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**Fracture risk and bone health following a stroke are inadequately considered by physicians: a UK survey of practice**

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## Abstract

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3 **Background:** Osteoporotic fragility fractures and stroke disease are both common. Fracture risk is  
4 substantially increased following a stroke. Fracture risk assessment tools are available (e.g.  
5 FRAX/Qfracture); however, stroke guidelines provide little advice. We aimed to determine current  
6 practice amongst UK stroke physicians regarding assessment and management of bone health in  
7 patients following a stroke.  
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18 **Methods:** An anonymous web-based survey was emailed to all 140 NHS consultant stroke  
19 physicians registered with the British Association of Stroke Physicians (BASP) from November  
20 2013 to April 2014. Multiple choice questions determined current usual practice.  
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28 **Results:** Almost all (98.5%) reported working in NHS trusts with no specific post-stroke bone  
29 health guidance. Fewer than 1/6 were fully aware of post-stroke fracture risk; most underestimated  
30 risk. Less than 1/10 regularly assessed bone health post-stroke, in contrast 78.1% regularly assessed  
31 falls risk. Despite this, 89.5% who assessed falls risk did not continue to consider fracture risk.  
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## 1.0: Introduction

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3 Stroke disease is a major cause of morbidity and mortality with over 1.1 million strokes occur  
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5 annually across Europe<sup>1</sup>. The annual estimated economic cost of stroke in Europe is €27 billion,  
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7 with more people surviving strokes more than half of stroke survivors are left with a degree of  
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9 disability or dependency<sup>2</sup>. Furthermore, over 3.5 million fragility fractures are sustained across  
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11 Europe each year and this number is increasing as the prevalence of osteoporosis increases<sup>3</sup>.  
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13 Fracture risk is quoted to be increased two to four fold in those surviving a stroke, compared to age-  
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15 matched controls<sup>4</sup>. Hip fractures are particularly common within the first year following stroke with  
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17 a greater propensity to fracture on the paretic side and lead to poorer outcomes than in a non-stroke  
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19 population<sup>4-8</sup>. Immobility, impaired nutrition and medication adherence as well as certain  
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21 medications prescribed more commonly within a stroke population (*e.g.* anticonvulsants) contribute  
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23 to increased bone fragility post-stroke<sup>6</sup>. In addition to increased bone fragility, falls are more  
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25 common within a stroke population increasing the likelihood of a fracture being sustained.  
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35 In the UK, the National Institute for Health and Care Excellence (NICE) provide guidance to  
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37 improve health and social care; they recommend assessing fracture risk in all adults aged >50 years  
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39 with risk factors including 'immobility *e.g.* due to neurological disease'<sup>9</sup>. NICE supports the use of  
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41 fracture risk assessment tool such as FRAX<sup>10</sup> and Qfracture<sup>11</sup>; however, fracture risk assessment  
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43 currently remains unaddressed in UK stroke management guidelines<sup>12-14</sup>. This is in contrast to  
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45 European guidance which does specify the need to address falls risk reduction through a multi-  
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47 disciplinary intervention as well as considering bone strengthening medication<sup>15</sup>; however,  
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49 currently fracture risk assessment is not currently mentioned within these European stroke  
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51 organization guidelines.  
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59 We aimed to survey UK stroke physicians and determine current practice when assessing fracture  
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risk and managing bone health of patients admitted to NHS hospitals with a diagnosis of stroke.

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## 2.0: Methods

### 2.1: *Study design*

The British Association of Stroke Physicians (BASP) has 701 members, of whom 140 are registered as NHS stroke consultants. A web-based survey was constructed using the University of Bristol Online Survey template<sup>16</sup> (appendix A) distributed by BASP to these 140 consultants, aiming to ascertain physician's current usual practice and asked physicians; their duration and location of work as a consultant, whether guidelines existed within their hospital for assessing bone health and fracture risk in stroke patients; their knowledge of the impact stroke has on fracture risk; their usual practice when assessing and managing various aspects of bone health and future fracture and falls risks post stroke; and their level of confidence when prescribing specific osteoporosis treatments following a stroke. All questions were mandatory and users could not move onto the next question or submit the completed survey until all questions had been answered. BASP approved the conduct of this survey. BSAP sent reminders up to 3 times over 5 months (November 2013-April 2014). Responses were anonymous, identifiable only by geographical region of practice.

### 2.2: *Statistics*

Data were cleaned and checked for consistency; categories were condensed where appropriate. Descriptive statistics are presented as mean (SD: standard deviation) for continuous and count (percentages) for categorical variables. Categorical variables were cross-tabulated; the Chi-squared ( $\chi^2$ ) test used to assess the strength of associations.

### 3.0: Results

#### 3.1: *Geographical area*

In total 73(52%) consultant stroke physicians completed the survey. Geographical areas of practice were spread across England, Scotland and Northern Ireland; we received no responses from Wales (appendix B).

#### 3.2: *Current bone health management guidelines*

Only 2(1.5%) physicians worked in an NHS hospital which had a bone health guideline for patients surviving stroke. The majority of physicians 63(86%) worked in hospitals with no formalized guideline; the remainder were unsure.

#### 3.3: *Impact of stroke on fracture risk*

Fracture risk increases two to four fold following a stroke<sup>4-8</sup>; whilst 10(13.7%) physicians were aware of this, the majority 42(57.5%) underestimated fracture risk (appendix C).

#### 3.4: *Assessment and management of future bone health and falls*

Physicians were asked to consider, over the previous 6 months, how often they had assessed future bone health in stroke patients admitted to hospital (Table 1). The majority 42(57.5%) stated they rarely or never considered this. No physicians always assessed future bone health but 7(9.6%) reported doing so regularly. Falls risk assessment was better addressed: the majority 57(78.1%) always or regularly assessed falls risk post-stroke; however, of these 51(89.5%) did not then go on to regularly assess fracture risk. Only 2 physicians (2.7%) stated they never assessed falls risk in their stroke patients.

#### 3.5: *Prescription of osteoporosis medications*

1 Overall 7(9.6%) physicians regularly prescribed calcium and vitamin D supplementation to patients  
2 post stroke. Vitamin D levels were checked and replacement prescribed regularly by only 2(2.7%)  
3 physicians. Almost half 35(47.9%) never or rarely initiated a new prescription for calcium and  
4 vitamin D supplementation, and fewer still initiated a new prescription for vitamin D  
5 supplementation alone 58(79.5%). 27(36.9%) physicians sometimes or regularly initiated new anti-  
6 resorptive medications; 16(22%) had never done so. Most 53(72.6%) rarely or never measured  
7 vitamin D levels. The majority 53(72.6%) had never recommended hip protectors.

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18 The impact of phenytoin on bone health was poorly appreciated; 33(45.2%) reported never  
19 considering its effect on bone health, only 11(15.1%) regularly or always considered its impact.  
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21 Knowledge of post-stroke fracture risk was strongly associated with consideration of osteoporosis  
22 when prescribing phenytoin ( $p<0.001$ ).  
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### 30 *3.6: Fracture risk assessment*

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32 Physicians were asked about their usage of the two NICE endorsed fracture risk assessment tools  
33 (Appendix D). No physicians reported routine use of either FRAX or Qfracture (Table 2). 65(89%)  
34 had heard of FRAX but 31(42.5%) had never used it, and 26(36%) had only used it rarely.  
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### 3.7: *Self-reported confidence of stroke physicians when prescribing osteoporosis medications*

Physicians were asked to indicate their level of confidence when prescribing various osteoporosis medications following a stroke. Overall 66 of 73 physicians (90.4%) felt confident to initiate the oral bisphosphonate Alendronic acid, if needed, post stroke (Table 2); although, 40 (60.6%) of whom responded that they never or rarely initiated Alendronic acid in the last 6 months. Physicians felt less confident to prescribe anti-resorptive medications other than Alendronic acid; 58(82.9%) were confident to prescribe Risedronate, 21(31.3%) Ibandronic acid and 20(29.9%) Zoledronic



acid. Of those who felt confident to prescribe these anti-resorptives, they were unlikely to report having done so recently. Of those who were confident 34 (58.6%), 10 (47.6%) and 10 (50%) had never or rarely prescribed Risedronate, Ibandronic acid or Zoledronic acid respectively in the last 6 months.

Only 26(37.7%) indicated they were aware Strontium Ranelate is contraindicated following a stroke. 15(21.7%) felt confident prescribing Strontium Ranelate and 6(9.4%), felt similarly for Raloxifene.

## 4.0: Discussion

### 4.1: Discussion of results

Almost all UK stroke consultants reported working in NHS hospitals with no specific guidance or policy addressing the assessment and management of bone health in patients following a stroke.

Less than 1 in 6 were fully aware of the impact strokes have on future fracture risk, with the majority of physicians underestimating the risk. Perhaps as a result of this under appreciation, less than 1 in 10 regularly assess bone health post-stroke. No stroke physicians were routinely using either FRAX or Qfracture to guide fracture risk assessment; in fact 11% and 51% respectively were unaware of these NICE endorsed tools<sup>10,11</sup>.

Despite being contraindicated in cerebrovascular disease, nearly 22% felt confident prescribing Strontium Ranelate post stroke<sup>17</sup>. Similarly almost 10% felt confident prescribing Raloxifene, which is cautioned in stroke<sup>18</sup>. Although many physicians reported feeling confident prescribing Alendronic acid, and to a lesser extent other bisphosphonates, this did not translate into reporting of prescription, with over half of those who felt confident to prescribe anti-resorptive therapies stating they had never or rarely done so in the last 6 months.

Post stroke epilepsy is estimated to affect between 2-11% of stroke survivors<sup>19</sup>. Antiepileptic drugs (AEDs) may be initiated for post-stroke epilepsy and are associated with increased falls risk. Enzyme inducing AEDs (*e.g.* phenytoin) are well recognised causes of BMD loss, through their induction of cytochrome P450 enzymes, responsible for converting vitamin D into its inactive metabolite, leading to hypovitaminosis D; however, non-enzyme inducing AEDs also affect BMD<sup>20</sup>. Despite this impact on BMD and fracture risk, only 15% of stroke physicians surveyed routinely considered bone health when prescribing phenytoin.

1 There are many components of post-stroke care to consider, and bone health may seem less  
2 important when considered alongside all other factors, plus longer-term outcomes may be difficult  
3 to predict in the early stages of care: 1 in 8 die within 30 days of stroke<sup>21</sup>. Bone health therefore  
4 may be best assessed during rehabilitation. Falls risk was reported to be much more frequently  
5 considered than fracture risk. As most fractures result from a fall, the reason for this disconnect is  
6 not clear, but highlights potential capacity to change clinical practice to routinely include fracture  
7 risk assessment along with that of falls.  
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#### 18 4.2: *Limitations*

19 Whilst designed as a short pragmatic survey, our study has limitations; all self-reported data are  
20 subject to recall bias, furthermore our response rate (52%) limits generalizability, particularly in  
21 Wales. We have no qualitative assessment to aid understanding of physician's reasoning behind  
22 their responses. This may be particularly pertinent to the prescription of anti-resorptive medications  
23 where physicians indicated their confidence in prescribing yet this did not consistently translate into  
24 active prescribing. We focused on secondary care physicians who may be largely involved in acute  
25 stroke care rather than post-stroke rehabilitation. We did not survey the practice of primary care  
26 physicians who may assess fracture risk in patients following hospital discharge.  
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## 5.0: Conclusion

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3 Our national survey highlights heterogeneity in the approach of UK stroke physicians to the  
4 assessment and management of bone health and fracture risk in patients following a stroke with  
5 overall under-appreciation of fracture risk and low levels of assessment. Despite the availability of  
6 fracture risk assessment tools, which are endorsed nationally (by NICE), fracture risk assessment is  
7 currently inadequately considered post-stroke. Our findings support the need for clearer guidelines  
8 regarding fracture risk assessment and bone health in patients who have experienced a stroke and  
9 strategies to increase awareness amongst physicians.  
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## 8.0: Disclosures

40 None  
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**References**

1. Truelsen T, Piechowski-Jozwiak B, Bonita R, Mathers C, Bogousslavsky J, Boysen G. Stroke incidence and prevalence in Europe: a review of available data. *Eur J Neurol.* 2006; 13:581-98.
2. Di Carlo A. Human and economic burden of stroke. *Age Ageing.* 2009; 38:4-5
3. Hernlund E, Svedbom A, Ivergard M, Compston J, Cooper C et. al. Osteoporosis in the European Union: Medical Management, Epidemiology and Economic Burden. A report prepared in collaboration with the International Osteoporosis Foundation (IOF) and the European Federation of Pharmaceutical Industry Associations (EFPIA). *Arch Osteoporos.* 2013 8:136. DOI: 10.1007/s11657-013-0136-1.
4. Ramnemark A, Nyberg L, Borssen B, Olsson T, Gustafson Y. Fractures after stroke. *Osteoporosis Int.* 1998;8:92-5
5. Myint PK, Poole KES, Warburton EA. Hip Fractures after Stroke and their Prevention. *QJM.* 2007;100:539-545
6. Carda S, Cisari C, Ivernizzi M, Bevilacqua M. Osteoporosis after Stroke: A Review of the Causes and Potential Treatments. *Cerebrovasc Dis.* 2009;28:191-200
7. Kanis J, Oden A, Johnell O. Acute and long-term increase in fracture risk after hospitalisation for stroke. *Stroke.* 2001; 32: 702-6
8. Yuan ZC, Mo H, Guan J, He JL, Wu ZJ. Risk of hip fracture following stroke, a meta-analysis of 13 cohort studies. *Osteoporos Int.* 2016. DOI 10.1007/s00198-016-3603-x
9. NICE clinical guideline 146: Osteoporosis - assessing the risk of fragility fracture, 2012. National Institute for Health and Care Excellence website. <https://www.nice.org.uk/guidance/cg146>.

10. Kanis A. FRAX World Health Organisation Fracture Risk Assessment Tool. FRAX website. <http://www.shef.ac.uk/FRAX/>.
11. ClinRisk Ltd. Qfracture 2013 Risk Calculator. QFracture website. <http://www.qfracture.org/>.
12. Stroke Intercollegiate Working Party. National Clinical Guidelines for Stroke 4th edition, 2012. Royal College of Physicians website. <https://www.rcplondon.ac.uk/sites/default/files/national-clinical-guidelines-for-stroke-fourth-edition.pdf>.
13. NICE clinical guideline 162: Stroke Rehabilitation - Long term rehabilitation after stroke, 2013. National Institute for Health and Care Excellence website. <http://www.nice.org.uk/guidance/CG162>.
14. NICE clinical guideline 68: Stroke - Diagnosis and Initial management of Acute Stroke and Transient Ischaemic Attack (TIA) 2008. National Institute for Health and Care Excellence website. <http://www.nice.org.uk/Guidance/CG68>.
15. Ringleb PA, Bousser M, Ford G et al for The European Stroke Organisation (ESO) Executive Committee and the ESO Writing Committee. Guidelines for management of ischaemic stroke and transient ischaemic attack 2008. [http://www.congrex-switzerland.com/fileadmin/files/2013/eso-stroke/pdf/ESO08\\_Guidelines\\_English.pdf](http://www.congrex-switzerland.com/fileadmin/files/2013/eso-stroke/pdf/ESO08_Guidelines_English.pdf).
16. The Bristol Online Surveys. University of Bristol website. <http://www.survey.bris.ac.uk/>.
17. Drug safety update. Strontium Ranelate: Cardiovascular risk, 2014. Medicines and Healthcare Products Regulatory Agency website. <https://www.gov.uk/drug-safety-update/strontium-ranelate-cardiovascular-risk>.
18. Barrett-Connor E, Mosca L, Collins P et al; Raloxifene Use for the Heart (RUTH) trial investigators. Effects of Raloxifene on cardiovascular events and breast cancer in postmenopausal women. *N Eng J Med*. 2006;355: 125-37

19. Jungehulsing GJ, Heuschmann PU, Holtkamp M, Schwab S, Kolominsky-Rabas PL. Incidence and predictors of post-stroke epilepsy. *Acta Neurol Scand.* 2013; 127: 427-430
20. Meier C, Kraenzlin ME. Antiepileptics and bone health. *Ther Adv Musculoskelet Dis.* 2011; 3:235-43.
21. State of the Nation - Stroke statistics 2016. The Stroke Association website.  
[https://www.stroke.org.uk/sites/default/files/state\\_of\\_the\\_nation\\_2016\\_110116\\_0.pdf](https://www.stroke.org.uk/sites/default/files/state_of_the_nation_2016_110116_0.pdf)

**Table 1. NHS stroke physician's self-reported assessment and management of bone health and falls in patients admitted with stroke**

| <b>When considering the last 6 months of practice:</b>  | <b>Never<br/>N(%)</b> | <b>Rarely<br/>N(%)</b> | <b>Sometimes<br/>N(%)</b> | <b>Regularly<br/>N(%)</b> | <b>Always<br/>N(%)</b> |
|---|-----------------------|------------------------|---------------------------|---------------------------|------------------------|
| How frequently did you assess future bone health?   | 12(16.4)              | 30(41.1)               | 24(32.9)                  | 7(9.6)                    | 0                      |
| How frequently did you assess future falls risk?  | 2(2.7)                | 3(4.1)                 | 11(15.1)                  | 44(60.3)                  | 13(17.8)               |
| How frequently did you initiate a new prescription for calcium and vitamin D supplementation?                                 | 5(6.8)                | 30(41.1)               | 31(42.5)                  | 6(8.2)                    | 1(1.4)                 |
| How frequently did you initiate a new prescription for vitamin D supplementation (without calcium)?                           | 20(27.4)              | 38(52.1)               | 14(19.2)                  | 1(1.4)                    | 0                      |
| How frequently did you initiate a new prescription for an anti-resorptive medication ( <i>e.g.</i> Alendronate)?              | 16(21.9)              | 30(41.1)               | 25(34.2)                  | 2(2.7)                    | 0                      |
| What best describes your practice when measuring vitamin D levels in patients admitted with a stroke?                         | 19(26)                | 34(46.6)               | 18(24.7)                  | 2(2.7)                    | 0                      |
| How frequently did you recommend the use of hip protectors?   | 53(72.6)              | 12(16.4)               | 7(9.6)                    | 1(1.4)                    | 0                      |
| How frequently did you consider osteoporosis when planning whether to discharge a patient on a new prescription of phenytoin? | 33(45.2)              | 17(23.3)               | 12(16.4)                  | 8(11)                     | 3(4.1)                 |



**Table 2. NHS stroke physician's self-reported level of confidence when prescribing osteoporosis treatments following stroke.**

|                           | <b>N</b> | <b>Confident<br/>N(%)</b> | <b>Unconfident<br/>N(%)</b> | <b>Prescription is<br/>contraindicated<br/>N(%)</b> |
|---------------------------|----------|---------------------------|-----------------------------|---|
| Alendronic acid (oral)    | 73       | 66(90.4)                  | 6(8.2)                      | 1(1.4)  |
| Risedronate sodium (oral) | 70       | 58(82.9)                  | 11(15.7)                    | 1(1.4)  |
| Ibandronic acid (oral)    | 67       | 21(31.3)                  | 45(67.2)                    | 1(1.5)  |
| Strontium ranelate (oral) | 69       | 15(21.7)                  | 28(40.6)                    | 26(37.7)  |
| Raloxifene (oral)         | 66       | 6(9.1)                    | 41(62.1)                    | 19(28.8)  |
| Denosumab (s/c)           | 67       | 13(19.4)                  | 53(79.1)                    | 1(1.5)  |
| Zoledronic acid (iv)      | 67       | 20(29.9)                  | 44(65.7)                    | 3(4.5)  |

## **Supplementary material (appendices)**

### **Contents**

**A:** Online survey questions

**B:** Geographical area of practice of responding physicians

**C:** NHS stroke physician's self-reported knowledge of the rate at which fracture risk is increased following a stroke.

**D:** NHS stroke physician's self-reported awareness and use of online fracture risk assessment tools when managing stroke patients

## Appendix A

### Online Survey questions

1. Do you have guidelines in your trust for the management of bone health in patients surviving stroke?

- Yes
- No

2. Thinking about your knowledge of bone health in patients with stroke, on average after stroke, fracture risk is:

- Unchanged
- Increased by 20%
- Increased by 50%
- Doubled
- Increased 2-4 fold
- Increased >4 fold
- Don't know

Thinking about the last 6 months of your practice managing patients with a diagnosis of stroke:

3. How frequently have you assessed the bone health of patients during an admission with stroke?

- Never
- Rarely
- Sometimes
- Regularly
- Always

4. How frequently have you initiated a new prescription for calcium and vitamin D supplementation in patients during an admission with stroke?

- Never
- Rarely
- Sometimes
- Regularly
- Always

5. How frequently have you initiated a new prescription for vitamin D supplementation (without calcium) in patients during an admission with stroke?

- Never
- Rarely
- Sometimes
- Regularly
- Always

6. What best describes your practice when measuring Vitamin D levels in stroke patients?

- I never check Vitamin D levels in stroke patients
- I rarely check Vitamin D levels in stroke patients
- I sometimes check Vitamin D levels in stroke patients
- I regularly check Vitamin D levels in stroke patients
- I always check Vitamin D levels in stroke patients

7. How frequently have you initiated a new prescription for a bisphosphonate (e.g. alendronate), to reduce future fracture risk, during an admission with stroke?

- Never
- Rarely
- Sometimes
- Regularly
- Always

8. How frequently do you consider osteoporosis when you plan to discharge a patient on a new prescription of phenytoin?

- Never
- Rarely
- Sometimes
- Regularly
- Always

9. How frequently do you use an online fracture risk assessment tool e.g. FRAX or Qfracture to assess your patients fracture risk?

- I have never heard of any online fracture risk assessment tools
- I have heard of these tools but have never used them in stroke patients
- I rarely use a fracture risk assessment tool in stroke patients
- I sometimes use a fracture risk assessment tool in stroke patients

- I regularly use a fracture risk assessment tool in stroke patients
- I always use a fracture risk assessment tool in stroke patients

10. When treating osteoporosis post stroke describe how you would feel prescribing the following osteoporosis treatments:

- Alendronate (oral)
- Risedronate (oral)
- Ibandronate (oral)
- Strontium (oral)
- Raloxifene (oral)
- Denosumab (s/c)
- Zoledronate (iv)

*Options:*

- If indicated I would feel confident starting post stroke
- If indicated I would feel unconfident starting post stroke
- Contraindicated post-stroke

## Appendix B

### Geographical area of practice of responding physicians

| Location                 | Number    |
|--------------------------|-----------|
| East Midlands            | 10        |
| East of England          | 8         |
| Kent Surrey Sussex       | 3         |
| London                   | 5         |
| Mersey                   | 1         |
| Northern England         | 5         |
| North West England       | 3         |
| Oxford                   | 1         |
| Severn                   | 6         |
| South West Peninsula     | 5         |
| Wessex                   | 3         |
| West Midlands            | 4         |
| Yorkshire and the Humber | 4         |
| East of Scotland         | 4         |
| North of Scotland        | 1         |
| South East Scotland      | 4         |
| West of Scotland         | 4         |
| Ireland                  | 2         |
| Wales                    | 0         |
| <b>Total</b>             | <b>73</b> |

## Appendix C

**NHS stroke physician's self-reported knowledge of the rate at which fracture risk is increased following a stroke.**

|                    | <b>N(%)</b> |
|--------------------|-------------|
| Increased by 20%   | 23(31.5)    |
| Increased by 50%   | 5(6.8)      |
| Doubled            | 14(19.2)    |
| Increased 2-4 fold | 10(13.7)    |
| Increased >4fold   | 4(5.5)      |
| Unsure             | 17(23.3)    |

## Appendix D

### NHS stroke physician's self-reported awareness and use of online fracture risk assessment tools when managing stroke patients

|           | Never heard of<br>N(%) | Heard of but never used<br>N(%) | Rarely use<br>N(%) | Sometimes use<br>N(%) | Regularly use<br>N(%) | Always use<br>N(%) |
|-----------|------------------------|---------------------------------|--------------------|-----------------------|-----------------------|--------------------|
| FRAX      | 8(11)                  | 31(42.5)                        | 26(35.6)           | 8(11)                 | 0                     | 0                  |
| Qfracture | 37(50.7)               | 28(38.4)                        | 7(9.6)             | 1(1.4)                | 0                     | 0                  |