



High prevalence of risk factors for low bone mineral density and estimated fracture and fall risk among elderly medical inpatients: a missed opportunity

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Abstract

Aims (1) To calculate the absolute fracture risk by using the fracture risk assessment (FRAX) model among elderly medical inpatients; (2) to assess the risk of falls, especially among patients with increased risk of fractures; and (3) to design and implement a bone health protocol to improve the assessment of fracture risk.

Methods The study participants were all inpatients admitted to the medical wards at University Hospital Kerry, Ireland. All consecutive eligible patients aged ≥ 65 years were prospectively evaluated to populate clinical risk factor variables used in the FRAX model and the fall assessment was made by using Fracture Risk Questionnaire.

Results Consecutive 465 medical inpatients were screened, and 200 eligible medical inpatients were evaluated. The mean age of the cohort was 73.8 ± 9 years and 56% were male. The body mass index of the cohort was 27 ± 5 , and only 21% ($n = 42$) of patients reported having ever had a DXA scan. Previous personal history of low fragility fracture was present in 20.5% ($n = 41$) of the patients. The absolute 10-year risk of major osteoporotic and hip fracture was 15 ± 12 and 7.6 ± 11 , respectively, and 25.5% ($n = 51$) and 64.5% ($n = 129$) respectively of the cohort had fracture risks exceeding the National Osteoporosis Federation (NOF) thresholds for treatment. High fall risk was noted in 63% of the cohort.

Conclusions A very high prevalence of fracture and fall risk was noted. A medical inpatient stay offers a window of opportunity for assessment of osteoporotic fracture risk. With these findings, a bone health protocol has been developed.

Keywords Bone mineral density · Fall · Fracture · Inpatients · Prevalence

Background

Osteoporosis is an increasing cause for concern. One in three women and one in five men over the age of 50 years of age may have osteoporosis [1], which is a clinically silent disease unless a fracture occurs. Our challenge is to prevent, diagnose, and treat osteoporosis before disability from fractures occurs. Typical hip fracture results in approximately 2800 hospital admissions each year and 80% are over 75 years of age with an average length of hospital stay of 18 days, and only less than one-third go directly home after their hospital admission

[2]. Importantly, these hip fractures are potentially preventable. Despite recent gains in the awareness and treatment of osteoporosis, it remains commonly undiagnosed and underappreciated.

In 2008, a WHO task force introduced a Fracture Risk Assessment Tool (FRAX), which estimates the 10-year probability of hip fracture and major osteoporotic fracture (hip, clinical spine, proximal humerus, or forearm) for untreated patients between ages 40 and 90 years by simply using easily obtainable clinical risk factors [3]. The National Osteoporosis Foundation (NOF) has recommendations of managing patients based on FRAX scores [4].

Falls, especially in the elderly, lead to an increase in the risk of hospitalization and a significant health decline. It is estimated that one in every three people over the age of 65 years and one in two people over the age of 80 fall every year [2]. In 2008, it was estimated that the current yearly economic costs of falls in older people are approximately €400 million. This could increase to €2 billion in the next 25 years in the absence

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of a strategic approach to this serious and preventable problem [2]. The average length of hospital stay following a fall is 12.7 days (average length of stay for all causes in this age group is 11.5 days). Hip fractures are one of the most serious injuries due to a fall [2].

The incidence of osteoporotic fractures increases with advancing age, and osteoporosis is often ignored in elderly patients due to other chronic illnesses. A medical inpatient stay offers a window of opportunity for assessment of osteoporotic fracture risk and the initiation of appropriate bone protection. The objective of our study was to improve the assessment of fracture risk among medical inpatients by, firstly, calculating the absolute fracture risk by examining the clinical risk factors used in the FRAX model and to determine the proportion of patients whose absolute fracture risk exceeds the NOF thresholds for treatment and secondly, to assess the risk of falls, especially among patients with increased risk of fractures, and finally, to design and implement a bone health protocol to improve the assessment of fracture risk.

Methods

This study was carried out in the setting of a secondary care referral center. The study participants were all consecutive medical patients admitted to the medical wards at University Hospital Kerry, Ireland. Patients excluded were those under the age of 65, patients who do not speak English, patients with learning difficulties, patients with a Mini-Mental State result of below 12 points, and patients who were deemed to be too ill to talk to.

All consecutive eligible patients were prospectively evaluated to populate 11 clinical risk factor variables used in the FRAX model, and fall assessment was made by using the revised Fracture Risk Questionnaire (FRQ) [5]. For the whole cohort, FRAX risk scores were calculated without information on bone density. The revised FRQ is a 12-item self-assessment questionnaire with 14 points in total and the cut-off points for fall risk are ≥ 4 [5]. Additionally, by a short interview with the patients, it was explored whether they are using any osteoporosis-related medications, or they ever had a DXA scan. The fracture risk through the FRAX model can be calculated with or without knowledge of BMD. Eleven clinical risk factors used in the FRAX calculator include age, sex, smoking status (currently smoking or not), alcohol intake (at least 3 units/day), glucocorticoid use (at least 5 mg/day of prednisolone for 3 months or equivalent), diagnosis of rheumatoid arthritis, diagnosis of a condition related to secondary osteoporosis, past fracture, and parent fracture history [3, 6]. For the entire cohort, BMI calculated from height and weight was substituted for BMD in the FRAX calculator [7]. BMI was imputed only once in the BMI section.

Statistical analysis was performed using the SPSS software, version 17. Significance was defined as $p < 0.05$ (two-tailed). A chi-square (χ^2) statistic was used to investigate the distributions of categorical variables, and continuous variables were analyzed using Student's *t* test. The study was conducted in adherence with the Declaration of Helsinki and International Committee on Harmonization good clinical practices.

Results

Overall, 465 consecutive medical inpatients were reviewed, and among them, consecutive 200 medical inpatients fulfilling the inclusion and exclusion criteria were identified and underwent further evaluation. The mean age of the cohort was 73.8 ± 9 years, and 56% were male (Table 1). The body mass index of the cohort was 27 ± 5 . Table 1 describes the prevalence of common risk factors of low BMD among this cohort of 200 patients. Only 21% ($n = 42$) of patients reported having ever had a DXA scan, but the results were available for only five patients after extensive hospital record review. Hence, for the entire cohort, BMI calculated from height and weight was substituted for BMD in the FRAX calculator.

Only 31% ($n = 62$) of the whole cohort was using some form of bone-related treatment (Table 1). High fall risk was noted in 63% of the cohort as per the FRQ score. Significantly higher number of patients with elevated fracture risk had also high risk of falls (70% vs. 50%, $p = 0.04$). Among the whole cohort, the absolute 10-year risk of major osteoporotic fracture was 15 ± 12 , and of hip fracture was 7.6 ± 11 . We noted that 64.5% ($n = 129$) of the cohort exceeded the NOF's 3% hip fracture risk threshold for treatment, and 25.5% ($n = 51$) of the cohort exceeded the NOF's 20% major fracture risk threshold and these patients were largely untreated.

Table 2 describes the gender difference as regards the presence of these clinical risk factors for low BMD. Among this cohort, although female were older, they had comparable BMI, fall risk, smoking, secondary osteoporosis, and previous history of fractures. Overall, the 10-year absolute risk for hip or any major osteoporotic fracture was much higher among female, but more of them had DXA scan and been on some bone protection therapy.

With these findings, a bone health protocol has been developed (Fig. 1). This simple one-page questionnaire will be completed on all medical inpatients aged ≥ 65 years, and the patients will be identified with high risk of fractures and falls for further management.

Discussion

This exploratory study provides a snapshot of the prevalence of significant risk factors for osteoporotic fractures. Very high

Table 1 Demographic characteristics and the brief summary of results

Total number of medical inpatients during the study period	465
Patients excluded as per the exclusion criteria	265
Age < 65 = 203	
Moderately confused elderly patients = 19	
Who do not speak English = 5	
Patients acutely unwell and/or in high dependency	
Unit/coronary care unit = 38	
Total number of patients assessed	200
Mean age of patients	73.8 ± 9 years (range)
Male	56% (n = 112)
Prevalence of risk factors for low BMD	
Previous personal history of low fragility fracture	20.5% (n = 41)
Parental history of fracture	13.5% (n = 27)
Current smoking	17% (n = 34)
Current steroids	22% (n = 44)
History of rheumatoid arthritis	7.5% (n = 15)
Secondary osteoporosis	13% (n = 26)
Usage of alcohol > 3 units	11.5% (n = 23)
Body mass index	27 ± 5
Therapies for low BMD	
Supplemented calcium and vitamin D only	48 (24%)
Oral bisphosphonates	13 (6.5%)
Hormone replacement therapy	1(0.5%)
Fall frequency	
No falls	39 (19.5%)
< 1 fall in 6 months	132 (66%)
≥ 1 fall in 6 months	29 (14.5%)
≥ 1 fall in 1 month	7 (3.5%)

prevalence of such risk factors was noted and even worryingly, was the finding of higher risk of falls which further

increases the risk of fractures. Poor screening and treatment of osteoporosis has been reported worldwide, and every effort

Table 2 Gender difference of the risk factors for low bone mineral density and estimated fracture and fall risk

Variable	Female	Male	p value
Previous history of fracture	28 (25)	28 (31)	0.90
Current smoking	15 (13)	19 (21)	0.57
Alcohol > 3 units a day	4.5 (4)	17 (19)	0.006
Secondary osteoporosis	14 (12)	12.5 (14)	0.81
High fall risk	64 (60)	62 (66)	0.87
Age	76 ± 9	72 ± 8.5	< 0.001
Body mass index	26.6 ± 4.5	27.4 ± 5.8	0.30
Already on osteoporosis treatment	50 (44)	16 (18)	< 0.001
Familiar with osteoporosis	81 (71)	48 (54)	< 0.001
Had a DXA scan	36 (32)	9 (10)	< 0.001
10-year absolute risk for “any major” fracture	22.7 ± 14.6	8.8 ± 5	< 0.001
10-year absolute risk for hip fracture	12.6 ± 14.6	3.6 ± 3.6	< 0.001
Major osteoporotic fracture (10-year risk of ≥ 20%)	52 (46)	4.6 (5)	< 0.001
Hip fracture (10-year risk of ≥ 3%)	82 (72)	51 (57)	< 0.001

Presented as percentage (numbers)

Fig. 1 Kerry Bone Health Protocol was designed before the study was initiated. This protocol, which combined clinical risk factors used to calculate FRAX score, along with information on mobility and fall frequency. Moreover, this provides guidance as regards the cut offs to consider further intervention.

Kerry Bone Health Protocol

MRN/Sticker				
1)	Age (Target 65 and above):	_____		
2)	Sex:	Male	Female	
3)	Weight (kg):	_____		
4)	Height (cm):	_____		
5)	Previous fracture?	Yes	No	
6)	Parent fracture hip?	Yes	No	
7)	Current smoking?	Yes	No	
8)	Current Steroids	Yes	No	
9)	Rheumatoid arthritis	Yes	No	
10)	Secondary osteoporosis*	Yes	No	
11)	Alcohol >3 units/day	Yes	No	
12)	Ever had a DEXA scan?	Yes	No	When? Where? Results?
13)	Are you on any supplements /treatment for osteoporosis?	Yes	No	
14)	If YES, please specify what -	HRT, Vit D/Ca, biphosphonates, Prolia, Protelos, PTH		
15)	Mobility (for majority of hours awake)	Independent	Walking aid/care assistance	Bedbound
16)	Fall frequency	<1 in 6/12 ≥1/month	1 or> in 6/12 ≥1/week	≥1/day

Click this website & calculate Fracture risk <https://www.shef.ac.uk/FRAX/tool.aspx?country=48>

10 year Major Osteoporotic Fracture Risk: ----- [Is this score ≥20%]**

10 year Hip Fracture risk: ----- [Is this score ≥3%]**

****Request DEXA scan and consider treatment accordingly**

*Secondary osteoporosis: Untreated hyperthyroidism, chronic kidney disease, type 1 DM, osteogenesis imperfecta, hypogonadism, premature menopause <45 yo, chronic malnutrition/malabsorption and chronic liver disease.

should be made to identify high-risk patients at every possible interaction with medical care.

From the clinical standpoint, the results of this study are important in a number of ways. Firstly, our study shows that the significant risk factors for fractures are not only very common among unselected medical inpatients, but also these remain unidentified. Poor screening and treatment of osteoporosis has been reported worldwide, and hence, countless

regional and international medical societies from different disciplines, such as endocrinology, rheumatology, primary care physicians, and geriatric medicine, have put forth recommendations for its screening and treatment. However, unfortunately, this has not seeped well into routine medical practices, and the findings of our study are a clear reflection of the same. A recent study, where authors used electronic patient records, has found that about 10.1% of the cohort exceeded the

NOF's 20% major fracture risk threshold and 32.5% exceeded the NOF's 3% hip fracture risk threshold [8]. In comparison, a significantly higher number of patients in our study exceeded the NOF threshold for treatment, and one plausible explanation is the older age of our cohort (mean age 73.8 years vs. 68.5 years) [8]. Similarly, another study has shown that the percentage of patients (mean age of 68.5 years) exceeding the treatment threshold was 50% [9].

Secondly, we believe that inpatient stay provides an important opportunity and in many cases, may be the first interaction with medical care to identify patients at high risk of fractures. To our knowledge, there are no widely used or recommended pathways for identifying, screening, or treating such medical inpatients. Our study highlights that the opportunity to identify such patients early is clearly missed, which can potentially lead to fractures and its associated significant negative impacts. Strategies mainly focusing on improved communication between different disciplines should be explored especially among primary care physicians, hospitalists, and geriatricians. A previous study has shown that in geriatric patients, simple educational strategies can significantly improve the assessment and management of bone health in at-risk patients [10]. Thirdly, our study showed surprisingly high prevalence of increased fall risk among unselected medical inpatients. Fall screen is the first step in preventing falls and medical inpatient stay again provides a unique opportunity to focus on assessing, prescribing, and taking action through a comprehensive multidisciplinary program. In the context of a busy clinical inpatient stay with multiple acute medical issues to address, it may not be always possible for clinicians to provide an interdisciplinary plan for patients at high risk of falls. However, we believe that through simple falls screening assessments for elderly patients, at-risk patients can be identified and if needed, referrals can be arranged to other affiliated departments and specialty providers who can further assist in fall prevention. Customized patient care plans and individualized recommendations to prevent falls are the ways forward.

Elderly medical inpatients are at significant risk of osteoporotic fracture and this appears largely unrecognized and under-treated. FRAX has the potential to identify and improve fracture risk assessment for patients with low bone density, directing clinical fracture prevention strategies to those who can benefit the most. Many of the clinical risk factors used in the FRAX calculator are readily available during the routine medical admission clerking. However, inpatient medical notes can potentially fail to record important details of patient history and findings, and to overcome the problems with content and legibility of notes, we have introduced a bone health protocol for our general medical inpatients aged ≥ 65 years, which could relieve physicians of the need to retrospectively collect these risk factors. This one-page protocol outlines all risk factors used in FRAX score, and also enquires about the

frequency of falls; patients, whose fracture risk exceeds NOF guidelines, are identified and further management is arranged.

The following are the strengths of our study: to minimize the selection bias, we have recruited all consecutive patients, and the prospective analysis of patients since the previous studies have mainly studied these clinical risk factors by electronic patient records or by retrospective analysis of data. Moreover, we have studied not only the clinical risk factors, but also the important details as regards the risk and frequency of falls. We used NOF thresholds for intervention, since these are easy to apply at ward level and do not change at individual patient level. The National Osteoporosis Guideline Group (NOGG) recommendations were not used in our study since these recommendations for decision-making differ from patient-to-patient basis, and likely will lead to suboptimal measurement of fracture risk at the ward level.

We acknowledge that there are several limitations to our study. For example, patients with mild-moderate cognitive impairment were included in this study who may not be able to accurately answer subjective questions about previous falls and fractures. We also included these patients to obtain a better representation of elderly population. However, we also obtained data regarding subjective questions (such as falls and fractures) from medical records, GP letters, and also from their immediate family members. We also acknowledge that FRAX has not been validated in hospital inpatients, and further prospective studies are required. However, recently published SCOOP trial confirms the utility of this approach among community dwellers. This study has shown that screening of older women using the FRAX tool leads to 28% relative risk reduction in hip fractures [11]. Further prospective studies are required to validate FRAX as a screening tool among hospitalized inpatients. Additionally, in our study, fall assessment was made by using FRQ, which needs further validation, and reasons for admission and medications used were not collected. Given the described exclusion criteria and since this was not a population-based study, there is a risk of selection bias.

To conclude, high prevalence of fracture and fall risk was noted among medical inpatients. Fracture risk assessment can be easily carried out in the wards as a part of routine admission clerking. A simple-to-apply protocol has been developed, which has resulted in appropriate identification of patients with high risk of fractures. The introduction of this bone health protocol will greatly help in our challenge to prevent, diagnose, and treat osteoporosis before disability from fractures occurs.

Compliance with ethical standards

The study was conducted in adherence with the Declaration of Helsinki and International Committee on Harmonization good clinical practices.

Conflict of interest M Haroon received educational grants from AbbVie and Pfizer. None of the other named authors have any conflicts of interest.

References

- Office of the Surgeon General (US). Bone health and osteoporosis: a report of the surgeon general. Rockville (MD): Office of the Surgeon General (US); 2004. Available from: <http://www.ncbi.nlm.nih.gov/books/NBK45513/>. Accessed March 2014
- http://www.hse.ie/eng/services/publications/olderpeople/Executive_Summary_-_Strategy_to_Prevent_Falls_and_Fractures_in_Ireland%E2%80%99s_Ageing_Population.pdf
- Kanis JA, Johnell O, Oden A, Johansson H, McCloskey E (2008) FRAX and the assessment of fracture probability in men and women from the UK. *Osteoporos Int* 19(4):385–397
- Cosman F, de Beur SJ, LeBoff MS, Lewiecki EM, Tanner B, Randall S, Lindsay R, National Osteoporosis Foundation (2014) Clinician's guide to prevention and treatment of osteoporosis. *Osteoporos Int* 25(10):2359–2381
- Rubenstein LZ, Vivrette R, Harker JO, Stevens JA, Kramer BJ (2011) Validating an evidence-based, self-rated fall risk questionnaire (FRQ) for older adults. *J Saf Res* 42(6):493–499
- Kanis JA, Oden A, Johansson H, Borgström F, Ström O, McCloskey E (2009) FRAX and its applications to clinical practice. *Bone* 44:734–743
- De Laet C et al (2005) Body mass index as a predictor of fracture risk: a meta-analysis. *Osteoporos Int* 16:1330–1338
- Unni S, Yao Y, Milne N, Gunning K, Curtis JR, LaFleur J (2015) An evaluation of clinical risk factors for estimating fracture risk in postmenopausal osteoporosis using an electronic medical record database. *Osteoporos Int* 26(2):581–587
- Pluskiewicz W, Adamczyk P, Franek E, Leszczynski P, Sewerynek E, Wichrowska H, Napiorkowska L, Kostyk T, Stuss M, Stepień-Kłos W, Golba KS, Drozdowska B (2010) Ten-year probability of osteoporotic fracture in 2012 Polish women assessed by FRAX and nomogram by Nguyen et al.—conformity between methods and their clinical utility. *Bone* 46(6):1661–1667
- Scott TA, Beveridge A, Ni CD (2016) Suboptimal bone protection in geriatric inpatients and effect of a simple educational and mnemonic strategy. *Australas J Ageing* 35(3):E36–E39
- Shepstone L, Lenaghan E, Cooper C, Clarke S, Fong-Soe-Khioe R, Fordham R, Gittoes N, Harvey I, Harvey N, Heawood A, Holland R, Howe A, Kanis J, Marshall T, O'Neill T, Peters T, Redmond N, Torgerson D, Turner D, Mc Closkey E; SCOOP Study Team. Screening in the community to reduce fractures in older women (SCOOP): a randomised controlled trial. *Lancet*. 2017 Dec 15. pii: S0140–6736(17)32640–5. doi: [https://doi.org/10.1016/S0140-6736\(17\)32640-5](https://doi.org/10.1016/S0140-6736(17)32640-5). [Epub ahead of print]