Hospital-wide surveillance of fracture risk assessment by both FRAX and medication patterns in acute care hospital

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Summary

To identify patients at a high risk for primary and secondary osteoporotic fractures using fracture risk assessments performed using the current method and the proposed method, in an acute care hospital and to identify departments where high-risk patients are admitted. This retrospective study included patients aged 40–90 years who were hospitalized at Fujita Health University Hospital. We collated the clinical data and prescriptions of all study participants. We also gathered data pertaining to risk factors according to Fracture Risk Assessment Tool (FRAX). Of the 1,595 patients, the mean number of major osteoporotic fracture risk predicted using FRAX was 11.73%. The department of rheumatology showed the highest fracture risk (18.55 ± 16.81) and had the highest number of patients on medications that resulted in reduced bone mineral density (1.07 ± 0.98 medication). Based on the FRAX, the proportion of patients in the high-risk group in this department was significantly higher compared with those in the remaining departments with respect to glucocorticoid administration, rheumatoid arthritis, and secondary osteoporosis. However, the departments included in the high-risk group were not necessarily the same as the departments included in the top group, based on the administered medications. FRAX score is calculated based on various risk factors; however, only glucocorticoid corresponds to medications. We should focus on medication prescription patterns in addition to FRAX to improve fracture risk assessment in hospital-wide surveillance. Therefore, we recommend the use of FRAX along with the prescribed medications to identify departments that admit high-risk patients.

Keywords: Fracture risk assessment, Fracture prevention, Osteoporosis Liaison Service, Fragility fracture
Introduction

Fractures are a major health concern, and the annual number of affected patients is expected to increase owing to the aging population. A fragility fracture (FF) is caused by a minor external traumatic force, such as a fall from standing height, and may lead to being bedridden or even developing cerebrovascular disease or dementia. Additionally, FF is more likely to be caused by osteoporosis. Osteoporosis is characterized by a reduction in bone mass and alteration of bony architecture, resulting in increased bone fragility and risk for various fractures [1-3]. Hernlund et al. [4] have reported that 6.6% of men and 22.1% of women aged >50 years develop osteoporosis in the European Union. Yoshimura et al. [5, 6] have calculated that 800,000 men and 5,600,000 women among the total population in Japan will develop osteoporosis. Osteoporosis treatment presents many practical challenges [7-10]. The time from disease onset to initial treatment is generally long, and long-term compliance is poor. Moreover, there are only few subjective symptoms at the early stage of osteoporosis; therefore, osteoporosis may not be detected for decades, until the patient develops a pathological fracture [11]. Epidemiological studies comparing multinational races indicate that the bone mineral density (BMD) is lower [12, 13] and the prevalence of less painful vertebral fractures is higher [14] in Japanese women. Additionally, hip fracture (HF) incidence rates among Japanese men and women are lower than those among Americans and Europeans [15, 16]. To address these issues, it is necessary to establish cooperation between acute care-providers, rehabilitation hospital staff, and physicians in charge as well as a collaborative system between emergency hospitals and clinics in Japan.

The Fracture Liaison Service (FLS) was initiated in the late 1990s in Europe to prevent the occurrence of secondary fractures [17-19]. FLS is a medical team composed of various health care professionals, such as physicians, nurses, pharmacists, and physical therapists, who cooperate in the management of patients with FFs to prevent secondary fractures. The collaborative action of FLS leads to a decrease in the incidence of related refracture and mortality. Moreover, FLS is cost-effective, as it reduces the overall medical costs [20, 21]. Furthermore, the Osteoporosis Liaison Service (OLS) was initiated in 2012 in Japan to prevent both primary and secondary fractures in patients with fracture risk. The OLS provides educational programs, medical check-ups for detecting bone fragility, and risk assessment for primary fractures in addition to the functions of FLS. A model-based, cost-effectiveness analysis has revealed that the OLS program has been effective in preventing secondary fractures in osteoporotic Japanese women with history of HF [22]. However, an efficient screening method for primary fractures has not been established yet, because it is difficult to identify at-risk patients to effectively prevent primary fractures.

The Fracture Risk Assessment Tool (FRAX) is a well-known scoring system for predicting the probability of osteoporotic fractures, and its process of application has been individually adapted by many countries, including Japan [23-26]. The FRAX algorithms, which have been developed by the World Health Organization, predict the 10-year risk of HF and the 10-year risk of major osteoporotic fracture (MOF; clinical spine, forearm, hip, or shoulder fracture). The fracture risk is usually assessed using FRAX in Japan, because one of the criteria for initiating pharmacological treatment to prevent FF is shown in the Japanese 2015 guidelines for the prevention and treatment of osteoporosis. FRAX does not require measurement of BMD, which allows for its practical and widespread application. Dual-energy X-ray absorptiometry, quantitative computed tomography, and quantitative ultrasonography can be used for the assessment of bone mass, but these measurements require expensive equipment. FRAX can be applied to calculate fracture risk.
easily; therefore, this is a simple assessment tool for osteoporosis and the most suitable screening method for primary prevention of FF.

There have been no reports comparing the risk of FF systematically for each clinical department in a hospital. It is important to identify clinical departments with patients at high risk for FF because osteoporosis is a chronic disease caused by complicated factors. Simple screening of every hospitalized patient may help in the early detection and treatment of osteoporosis. However, there are some problems with the use of FRAX. Among the factors used in FRAX, glucocorticoid is the only medication factor. Some reports suggested that some medications are associated with an increased risk of osteoporosis by reducing the BMD. For example, benzodiazepines may induce dizziness, and proton pump inhibitor inhibitors (PPIs) may affect bone regeneration and implant osseointegration [27, 28]. Most patients with osteoporosis are older individuals, in whom complications may likely to occur when taking medications. Hence, it was necessary not only to use FRAX but also to investigate medication patterns for screening primary fracture. Furthermore, hospital-wide surveillance using this method would help identify the clinical departments where many high-risk patients were admitted.

In this study, we aimed to assess the risk of FF at each clinical department using an efficient screening method for primary fracture, i.e., the method of both using FRAX and prescribing medication, in acute-care hospitals in Japan.

Materials and methods

Subjects and study design

The study subjects included patients aged 40–90 years who were hospitalized at one of the 23 clinical departments (except the department of pediatrics) of Fujita Health University Hospital between September 2017 and March 2018. This retrospective study collected in-patient data from the electronic databases of the hospital. The 23 clinical departments were as follows: emergency, cardiology, respiratory medicine, gastroenterology, hematology, rheumatology, nephrology, endocrinology, neurology, psychiatry, dermatology, gastroenterological surgery, cardiovascular surgery, thoracic surgery, endocrine surgery, breast surgery, neurosurgery, orthopedic surgery, plastic surgery, urology, gynecology, otolaryngology, and ophthalmology. The subject data used for statistical analysis had the following characteristics: adhered to all the above-mentioned criteria, referred to pharmaceutical care by a pharmacist during hospitalization, and corresponding to either own bone fracture experiment or to proximal thighbone fracture in parents.

Investigations

We collated the clinical and demographic data of all study participants, including age, height, weight, and body mass index (BMI, kg/m²). We also gathered data pertaining to risk factors according to FRAX, such as sex, history of FFs, parental history of HF, smoking status, history of glucocorticoid therapy, rheumatoid arthritis, and intake of ≥3 U of alcohol/day. Furthermore, we gathered data on the secondary causes of osteoporosis, including early menopause, malabsorption, osteogenesis imperfecta, and untreated hyperthyroidism. FRAX score was calculated using the FRAX Japan-specific data for major osteoporotic fractures (MOFs) and HFs [29].
Medications

Medications were classified according to the Anatomic Therapeutic Chemical (ATC) classification system. In the literature [30-35], medications associating with an increased risk of osteoporosis by reduction of BMD were identified as bone-related medicine (BRM) and included anticonvulsants, glucocorticoids, H₂-receptor inhibitors, PPIs, and thiazolidinediones. Furthermore, we identified and recorded if the in-patients had been prescribed medications that could increase the risk of occurrence of fractures, also known as fracture-related medicine (FRM), e.g., antiarrhythmic drugs, anti-Parkinson’s drugs, anti-psychotics, barbiturates, benzodiazepines, hypnotics/sedatives, loop diuretics, nitrates, other antidepressants, selective serotonin reuptake inhibitors, thiazides, thiazide-like diuretics, and tricyclic antidepressants. The administration of anti-osteoporotic medications, as defined by the Japanese Pharmacopoeia, was also recorded, and the list included calcium L-aspartate hydrate, dibasic calcium phosphate hydrate, estriol, conjugated estrogens, estradiol, alfacalcidol, calcitriol, eldecalcitol, menatetrenone, etidronate disodium, alendronate sodium hydrate, sodium risedronate hydrate, minodronic acid hydrate, ibandronate sodium hydrate, raloxifene hydrochloride, bazedoxifene acetate, elcatonin, teriparatide, teriparatide acetate, denosumab, ipriflavone, and nandrolone decanoate. This study identified only use or non-use of medication.

Statistical analysis

Numerical values were expressed as means ± standard deviations. Clinical departments included in the study (as listed earlier) were classified into two categories composing of three groups each: based on osteoporotic fracture risk (category A) and based on the risk level calculated from taking BRMs (category B). The classification of each category was sequentially ordered from the highest number; furthermore, they were divided into three groups based on the clinical department. In other words, 23 clinical departments were classified into groups of 7, 8, and 8 each. The Chi-square test was performed for comparisons of ratios among the three groups. Subsequent multiple comparisons were performed by applying the Chi-square test with the Bonferroni correction. One-way analysis of variance (ANOVA) with post-hoc Tukey’s test was performed for comparing numerical values among the three groups. SPSS ver. 25.0 (IBM Corporation, Armonk, NY, USA) was used for all statistical analyses. P-values of <0.05 were considered statistically significant.

Ethics statement

The present study was approved by the Fujita Health University School of Medicine Epidemiological and Clinical Research Ethics Committee (HM18-045, HM18-280).

Results

Patient characteristics

The study population consisted of 1,595 patients. The patient characteristics are listed in Table 1. Most patients were men, aged 60–79 years, and had 18.5 kg/m² ≤ BMI < 25 kg/m². As shown in Table 1, the mean number of MOF predicted using FRAX was 11.73%, whereas that of HF was 4.90%. Patients were classified into the following three groups based on the degree of obesity: obesity group, 25 kg/m² ≤BMI; normal group, 18.5 kg/m² ≤ BMI < 25 kg/m²; and underweight group, BMI <18.5 kg/m². The number of
patients with osteoporotic fractures including both MOF and HF were found to successively increase in the underweight, normal, and obesity groups (data not shown), indicating a positive correlation between degree of obesity and osteoporotic fracture risk. A similar positive association was noted between fracture risk and age with the risk of osteoporotic fractures observed to increase in patients belonging to the successive older-age groups, i.e., patients aged 40–59 years, 60–79 years, and 80–90 years (data not shown).

**Influence of clinical department of admission on category A**

Clinical departments included in the study (as listed earlier) were classified into three groups based on tertiles according to the level of osteoporotic fracture risk associated with the study patients, i.e., i) the high-risk group, which included the top seven departments, had patients with the highest risk of MOF; ii) the low-risk group, which included eight departments, had patients with the lowest risk of MOF; and iii) the moderate-risk group, which included the remaining departments. The high-risk group comprised the departments of rheumatology (MOF rate, 18.55%), emergency (17.74%), orthopedic surgery (16.69%), gastroenterology (14.41%), psychiatry (13.51%), nephrology (12.41%) and neurology (11.86%) (Table 2). HF rate was also higher in this group than in the other two groups. The characteristics of patients of each clinical department are summarized in Supplementary 1.

**Identification of risk factors for severe MOF on category A**

BMI and age are important risk factors for osteoporotic fracture. However, the proportion of patients in the high-risk group was not significantly higher than that in the moderate-risk group with respect to age and BMI (Table 3). The proportion of women in the high-risk group was significantly higher than that in the moderate-risk group but not significantly higher than that in the low-risk group. Furthermore, the proportion of patients in the high-risk group was significantly higher than those of the other groups with respect to other risk factors, including previous fracture, glucocorticoid administration, rheumatoid arthritis, and secondary osteoporosis.

**Influence of clinical department of admission on category B**

Among the total of 1,595 patients, we were able to collate data on medications prescribed during hospitalization in 1,562 patients. Patients admitted to the departments of rheumatology, cardiology, hematology, nephrology, orthopedic surgery, respiratory medicine, and neurosurgery were found to be classified into the top group of BRMs that could decrease BMD (Table 4). However, the departments included in the high-risk group, based on category A, were not necessarily the same as the departments included in the top group based on category B. Additionally, in-patients from the departments of psychiatry, nephrology, cardiology, neurology, cardiovascular surgery, breast surgery, and gastroenterology were administered FRMs, which increased their risk of accidental falls (Table 4). Several patients who were already receiving medications for the prevention or treatment of osteoporosis belonged to the departments of nephrology (41.0%) and rheumatology (35.7%) and were involved in a high risk of osteoporotic fractures in this study (Table 5).
Discussion

In this study, we used the medical data of hospitalized patients admitted in every clinical department, except in the department of pediatrics, of Fujita Health University Hospital to perform a comparative study of their risk of sustaining osteoporotic fractures. Emergency and orthopedic surgery departments, which frequently admit patients with fractures, were included in the high-risk group in category A. Few elderly and lean patients were included in the high-risk group, although the FF risk was inversely related to BMI and positively associated with aging. This result suggests that taking glucocorticoids, having rheumatoid arthritis, or having secondary osteoporosis may be more important for the FF risk than age and BMI.

Epidemiological studies showed that osteoporosis is associated with some diseases, such as diabetes mellitus, hyperparathyroidism, hyperthyroidism, chronic obstructive pulmonary disease, and rheumatoid arthritis [36-38]. Many patients with these diseases may undergo medical checkups at one or more departments of rheumatology, endocrinology, and respiratory medicine in Japan. The department of rheumatology was classified into the high-risk group in category A because many in-patients develop rheumatoid arthritis and other collagen diseases and they were frequently treated with glucocorticoids. However, the departments of respiratory medicine and endocrinology were not classified into the high-risk group on category A. Although these departments had hospitalized patients with diseases related to osteoporosis, FRAX does not take the risk factor of several osteoporosis-related illnesses into account. Considering that osteoporosis has a high incidence in postmenopausal women, osteoporotic risk associated with the departments of breast surgery and gynecology (with solely female in-patients) was expected to be higher [39]. However, we found that both departments were classified into the low-risk group in category A, and the patients may have background characteristics that could be factors leading to a lower FRAX score, including younger age, obesity, glucocorticoid use, and rheumatoid arthritis. As cross-departmental medical teams, including the OLS, have been developed, cross-departmental studies may lead to new interesting discoveries.

In the departments of rheumatology, nephrology, and orthopedic surgery, which were also included in the high-risk group, attending physicians frequently prescribed BRMs for patients. For example, the department of nephrology commonly used PPIs and the departments of rheumatology and orthopedic surgery frequently prescribed glucocorticoids (data not shown). Although glucocorticoids are prescribed for various diseases, we must monitor its long-term side effects, including osteoporosis caused by glucocorticoid use. PPIs are known to be safe with rare severe side effects. However, some reports showed new side effects of PPI including decreased BMD and increased risk of fractures [40-42]. The risk of osteoporosis and fractures caused by medications on these departments was clarified. On the other hand, medications for osteoporosis were also widely administered on the same departments; thus, appropriate treatment for osteoporosis had already been implemented.

The departments of cardiology, hematology, neurosurgery, and respiratory medicine were classified into the top group of BRMs, but not into the high-risk group. These results indicate that there is a limit on hospital-wide surveillance of FF risk assessment when using only FRAX as the screening method, because those in the high-risk group did not necessarily belong to the top group of BRMs. Therefore, FRAX alone as a screening method is insufficient for hospital-wide surveillance. However, there was a limitation to the classification method, which was intended for 23 clinical departments, because each category was
sequentially ordered from the highest number. Alternatively, this is a convenient method that can be used to sort for the comparison of every clinical department.

One of the strengths of the present study is that it included patients across various clinical departments and was led by a pharmacist who was not affiliated to any of the departments specifically. Another strength is that its conclusions can be used to identify the departments with at-risk patients who should be targeted by the OLS to achieve maximum benefits. However, this study has many limitations. Firstly, BMD could only be measured in a few patients. If we could obtain a large amount of BMD data at every department, we would be able to clearly elucidate the relationship between bone fracture risk and clinical department, i.e., measuring BMD would enable us to compare the patients definitively diagnosed with osteoporosis among the clinical departments. Screening for the risk of both MOF and HF using FRAX and assessment of current bone condition using BMD estimation could improve the accuracy and applicability of the findings. Finally, the influence of various complications and medications are neglected by FRAX. The history of glucocorticoid therapy, rheumatoid arthritis, and secondary osteoporosis are considered in FRAX risk assessment, but other diseases, such as chronic obstructive pulmonary disease and chronic kidney disease [36, 37], which can cause osteoporosis, are not included. Medications, such as antidepressants and benzodiazepines, which are known to cause falls, can also increase the risk of FF; however, these were not included in the analysis. Following the exclusion of patients with fractures and by subsequently performing multiple screenings including FRAX and generally prescribed medications, high-risk patients who have been overlooked can be identified and treated at an early stage. This study can be the first step for establishing efficient screening methods for identifying hospitalized patients with osteoporosis. In this study, we did not consider both medication dosage and the dosage period, because this study did not aim for accurate extraction. Additionally, this study must be considered as the primary stage in verifying whether the FRAX score alone can be used to examine hospital-wide surveillance of fracture risk assessment. The second aim of this study was quick identification of target patients in the hospital-wide surveillance procedure; therefore, the effect of each medication on fractures could be a determining factor. Unfortunately, this study’s methodology cannot be used to provide these details. PPIs and H₂ blockers, which have been reported to have long-term effects on BMD, are overestimated, because the duration of medicine usage was not calculated. Therefore, further studies are warranted for more precise screening.

In summary, clinical departments that commonly prescribe glucocorticoid therapy and/or treat the diseases that can cause secondary osteoporosis, have a higher number of patients at high risk for developing FF. FRAX is a convenient screening tool for surveillance of fracture risk. However, its use is inefficient for hospital-wide surveillance of fracture risk assessment. Therefore, we recommend the use of FRAX together with prescribed medications on hospital-wide surveillance of fracture risk assessment.

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Takao Tobe: critical revision of the article for important intellectual content
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Takahiro Toda: analysis and interpretation of data
Mitsuhiro Morita: conception and design of the study
Mika Watanabe: collection and assembly of data
Shigeki Yamada: conception and design of the study
Atsushi Suzuki: drafting of the article
Takahiro Hayashi: final approval of the article

**Conflict of interest**

The authors declare no conflict of interest.

**Supplementary Materials**

This article contains supplementary materials.
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| Characteristics | Value |
|-----------------|-------|
| Sex             |       |
| Men             | 883 (55.4%) |
| Women           | 712 (44.6%) |
| Age, mean ± SD  | 67.1 ± 12.2 |
| 40–59 years     | 413 (25.9%) |
| 60–79 years     | 933 (58.5%) |
| 80–90 years     | 249 (15.6%) |
| Height, mean ± SD | 160.0 ± 9.6 |
| Weight, mean ± SD | 58.7 ± 12.9 |
| BMI, mean ± SD  | 22.8 ± 4.0 |
| Obesity (25 ≤ BMI) | 407 (25.5%) |
| Normal weight (18.5 ≤ BMI < 25) | 995 (62.4%) |
| Underweight (BMI < 18.5) | 193 (12.1%) |
| Previous fracture | 398 (25.0%) |
| Parent fractured hip | 122 (7.6%) |
| Current smoking | 200 (12.5%) |
| Glucocorticoids | 94 (5.9%) |
| Rheumatoid arthritis | 62 (3.9%) |
| Secondary osteoporosis | 149 (9.3%) |
| Alcohol | 412 (25.8%) |
| Major osteoporotic fracture | 11.7 ± 10.5 |
| Hip fracture | 4.9 ± 7.1 |

BMI, body mass index; SD, standard deviation

Data presented as n (%) unless otherwise stated.
| Risk group     | Department                      | n  | MOF (%)       | HF (%)       |
|---------------|---------------------------------|----|---------------|--------------|
| High-risk group (n = 499) | Rheumatology                    | 32 | 18.55 ± 16.81 | 8.92 ± 11.52 |
|               | Emergency                        | 51 | 17.74 ± 12.93 | 9.20 ± 9.39  |
|               | Orthopedic surgery               | 69 | 15.72 ± 14.83 | 6.71 ± 9.80  |
|               | Gastroenterology                 | 163| 14.41 ± 10.92 | 6.70 ± 7.19  |
|               | Psychiatry                        | 18 | 13.51 ± 14.97 | 5.94 ± 9.86  |
|               | Nephrology                       | 100| 12.41 ± 11.33 | 5.34 ± 8.05  |
|               | Neurology                        | 36 | 11.86 ± 10.16 | 4.84 ± 5.96  |
| Moderate-risk group (n = 691) | Gastroenterological surgery      | 100| 11.81 ± 8.46  | 4.91 ± 5.38  |
|               | Endocrinology                    | 63 | 11.72 ± 8.79  | 4.83 ± 5.57  |
|               | Hematology                       | 76 | 11.66 ± 11.41 | 5.53 ± 9.32  |
|               | Respiratory medicine             | 100| 11.61 ± 9.53  | 5.43 ± 7.22  |
|               | Ophthalmology                    | 100| 11.47 ± 8.63  | 4.12 ± 5.08  |
|               | Cardiology                       | 100| 10.79 ± 10.13 | 4.53 ± 7.77  |
|               | Cardiovascular surgery           | 52 | 10.44 ± 9.45  | 4.62 ± 7.08  |
|               | Neurosurgery                     | 100| 10.38 ± 7.37  | 4.01 ± 4.86  |
| Low-risk group (n = 405)   | Dermatology                      | 45 | 9.99 ± 9.27   | 3.59 ± 5.21  |
|               | Urology                          | 100| 9.83 ± 8.23   | 3.78 ± 5.40  |
|               | Thoracic surgery                 | 34 | 9.73 ± 7.67   | 4.20 ± 6.90  |
|               | Breast surgery                   | 50 | 8.76 ± 9.47   | 2.51 ± 5.73  |
|               | Endocrine surgery                | 34 | 8.14 ± 8.72   | 2.44 ± 3.88  |
|               | Obstetrics and gynecology        | 70 | 8.04 ± 10.04  | 2.37 ± 5.85  |
|               | Otolaryngology and bronchoesophagology | 63 | 7.12 ± 5.38 | 2.22 ± 2.67  |
|               | Plastic surgery                  | 9  | 3.98 ± 1.75   | 0.53 ± 0.42  |

HF, hip fracture; MOF, major osteoporotic fracture
Data are presented as means ± standard deviations.
| Characteristic                  | Low-risk group (n = 405) | Moderate-risk group (n = 691) | High-risk group (n = 499) |
|--------------------------------|--------------------------|------------------------------|--------------------------|
| Women                          | 225 (55.6%)              | 241 (34.9%)†                | 246 (49.3%)†             |
| Age, mean ± SD                 | 62.1 ± 13.0              | 68.6 ± 10.6*                | 69.0 ± 12.5*             |
| BMI, mean ± SD                 | 23.1 ± 3.9               | 22.7 ± 3.8                  | 22.7 ± 4.4               |
| Previous fracture              | 75 (18.5%)               | 168 (24.3%)                 | 155 (31.1%)*             |
| Parent fractured hip           | 27 (6.7%)                | 59 (8.5%)                   | 36 (7.2%)                |
| Current smoking                | 44 (10.9%)               | 96 (13.9%)                  | 60 (12.5%)               |
| Glucocorticoids                | 19 (4.7%)                | 25 (3.6%)                   | 50 (10.0%)*              |
| Rheumatoid arthritis           | 11 (2.7%)                | 15 (2.2%)                   | 36 (7.3%)†              |
| Secondary osteoporosis         | 20 (4.9%)                | 43 (6.2%)                   | 86 (17.2%)*              |
| Alcohol                        | 121 (29.9%)              | 184 (26.6%)                 | 107 (21.4%)‡             |
| MOF                            | 8.7 ± 8.4                | 11.3 ± 9.2*                 | 14.9 ± 12.7‡            |
| HF                             | 3.0 ± 5.2                | 4.7 ± 6.6*                  | 6.7 ± 8.5*‡             |

BMI, body mass index; HF, hip fracture; MOF, major osteoporotic fracture; SD, standard deviation
Data are presented as n (%) unless otherwise stated.

*P < 0.001 (vs. low-risk group); ‡P = 0.015 (vs. low-risk group); †P < 0.001 (vs. moderate-risk group).
**Table 4**  Correlation between clinical departments and medications associating with osteoporosis or fracture

| Prescription group | Department (n) | BRM* (medication number) | FRM** (medication number) |
|--------------------|---------------|---------------------------|---------------------------|
| **Top group** (n = 593) | Rheumatology (28) | 1.07 ± 0.98 | 0.21 ± 0.63 |
| | Cardiology (98) | 0.67 ± 0.59 | 0.68 ± 0.74 |
| | Hematology (74) | 0.66 ± 0.58 | 0.24 ± 0.46 |
| | Nephrology (100) | 0.58 ± 0.64 | 0.79 ± 0.73 |
| | Orthopedic surgery (96) | 0.56 ± 0.69 | 0.39 ± 0.69 |
| | Respiratory medicine (98) | 0.54 ± 0.76 | 0.35 ± 0.61 |
| | Neurosurgery (99) | 0.53 ± 0.63 | 0.25 ± 0.58 |
| **Middle group** (n = 574) | Psychiatry (19) | 0.47 ± 0.61 | 1.47 ± 1.17 |
| | Neurology (36) | 0.47 ± 0.61 | 0.64 ± 0.80 |
| | Cardiovascular surgery (52) | 0.44 ± 0.54 | 0.44 ± 0.73 |
| | Endocrinology (64) | 0.44 ± 0.59 | 0.23 ± 0.50 |
| | Gastroenterology (157) | 0.43 ± 0.69 | 0.39 ± 0.66 |
| | Gastroenterological surgery (98) | 0.42 ± 0.57 | 0.20 ± 0.47 |
| | Urology (100) | 0.40 ± 0.67 | 0.26 ± 0.58 |
| | Emergency (48) | 0.35 ± 0.52 | 0.33 ± 0.65 |
| **Bottom group** (n = 395) | Otolaryngology (62) | 0.32 ± 0.57 | 0.13 ± 0.38 |
| | Dermatology (44) | 0.31 ± 0.60 | 0.36 ± 0.74 |
| | Thoracic surgery (33) | 0.30 ± 0.64 | 0.21 ± 0.55 |
| | Ophthalmology (98) | 0.20 ± 0.48 | 0.24 ± 0.56 |
| | Gynecology (70) | 0.17 ± 0.45 | 0.07 ± 0.26 |
| | Breast surgery (46) | 0.12 ± 0.44 | 0.42 ± 0.81 |
| | Endocrine surgery (33) | 0.09 ± 0.29 | 0.12 ± 0.41 |
| | Plastic surgery (9) | 0 | 0.11 ± 0.33 |

*BRM, medications associated with an increased risk of osteoporosis due to the reduction of bone mineral density were identified as bone-related medicines.

**FRM, medications that could increase the risk of fractures were identified as fracture-related medicines.

Data are presented as means ± standard deviations.
### Table 5: Proportion of patients receiving medications for osteoporosis on each clinical department

| Department (total number) | Proportion of patients received number (%) |
|---------------------------|-------------------------------------------|
| Nephrology (100)         | 41 (41.0%)                                |
| Rheumatology (28)        | 10 (35.7%)                                |
| Orthopedic surgery (96)  | 17 (17.7%)                                |
| Psychiatry (19)          | 3 (15.8%)                                 |
| Urology (100)            | 12 (12.0%)                                |
| Gastroenterology (157)   | 18 (11.5%)                                |
| Neurology (36)           | 4 (11.1%)                                 |
| Neurosurgery (99)        | 11 (11.0%)                                |
| Breast surgery (46)      | 5 (10.9%)                                 |
| Hematology (74)          | 7 (9.5%)                                  |
| Ophthalmology (98)       | 9 (9.2%)                                  |
| Thoracic surgery (33)    | 3 (9.1%)                                  |
| Dermatology (44)         | 4 (9.1%)                                  |
| Gynecology (70)          | 6 (8.6%)                                  |
| Emergency (48)           | 4 (8.3%)                                  |
| Gastroenterological surgery (98) | 8 (8.2%)                   |
| Cardiology (98)          | 7 (7.1%)                                  |
| Respiratory medicine (98) | 7 (7.1%)                                |
| Endocrinology (64)       | 4 (6.3%)                                  |
| Cardiovascular surgery (52) | 1 (1.9%)                      |
| Otolaryngology (62)      | 1 (1.6%)                                  |
| Plastic surgery (9)      | 0 (0.0%)                                  |
| Endocrine surgery (33)   | 0 (0.0%)                                  |