Osteoporosis quantifying the problem

Mike Nowitz
Quantifying the problem

- Population
- Individual
Quantifying the problem

- Population
- Individual
Population

• Osteoporosis is a common condition.
• +/- 380,000 New Zealanders suffer from Osteoporosis.
Population

– Estimated 80,000 people had Osteoporotic fractures in 2007.

– Equates to a fracture every 6 minutes.

– Projected 30% increase by 2020.
• In NZ - 3800 hip fractures occur each year
  – One hip fracture every 2.5hrs
  – 25% have a full recovery
  – 25% of patients die in the year following a hip fracture
    » Age
    » Sex
    » Home vs. residential care
  – 50% loss of independence + limited ambulation
Quantifying the problem

- Population
- Individual
Individual

• Do I have Osteoporosis?

• How bad is it?
Bone Anatomy.

- **Compact bone** - 80% of the skeleton
  - Outer layer of all bones & Shafts of long bones
    - Provides support / Mechanical lever
- **Trabecular bone** – 20% of the skeleton
  - Ends of long bones & flat bones
    - Resists multidirectional forces
    - Transfers forces
Bone Physiology.

- Bone is constantly being remodeled.
  - Adapts to new loads
  - Repairs damage
  - Maintains circulating calcium levels

- In the first 20 years formation exceeds resorption → **bone growth**.
- Peak bone mass at age 20 -30.
- Then resorption exceeds formation → **bone loss**.
Bone Physiology.

- Aim – maximise bone density in childhood and minimise bone loss in adulthood.
Bone Strength

• Bone mineral density
  • Bone mineral content (g) ÷ Bone area (cm\(^2\)) = BMD (g/cm\(^2\)) ≡ bone strength

• Many influences
  • Genetics
  • Adequate Nutrition
  • Mechanical loading
  • Hormone status
  • Systemic illness
Why measure bone density?

- Assess the current BMD.
- Establish a baseline for future monitoring.
- Provide information on the probability of future fractures.
• Measuring the bone density & establish a baseline for future monitoring.
• Provide information on the probability of future fractures.
Measurement of bone density

• Plain film
  – Carpal width
  – Singh Index

• DEXA
Grade 6
all normal trabecular groups visible; proximal end of femur completely occupied by cancellous bone

Grade 5
principal tensile and compressive trabeculae accentuated; Ward triangle prominent

Grade 4
principal tensile trabeculae reduced in number but still can be traced from lateral cortex to femoral neck

Grade 3
break in continuity of principal tensile trabeculae opposite greater trochanter

Grade 2
only principal compressive trabeculae can be seen; all tensile trabeculae

Grade 1
principal compressive trabeculae markedly reduced in number
DEXA
WHO Classification 1994

- The bone density can be
  - Normal
  - Decreased
  - Increased
T and Z scores.

• **T-score**
  – The number of standard deviations below / above the average of a young adult at peak bone density.

• **Z-score**
  – The number of standard deviations below / above an average person of the same age, race and gender.
Measurement of Bone Density

- (T score ≥ -1)
  - Normal
Measurement of Bone Density

- (T score < -1 & > -2.5)
  - Reduced
    - Osteopaenic Osteo + penia (poverty)
Measurement of Bone Density

- (T score ≤ -2.5)
  - Reduced
    - Osteoporotic  _Osteo_ + _poros_(pore) + _osis_(condition)
Measurement of Bone Density

- (T score ≤ -2.5 & osteoporotic fracture)
  - Reduced
    - Established Osteoporosis
Measurement of Bone Density

Results Summary:

<table>
<thead>
<tr>
<th>Region</th>
<th>Area [cm²]</th>
<th>BMC [g]</th>
<th>BMD [g/cm²]</th>
<th>T-score</th>
<th>PR (Peak Reference)</th>
<th>Z-score</th>
<th>AM (Age Matched)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>12.56</td>
<td>10.14</td>
<td>0.808</td>
<td>-1.7</td>
<td>82</td>
<td>-0.6</td>
<td>92</td>
</tr>
<tr>
<td>L2</td>
<td>14.73</td>
<td>13.76</td>
<td>0.935</td>
<td>-0.8</td>
<td>91</td>
<td>0.3</td>
<td>103</td>
</tr>
<tr>
<td>L3</td>
<td>14.99</td>
<td>14.47</td>
<td>0.965</td>
<td>-1.1</td>
<td>89</td>
<td>0.1</td>
<td>101</td>
</tr>
<tr>
<td>L4</td>
<td>15.83</td>
<td>15.01</td>
<td>0.948</td>
<td>-1.0</td>
<td>89</td>
<td>0.2</td>
<td>102</td>
</tr>
<tr>
<td>Total</td>
<td>58.10</td>
<td>53.38</td>
<td>0.919</td>
<td>-1.2</td>
<td>88</td>
<td>0.0</td>
<td>100</td>
</tr>
</tbody>
</table>
Measurement of Bone Density

Results Summary:

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<th>AM (Age Matched)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neck</td>
<td>5.22</td>
<td>3.37</td>
<td>0.645</td>
<td>-1.8</td>
<td>76</td>
<td>-0.1</td>
<td>98</td>
</tr>
<tr>
<td>Troch</td>
<td>11.99</td>
<td>7.16</td>
<td>0.597</td>
<td>-1.1</td>
<td>85</td>
<td>0.2</td>
<td>103</td>
</tr>
<tr>
<td>Inter</td>
<td>19.35</td>
<td>18.10</td>
<td>0.935</td>
<td>-1.1</td>
<td>85</td>
<td>0.1</td>
<td>102</td>
</tr>
<tr>
<td>Ward's</td>
<td>1.17</td>
<td>0.52</td>
<td>0.446</td>
<td>-2.5</td>
<td>61</td>
<td>0.0</td>
<td>100</td>
</tr>
</tbody>
</table>
• Measure the bone density.
• Provide information on the probability of future fractures.
Probability of Future Fractures

– Normal
  • Does not mean that a fracture will not occur but is less likely.

– Osteoporosis
  • Does not mean that a fracture will occur but is more likely.
Probability of Future Fractures

- When moving between T scores the risk is not linear.

![T score vs Risk](image)
Probability of Future Fractures

– Individuals with T scores of < 2.5 have the greatest fracture risk.
Probability of Future Fractures

– Individuals with T scores of < 2.5 have the greatest fracture risk.

– But most fractures occur in individuals with T scores > -2.5
Probability of Future Fractures

– Individuals with T scores of < 2.5 have the greatest fracture risk.
– But most fractures occur in individuals with T scores > -2.5
– Reliance on BMD alone will miss at risk individuals.
Probability of Future Fractures

– Clinical risk factors that are independent of BMD need to be incorporated into the risk assessment
  – Age
  – Fracture History
  – Steroid use
  – Smoking / Alcohol
  – Parental Hx. of hip fracture
  – Rheumatoid Arthritis
  – BMI

– Use the International Osteoporosis Foundations one minute test.
ABOUT IOF
The International Osteoporosis Foundation (IOF) is the largest global non-governmental organization dedicated to the prevention, diagnosis and treatment of osteoporosis...
Read about IOF

ABOUT OSTEOPOROSIS
Osteoporosis is a disease in which the density and quality of bone is reduced, increasing the risk of fracture. It affects around one in three women and one in five men around the world...
Find out about osteoporosis

Patients & Public
Complete information about osteoporosis and what you can find an osteoporosis society in your country or region. Take the risk
Visit: Patients & Public

Health Professionals
Useful information about osteoporosis and related topics. Educational materials, training courses.
Visit: Health Professionals

Are you at risk of osteoporosis?
Take the IOF One-Minute Osteoporosis Risk Test

Want more info? Contact an

Education Committee
Are you among the one in three women, and the one in five men who will be affected by osteoporosis?

What is osteoporosis?

Osteoporosis is a disease in which the density and quality of bone is reduced, increasing the risk of fracture. It affects around one in three women and one in five men around the world...

Read more
The NEW Interactive IOF One-Minute Osteoporosis Risk Test

Your family history

Have either of your parents been diagnosed with osteoporosis or broken a bone after a minor fall (a fall from standing height or less)?
[ ] yes [ ] no

Did either of your parents have a "dowager’s hump"?
[ ] yes [ ] no

Your personal clinical factors

These are fixed risk factors that one is born with or cannot alter. But that is not to say that they should be ignored. It is important to be aware of fixed risks so that steps can be taken to reduce loss of bone mineral.

Are you 40 years old or older?
[ ] yes [ ] no
Probability of Future Fractures

How do we combine the risks conferred by:

- BMD
- Age
- Sex
- BMI
- Clinical risk factors

In a reliable and reproducible way?
Probability of Future Fractures

- 71 year old woman
- Xrays show vertebral crush fracture
- 1.59 meters tall, 64.7 kg
- Non smoker, no steroids, little alcohol
- Describes good health (no past history)
- remains active
- No hx of parental hip fracture
- Her femoral neck T score -3.5
Probability of Future Fractures

- 71 year old woman
- Xrays show vertebral crush fracture
- 1.59 meters tall, 64.7 kg
- Non smoker, no steroids, little alcohol
- Describes good health (no past history)
- remains active
- No hx of parental hip fracture
- Her femoral neck T score -3.5
Probability of Future Fractures

- 2008 WHO collaborating with the Centre for Metabolic Bone Diseases introduced the Fracture Risk Assessment Tool
- **FRAX**
  - Combines BMD and Clinical risk factors.
  - Computes the 10 year probability of a hip fracture or of a major osteoporotic fracture (spine, hip, humerus or forearm)
Welcome

The FRAX™ tool has been developed by WHO to evaluate fracture risk of patients. It is based on individual patient models that integrate the risks associated with clinical risk factors as well as bone mineral density (BMD) at the femoral neck.

The FRAX™ models have been developed from studying population-based cohorts from Europe, North America, Asia and Australia. In their most sophisticated form, the FRAX™ tool is computer-driven and is available on this site. Several simplified paper versions, based on the number of risk factors are also available, and can be downloaded for office use.

The FRAX™ algorithms give the 10-year probability of fracture. The output is a 10-year probability of hip fracture and the 10-year probability of a major osteoporotic fracture (clinical spine, forearm, hip or shoulder fracture).

This is a beta version

Dr. John A Kanis
Professor Emeritus, University of Sheffield

Links:
Japan Osteoporosis Foundation : [http://www.joof.or.jp/](http://www.joof.or.jp/)

© World Health Organization Collaborating Centre for Metabolic Bone Diseases, University of Sheffield, UK
Questionnaire:

1. Age (between 40-90 years) or Date of birth
   Age: ___________________ Date of birth: ___________________

2. Sex
   ☐ Male ☐ Female

3. Weight (kg)
   ___________________

4. Height (cm)
   ___________________

5. Previous fracture
   ☐ No ☐ Yes

6. Parent fractured hip
   ☐ No ☐ Yes

7. Current smoking
   ☐ No ☐ Yes

8. Glucocorticoids
   ☐ No ☐ Yes

9. Rheumatoid arthritis
   ☐ No ☐ Yes

10. Secondary osteoporosis
    ☐ No ☐ Yes

11. Alcohol 3 or more units per day
    ☐ No ☐ Yes

12. Femoral neck BMD (g/cm²)
    Select DXA ☐

    Clear ☐ Calculate ☐
**Questionnaire:**

1. Age (between 40-90 years) or Date of birth
   - Age: 65
   - Date of birth: Y: _ M: _ D: _

2. Sex
   - Male [ ] Female [ ]

3. Weight (kg)
   - 70

4. Height (cm)
   - 170

5. Previous fracture
   - No [ ] Yes [ ]

6. Parent fractured hip
   - No [ ] Yes [ ]

7. Current smoking
   - No [ ] Yes [ ]

8. Glucocorticoids
   - No [ ] Yes [ ]

9. Rheumatoid arthritis
   - No [ ] Yes [ ]

10. Secondary osteoporosis
    - No [ ] Yes [ ]

11. Alcohol 3 or more units per day
    - No [ ] Yes [ ]

12. Femoral neck BMD (g/cm²)
    - T-Score: -2.1

---

**BMI** 24.2

The ten year probability of fracture (%)

with BMD

- Major osteoporotic: 10
- Hip fracture: 1.9

View NOGG Guidance
Intervention Threshold

Major Fracture - 10 year fracture probability

Hip - 10 year hip fracture probability
**Questionnaire:**

1. Age (between 40-90 years) or Date of birth
   - Age: 65
   - Date of birth: Y: [ ] M: [ ] D: [ ]

2. Sex
   - Male
   - Female

3. Weight (kg)
   - 70

4. Height (cm)
   - 170

5. Previous fracture
   - No
   - Yes

6. Parent fractured hip
   - No
   - Yes

7. Current smoking
   - No
   - Yes

8. Glucocorticoids
   - No
   - Yes

9. Rheumatoid arthritis
   - No
   - Yes

10. Secondary osteoporosis
    - No
    - Yes

11. Alcohol 3 or more units per day
    - No
    - Yes

12. Femoral neck BMD (g/cm²)
    - T-Score: -2.1

**BMI 24.2**
The ten year probability of fracture (%)

**with BMD**
- Major osteoporotic: 17
- Hip fracture: 3.2

*View NOGG Guidance*
Summary

- Osteoporosis is a common condition.
- Develop a culture of bone health.
- Identify people at risk before they fracture.
- Treat / preserve bone mineral where appropriate.
Is there a tool to help me decide which patients need assessment?
**Questionnaire:**

1. Age (between 40-90 years) or Date of birth
   - Age: 65
   - Date of birth: Y:  , M:  , D:  

2. Sex
   - Male
   - Female

3. Weight (kg)
   - 70

4. Height (cm)
   - 170

5. Previous fracture
   - No
   - Yes

6. Parent fractured hip
   - No
   - Yes

7. Current smoking
   - No
   - Yes

8. Glucocorticoids
   - No
   - Yes

9. Rheumatoid arthritis
   - No
   - Yes

10. Secondary osteoporosis
    - No
    - Yes

11. Alcohol 3 or more units per day
    - No
    - Yes

12. Femoral neck BMD (g/cm²)
    - Select DXA
    - 

**BMI 24.2**

The ten year probability of fracture (%)

**without BMD**

- Major osteoporotic: 16
- Hip fracture: 3.4

[View NOGG Guidance]
Assessment threshold - Major fracture

10 year probability of major osteoporotic fracture (%)

Age (years)

- Red: Treat
- Orange: Measure BMD
- Green: Lifestyle advice and reassure
Who gets funding for Alendronate or MSD DEXA scans?
MSD DXA funding criteria

**FOSAMAX PLUS® funding & MSD DXA criteria**

Merck Sharp & Dohme fund DXA scans to assist patients to access treatment for osteoporosis. (The funding is ONLY for patients who would not otherwise be able to have a DXA)

Select patient category and follow process:

<table>
<thead>
<tr>
<th>STEROID INDUCED OSTEOPOROSIS</th>
<th>OSTEOPOROSIS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Patient Prescribed Steroids</strong></td>
<td><strong>OSTEOPOROSIS</strong></td>
</tr>
<tr>
<td>- For at least 3 months</td>
<td>Patient (&lt;75) years</td>
</tr>
<tr>
<td>- (\geq 5) mg/day prednisone equivalents</td>
<td>Patient has T-score (\leq 3.0)</td>
</tr>
<tr>
<td><strong>Has fracture</strong></td>
<td>Patient (\geq 75) years*</td>
</tr>
<tr>
<td></td>
<td><strong>Has fracture</strong></td>
</tr>
<tr>
<td></td>
<td>Has 1 fracture</td>
</tr>
<tr>
<td></td>
<td>Has 2 or more fractures</td>
</tr>
<tr>
<td></td>
<td>Has fracture</td>
</tr>
<tr>
<td></td>
<td>Apply for FOSAMAX PLUS®</td>
</tr>
<tr>
<td></td>
<td>Apply for FOSAMAX PLUS®</td>
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<tr>
<td></td>
<td>Apply for FOSAMAX PLUS®</td>
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</table>

**THE ONLY PATIENT GROUPS THAT QUALIFY FOR AN MSD FUNDED DXA SCAN**

- FOSAMAX PLUS® can be purchased privately for patients who do not meet the funding criteria
- MSD is not able to fund DXA scans for patients \(\geq 75\) years who DO NOT have an osteoporotic fracture
- MSD is not able to fund repeat DXA scans
The patient must meet ALL criteria in EITHER box below (for Merck Sharp & Dohme to fund the scan)

### STEROID INDUCED OSTEOPOROSIS

- **Patient has been prescribed steroids**
  - For at least 3 months and is receiving ≥ 5 mg/day prednisone equivalent

- **Patient has not had an osteoporotic fracture**
  - If the patient has had a fracture they do not need a DXA to access treatment

- **Patient does not have medical insurance that covers DXAs**

### OSTEOPOROSIS

- **Patient is <75 years**

- **Patient has 1 osteoporotic fracture**
  - If the patient has 2 or more fractures they do not need a DXA scan to access treatment

- **Patient does not have medical insurance that covers DXAs**

In alignment with PHARMAc criteria (based on WHO guidelines), should the patient be eligible for treatment I wish to commence this patient on FOSAMAX PLUS® (alendronate 70mg/colexiciferol 2800IU, MSD).

Patient must meet ALL criteria in either box to be eligible for MSD funded DXA.

**Section 1**

Steroid Induced Osteoporosis

**Section 2**

Osteoporosis
FRAX is Binary.
• FRAX does not take into account dose / number of fractures etc.

» FRAX is a guide and does not replace clinical judgement.
The Future?
• Increased range of drugs for OP in NZ.
• Use of fracture probability rather than T score to assess eligibility for funding.
• Micro CT.