Calculation Skills: Osteoporosis and prevention of fragility fractures

The National Institute of Health (2014) explain osteoporosis as 'a disease in which the bones become weak and are more likely to break', suggesting the most vulnerable areas for the fractures to be the wrist, the spine and the hips. The increase risk of fracture in osteoporosis is a consequence of the low bone mass and the deterioration of the bone structure, (NICE 2016). The definition of osteoporosis is supported by criteria set by the World Health Organisation (WHO) (2007), stating that osteoporosis relates to a bone mineral density (BMD) of 2.5 standard deviations or more below the average value for young healthy women.

Question 1

Women are at greater risk of osteoporosis, with the risk increasing with age. NICE (2011) report that at by 80 years of age, the prevalence of osteoporosis is 25 times higher than at 50 years of age (when it is 2%).

(i) What is the prevalence at 80 years?
(ii) Assuming that the prevalence increases at a consistent rate per year between the age of 50 and 80 years, what would the prevalence be at 69 years?

Question 2

A 2008 study, aiming to identify the incidence of fractures in England (Donaldson et al. 2008) estimated that the incidence was 3.6 fractures per 100 people per year. NICE (2016) suggest that 180,000 of the fractures in England and Wales each year are as a result of osteoporosis.

(i) Based on a population of 53 million in England, how many fractures occur annually in England?
(ii) Assuming the same incidence rate in Wales (with a population of 3 million), what percentage (rounded up or down to the nearest whole number) of fractures in England and Wales are likely to be as a result of osteoporosis?

Question 3

One of the risk factors associated with reduced bone mineral density (BMD) is a Body mass index* (BMI) of less than 18.5 kg/m² (NICE 2016). Which patient/s in table 1 are at increased risk of osteoporosis (based on BMI alone). Round your BMIs up or down to two decimal points.

*BMI = Kg/M^2

Table 1: Patient weight and height data for BMI		
Patient	**Weight (kg)**	**Height (m)**
Gillian	39	1.4
Patricia	53	1.7
Rosemary	69	1.9
Alison	49	1.6

Question 4

Lucille was identified as being at high risk of fragility fracture following assessment of fragility risk and a dual-energy x-ray absorptiometry (DXA) scan. She is to commence bone-sparing treatment and because her calcium intake is inadequate, she will also be prescribed calcium and vitamin D supplementation, with the following regime:

- alendronate 10 mg once daily
- Colecalciferol 400 international units with calcium carbonate 1.5 grams daily

(i) Alendronate tablets are available in packs of 28 10mg tablets, at a cost of £3.25. In order to treat Lucille throughout the whole of November 2018 and up to and including her next appointment on 27th January 2019, how many packs will need to be prescribed?

(ii) Colecalciferol 400 international units with calcium carbonate 1.5 gram tablets cost £3.65 for 56 tablets. What is the cost of 14 days treatment (rounded up or down to nearest pence)?

Question 5

NICE (2016) recommend that treatment with alendronate should continue for up to 10 years for patients whose fragility fracture risk remains high. A recent study by Leal et al (2016) suggested that the additional cost to the health service within the first year following treatment of a hip fracture was £10,860 per patient. A GP appointment costs approximately £36 (Personal Social Services Research Unit 2016) and a DXA scan, approximately £120.

A preventative plan can prove significantly more cost effective than treating a patient following a fracture. Calculate the difference in cost between that identified by Leal et al, for the first year following treatment of a hip fracture and the cost of the following seven year treatment plan for Lucille:

- two follow up appointments per year
- two repeat DXA scans within the 7 year period
- drug treatment regime as indicated in question 4

For the purpose of your calculations, assume all years have 365 days and base drug costs on the price of single tablets.

Answers

Question 1

(i) 25 x 2 % = 50%

(ii) Years between 50 and 80 = 30
Difference in prevalence: 50 -2 = 48
Increase per year: 48 ÷ 30 = 1.6
Years between 50 and 69 = 19

Expected prevalence = 1.6 x 19 = 30.4%

Question 2

(i) 53 million ÷ 100 = 530,000

530,000 x 3.6 = 1,908,000

(ii) Fracture in Wales = 3 million ÷ 100 x 3.6 = 108,000
Fractures in England and Wales = 1,908,000 + 108,000 = 2,016,000
1% of fractures = 2,016,000 ÷ 100 = 20160
180,000 ÷ 20160 = 9% (rounded up)

Question 3

Gillian: BMI = 39 ÷ (1.4 x 1.4) = 19.90

Patricia: BMI = 53 ÷ (1.7 x 1.7) = 18.34

Rosemary: BMI = 69 ÷ (1.9 x 1.9) = 19.11

Alison: BMI = 49 ÷ (1.6 x 1.6) = 19.14

Patricia is at increased risk based on BMI alone.

Question 4

(i) Days of treatment = November 30 days
December 31 days
January 27 days
Total = 88
Packs required = 88 ÷ 28 = 3.14 (so, 4 packs needed).

(ii) (£3.65 ÷ 56) x 14 = 91p (rounded down)

Question 5

7 years = 365 x 7 = 2555

Cost of treatment with alendronate: (£3.25 ÷ 28) x 2555 = £296.56

Cost of treatment with colecalciferol with calcium carbonate: (3.65 ÷ 56) x 2555 = £166.53

Cost of GP appointments: £36 x 14 = £504

Cost of DXA scans = £120 x 2 = £240

Total cost of treatment plan = £296.56 + £166.53 + £504 + £240 = £1207.09

Saving = £10,860 - £1207.09 = £9652.91

References

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