

EVOLUTION OF COMPREHENSIVE HOSPITAL CARE PATHWAYS TO ADVANCE THE TREATMENT OF FRAGILITY FRACTURES

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Fragility fractures of the hip are associated with high morbidity and mortality, and survivors have a 2 to 5-fold increased risk for subsequent fragility fractures. In the United States, although approximately 90% of patients with hip fractures have osteoporosis, only 19% of them receive osteoporosis evaluation and treatment [1]. To optimize skeletal health in fracture patients, appropriate follow-up should include a team approach for assessment and management of the underlying causes of skeletal fragility and for patient education [2]. Critical for success is to have a team of committed clinical champions who continuously review available evidence and work together to advance fracture care. A major challenge in this process has been to take advantage of existing hospital computerized tools to consistently implement our recommendations. This is an interim report on the evolution of pathways for multidisciplinary coordination of in-hospital and post-hospitalization care from 2002 to 2007.

VITAMIN D AND FRACTURE RISK.

Evidence shows the importance of incorporating vitamin D into the acute and chronic care of patients with fragility fractures. In a previous NIH-sponsored study of postmenopausal subjects admitted to BWH with hip fracture that required arthroplasty, we found that only 10% were vitamin D-sufficient [25-hydroxyvitamin D (25OHD) >32 ng/mL] [3]. Similar data have been reported worldwide and in the United States [reviewed in 4-6].

It is well appreciated that severe vitamin D deficiency in adults results in osteomalacia and in hypovitaminosis D myopathy. In addition, secondary hyperparathyroidism increases bone resorption and reduces bone mineral density. The recent literature on the efficacy of calcium and vitamin D to reduce fractures has not been consistent. Careful analysis of the doses of vitamin D used in those studies had led to resolution of some of the apparent inconsistencies on the efficacy of vitamin D and calcium supplementation on fracture risk. The alarming 2006 publication from The Women's Health Initiative (WHI) with attendant broad media coverage concluded that calcium and vitamin D did not reduce hip fracture in postmenopausal women followed for 7 years [7]. An important meta-analysis of the literature from randomized controlled trials had revealed that trials that had used 700 or 800 IU per day of vitamin D plus calcium showed consistent efficacy in reducing fracture risk by an average of 26%, compared with calcium or placebo, whereas trials with 400 IU vitamin D/day were not effective [8]. Although data from the Women's Health Initiative (WHI) concluded that calcium and vitamin D did not reduce hip fracture

[7], only 400 IU vitamin D was used in that study; nevertheless, hip fracture risk was reduced by 29% when non-compliant subjects were excluded from analysis [9]. From the publications that included measurements of serum 25(OH)D, it is clear that anti-fracture efficacy increases with higher achieved 25(OH)D levels; levels above 30 ng/mL were achieved with 700-800 IU vitamin D₃ [9]. Further, Bischoff-Ferrari's review of 7 trials indicate that 800 IU vitamin D/day did, but 400 IU/day did not reduce the risk of falling by 22 to 46%, an important risk factor for hip fractures [9]. Thus there are two direct musculoskeletal benefits of vitamin D sufficiency: fracture reduction with normalization of parathyroid hormone, and fall reduction as a result of increased muscle strength.

FRACTURE DISCHARGE RECOMMENDATIONS.

In 2003, we launched a formal initiative of discharging fragility fracture patients with recommendations for daily over-the-counter calcium and vitamin D supplements (600 mg elemental calcium/200 IU cholecalciferol, bid) and a daily multivitamin with 400 units of vitamin D (cholecalciferol) and with information how to obtain an osteoporosis evaluation. In this case, the role of the orthopedic team was to provide the patient with information that can aid fracture healing and promote skeletal health. The initiative to include that information on the computer-assisted discharge order summary was completed in 2003. This was accompanied with clinician training sessions on vitamin D physiology and skeletal pathophysiology and a discharge handout for the patients.

FRACTURE ADMISSION ORDER SET.

In 2004, an admission pathway was formulated and disseminated to orthopedic residents and staff in a handout, on a summary card, and with reinforcing emails. This pathway was based upon the knowledge of prevalence of vitamin D inadequacy in fracture patients and that it could be addressed safely and inexpensively. Pathway content was regularly reviewed by the multidisciplinary team and was revised based upon available evidence. It included orders for measurement of 25-hydroxyvitamin D in order to identify patients who may require immediate high-dose therapy for extreme vitamin D deficiency. Unfortunately, launching that plan coincided with problems with a newly adopted commercial chemiluminescent assay that failed to identify 25-hydroxyvitamin D₂, the metabolite that is produced from a common form of ingested vitamin D, ergocalciferol [10]. A recently published note exemplifies the problems encountered with this assay at BWH in early 2004; awareness resulted in the BWH changing the assay in mid-2004 [11].



You have entered a patient that qualifies for the Brigham's Hip Fracture pathway. Please order the following:

- a. An Endocrine Consult.
- b. These lab tests: 25-hydroxyvitamin D (results back within 7 days), calcium, albumin, ionized calcium, phosphate, creatinine.
- c. Administration of Vitamin D2 (ergocalciferol) 50,000 IU po X 1
- d. Administration of multivitamin po QD and calcium carbonate with cholecalciferol (600mg/200 IU per tablet) - one tab po BID with food.
- e. Upon discharge, please review the Discharge Pathway re: discharge medications and Endocrinology outpatient appointments.
- f. Please contact Dr. Mitchel Harris or Dr. Julie Glowacki with questions.

Figure 1. The pop-up reminder that appears when information about a fragility fracture patient is entered into OrthoDude.

To enhance the admission pathway, a pop-up reminder was launched on OrthoDude (a database and documentation tool used within the Partners system) in March, 2005, as a convenience for the admitting residents and fellows. This included the new instructions to order administration of one tablet of 50,000 IU ergocalciferol, unless contraindicated. Because it was still necessary for the surgeon to manually place the orders, efforts were made to implement them on the computerized order set for Trauma Service Admission. This was achieved in February, 2007, and will be tested for effectiveness with the 2007 cohort.

VITAMIN D STATUS IN HIP FRACTURE PATIENTS (2004-2006).

With IRB approval, we examined charts of cohorts of hip fracture patients admitted to BWH in August through December in 2004, 2005, and 2006. The starting month of August avoided data that had been collected during the 2003/2004 period with the assay problem. Use of comparable months in successive years ensured similar seasonal effects. Review of medical records was done 1 to 3 months after the end of the cohort year. Of the total of 60 patients for whom serum 25(OH)D was tested while in hospital, 50% were deficient (≤ 20 ng/mL) and only 33% were sufficient (≥ 32 ng/mL). The range was 7 to 67 ng/mL. These findings confirm earlier reports, including ours [3, 12, 13], of vitamin D inadequacy in fracture patients and stress the importance of correcting vitamin D status in patients with fragility fractures.

EFFECTIVENESS OF ADMISSION PATHWAY.

For the purposes of this IRB-approved study, we defined effectiveness of the admission pathway as the percent of subjects in each year's cohort that had documentation of the 25(OH)D result in the patient's medical record. During the 2004 period in which the pathway was disseminated through the BWH fracture service team by laminated card and emails, approximately 30% of the cohort had 25(OH)D assay results. The OrthoDude pop-up reminder was launched in March 2005 (Figure 1). Admission pathway effectiveness in 2005 was approximately 40% and was significantly increased in 2006, at 60%.

EFFECTIVENESS OF DISCHARGE PATHWAY.

For the purposes of this IRB-approved study, we defined effectiveness of the discharge pathway as the percent of medical records that indicated that upon discharge the patient was instructed to use daily over-the-counter calcium and vitamin D supplements. Because the discharge recommendations were introduced into the BICS computer-based discharge order set in 2003, it was no surprise that its effectiveness in the 2004 cohort was nearly 70%, a rate greater than that for the newer, manual admission pathway (30%). There have been subsequent increases in discharge pathway effectiveness.

CONCLUSION.

Vitamin D adequacy is defined, not by intake, but by the serum level of the major metabolites, 25(OH)D_{2,3}. The high prevalence of vitamin D-inadequacy in patients with fragility fractures stresses the importance of assessing and managing vitamin D status.

Our pilot pathway projects highlight the benefit of care pathways in the implementation of evidence-based practice guidelines for hospital patients with fragility fractures. Furthermore, this indicates that through the use of computerized pathways, training and reinforcement of guidelines, guided by multidisciplinary teams to update the recommendations, in-hospital improvements for fracture care and osteoporosis management can be practical.

There is an increasing number of reports of health care improvement projects to obtain follow-up evaluation and management of osteoporosis for patients who are identified with fragility fractures. Many of those hospital-based, clinic-based, and population-based efforts use dual energy x-ray absorptiometry (DXA) measurement of bone mineral density (BMD) after fracture as the outcome measure [14-16]. Some of the barriers identified in those care improvement projects include uncertainties about clinical responsibility, clinician resistance to modify traditional roles, paucity of support and resources for innovation, patient resistance, and information technology hurdles.

An analysis of a small survey sent to admitting orthopedic surgeons and to primary care physicians (PCPs) revealed that the surgeons were unanimous in their opinion that post-fracture attention to osteoporosis should rest with the PCP [17]. Of the PCPs, 70% responded that it was their responsibility and 30% responded that the responsibility ought to be shared with the surgeon. Another difference was that most orthopedic surgeons saw no limiting factors for scheduling follow-up bone density testing in patients hospitalized with fragility fractures, whereas 40% of the PCPs answered that they could treat without it or that the patients were too old or frail for it. Both groups responded that they would be more likely to treat elderly fracture patients if there was a safe and inexpensive medication with proven efficacy in fracture prevention. PCPs and medical specialists, such as endocrinologists, are in better position than the orthopedic trauma surgeon to supervise the follow-up evaluation and management of osteoporosis. Nevertheless, orthopedic surgeons can participate in patient education about

osteoporosis follow-up and vitamin D sufficiency for musculoskeletal health. In our fracture care pathway, Endocrinology consultations were important in the evaluation of osteoporosis and treatment of the underlying vitamin D deficiency.

We were initially startled by finding high prevalence of extreme vitamin D deficiency in a study cohort of fracture patients admitted to Brigham and Women's Hospital (BWH) [3]. It is a serious condition that is easily and inexpensively corrected, once recognized. Finding high prevalence of vitamin D deficiency in home-dwelling fracture and other patients motivated us to design, implement, and evaluate multidisciplinary, hospital-based care pathways to improve vitamin D status and osteoporosis care, including computer-assisted admission and discharge components. This ongoing work shows increasing effectiveness of computer-based directives. These pathways represent a much-needed paradigm shift in the care of fracture patients.

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