Group #2 – Final Group Project

Ty Lee, Kevin Scharnhorst and Michael Sleep

for Dr. David Liebovitz

MED INF 402 – Introduction to Clinical Thinking, Summer 2010

Northwestern University

Patient Scenario:
The clinician had recorded from previous history gathering that the patient was involved in a major automobile accident at the age of 23. Injuries were sustained to her pelvis and required that metal plates be installed to rebuild. The patient also sustained major brain trauma and was in a coma for the period of 4 weeks. After surgery, physical therapy was done to help the patient with her cognitive brain function and to train her to walk again. Therapy was also done on the lower back area to deal with pain sustained from the injury.

Through open and closed ended questions, the physician learns that the patient's Grandmother was diagnosed with Osteoporosis at the age of 52.

The patient also revealed that she had a hysterectomy at the age of 38 after other complications.

The patient's health history also indicates moderate use of tobacco and alcohol.

Patient shares that she is not exercise beyond walking.

I. Collection of patient history through evaluation of chief complaint

a. **Demonstrate the use of open and closed ended questions through role play exercise to form the patient agenda.**

DOCTOR: I see you are here today for back pain, is there anything else we need to focus on during this visit?
PATIENT: No, that is it
DOCTOR: Okay, show me where you are experiencing the pain.
PATIENT: points to lower back area
DOCTOR: is it on one side or both sides?
PATIENT: both sides
DOCTOR: Is there anything that makes the pain better or worse?
PATIENT: worse when I sneeze or have bowel movement
DOCTOR: On a scale of 1 to 10, with 1 being low and 10 high, how would you rate the severity of this pain?
PATIENT: 5
DOCTOR: Can you describe the pain?
PATIENT: The area is tender to the touch, pain is dull mostly, but sharpens with certain movements
DOCTOR: Did the pain start gradually or was it a sudden onset?
PATIENT: sudden onset
DOCTOR: Have you had this type of pain previously?
PATIENT: No, it was fine until 6 weeks ago
DOCTOR: are you on any medications including hormone replacement therapy or vitamins?
PATIENT: no, I haven't taken hormone replacement therapy, and don't take any vitamins regularly
DOCTOR: tell me about your diet
PATIENT: I think I'm lactose intolerant, so I avoid dairy products
DOCTOR: do you drink caffeine or alcohol?
PATIENT: yes, about 2 glasses of wine per week and a cup of coffee every morning
DOCTOR: do you use any tobacco products?
PATIENT: yes, I smoke
DOCTOR: how many cigarettes per day and how old were you when you started?
PATIENT: 5 per day, since I was 18
DOCTOR: Have you ever had any accidents or serious injuries?
PATIENT: Yes, in a car accident when I was 23. Fractured my pelvis and was in a coma for 4 weeks.
DOCTOR: Did you do any physical therapy after the accident?
PATIENT: Yes, I had to learn to walk again.
DOCTOR: Have you ever been hospitalized since then?
PATIENT: I had a hysterectomy when I was 38.

DOCTOR: Has anyone in your family been diagnosed with any illnesses or conditions?
PATIENT: Yes, my grandmother was diagnosed with osteoporosis when she was 52

b. **Explain and provide examples of how to capture the newly captured information into the patient's problem record within the EHR.**
As the physician works through the patient interview (dialogue) they are simultaneously articulating the responses into a mental framework to organize the data. The mental framework is well aligned with various components of the electronic health record, which are for the most part split two categories: narrative and discrete. The narrative data contains the patient story with the necessary clinical and non-clinical, non-quantitative information that a physician needs to form a complete understanding of the problem. Some of the information the patient provides is quantitative and easy to use in calculators (i.e. Smoking Pack Years, MedCalc, DXplain, etc.), or relevant for tracking / trending over time to monitor for improvement and deterioration of symptoms and conditions. The paragraphs below are an example of how the physician would articulate and document the information they glean from the interview (dialogue) above.

[Discrete] Chief Complaint: Lower back pain

[Discrete] Patient Demographics: Female, Age: 46 (Calculated from DOB)

[Discrete] Physical Exam: Vitals: 135lbs;

[Narrative] History of Present Illness: 46 year old female who complains of lower back pain. Was in normal state of health until 6 weeks ago, when the area became tender and she began to experience a dull but sharp pain. Past medical history is significant for a compression fracture of the pelvis due to motor vehicle accident that required metal plates and physical therapy. Patient denies exercise and admits to moderate alcohol and tobacco use.

[Narrative] Past Medical History: Hysterectomy: age 38, MVA (Motor Vehicle Accident): age 23, Pelvic fracture, TBI (traumatic brain injury) resulting in 4 week coma; physical therapy needed to recover cognitive and motor function: no known complications.

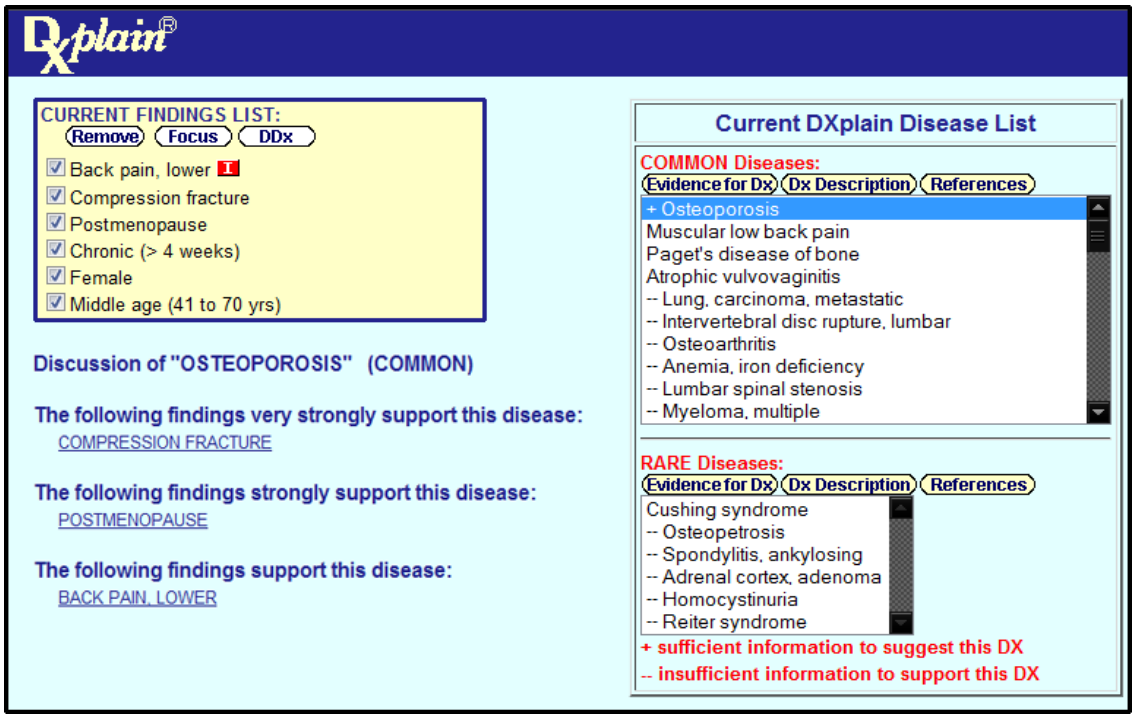
[Discrete] Social History: 2 drinks per week, Tobacco Use: 7 pack years, patient is sedentary.

[Discrete] Family History: Maternal grandmother diagnosed with osteoporosis at age 52.

II. Form differential diagnosis

a. **Implement DXplain for this**

Provided with the symptoms described in the chief complaint, demonstrate that they provide sufficient information to explore a disease further. Using the clues present in the chief complaint, use those as input and find a suggested diagnosis with sufficient supporting information.



b. Additional supporting information about Osteoporosis (Agabegi, 2008)

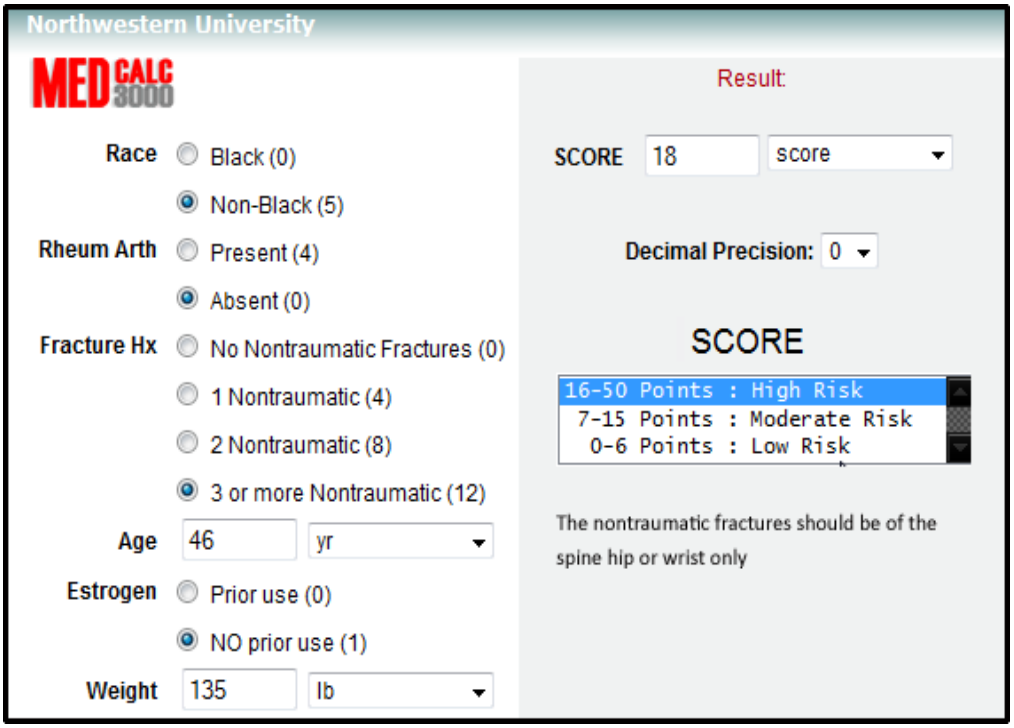
i. Risk Factors
   1. Estrogen Depletion
      a. Postmenopausal state – All women are estrogen-deficient after menopause; however, osteoporosis does no develop in all women
      b. History of athletic amenorrhea, eating disorders, oligomenorrhea
      c. Early menopause
   2. Female gender-women have a lower peak bone mass and smaller vertebral end plates
   3. Calcium deficiency/vitamin D deficiency
   4. Decreased peak bone mass
   5. Heritable risk factors-family history, European or Asian ancestry, thinness/slight build
   6. Decreased physical activity (prolonged immobility)
   7. Endocrine-hypogonadism in men (with low testosterone), hyperthyroidism, vitamin D deficiency
   8. Smoking and alcohol abuse
   9. Medications-corticosteriods, prolonged heparin use

ii. Diagnosis
   1. DEXA scan is the gold standard
      a. Very precise for measuring bone density
      b. Perform at menopause
      c. Take bone samples from the hip and the lumbar vertebrae. Compare the density of bone with a standard control, which is the bone density of a healthy 30-year-old person
      d. Can range from normal to osteopenia to osteoporosis
   2. Rule out secondary causes-check calcium, phosphorus, alkaline phosphatase, TSH, vitamin D, free PTH, creatinine, CBC

III. Apply the Bayesian Analysis Model using pre-test probability tools such as Med Calc

a. Demonstrate use of Med Calc

Based on the differential diagnosis obtained through DXplain, we have sufficient supporting symptoms to suggest Osteoporosis as a possible disease. Through the use of clinical prediction tools such as MedCalc, demonstrate how to calculate a predictive score for pre-test probability using the Osteoporosis Risk Score (Simple Calculated Osteoporosis Risk Estimation) through MedCalc 3000.



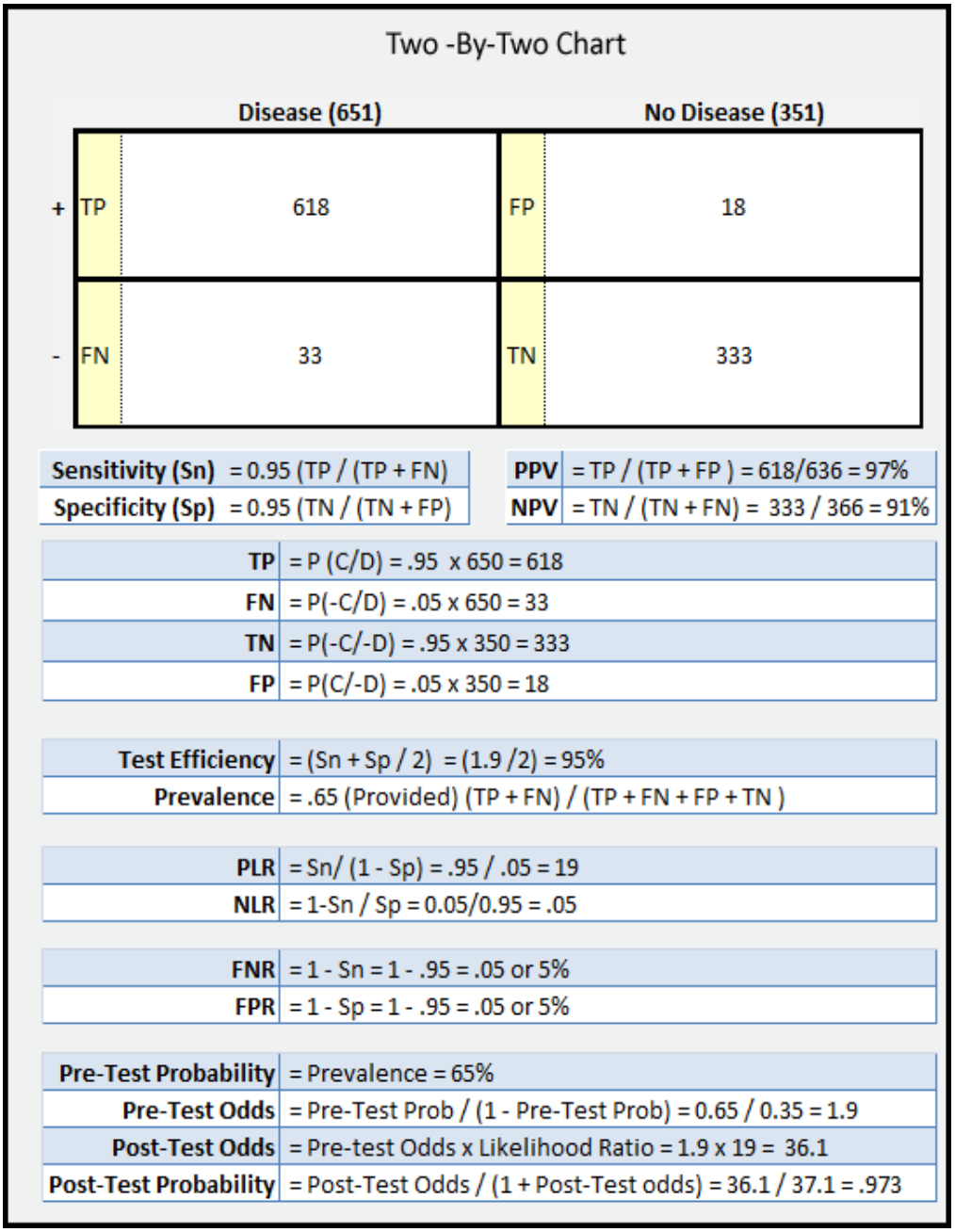
b. Figure out pre-test probability using Bayesian theorem.

Given the MedCalc results, the pre-test probability of Osteoporosis falls into the high rish range. The point scale for high risk is between 16-50 points. Given the input factors in MedCalc, our patient has a score of 18.

c. Determine clinical tests to rule in/out the disease. Select a test that is both highly specific and sensitive.

Assuming a prevalence of 65%, blood tests are issued to measure levels of calcium, phosphorus, vitamin D, testosterone, thyroid, and kidney function. The results of the blood tests alone are inconclusive, but are supportive enough to recommend a bone mineral density test with a DXA (dual-energy X-ray absorptiometry). The DXA is considered the Gold Standard in screening Osteoporosis. The procedure is safe, painless, and noninvasive. The test efficiency is 95% and has both a sensitivity and specificity of 95%. Demonstrate through the use of a two by two table and calculate the predictive value percentages.

Assume an approximate population size of 1000 people.



Two -By-Two Chart

		Disease (651)		No Disease (351)
+	TP	618	FP	18
-	FN	33	TN	333

Sensitivity (Sn)	= 0.95 (TP / (TP + FN)	**PPV**	= TP / (TP + FP) = 618/636 = 97%
Specificity (Sp)	= 0.95 (TN / (TN + FP)	**NPV**	= TN / (TN + FN) = 333 / 366 = 91%

TP	= P (C/D) = .95 x 650 = 618
FN	= P(-C/D) = .05 x 650 = 33
TN	= P(-C/-D) = .95 x 350 = 333
FP	= P(C/-D) = .05 x 350 = 18

Test Efficiency	= (Sn + Sp / 2) = (1.9 /2) = 95%
Prevalence	= .65 (Provided) (TP + FN) / (TP + FN + FP + TN)

PLR	= Sn/ (1 - Sp) = .95 / .05 = 19
NLR	= 1-Sn / Sp = 0.05/0.95 = .05

FNR	= 1 - Sn = 1 - .95 = .05 or 5%
FPR	= 1 - Sp = 1 - .95 = .05 or 5%

Pre-Test Probability	= Prevalence = 65%
Pre-Test Odds	= Pre-Test Prob / (1 - Pre-Test Prob) = 0.65 / 0.35 = 1.9
Post-Test Odds	= Pre-test Odds x Likelihood Ratio = 1.9 x 19 = 36.1
Post-Test Probability	= Post-Test Odds / (1 + Post-Test odds) = 36.1 / 37.1 = .973

IV. Innovative idea to integrate PHR to the EHR to proactively identify possible disease in patients.

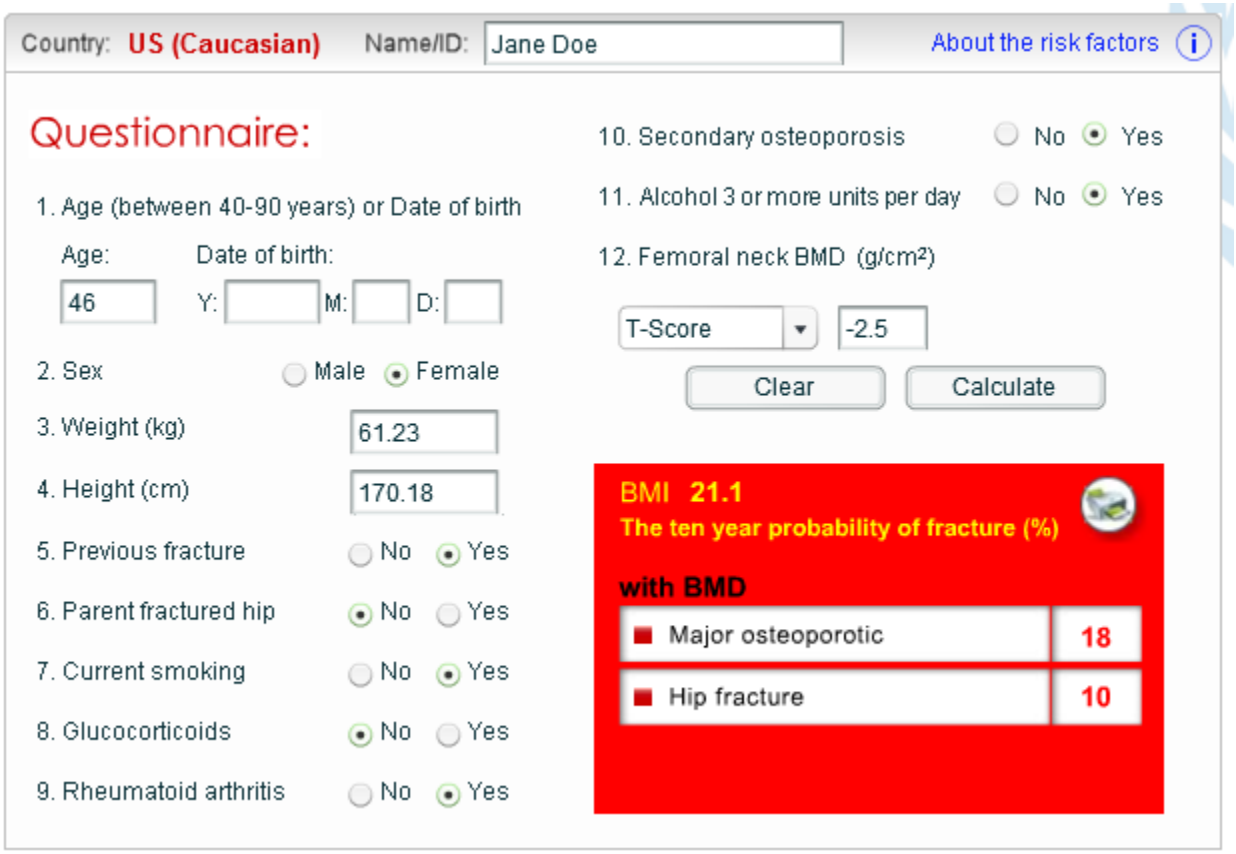
With a high prevalence, "Estimates indicate that as many as 50% of Americans older than 50 years will be at risk for osteoporotic fractures during their lifetimes. This translates to 12 million persons with osteoporosis by 2012". (Nelson et al)

Through integration with an EHR, personal health records (PHRs) could be aggregated and mined to identify patient populations at greater risk for Osteoporosis. Given current privacy concerns, we don't foresee this being a societal accepted method for at least another decade. In the shorter term, a more feasible idea is to have business intelligence built into PHRs, resulting in notification to the patient that they should inquire with their physician about risk factors and possible disease states during their next visit.
The goal of preventing fractures in patients at risk of Osteoporosis and promoting better quality of life in aging populations can be accomplished through the mining of a combined set of data elements, and a

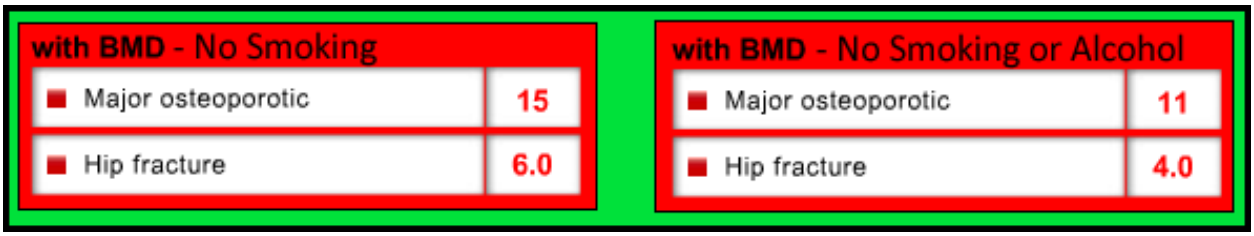
systematic identification of patients at high risk. Data elements such as Age, sex, height, BMI, history of fracture, family history of fracture, glucocorticoid use, smoking status, daily alcohol use, presence of rhumatoid arthritis would help identify patients at higher risk. Patients with higher risk would be prime candidates for Osteoporosis screening could then be recommended for such.

Early detection and treatment will reduce fractures that cause premature mortality, loss of independence and function, reduced quality of life, and substantial financial costs. (Nelson et al)

Applying the FRAX test to our case study patient, the 10 year probability of fracture is indicated below.



Early detection and influencing factors that place the patient at greater risk directly affect the probability factors. Life style factors can be changed to decrease the probability of disease in general and therefore lead to a longer and higher quality of life. The graphic below considers the elimination of two factors alone and together respectively to demonstrate these effects. You can see by eliminating smoking the probability of fracture decreases and then by also removing alcohol, the probabilities decrease yet further. The sooner you make adjustment to the contribution factors of Osteoporosis, the less sever its effects will be later in life.



The end result is that patient outcomes are improved with preventative measures to help reduce the probability of fracture or disease.

V. **Discuss possible implementation of patient education materials directly through the EHR. Describe how this might be implemented. With early detection and education this will serve to prolong the quality of life for patients with probable risk.**

Osteoporosis patient education materials (to help deliver the patient care plan) as detailed below can be executed via Electronic Health Record (EHR) medical and practice management capabilities. When this capability is fully integrated into one shared patient record in a macro health care information system, the patient can access educational materials and can facilitate a patient care plan via online questionnaires and for applicable health issues, home monitoring devices. Patient education tools can help and support patients manage their health proactively with information about diagnoses, treatment and medications (as detailed below in the care plan).

This type of EHR would follow the development of the interoperability standards set by the Certification Commission for Health Information Technology (CCHIT) and intends to continue to participate in the Commission's certification process. The system capability would include the capability to import e-documents via scanning and importing tools, as well as outside lab results.

This EHR capability to deliver patient education materials is covered in the 2003 report titled "Key Capabilities of an Electronic Health Record System," which the Institute of Medicine (IOM) details the capability as one of the eight core functions of an EHR system. (Bellantoni, 2010)

VI. **Establish plan for patient and follow up**

Post-diagnosis, the care plan for the patient needs to focus on the expected acute pain in the lower spine as related to vertebral compression, improving the knowledge and treatment plan to prevent further damage, improve nutrition as related to an inadequate intake of calcium, and ensuring that there's minimal risk for injury as related to effects of change in bone structure secondary to osteoporosis.

Immediately, there are a number of drug therapies that can help prevent bone loss and increase bone density, important to minimize the risk of spine and hip fractures, which include:

- Biphosphonates: increase bone density and may decrease the risk of future fractures
- Calcitonin: helps to get calcium into new bone
- Hormone replacement therapy (HRT): hormone called estrogen; close monitoring required
- Selective estrogen receptor modulators: estrogen-like effect on bones and may be used to prevent or treat osteoporosis

(Bellantoni, 2010)

Details of dosages below:

Calcium Intake	1500 mg daily (through diet and supplements)
Vitamin D	800 units daily is needed to increase bone mass
Alendronate* *(a biphosphonate, FDA approved*	**Dosage:** 10 mg daily to treat osteoporsis and 5 mg daily to prevent bone loss in women who are unable to take estrogen replacement. There are data to show that alternative alendronate dosing of 35 mg twice weekly, or 70 mg once weekly results in similar increases in bone density at one year to daily alendronate therapy, but with less gastrointestinal adverse reactions. **Efficacy:** Alendronate is shown in three year clinical trials to reduce the risk of new vertebral and hip fractures by 50%.

	Side Effects: Gastrointestinal are most common, especially nausea, acid reflux symptoms, and constipation. To maximize absorption, should be taken on an empty stomach with water only, waiting 30 minutes before eating or drinking. To minimize acid reflux, patients should not recline for one hour after a dose. To optimize treatment response, adequate calcium and vitamin D as described above are essential.
Risedronate *(a biphosphonate, FDA approved in April, 2000)*	**Dosage:** The recommended regimen is 5 mg orally daily for the treatment and prevention of postmenopausal osteoporosis"glucocorticoid-induced osteoporosis. **Efficacy:** In clinical trials, administration of risedronate to postmenopausal women resulted in decreases in biochemical markers of bone turnover. Data on bone mineral density increases and reductions in vertebral compression fractures are comparable to alendronate. **Side Effects**: Gastrointestinal are most common, especially nausea, acid reflux symptoms, and constipation. To maximize absorption, should be taken on an empty stomach with only water, waiting 30 minutes before eating or drinking. To minimize acid reflux, patients should not recline for one hour after a dose. To optimize treatment response, adequate calcium and vitamin D as described above are essential. Risedronate is not recommended for use in patients with severe renal impairment (creatinine clearance < 30 mL"min).
Etidronate *(FDA approved for treatment in Pagets Disease)*	**Efficacy:** Ealier studies showed efficacy in preventing vertebral fractures with cycled etidronate; however later data suggested that long-term etidronate may lead to impairment in new bone formation.
Calcitonin *(for those who do not tolerate bisphosphonate therapy)*	**Dosage:**200 units, or one metered puff daily alternating nostrils **Efficacy:** Calcitonin is shown to reduce the risk of vertebral fractures, but the effects on the hip appear to be less than that of bisphosphonate therapy.
Sodium Monofluorophosphate Plus calcium *(does not have FDA approval)* (Bellantoni, 2010)	**Dosage:** Not available for patient use except under research protocols. **Efficacy::** Although shown to reduce vertebral fractures, the effects on bone mineral density of the total hip were not significant.

VII. Summary

In this final project, we endeavored to demonstrate our learning as related to the Introduction in Clinical Thinking -- which we believe we accomplished successfully. The role playing exercise that we detailed illustrates our learning on the clinical environment where the clinical problem solving occurs. The dual narrative and structured content highlighted our understanding of how to collect the information and our understanding of how to build the information into a medical record. Using the various clinical tools we learned in this course and techniques, we used those tools to formulate a clinical hypotheses and diagnosis while caring for the patient. We articulated how an EHR can help with the clinicalal thought and decision making process through the usie of tools associated with a comprehensive EHR. We also generated novel ideas and approaches of how we may better leverage Medical Informatics concepts to improve the process. All education and learning we believe is documented in this final summary and presentation

References

Agabegi, Steven S., E. D. A. (2008). *Step-Up to Medicine* (2nd ed.). Baltimore: Lippincott Williams & Wilkins, a Wolters Kluwer business.

Bellantoni, M. F. (2010). Strategies for Osteoporosis Management in a Primary Care Setting. The John Hopkins Arthritis Center. Retrieved from: http://www.hopkins-arthritis.org/arthritis-info/osteoporosis/management.html

DXplain. (2010). Retrieved August 05, 2010 from *Galter Health Sciences Library* DXPlain: http://dxplain.org.ezproxy.galter.northwestern.edu/dxp/dxp.direct.pl.

Fracture Risk Assessment Tool. (2010). Retrieved August 09, 2010 from *FRAX, WHO Fracture Risk Assessment Tool*: http://www.shef.ac.uk/FRAX/.

MedCalc 3000 Medical Calculator. (2010). Retrieved August 05, 2010 from *Galter Health Sciences Library* MedCalc 3000: http://online.statref.com.ezproxy.galter.northwestern.edu/Utilities/MedCalc/MedCalc3000.aspx?SessionId=12A8B45FKCUXWJMV&prnt=sr&chwin=true .

Nelson, H. D., MD, MPH, Haney, E. M., MD, Dana, T., MLS, Bougatsos, C., BS, & Chou, R., MD. (2010). Screening for Osteoporosis: An Update for the U.S. Preventive Services Task Force. [Editorial]. *Annals of Internal Medicine, Vol. 153 No. 2*, 99-111 . Retrieved August 09, 2010 from the World Wide Web: http://www.annals.org.ezproxy.galter.northwestern.edu/content/153/2/99.longhttp://www.annals.org.ezproxy.galter.northwestern.edu/content/153/2/99.long.

Sheil, W. C., MD, FACP, FACR. (2009). *Osteoporosis Causes, Symptoms, Treatment - Authors and Editors on eMedicineHealth.* Retrieved August 06, 2010 from WebMD, eMedicineHealth: http://www.emedicinehealth.com/osteoporosis/article_em.htm#osteoporosis%20overview.