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ORIGINAL ARTICLE

Development of an electronic medical record based intervention to improve medical care of osteoporosis

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Abstract
Summary Osteoporosis is infrequently addressed during hospitalization for osteoporotic fractures. An EMR-based intervention (osteoporosis order set) was developed with physician and patient input. There was a trend toward greater calcium supplementation from July 2008 to April 2009 (s=0.058); however, use of antiresorptives (13%) or discharge instructions for BMD testing and osteoporosis treatment (10%) remained low.
Introduction Osteoporosis is infrequently addressed during hospitalization for osteoporotic fractures. The study population consisted of patients over 50 years of age.
Methods Northwestern Memorial Hospital is a tertiary care academic hospital in Chicago. This study was conducted from September 1, 2007 through June 30, 2009.
Results Physicians reported that barriers to care comprised nonacute nature of osteoporosis, belief that osteoporosis should be addressed by the PCP, low awareness of recurrent fractures, and radiographs with terms such as "compression deformity", "wedge deformity", or "vertebral height loss" which in their opinion were not clearly indicative of vertebral fractures. An EMR-based intervention was developed with physician and patient input. Over the evaluation period, 295 fracture cases in individuals over the age of 50 years in the medicine floors were analyzed. Mean age was 72± 11 years; 74% were female. Sites of fracture included hip n=78 (27%), vertebral n=87 (30%), lower extremity n=61 (21%), upper extremity n=43 (15%) and pelvis n=26 (9%). There was no increase in documentation of osteoporosis in the medical record from pre- to post-EMR implementation (p=0.89). There was a trend toward greater calcium supplementation from July 2008 to April 2009 (p=0.058); however, use of antiresorptives (13%) or discharge instructions for BMD testing and osteoporosis treatment (10%) remained low.
Conclusion An electronic medical record intervention without electronic reminders created with physician input achieves an increase in calcium supplementation but fails to increase diagnosis or treatment for osteoporosis at the time of hospitalization for a fragility fracture.

Keywords Gap in medical care · Physician attitudes · Adiographs · Information technology · Quality improvement · Prevention

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Introduction

Despite the presence of cost-effective interventions, osteoporosis is seldom addressed at the time of a fracture. Indeed, less than 10% of patients with hip fractures are treated for

osteoporosis [1]. Such data demonstrates the need for system-related change to address this major health concern. Shortcomings in the medical care of patients with chronic conditions such as osteoporosis have been frequently documented [2, 3]. Physicians' report that their failure to adhere to established clinical guidelines for chronic conditions are due to a lack of information as well as insufficient time to meet the needs of chronically ill patients [4]. As primary care practices are often organized to meet the acute and urgent needs of individual patients, the traditional organization and culture of medical practice may actually be primarily at fault [5]. Physicians fear missing serious illness more than other types of errors [6], so when faced with multiple demands and tasks, they gravitate toward those likely to have the greatest urgency or emotional investment [5]. Thus, the behavioral preference is often for addressing serious diseases, i.e., cancer care and heart disease, over providing the elements of good chronic illness care [7]. Asymptomatic vertebral fractures result in considerable morbidity and mortality; however, clinicians often fail to recognize such fractures as a "serious condition" [8–14].

Systems to support clinicians in chronic disease care are often underdeveloped and underused [15, 16]. Primary care physicians (PCPs) infrequently use organizational systems such as case management, feedback to physicians, disease registries, computer information systems, integrated practice guidelines, or patient self-management programs to improve chronic disease care [16, 17]. We theorize that hospital medicine physicians face similar challenges as those faced by PCPs in the management of chronic diseases.

Health Information Technology (HIT), particularly through Electronic Medical Records (EMRs), has provided a platform through which existing systems can be used to enhance care [18–22]. Overcoming the problem of underuse of effective treatments for chronic disease care has been accomplished through system changes in the processes of healthcare delivery [23–27]. The development of information systems or disease registries that identify populations of patients who are not receiving necessary care and communicate this information to physicians and/or patients have resulted in improved delivery of care for preventive services and chronic disease care in many instances [28–35]. EMR reminders typically generate an on-screen message to cue the physician to needed preventive measures [36] such as immunizations [37] and advanced directives [38]. Reminders have also been utilized for prevention of thromboembolic disorders [39] and inappropriate drug use [40] in hospitalized patients. EMR reminders are most effective when they are based on input of highly accurate data, integrate well into workflow, and are designed to be unobtrusive and rapid [41]. However, when EMR reminders are too numerous physicians may ignore these altogether [42].

The Chronic Care Model created by Wagner et al [43, 44]. describes multiple components of healthcare delivery systems that can be utilized to improve chronic disease care. The model depicts how health care can be directed toward improving the care of patients with chronic conditions through attention to 1) the central role of patient self-management, 2) the way healthcare delivery is organized, 3) methods for supporting evidence-based medical decision making and 4) the role that information systems can play in improving chronic disease care [7, 23, 24, 43, 45, 46]. EMRs, while currently only used by a small portion of practicing physicians [48], have great potential for advancing the goals of the chronic care model by providing clinical information and decision support. In this study, we plan to utilize all aspects of the chronic care model in order to develop patient-centered, evidence-based recommendations.

Methods

Institutional setting

Northwestern Memorial Hospital (NMH) is a tertiary care hospital located in downtown Chicago. The 550-bed institution serves as main teaching environment for students and residents of the Feinberg School of Medicine of Northwestern University. This study was conducted as a Quality Improvement Intervention and took place from September 1, 2007 through June 30, 2009. This study was approved by the Institutional Review Board of Northwestern University.

Physician focus groups

Physician focus groups were conducted with internal and hospital medicine physicians on staff at NMH. Four focus groups with six physicians per group (n=24) were conducted from July 2008 through March 2009. Focus groups were led by investigators (BJE, KAC and ADB). Discussions were divided into three sections: participant perceptions of the current state of osteoporosis care at NMH, barriers to care from the professional and system-related perspective and proposed solutions for this gap in medical care. Radiographic reports describing fractures were reviewed by participants and controversial terms listed in the reports were discussed. Some of the radiographic terms reviewed included "compression deformity," "loss of vertebral height," and "wedge deformity," among others. Two additional focus groups assisted in the evaluation of the order set.

Patient focus groups

A semistructured focus group protocol was designed to elicit participants' knowledge and attitudes about osteoporosis and

osteoporotic fractures as well as their past experiences (positive or negative) with osteoporosis management. Five focus groups with six to eight women were conducted (n=43). Groups were conducted between September 1, 2007 and December 10, 2007. Sessions lasted 90 min and included discussions about falls, fractures and their possible relation to osteoporosis. In addition, we explored women's perceptions and attitudes about osteoporosis. Participants were asked to indicate reasons for choosing to receive or forgo bone density testing, to elicit both barriers and facilitators to screening. Probes were used throughout the focus group sessions when needed to clarify responses or engage less vocal participants [47].

Data collection

Focus group sessions began with introductions of the moderators and the informed consent process, which included consent for audio taping the group discussion to reduce the need for notetaking and to facilitate analysis. All participants signed consent forms approved by the institutional review board; none refused participation. Discussion began once all participants had completed the questionnaire and lasted approximately 90 min. Following completion of the group discussion, participants were thanked and given $30 as compensation for their participation. All audiotapes were transcribed verbatim and carefully compared with the original recordings to ensure transcription accuracy. Personal identifiers were removed and the transcripts were distributed to two coders. The protocol was intentionally designed to elicit general perceptions, knowledge, and past experiences related to osteoporosis and related fractures.

Focus group analysis

Transcripts were analyzed using latent content and constant comparative techniques through which two coders independently assessed participant responses for focal themes before convening to compare and compile their findings. Through consensus, the coders constructed an overarching categorical system describing all issues surrounding osteoporosis management [47].

Baseline data

We had reviewed the frequency for diagnosis and treatment for osteoporosis in patients with new fragility fractures from January 2008 to July 2008 on a monthly basis. We identified over these 6 months that approximately 10% of patients were diagnosed and treated for osteoporosis (range 5–14%). Discharge instructions for osteoporosis follow-up were present in only 5% of cases.

Development of a multidisciplinary team

A team was created with members of the clinical informatics team, hospital administration, medical faculty (Internal and Hospital Medicine), nursing, pharmacy and programmers of the electronic data warehouse (EDW).This team met on a monthly basis to review progress on this project and develop next steps.

Development of fracture/osteoporosis order set

Based on recommendations of primary care physicians (and with their ongoing feedback) we developed an order set including the following elements: a) diagnosis and evaluation of osteoporosis, laboratory testing for secondary causes of bone loss, calcium supplementation and antiresorptive therapy; b) physician resource list with useful links to clinical guidelines (National Osteoporosis Foundation, American Academy of Clinical Endocrinologists and American College of Rheumatology) for postmenopausal and glucocorticoid-induced osteoporosis, among others and c) patient education (Figs. 2, 3 and 4). The patient education material was written at a sixth grade level and reviewed the diagnosis of osteoporosis and relevance of current fracture as well as prevention of future fractures with osteoporosis therapy. Patients were recommended to have a bone density test upon hospital discharge and follow-up with their PCP or the Bone Health Center. Patient education material (Fig. 4) would be linked with a nurse order in such a fashion that when the physician triggered the order set, patient instructions would be printed and nursing staff would review these with the patient.

Review of order set with physicians

Two additional focus groups with ten physicians provided feedback and recommendations about the fracture/osteoporosis order set that was created in the second part of this study.

Collaboration with the nursing department

In order to secure nursing leadership support, we met with nursing managers. Nursing managers expressed support for this project.

Identification of fractures

The identification of fractures posed a considerable challenge as numerous diagnostic algorithms were used in patients hospitalized over the age of 50 years. Fractures presenting as an admitting diagnosis proved to have an unacceptably low sensitivity of 23% (specificity 36%). A

review of nurse notes about fractures and fall risk unfortunately yielded low results due to the widespread use of fall precautions among older patients, sensitivity 11% (specificity 62%). A third identification method consisted of "parsing of radiographic text" for terms such as fracture, compression fracture and biconcave deformity among others, which yielded a sensitivity of 90% and specificity 85%. Therefore, searches were conducted on a monthly basis identifying patients admitted to Medicine services with fractures. Retrospective medical record review allowed us to assess whether or not physicians identified the osteoporotic fractures and proceeded with osteoporosis counseling, evaluation, treatment and discharge recommendations.

Dissemination of osteoporosis order set

The osteoporosis order set was presented to the medical staff and medicine residents in a lecture along with handouts (July 2008). An EMR-based notice was posted for 3 weeks (July 2008), which read: "Current osteoporosis treatment of fragility fractures is under 10%, osteoporosis order set is now available."

Fragility fracture identification as potential cases for osteoporosis order set use

Low or minimal trauma fractures were evaluated in individuals over the age of 50 years and patients who did not have a prior diagnosis or treatment of osteoporosis.

Exclusion criteria

Exclusion criteria included end stage renal disease, metastatic cancer, fracture reported as "pathological", admission to palliative care unit and other metabolic bone diseases.

Primary outcomes

Primary outcomes included: a) diagnosis of osteoporosis made in medical record; b) counseling, evaluation and pharmacologic treatment of osteoporosis recorded in medical record and c) instructions for medication compliance, bone density testing and follow-up included in discharge summary.

Chart abstraction

fter order set implementation, two trained reviewers abstracted data from EMR, and data was validated by the investigators (BJE and ADB). Fractures were classified by site of fracture, analysis was carried out by monthly intervals and trend in diagnosis and treatment rates were sought. Additionally, causes for possible nontreatment were sought such as patient or family refusal and intolerance to bisphosphonates, among others.

Analysis

Medical records were reviewed for a) identification of osteoporotic fracture, b) evaluation for osteoporosis, and use of the osteoporosis order set, c) treatment for osteoporosis and d) inclusion of recommendations within discharge summary. The data sets were analyzed by using statistical software package R version 2.9.0 [48]. The analysis was conducted using a quasiexperimental design with relatively high levels of internal validity, the interrupted time series design [49].

Results

Physician focus groups

Four focus groups were conducted with 24 hospitalists and internists. Physicians reported that barriers to osteoporosis care comprised the nonacute nature of osteoporosis, the belief that osteoporosis should be addressed by the PCP in the office, the low awareness of high risk of recurrent fractures and the reported need for additional training in osteoporosis. Institutional barriers noted included radiographic reports using confusing terms such as "compression deformity" or "wedge deformity" on radiographs that were not clearly indicative in their opinion of reflecting fractures. Physicians expressed reluctance to use generic EMR reminders, citing EMR reminders as too numerous and intrusive. However, the creation of a fracture order set that used physicians' direct input was commended. Factors that would motivate physicians to address osteoporosis would include identifying such a project as a Quality Improvement project. Therefore, the system physicians reported that they would be most likely to use a "Fracture Order set" with orders for calcium, vitamin D and osteoporosis therapy with BMD testing after discharge. Including such orders in the discharge instructions would improve communication with PCP. Physician resources recommended were internet links to evidence-based clinical guidelines as well as patient education material. After drafting a proposed order set, the draft was presented to the last two physician focus groups; physician feedback served to further refine the final order set which is shown in Figs. 1, 2 and 3).

Barriers to osteoporosis care could be divided into physician-, patient-, and system-related barriers. Physicians report that lack of knowledge, reluctance to contribute to polypharmacy and cost to the patient limit their effectiveness. Physicians confided that their knowledge of osteoporosis was limited, requiring CME courses in order to feel confident of the medical management. Clinicians were

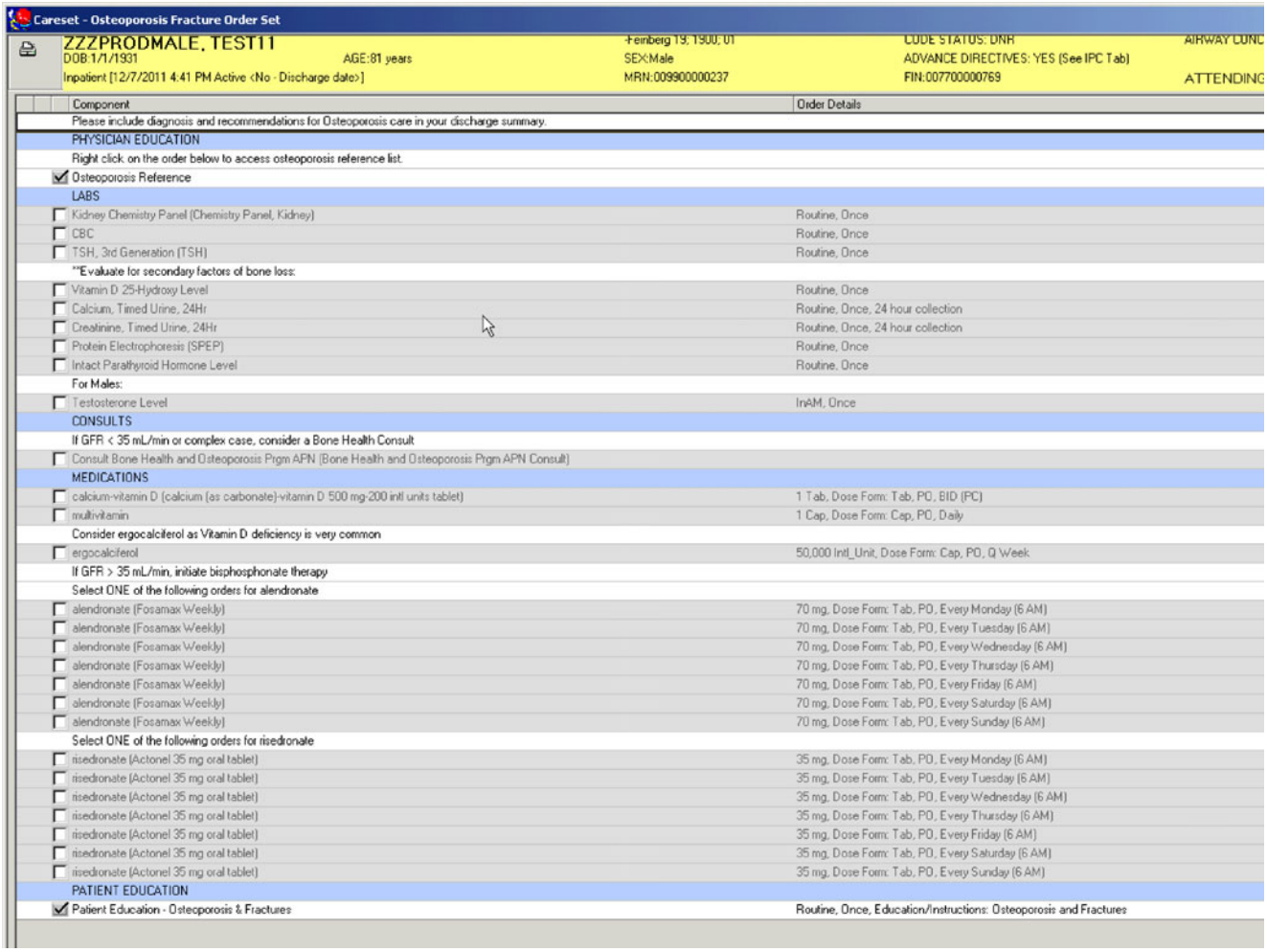

Fig. 1 Medical evaluation order set

concerned about multiple comorbidities. Lastly, hospital-based physicians were concerned about intrusion in the PCPs management; they would prefer that all osteoporosis care be provided by the PCP. In addition to a fragility fracture and risk factors, many clinicians rely on the results from a BMD test so that they are hesitant to start pharmacologic therapy for osteoporosis if a BMD is not available even after occurrence of a fragility fracture. Prior studies have likewise demonstrated that a BMD test increases the likelihood of osteoporosis treatment among PCPs [50] and orthopaedists [51].

Patient focus groups

Five focus groups with 36 women were conducted. Although postmenopausal women reported they believed they had adequate knowledge about osteoporosis; [52, 53] none of the participants attributed their prior fracture to underlying low bone mass or osteoporosis but only attributed it to the preceding fall. Women also significantly underestimated their risk of future fractures (estimating <1% instead of the more accurate 20%), and ageism or stigmatization of osteoporosis was evident. Women confused osteoporosis and osteoarthrtitis and believed that nonsteroidal medications (NSAIDS) were strengthening their bones. These results demonstrate that factors that impede individuals' acquisition of information about osteoporosis include: inadequate knowledge about osteoporosis, stigmatization and a false sense of security that may prevent individuals from seeking specialized care for osteoporosis [47].

Development of the fracture/osteoporosis order set

After meeting with hospital leadership and reviewing the evidence for the gap in medical care, we developed, in collaboration with the hospital information technology team, the osteoporosis order set. EMR functionality was discussed as well as linking order set with nursing orders. Multiple attempts and refinements were incorporated into the set following physician recommendations. The order set

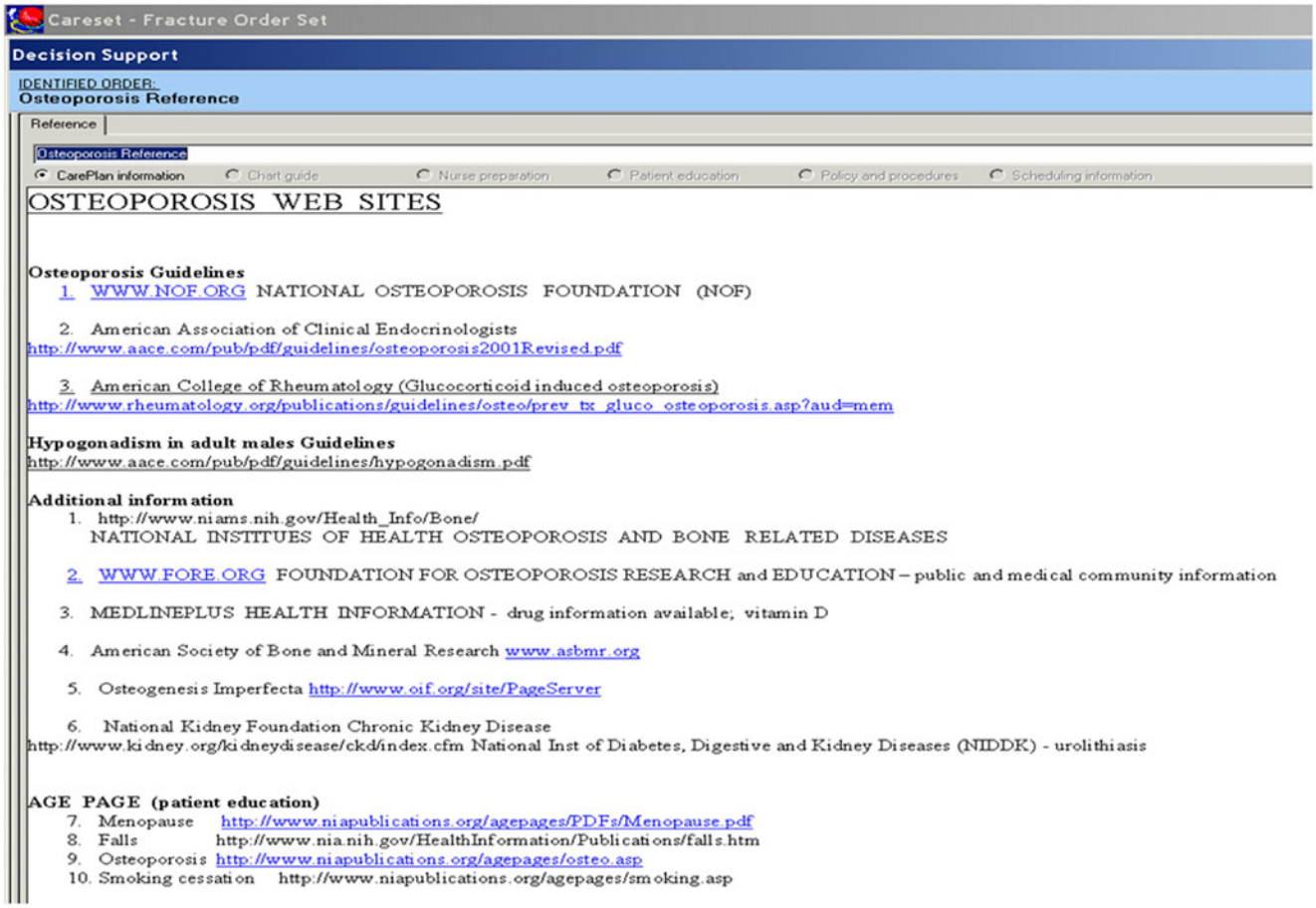

Fig. 2 Physician resources order set

included medical evaluation (Fig. 1), physician resources (Fig. 2), and patient education (Fig. 3). However, a physician reminder was not included due to the IT leadership's concerns about physician complaints with excessive and intrusive EMR reminders.

Assessment of diagnosis and treatment for patients with osteoporosis fractures

Over the following months, we evaluated the diagnosis and treatment rate for newly identified fractures. The IT team identified radiographic fractures. Diagnosis and treatment rates remained low during the duration of the evaluation period. Two hundred ninety-five fracture cases in individuals over the age of 50 years in the medicine floors were analyzed. Mean age was 72±11 years; 74% were female; sites of fracture included hip n=78 (27%), vertebral n=87 (30%), lower extremity n=61 (21%) upper extremity n=43 (15%) and pelvis n=26 (9%). Availability of an osteoporosis order set showed a modest improvement in clinical care, with a trend toward greater calcium supplementation from July 2008 to April 2009 (p=0.058); however, osteoporosis diagnosis, evaluation or use of antiresorptives remained low (n=38 (13%) (p=0.89)). Completing the initial 11-month evaluation, results were presented to the medicine residents, medical staff, and radiology leadership (Fig. 4).

Discussion

Physicians reported that barriers to osteoporosis care comprised the nonacute nature of osteoporosis, the belief that osteoporosis should be addressed by the PCP in the office, the low awareness of high risk of recurrent fractures, and the reported need for additional training in osteoporosis. Institutional barriers noted included radiographic reports using confusing terms such as “compression deformity” or “wedge deformity” on spine films that were not clearly indicative in their opinion of reflecting fractures. Physicians expressed reluctance to use generic EMR reminders, citing EMR reminders as too numerous and intrusive. An EMR intervention developed with physician input, yet without physician reminders, had a modest effect on increasing evaluation or treatment for osteoporosis over the following months. Physicians remained, for the most part, unengaged in the evaluation of osteoporosis in patients who are hospitalized with fractures.

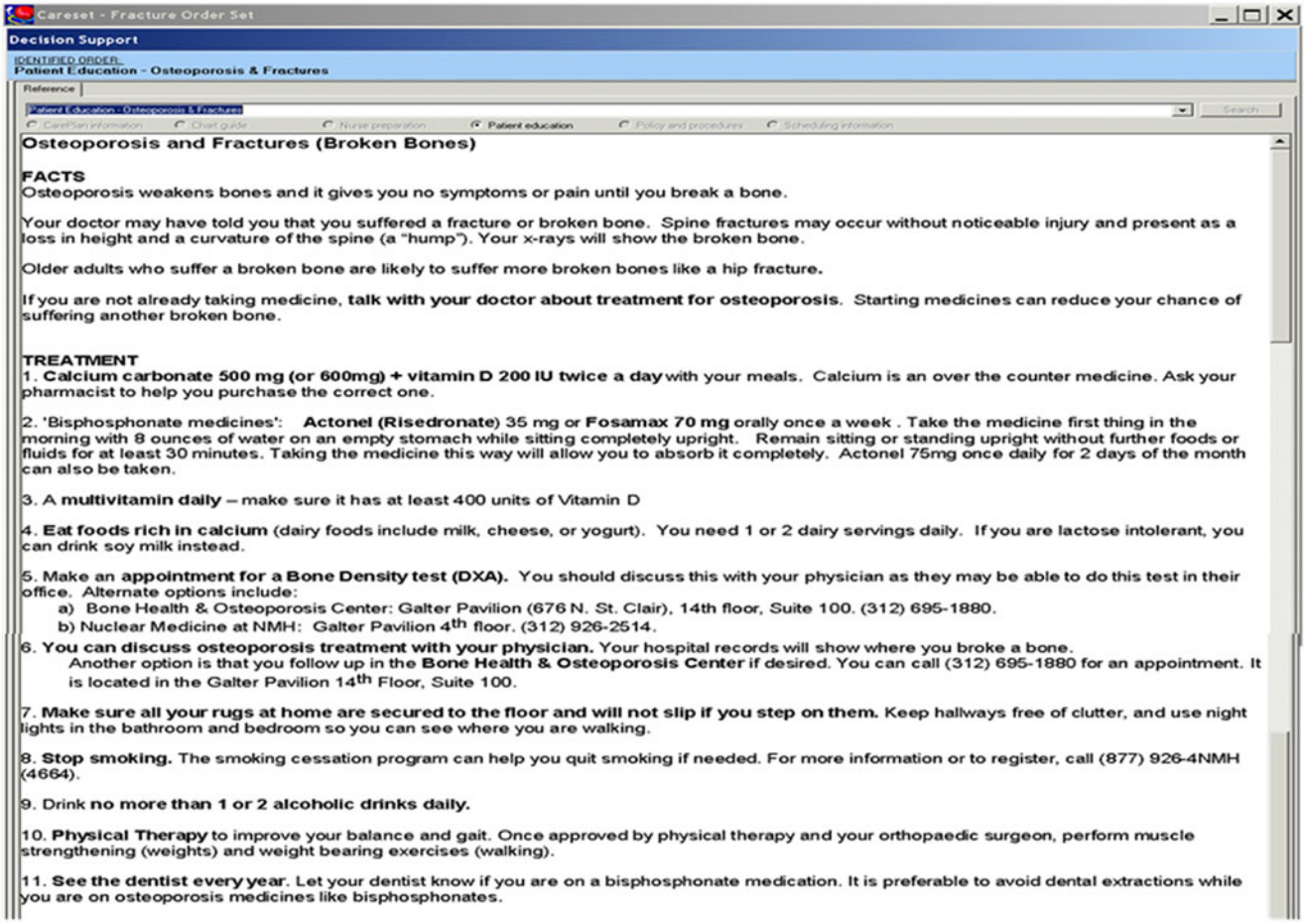

Fig. 3 Patient education order set

Physicians commented that the limited length of stay, competing comorbidities and the nonacute nature of osteoporosis were common reasons this disease was underappreciated. Findings were attributed to confusion over the radiologic reports with terms of "compression deformity" or "loss of vertebral height" not clearly identifying fractures. A greater emphasis is placed on the acute disease motivating hospitalization, and incidental findings are expected to be addressed by the PCP. Individuals with hip fracture admitted to the medical service tend to have multiple comorbidities and thus,

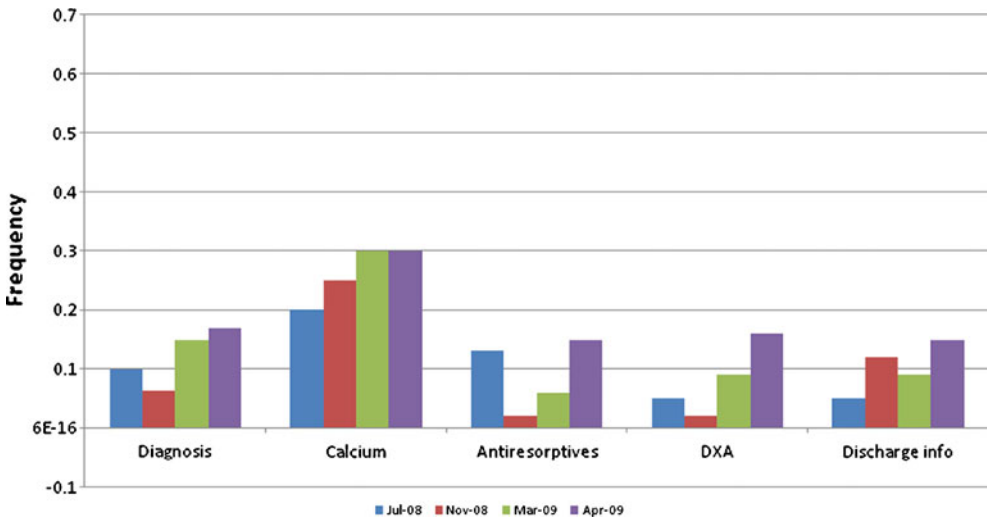

Fig. 4 Patient education material were linked with a nurse order in such a fashion that when the physician triggered the order set, patient instructions would be printed and nursing staff would review these with the patient

osteoporosis is not considered a medical priority. Thus, our findings confirm that physician-related barriers to care remain to be fully overcome [54]. Our findings confirm Bliuc's findings where EMR-based interventions only led to an increase in BMD testing, yet had no effect on treatment rates [55]. Feldstein et al., however, were able to modestly increase BMD testing and/or treatment with an EMR intervention after wrist fracture [56].

Similar physician-related barriers were noted by McLellan in Glasgow where orthopedic surgeons failed to refer patients to BMD testing after the occurrence of a fracture. Thus, an alternative system was designed with assistance from a nurse liaison [57]. Physician notification about osteoporosis was of limited success in Harrington's work as it resulted in only 20% of suitable patients being evaluated and treated. More so, the coordination by a nurse liaison was vital to success [58]. Direct patient contact and shared medical appointments in Geisinger resulted in an increase in BMD testing and osteoporosis treatment as compared to standard care [59]. In Kaiser Permanente, most quality improvement work is coordinated by team care managers with physician involvement at time of evaluation [60]. Majumdar et al. reported that a nurse-led intervention was superior to a multifaceted intervention similar to ours after wrist fracture [61]. Sixty-five percent of successful European fracture care models are led by a central coordinator (nurse liaison) [62]. Thus, although it would appear that the most effective systems of care delivery for fragility fracture have included coordinator-led interventions [54, 63–65], given the limited resources within institutions, staff resources may not be readily available.

Many system-related barriers were addressed by the institution, committing administrative, information technology and clinical resources to this project. Further refinement of this IT-based intervention by either including a physician reminder in the EMR or modifying radiology reports have yet to be tested as possible solutions to this problem. Some previously described system barriers that play a role in the gap in medical care after osteoporosis-related fractures include a lack of electronic medical records, incomplete discharge summaries such as lack of information about outstanding results or need for additional testing. Discharge summaries may not arrive at the PCPs in time for the follow-up visit [66–69]. We should also contemplate whether reimbursement for hospitalization based on diagnosis-related groups (DRG) may play a role in the reluctance to perform additional testing (DXA) by clinicians [54]. A recent barrier to medical care for osteoporosis resulted from the reduction on bone density testing reimbursement (2007) leading to decreasing numbers of osteoporosis centers [70]. In-hospital-based QI interventions such as smoking cessation and pneumococcal immunization, however, highlight the effectiveness of the hospital setting to identify and initiate treatment for high risk populations [71, 72]. Hospitalization with an osteoporotic fracture may likewise represent an opportunity to identify high risk patients with osteoporosis, initiate treatment and ultimately improve outcomes [73]. This study confirms that an IT-based intervention without physician reminders results in an increase in calcium supplementation but fails to enhance diagnosis or treatment for osteoporosis.

Patient barriers to care exist such a low level of awareness about osteoporosis (low stage of change)—the decision-making process that enables individuals to recognize and take action about a medical problem or not [74]. Women who sustain fractures have been reported to attribute the fracture occurrence to the fall, and they confuse osteoarthritis and osteoporosis and they express fear of medication side effects and overall financial cost [47]. The likelihood of seeking care for osteoporosis declines with advancing age by 42% for each additional 10 years of age beyond the age of 50 years. Thus, patients over the age of 65 years such as our study population would be at the highest risk of recurrent fractures, yet have the lowest awareness of osteoporosis [75].

Despite years of effort and numerous programs to improve the quality and safety of health care, major problems persist. Reasons for the slow pace of improvement have been identified such as resistance to change among health professionals, organizational structures that block improvement of care and dysfunctional financial incentives [76, 77]. Different approaches have been tried to speed up improvement such as medical audits, evidence-based guidelines, accreditation, disease management, public reporting of performance indicators, financial incentives, revalidation of professionals and collaboratives. Research on the effect of these approaches is scarce, but the evidence shows that even well-developed improvement programs are often only partially effective [78, 79].

Limitations to this study include the qualitative aspect of this study, being conducted in an academic institution located in an urban setting, thus our findings may not be extrapolated to suburban or rural community hospitals. An EMR-based intervention is able to increase calcium use in patients with osteoporotic fractures. However, further diagnostic or pharmacologic therapy for osteoporosis is not addressed. Our findings highlight physician-related barriers to medical care of osteoporosis. It would appear that competing demands for the clinicians' time, confusion over radiographic reporting and "nonacute nature of osteoporosis" would play a role in the lack of attention to osteoporosis care.

Conflicts of interest Edwards is a consultant at Amgen, Eli Lilly, Speaker's Bureau Amgen, Warner, Eli Lilly. Bunta, Anderson, Bobb, Hahr, O'Leary, Agulnek, Andruszyn, Cameron, May, Dillon, Baker and Williams declare no conflicts of interest.

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