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Importance of Vitamin D in Hospital-Based Fracture Care Pathways

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Abstract

Objectives—This project was developed to identify ways to support hospital-based improvements for the identification and management of osteoporosis following treatment of a fragility fracture.

Design—This is a retrospective review of medical records of sets of consecutive patients who were admitted for surgical treatment of fragility fracture following introduction of several versions of admission and discharge care pathways. Effectiveness of the admission pathway was defined as % subjects with measurement of serum 25-hydroxyvitamin D (25(OH)D) during hospitalization; effectiveness of the discharge pathway was defined as % subjects with documentation of instructions for calcium and/or vitamin D supplementation.

Setting—This study reviewed medical records of patients admitted to hospital for surgical treatment of a fragility fracture.

Participants—Medical records were evaluated for 98 patients older than 50-years who were admitted with a fragility fracture of the hip or femur.

Measurements—Medical records were reviewed for the % subjects with documentation of an in-hospital order for serum 25(OH)D and with documentation of instructions to patients upon discharge concerning calcium and vitamin D intake. Median value of serum 25(OH)D was calculated.

Results—In accordance with the admission pathway, serum 25(OH)D was measured in 37% (36/98). The median 25(OH)D level was 19.5 ng/mL; 78% were vitamin D insufficient [serum 25(OH)D < 32 ng/mL] and 36% were vitamin D deficient [serum 25(OH)D < 15 ng/mL]. In accordance with the discharge pathway, 74% (71/96) were discharged on calcium and/or vitamin D.

Conclusion—The high prevalence of vitamin D insufficiency (78%) observed in this study affirms the importance of incorporating vitamin D supplementation in hospital-based fracture care pathways. The discharge pathway was more effective than the newer admission pathway, a finding attributable to effects of familiarity, retraining, and introduction of computer-prompts. These evolving pathways represent a much-needed paradigm shift in the care of fragility fracture patients.

Keywords

Fracture; vitamin D; osteoporosis; care improvement

Introduction

Hip fractures are associated with significant morbidity and mortality, but fewer than 30% of hip fracture patients worldwide receive osteoporosis evaluation and treatment (1–6). In the United States, only 19% of hip fracture patients receive osteoporosis evaluation and treatment (7). Recommendations have been made to improve the post-fracture assessment and medical care of these patients, with focus on increasing the proportion receiving osteoporosis evaluation and therapy (8–10). Those recommendations, however, have not included evidence-based guidance for evaluation of vitamin D status or vitamin D therapy.

Vitamin D-deficiency and insufficiency have been identified in international studies of fracture patients (11–15). In a recent evaluation of United States community-living postmenopausal women with hip fracture, we reported that 50% of them had extreme vitamin D-deficiency (≤ 12 ng/mL or 30 nmoles/L) (16). In a larger study with 110 women with fragility fracture of the hip, vitamin D-insufficiency (≤ 32 ng/mL) was present in 96% (17). A subsequent study of women and men with fragility fracture of the hip, humerus, spine, rib, or wrist indicated that nearly all had vitamin D-inadequacy (<30 ng/mL)(18). Data associating lower vitamin D levels with reduced muscle strength and increased risk of falls provides additional impetus for ensuring that hip fracture patients are evaluated and optimally treated for vitamin D insufficiency (17,19–21).

This project was developed to identify ways to support hospital-based improvements for the identification and management of osteoporosis following treatment of a fragility fracture. As a multidisciplinary team, we implemented and revised several admission and discharge pathways for hip fracture patients to include evaluation and management of vitamin D status. We report on the use of these evolving hospital-based pathways and on the vitamin D status in these patients.

Material and Methods

The original admission pathway was implemented in 2004 for all patients over the age of 50 years with fragility fracture of the hip. That version instructed the orthopedic surgeon to initiate daily calcium carbonate/cholecalciferol (600 mg elemental calcium/200 IU cholecalciferol, with meals, *bid*) and a multivitamin (containing 400 IU cholecalciferol), to measure serum calcium, albumin, and 25-hydroxyvitamin D [25(OH)D] (DiaSorin radioimmunoassay, DiaSorin, Stillwater, MN), and to request a consultation from the Division of Endocrinology. The carbonate form of calcium was chosen on the basis of a cost-effectiveness study that reported clinical bioavailability equivalent to more costly formulations (22). The admission pathway was amended in 2005 (Table I) to additionally recommend a single dose of vitamin D₂ (50,000 IU ergocalciferol) upon admission, based on demonstrated safety (23,24). At this time in the United States, there is no available preparation of 50,000 IU of vitamin D₃ (cholecalciferol).

Earlier, in 2003, we implemented a computer-assisted discharge pathway for hip fracture patients at BWH. The discharge pathway prompts the orthopedic surgeon to prescribe daily calcium carbonate with vitamin D₃ (600 mg elemental calcium/200 IU cholecalciferol, *bid*), additional vitamin D₃ (400 IU cholecalciferol), a multivitamin (containing 400 IU cholecalciferol), and outpatient osteoporosis evaluation (Table I).

In this study, we retrospectively reviewed medical records of all consecutive patients aged ≥ 50 years admitted with a fragility fracture of the hip or femur to BWH between August 1 and December 31 during 2004 and during the same time period in 2005. Each patient's record was reviewed by a board-certified orthopedic surgeon to determine whether the fracture represented a fragility (low-trauma) fracture and all non-fragility fractures were excluded. All progress

notes, orders, and laboratory test results for each patient were reviewed by a board-certified endocrinologist. For the purposes of this study, effectiveness of the admission pathways was defined as the measurement of serum 25(OH)D during the hospital admission and effectiveness of the discharge pathway, as a note in the charge that the patient received a recommendation for calcium and/or vitamin D. This study was conducted with approval from and annual review by the hospital's human research committee.

Statistical analysis was performed with SAS version 8.2 (SAS Institute, Cary, NC). Categorical data are reported as frequencies and continuous data are reported as the mean $\pm$ standard deviation, unless otherwise specified. Comparisons of frequencies were performed using Fisher's Exact Test. Significance is indicated for $p < 0.05$; all p -values are two-sided.

Results

98 consecutive patients were admitted with a fragility fracture of the hip or femur in the study periods (August through December) in 2004 ($n=57$) and 2005 ($n=41$). Of the total, 72% were women and the mean age was 76.0 ± 11.9 years. In this series, women were significantly older than men (78.7 ± 10.2 v. 68.8 ± 13.3 years; $p < 0.0001$). There were no significant differences in these parameters between the two study periods.

Admission Pathway

Serum 25(OH)D was measured in 37% (36/98), with no significant difference between the two study periods. The median 25(OH)D level was 19.5 ng/mL; 78% were vitamin D insufficient [serum 25(OH)D < 32 ng/mL] and 36% were vitamin D deficient [serum 25(OH)D < 15 ng/mL]. For the subset of patients seen during 2005, 29% (12/41) received 50,000 IU ergocalciferol on admission as instructed by the amended admission pathway.

Discharge Pathway

74% (71/96; 2 patients died prior to discharge) were discharged on calcium and/or vitamin D as instructed by the discharge pathway. There was no significant difference between the two study periods. The discharge pathway was older, more familiar, computer-based, and more effective (74%) than the newer admission pathway which was surgeon controlled (37%, $p < 0.001$).

Discussion

This study describes our two-year experience with evolving multidisciplinary hospital-based admission and discharge pathways for patients admitted to the Brigham and Women's Hospital with a fragility fracture of the hip or femur. The high prevalence of vitamin D insufficiency observed in this study is in accordance with prior international (11–15) and American (16–18) reports and affirms the importance of incorporating vitamin D evaluation and therapy recommendations into the design of fracture care pathways. Further interventions may be needed to ensure continued use of supplements, shown to be efficacious for musculoskeletal health (25). A recent study indicated that a very low proportion (3.6%) of aged residents in nursing homes in Helsinki were receiving the recommended amount of vitamin D (26).

The older discharge pathway was more effective than the newer admission pathway, a finding attributable to the effect of familiarity, retraining, and computer-prompting. According to our ongoing analysis to increase pathway effectiveness, computer assistance, retraining, and multidisciplinary teams are necessary to advance the care of fracture patients. Computer aids have been implemented for the latest version of the admission pathway, as a result of this analysis.

Conclusion

The high prevalence of vitamin D insufficiency (78%) observed in this study corresponds with prior reports and reaffirms the importance of incorporating vitamin D recommendations in hospital-based fracture care pathways. These evolving pathways, initially designed for hip fractures, can be applied to other fragility fractures and show improved effectiveness with computer-assistance and familiarity of the multidisciplinary team of caregivers. They represent a much-needed paradigm shift in the care of fracture patients.

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TABLE I

ADMISSION PATHWAY

- A. An Endocrine consult.
- B. These lab tests: 25-hydroxyvitamin D, calcium, albumin, ionized calcium, phosphate, creatinine.
- C. Administration of vitamin D₂ (ergocalciferol), 50,000 IU *po* × 1.
- D. Administration of
 - 1. multivitamin *po qd* (containing 400 IU vitamin D₃),
 - 2. calcium carbonate with vitamin D₃ (600 mg/200 IU per tablet), one tablet *po* with food *bid*.

DISCHARGE PATHWAY

- A. Instructions to patient for the following supplements
 - 1. multivitamin *po qd* (containing 400 IU vitamin D₃),
 - 2. calcium carbonate with vitamin D₃ (600 mg/200 IU per tablet), one tablet *po* with food *bid*,
 - 3. additional vitamin D₃ alone (400 IU).
 - B. Instructions to patient how to make an outpatient endocrine appointment for osteoporosis evaluation and treatment.
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