 (1%)	6 (1%)	1 (1%)	0.814
Shaft & distal femur	154 (26%)	144 (27%)	14 (20%)	0.232
Other	18 (3%)	13 (2%)	5 (7%)	**0.027**
Previous osteoporosis diagnosis (before fracture)	173 (29%)	156 (29%)	17 (25%)	0.424
Osteoporosis treatment AFTER primary fragility fracture	65 (11%)	56 (10%)	9 (13%)	0.523
Bone health evaluation **referral** AFTER primary fracture	184 (31%)	156 (29%)	28 (41%)	0.055
Bone health **evaluation** AFTER primary fracture	33 (5%)	27 (5%)	6 (9%)	0.213
Location of secondary fracture	N/A	N/A	N/A	N/A
Spine	N/A	N/A	1 (1%)	N/A
Hip	N/A	N/A	37 (54%)	N/A
Wrist	N/A	N/A	6 (9%)	N/A
Humerus	N/A	N/A	5 (7%)	N/A
Pelvis	N/A	N/A	2 (3%)	N/A
Shaft & distal femur	N/A	N/A	14 (21%)	N/A
Other	N/A	N/A	5 (7%)	N/A

Values are reported as N (Percent). P-values from categorical variables were obtained from Chi-squared testing.
Boldface indicates P<0.5.
SERM: Selective estrogen receptor modulator

Table 4. Patient characteristics and demographics of patients who sought bone health evaluation versus those who did not.

Variable	No Bone Health Evaluation (N=154)	Bone Health Evaluation (N=24)	P-Value
Gender (Female)	114 (74%)	22 (92%)	0.058
Age	**80 [71-87]**	**72 [66-82]**	**0.015**
BMI	23.5 [21.0-27.2]	24.9 [21.0-30.0]	0.200
LMP	49 [45-52]	50 [48-54]	0.325
Vitamin D level	32 [20-41]	30 [22-43]	0.887
Calcium Supplementation	56 (36%)	11 (46%)	0.373
Vitamin D supplementation	79 (51%)	16 (67%)	0.160
Type 2 diabetes mellitus	40 (26%)	7 (29%)	0.741
Hypertension	121 (79%)	18 (75%)	0.694
Self-reported physical activity	85 (55%)	14 (58%)	0.773
Self-reported weightbearing exercise	87 (56%)	14 (58%)	0.866
Any caffeine intake	**29 (19%)**	**9 (38%)**	**0.038**
Any alcohol use	**28 (18%)**	**10 (42%)**	**0.009**
Prior tobacco use	49 (32%)	5 (21%)	0.276
Active tobacco use	10 (6%)	2 (8%)	0.738
Active GCS use	31 (20%)	4 (17%)	0.691
Seizure medication	25 (16%)	1 (4%)	0.119
Drug use	7 (5%)	1 (4%)	0.934
Family history of osteoporosis	**7 (5%)**	**7 (29%)**	**<0.001**
Secondary fracture	23 (15%)	5 (21%)	0.460

Values are reported as Median [Interquartile range] or N (Percent) as appropriate. Continuous variables were assessed for normality via Shapiro-Wilk's test. As no continuous variables were determined to be normally distributed, Mann-U Whitney testing was performed to determine P-values for continuous variables. P-values from categorical variables were obtained from Chi-squared testing.
Boldface indicates P<0.5.
BMI: Body mass index
LMP: Age of last menstrual period
GCS: Glucocorticosteroid

Table 5. Fracture characteristics and osteoporosis treatments patients who sought bone health evaluation versus those who did not.

Variable	No Bone Health Evaluation (N=154)	Bone Health Evaluation (N=24)	P-Value
Previous osteopenia treatment	39 (26%)	6 (25%)	0.945
Bisphosphonates	8 (5%)	3 (13%)	0.170
Teriparatide	**0 (0%)**	**1 (4%)**	**0.011**
SERM	0 (0%)	0 (0%)	N/A
Calcitonin	1 (1%)	1 (4%)	0.130
Denosumab	1 (1%)	0 (0%)	0.691
Calcium supplementation	21 (14%)	5 (21%)	0.360
Vitamin D	36 (24%)	6 (25%)	0.875
Location of Primary fracture			
Spine	0 (0%)	0 (0%)	N/A
Hip	97 (63%)	13 (54%)	0.408
Wrist	**13 (8%)**	**6 (25%)**	**0.015**
Humerus	7 (5%)	2 (8%)	0.431
Pelvis	3 (2%)	0 (0%)	0.490
Shaft & distal femur	41 (27%)	3 (13%)	0.136
Other	6 (4%)	1 (4%)	0.949
Previous osteoporosis diagnosis (before fracture)	**43 (28%)**	**15 (63%)**	**0.001**
Osteoporosis treatment AFTER primary fragility fracture	**16 (10%)**	**10 (42%)**	**<0.001**
Bisphosphonates	**11 (7%)**	**9 (38%)**	**<0.001**
Teriparatide	**0 (0%)**	**1 (4%)**	**0.011**
SERM	**0 (0%)**	**1 (4%)**	**0.011**
Calcitonin	1 (1%)	0 (0%)	0.692
Denosumab	3 (2%)	0 (0%)	0.490
Location of secondary fracture			
Spine	**0**	**0**	**N/A**
Hip	17 (11%)	2 (8%)	0.334
Wrist	1 (1%)	1 (4%)	0.145
Humerus	1 (1%)	0 (0%)	0.671
Pelvis	1 (1%)	0 (0%)	0.671
Shaft & distal femur	2 (1%)	1 (4%)	0.338
Other	1 (1%)	0 (0%)	0.671

Values are reported as N (Percent). P-values from categorical variables were obtained from Chi-squared testing.
Boldface indicates P<0.5.
SERM: Selective estrogen receptor modulator

Table 6. Multivariable Logistic Regression Model for Bone Health Evaluation

Variable	Odds Ratio	95% Confidence Interval
Age	0.94*	0.90-0.99
Prior diagnosis of osteoporosis prior to first fracture	4.55*	1.81-11.44

* indicates statistical significance.

Multivariable logistic regression performed with Stata Version 18.0
Patients with missing variables were excluded.
AUC:0.740
N=178