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A Pharmaceutical Care Model on Osteoporosis:
Targeting patient groups

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For my mentor and friend

Prof Stephen Hudson

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“Good people are good people and we accidentally find them. Work is needed to keep them on life's unfair trip. We all need a combination of compliments (a few from time to time) music (mostly intensively), laughs (certainly often). All best shared. “

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GERMAN ABSTRACT- ZUSAMMENFASSUNG

A pharmaceutical Care Model on Osteoporosis: Targeting patients groups

Altersbedingte Erkrankungen wie Osteoporose werden in Europa in den nächsten Jahren stark zunehmen. Die Knochenkrankheit geht mit einem erhöhten Frakturrisiko einher und ist mit hohen Kosten und einer unter Umständen stark verminderten Lebensqualität verbunden. Ausgehend von diesen Fakten wird die Wichtigkeit der Einführung und Einhaltung eines evidenzbasierten hochwertigen Standards für Prävention, Früherkennung und Therapie deutlich. Die Einführung eines so genannten „Medication Assessment Tool“ (MAT) durch Pharmazeuten, kann dabei helfen die Qualität der Verschreibungspraxis auf dem Gebiet der Osteoporosetherapie zu ermitteln.

Im Rahmen des vorliegenden Projektes wurde eine retrospektive Studie an GPASS®-Daten aus drei allgemeinmedizinischen Praxen in Glasgow durchgeführt (n= 319 Patienten; A= 154, B= 62, C= 103). Eingeschlossen wurden Patienten, die im genannten System als osteoporotisch oder osteopenisch registriert waren. MATosteo besteht aus 19 Kriterien- jedes davon stellt eine Guidelineempfehlung dar. Das Werkzeug selbst wurde von anerkannten, lokal tätigen, Osteoporoseexperten im Rahmen von Interviews evaluiert.

Zwei unabhängige Forscher prüften MATosteo hinsichtlich seiner Zuverlässigkeit und erzielten dabei eine Übereinstimmung in ihren Ergebnissen von 99.6% (Minimum 95.0%). Die Einhaltung der Guidelines wurde als „Guidelines Adherence“ in Prozent ausgedrückt und als niedrig (<50%), mittel (50-69.9%) oder hoch (>69.9%) eingestuft. Die Analyse ergab für alle drei Patientenkollektive eine mittlere Guidelineadherence von durchschnittlich 61.7% (CI 95% 59.8, 63.6). 148/260 (56.9%) Osteoporosepatienten wurden mit einem Bisphosphonat behandelt. Nur drei Patienten wurde ein Alternativmedikament verschrieben (Strontiumranelat). 35/260 (13.5%) erhielten nur Calcium und/oder Vitamin D. 110/260 (42.3%) wurden, trotz gestellter Diagnose, nicht behandelt.

MATosteo ist ein systematisches und zuverlässiges Instrument. Ergebnisse, die eine mittlere oder gar niedrige Guidelineadherence aufzeigen, können als Ausgangspunkt für informelle Diskussionen mit dem Verschreiber genutzt werden und der Entwicklung von Initiativen zur Verbesserung der Verschreibungspraxis dienen.

ABSTRACT

A pharmaceutical Care Model on Osteoporosis: Targeting patients groups

Background

As Europe's population is ageing the implementation of an evidence based standard for screening, diagnosis and treatment, especially for age associated diseases, like osteoporosis, will become more and more important. A Medication Assessment Tool (MATosteo) developed and used by pharmacists is now supposed to help to improve osteoporosis care in Scotland by identifying weak points in prescribing.

Objectives

To test a Medication Assessment Tool used for the application to GPASS® data and to demonstrate it's use in the evaluation of the level of adherence to guidelines and as a clinical audit tool. To find a method to analyse a large amount of data in an accurate and reproducible way.

Design

Retrospective Survey with a tool designed for medication assessment consisting of 19 criteria, each representing a guideline recommendation.

Setting

Patients (n=319) registered as osteopenic (n= 59) or osteoporotic (n= 260) on the GPASS® database of three general medicinal practices in Glasgow; A (n= 154), B(n= 62) and C (n= 103). Interviewees who have been nominated and accepted the invitation.

Results

The inter-rater reliability testing of the MATosteo by two independent researchers showed mean agreements of 99.6% (minimum 95% with 100% shown in 18/21). Adherence to guidelines was rated intermediate in all 3 practices and in total; A= 65.8% (CI 95% 62.3, 69.3); B= 52.1% (CI 95% 47.8, 56.4); C=61.4% (CI 95% 57.7, 65.1) Total=61.7% (CI 95% 59.8, 63.6). Some 148/260 (56.9%) patients with osteoporosis received a bisphosphonate. Overall only 3/112 (2.7%) patients not treated with a bisphosphonate were treated with an alternative (all 3 with Strontium ranelate).110/260 (42.3%) were untreated. 35/260 (13.5%) received only calcium and vitamin D.

Conclusion

MATosteo is a systematic and reliable audit tool for measuring quality of prescribing if full access to data is provided and the standard applied is most up to date and evidence based. Results ranked as intermediate (50- 69.9%) or low (< 50%) adherence to guidelines can be used as a starting-point for the development of pharmaceutical care initiatives.

LIST OF ABBREVIATIONS

ADE	Adverse drug event
ADR	Adverse drug reaction
BMD	Bone mineral density
BMI	Body mass index
BMU	Basic multicellular units
BNF	British National Formulary
BP	Bisphosphonate
CFPP	Community Falls Prevention Program
CI	Confidence interval
CKD	Chronic kidney disease
CMP	Clinical Management Plan
CMS	Chronic medication service
DADS	Direct access DEXA scans
DEXA	Dual energy X-ray absorptiometry
DXA	Dual energy X-ray absorptiometry
FLS	Fracture liaison service
GI	Gastrointestinal
GP	General Practitioner
GPASS	General Practice Administrative Software for Scotland
HRT	Hormone Replacement Therapy

IDQ	Insufficient data on the qualifier
IDS	Insufficient data on the standard
IU	International unit
i.v.	Intravenous
MAS	Minor ailment service
MAT	Medication Assessment Tool
MATosteo	Medication Assessment Tool for Osteoporosis
N/A	Not applicable
NHS	National Health Service
NICE	National Institute for Health and Clinical Excellence
No(J)	No justified
No(U)	No unjustified
ON	Osteopenia
OS	Osteoprosis
PTH	Parathyroid hormone
QUALYS	Quality adjusted life years
RANKL	Receptor activator of Nuclear Factor□B – Ligand
SCDS	Secondary care DXA service
SIGN	Scottish Intercollegiate Guideline Network
SD	Standard deviation
UK	United Kingdom

LIST OF TABLES

Number	Content	Page
1	How to prevent falls	8
2	Substances that higher the risk of falls	9
3	Effectiveness of guidelines	23
4	Ethical principles for guidelines	24
5	Changes in MATosteo	40
6	Demonstration of interrater reliability	47
7	Characteristics of test population A, B anc C	48
8	Adherence and applicability per criterion GP A, B and C	50
9	Level of adherence GP A, B and C	53
10	Characteristics of test population A	55
11	Adherence and applicability per criterion GP A	57
12	Level of adherence GP A	60
13	Adherence per patient GP A	61
14	Characteristics of test population B	67
15	Adherence and applicability per criterion GP B	68
16	Level of adherence GP B	71
17	Adherence per patient GP B	72
18	Characteristic of test population C	76
19	Adherence and applicability GP C	78
20	Level of adherence GP C	81

21	Adherence per patient GP C	82
22	Comparison between GP A, B and C; Fisher's exact test	88

LIST OF FIGURES

Number	Content	Page
1	Applicability to each criterion	87
2	Adherence per criterion for practice A, B and C	88
3	Content of MATosteo	99
4	Problems that might occur when performing the audit	100
5	Qualification of the auditor	100
6	Handling of results	101
7	Treatment of Osteopenia	101
8	Treatment of osteoporosis primary prevention	103
9	Treatment of osteoporosis secondary prevention	104

LIST OF APPENDICES

Number	Content	Page
1	Project Protocol	128
2	MATosteoLuf	136
3	MATosteo[19]	144
4	Database protocol	152
5	Instructions query builder	183

CONTENT

1. INTRODUCTION 1

1.1 Definition 1

1.2 Epidemiology 1

1.3 Aetiology 2

1.4 Bone function and structure 3
1.4.1 Bone remodelling 3
1.4.2 The role of bones in calcium and phosphorus homoeostasis 4

1.5 Influences on bone health 5
1.5.1 Risk factors for osteoporosis 5
1.5.1.1 Non-modifiable risk factors 6
1.5.1.2 Modifiable risk factors 6

1.6 Prevention 7
1.6.1 Non-pharmacological interventions 7
1.6.1.1 Falls prevention 7
1.6.1.2 Physical Exercise 9
1.6.1.3 Life style adjustements 9
1.6.1.4 Nutritional Counselling 10
1.6.1.5 Hip protectors 10
1.6.1.6 Osteoporosis knowledge and preventative behaviour 11
1.6.2 Pharmacological interventions 11

1.7 Symptoms 12
1.7.1 Hip fractures 12
1.7.2 Vertebral fractures 13

1.8 Diagnosis 13

1.9 Treatment options 14
1.9.1 Antiresorptive agents 15
1.9.1.1 Bisphosphonates 15
1.9.1.1.1 Alendronic acid 16
1.9.1.1.2 Risedronate 17
1.9.1.1.3 Etidronate 17
1.9.1.2 Raloxifene 17
1.9.1.3 Strontium ranelate 18
1.9.1.4 Calcitonin 18
1.9.1.5 Oestrogen 18
1.9.2 Osteoanabolic agents 19
1.9.2.1 Teriparatide 19

1.10 Frequent challenges in osteoporosis treatment 19
1.10.1.1 Renal impairment 20
1.10.1.2 Non-compliance 21
1.10.1.3 Inappropriate prescribing 21
1.10.1.4 Adverse drug events 22

1.11 Pharmaceutical care 22

1.12 Clinical guidelines 23
1.12.1 Guidelines used in MATosteo 24

1.13 National Health Service Scotland (NHSScotland) 24

1.14 Important pharmacy services 25
1.14.1 NHS minor ailment service (Masud, McClung et al.) 25
1.14.2 NHS chronic medication service (CMS) 26

1.15 Role of pharmacists in the Scottish healthcare system 26
1.15.1 Non-medical Prescribing and Prescribing by Pharmacists 27

1.16 GPASS 27

1.17 Osteoporosis management in Greater Glasgow and Clyde 28
1.17.1 Fracture liaison service (FLS) 28
1.17.2 Direct Access DXA service (DADS) 28
1.17.3 Secondary Care DXA service (SCDS) 28
1.17.4 Bone/ Mineral Metabolism Clinics 29
1.17.5 Community Falls Prevention Program (CFPP) 29

1.18 MAT 29

2 AIMS AND OBJECTIVES 30

3 METHODS 31

3.1 Literature research and project planning 31

3.2 Study design 31
3.2.1 Inclusion criteria 31
3.2.2 Exclusion criteria 32

3.3 Data collection 32

3.4 Revising MATosteo 33

3.5 Data analysis 33
3.5.1 First step: pre-sorting data 33
3.5.2 Second step: creating data items and main tables for the Query Builder" 34
3.5.3 Third step: Importing main tables into the query builder 35
3.5.4 Applying MATosteo 36
3.5.4.1 Using the "Read Code" field only 36
3.5.4.2 Using the "Read Code" field in combination with the "Drugs" field 37
3.5.5 Calculation of Adherence and Applicabiltiy 37

3.6 Demonstration of interrater reliability 38

3.7 Adaptation to local needs and validation of MATosteo[19] 38
3.7.1 Invitation to interviews 38
3.7.2 Interview technique and follow up 39

4 RESULTS 40

4.1 Revised MATosteo 40

4.2 Revised database protocol 46

4.3 Demonstration of inter-rater reliability 47

4.4 Total 48

4.4.1 Demographics 48
4.4.2 Adherence per criterion 50
4.4.3 Level of Adherence 53
4.4.4 Main findings 54
4.4.4.1 Patients with osteoporosis 54
4.4.4.2 Patients with osteopenia 54

4.5 Practice A 54
4.5.1 Demographics 55
4.5.2 Adherence per Criterion 57
4.5.3 Level of Adherence 60
4.5.4 Adherence per patient 61
4.5.5 Main findings 65
4.5.5.1 Patients with osteoporosis 65
4.5.5.2 Patients with osteopenia 66

4.6 Practice B 66
4.6.1 Demographics 66
4.6.2 Adherence per Criterion 68
4.6.3 Level of Adherence 71
4.6.4 Adherence per patient 72
4.6.5 Main findings 74

4.7 Practice C 76
4.7.1 Demographics 76
4.7.2 Adherence per Criterion 78
4.7.3 Level of Adherence 81
4.7.4 Adherence per patient 82
4.7.5 Main findings 85
4.7.5.1 Patients with osteoporosis 85
4.7.5.2 Patients with osteopenia 86

4.8 Comparison between practices 87
4.8.1 Applicability to each criterion per practice 87
4.8.2 Clinical guideline adherence to each criterion per practice 87

4.9 Validation of MATosteo and adaptation to local needs 90
4.9.1 Summary Interview I 90
4.9.2 Summary Interview II 92
4.9.3 Summary Interview III 94
4.9.4 Summary Interview IV 97
4.9.5 Main findings 99

4.10 Guidance for the prescriber- summary of the guidelines 101
4.10.1 Osteopenia 101
4.10.2 Osteoporosis primary prevention 103
4.10.3 Osteoporosis secondary prevention 104

5 DISCUSSION 105

5.1 General observations 105

5.2 Reviewing MATosteo 106

5.3 Data 106
5.3.1 Collection 107
5.3.2 Creation of a database protocol 108

5.4 Analysis 108
5.4.1 Manually 108

5.4.2 Microsoft Access®- classical query building 109
5.4.3 Query builder 109

5.5 Results 110
5.5.1 Demographics 111
5.5.2 Weak points of osteoporosis care in Glasgow 112
5.5.3 Strengths of osteoporosis care in Glasgow 113
5.5.4 Handling of results 114

5.6 Interviews 115

5.7 Strengths of the project 116

5.8 Limitations of the project 117

6 PROPOSALS FOR THE FUTURE 118

7 CONCLUSION 120

8 REFERENCES 122

9 APPENDICES 127

9.1 Appendix 1 128

9.2 Appendix 2 136

9.3 Appendix 3 144

9.4 Appendix 4 152

9.5 Appendix 5 183

10 CURRICULUM VITAE 200

1. INTRODUCTION

1.1 Definition

Osteoporosis is the most common bone disease in humans and defined as follows below (Mauck and Clarke 2006):
“Osteoporosis is a systemic skeletal disorder characterized by a low BMD and microarchitectural deterioration of bone tissue, leading to enhance bone fragility and a consequent increase of fracture risk.” (Brown J.P and Fortier M. 2006)

There are primary and secondary causes of osteoporosis (Mauck and Clarke 2006). Both forms affect women and men (Scottish Intercollegiate Guideline Network 2003). In primary osteoporosis the bone loss is associated with the ageing process. Secondary causes for the disease can be nutritional deficiency, certain medications and medical conditions (Mauck and Clarke 2006).

Osteoporosis is a chronic and progressive disease. Mostly there are no symptoms until the first fractures occur (Mauck and Clarke 2006; International Osteoporosis Foundation 2008). Those are however of notable concern as their impact on healthcare budgets, mortality, morbidity and patient’s quality of life is enormous (International Osteoporosis Foundation 2008). The most common sites for fractures due to osteoporosis are the vertebrae, hip and wrist (International Osteoporosis Foundation 2008; National Osteoporosis Foundation 2008).

Osteopenia is a condition of low bone density and a marker for the risk of fractures (Torpy, Lynm et al. 2006). It is the preliminary stage of osteoporosis.

1.2 Epidemiology

The prevalence of osteoporosis increases with age. As it is particularly common in postmenopausal women, one could conclude it is a disease of elderly women

(Scottish Intercollegiate Guideline Network 2003). Nevertheless, clinicians should be aware of the fact that men and younger people can also be affected for several reasons (National Osteoporosis Guideline Group 2008).

In the European Union, someone suffers an osteoporotic fracture every 30 seconds (International Osteoporosis Foundation 2008). In Scotland around 240000 people are affected by the disease. Over the age of 50 one in three women and one in twelve men suffer an osteoporotic fracture (Scottish Intercollegiate Guideline Network 2003). As the population ages in Europe the scope of the problem will increase enormously within the next few years (National Osteoporosis Foundation 2008).

Previous studies show clearly that different ethnic groups show different levels of bone density. Nevertheless, the role of ethnicity is still discussed controversially. In 1997 US researchers found out that the prevalence for osteoporosis is higher in non-Hispanic white women than in Mexican Americans and non- Hispanic black women (Looker, Orwoll et al. 1997). However recently a study was published where other conclusions were drawn. The researcher restricted data analysis to women with similar weight but belonging to different ethnic groups and demonstrated that ethnicity does not have an effect on rates of bone loss (Finkelstein, Brockwell et al. 2008).

Among men 30 to 60 percent of cases of demonstrable osteoporosis are associated with secondary causes, like hypogonadism, use of glucocorticoids and alcoholism. Around 50% of the cases of osteoporosis in perimenopausal women can be classified as secondary osteoporosis. The prevalence of secondary causes among postmenopausal women is supposed to be lower, though the numbers are not known for sure (Mauck and Clarke 2006).

1.3 Aetiology

As osteoporosis remains asymptomatic until the first fractures occur, knowledge about risk factors and causes is especially important for health care

professionals in order to screen sufficiently the population and identify patients as soon and quickly as possible (Mauck and Clarke 2006). Several strategies and assessment tools had been developed within the last years, but still this disease remains dramatically under-diagnosed and under-treated (International Osteoporosis Foundation 2008). Therefore, further work has to be done in order find out about the reasons for this phenomenon and to raise awareness of this problem equally among health care professionals and patients.

1.4 Bone function and structure

Bones form the skeleton of all vertebrates. Their mechanical purpose is to protect the internal organs, to make movements possible and to pass on sounds. Apart from these functions bones also take part in blood formation and have several metabolic tasks, like storing minerals or buffering the blood against excessive pH changes. Human bone mass increases during childhood and youth, reaches its' plateau when adults are young and starts to decrease around the age of 35 (Frost 1997).

Bone matrix consists of organic and mineral parts. The mineral part is mainly hydroxyl apatite, the organic one collagen type 1, which forms fibrils.

There are three main types of bone cells: osteocytes, osteoblasts and osteoclasts. Osteocytes transduce mechanical stimuli, which seem to activate osteoblasts (Parveen and Clark 2002). Osteoclasts and osteoblasts carry out the process of bone remodelling (Parfitt 1984).

1.4.1 Bone remodelling

Bones are subject to a permanent turnover. This process of bone remodelling is necessary to repair microdamage and to keep up other physiological functions of the human body. Bone resorption and bone formation are two closely linked functions. As long as they are well balanced, bone stays healthy and strong. Once equilibrium redeploys to resorption bone loss occurs.

Bone formation and bone resorption are linked together. BMUs (basic multicellular units) consist of mainly osteoclasts and osteoblasts (Frost 2000). The bone remodelling sequence can be represented as a multilevel process (Parfitt 1984). Microdamage in bone means that also osteocytes are damaged (Heino, Kurata et al. 2009). As well as factors like PTH, certain interleukins and certain prostaglandins, microdamage leads to release of factors to which osteoblasts respond by releasing RANK-L and MCS-F and reducing osteoprotegerin (Aktories, Foerstermann et al. 2005). Osteoclasts are now directed chemotactically to the resorption area. Osteoclastic activity leads to release of calcium by secreting proteases and hydrochloric acids. Inhibitors limit activity of osteoclasts and growth factors initiate osteoblast formation from stem cells. Osteoid is produced and mineralization takes place (Parveen and Clark 2002) (Aktories, Foerstermann et al. 2005). Osteoblasts are the so-called bone forming cells.

1.4.2 The role of bones in calcium and phosphorus homoeostasis

In the human body almost all of the calcium is stored in the bones. Only a small amount circulates in blood. Around 40 % of the plasma calcium are bound to albumin and has to be set free first, before it can be used for any physiological action (Hope, Longmore et al. 1993).

Phosphate takes part in most of the biochemical reactions of the human body. Around 80 % are stored in the bones (Parveen and Clark 2002).
The regulation of both calcium- and phosphate levels is closely linked together (Parveen and Clark 2002). The major hormones taking part in this process are PTH (parathyroid hormone) and Calcitonin. 1,25- dihydroxyvitamin D3 plays as well an important role in regulating calcium and phosphate homeostasis (Hope, Longmore et al. 1993).

When levels of free calcium decrease, PTH is released. As a consequence osteoclastic activity, intestinal absorption of calcium, synthesis of 1,25-

dihydroxyvitamin D3, renal tubular reabsorption of calcium and excretion of phosphate will be increased (Parveen and Clark 2002). Vitamin D increases calcium absorption in the gut as well as PTH does. Calcitonin lowers the levels of calcium and phosphate (Hope, Longmore et al. 1993). This response shows clearly why, a sufficient dietary intake of calcium and vitamin D is necessary to keep human bones strong and healthy. A permanent decrease leads to permanent release of calcium of bones and the fracture risk rises.

1.5 Influences on bone health

During childhood and young adulthood the basis for healthy bones is built. At the age of 20-25 the bone growth is completed and peak bone mass is reached. Peak bone mass is the maximum of bone mass that can be achieved during live. The higher it is, the lower the risk of developing brittle bones in a later phase of life. The keys to developing strong bones in this period are balanced nutrition and regular exercise (Brown J.P and Fortier M. 2006) (International Osteoporosis Foundation 2008).

With progressing age bone loss increases. The biggest reduction in bone density occurs during menopause due to decreasing oestrogen levels. Again it is very import during this period of life to exercise regularly and to ensure an adequate intake of calcium and vitamin D. However, lifestyle in general and environment have an impact on bone health as well. Certain factors can lead to a significant increase of fracture risk (Brown J.P and Fortier M. 2006).

1.5.1 Risk factors for osteoporosis

There are both modifiable and non-modifiable risk factors for osteoporosis (International Osteoporosis Foundation 2008).

1.5.1.1 Non-modifiable risk factors

Those risk factors cannot be influenced by lifestyle changes but are nevertheless important for risk assessment and for targeting patient groups.

- Age

  The risk of osteoporosis increases with ongoing age. In general women are likely to develop the disease earlier than men.
- Gender

  Women are at greater risk of osteoporosis than men.
- Ethnicity/ Race
- Family history

  There is evidence for a genetic impact on peak bone mass. This could be the explanation for the fact that some families are more likely to develop osteoporosis than others. However, this is controversial as it could also be due to similar lifestyle attitudes. Nevertheless someone who has one or more relatives suffering from osteoporosis is surely also at higher risk.
- Previous fracture

  Trials have shown that there is a significant link between sustaining a fracture during childhood and developing osteoporosis later on. As well it is clear that patients who already had a fracture are more likely to suffer from osteoporosis than others.
- Secondary causes of osteoporosis

  There is a large list of secondary causes for osteoporosis. Some of them are modifiable, e.g. by pharmacological intervention.

1.5.1.2 Modifiable risk factors

Knowledge about modifiable risk factors is very important as they can be used to give specific advice to patients in order to reduce the possibility of developing osteoporosis or to stem the progress of the disease. Modifiable risk factors are:

- Lack of physical activity

- Inadequate intake of calcium and vitamin D
- Smoking
- High intake of caffeine
- Frequent falls
- Low BMI

1.6 Prevention

Osteoporosis is a major burden on healthcare budgets and patients. Therefore, it is very important to healthcare providers to identify individuals at high risks and start preventative initiatives. The aim of course is to reduce osteoporosis incidence. However, osteoporosis prevention can also be seen in a different context- the prevention of fractures. Intervention should include pharmacological and non-pharmacological strategies (Gronholz 2008). Both strategies work only with the contribution of persons affected.

1.6.1 Non-pharmacological interventions

Non-pharmacological interventions are likely to be adequate for many individuals requiring primary prevention (before a fracture has occurred). The following possibilities are available: reducing falls risk, lifestyle modifications, nutritional counselling, physical exercise, osteopathic manipulative treatment and hip protectors (Gronholz 2008).

1.6.1.1 Falls prevention

Falls are a frequent problem among older people (Logan, Coupland et al. 2010)- up to 35% of seniors aged 65 years or older fall at least once a year. Between 5 and 10% of them suffer a serious injury. Mulifactorial interventions reduce the risk of falls and subsequent health costs significantly (McClure, Hughes et al. 2010).

Patients should be encouraged to modify their environment appropriately (Gronholz 2008; Vondracek and Linnebur 2009) in order to reduce their risk of falling. Frequently recommended measures are listed in the box below:

Table 1: How to prevent falls

Add grab bars in the bathroom
Increase lightning
Remove loose floor coverage
Install railings along stairways
Safe foot wear

(Mauck and Clarke 2006; Gronholz 2008; Vondracek and Linnebur 2009; Logan, Coupland et al. 2010)

It is also necessary to assess vision and to treat visual impairments (Mauck and Clarke 2006; Gronholz 2008; Vondracek and Linnebur 2009). Visual function takes part in the balance system by helping to detect perturbations of balance. Visual acuity and contrast sensitivity are moderately correlated to extent of sway, which is a risk factor for falls. It is a fact that older people, who are at higher risk for osteoporosis anyway, are more dependent on vision than younger. The fact that older people have longer reaction times and that the visual mechanism for correcting sway is relatively slow explains to some extent why it is harder for them to sufficiently correct loss of balance (Harwood 2001). Therefore, it is extremely important to correct visual impairments.

Several other diseases, e.g. cardiovascular disease or musculoskeletal disorders, lead to an increased risk of falls (Mauck and Clarke 2006; Vondracek and Linnebur 2009). Therefore they should be regularly monitored and adequately treated.

Pharmacists' contribution in reducing the risk of falls could be a medication review. It is important to avoid medication that leads to hypotension or alters mental status or gait stability (Mauck and Clarke 2006). The following table lists

some medication groups which have a potential to higher the risk of falling:

Table 2: Substances that higher the risk of falls

Diuretics
Antihypertensives
Benzodiazepines
Antipsychotics
Antidepressants

(Vondracek and Linnebur 2009)

1.6.1.2 Physical Exercise

Regular performance of physical exercise leads to an increased bone density and strengthens muscles and balance. Nevertheless not all kinds of sports are suitable for old people at risk of falls and/ or osteoporosis. It is best to recommend walking, mild forms of aerobic and resistance exercises as far as they are tolerated. It has been shown that it is possible to avoid up to 25% of falls, but there is no evidence that the risk of fractures decreases by exercise (Mauck and Clarke 2006).

1.6.1.3 Life style adjustments

Smoking decreased the BMD. Therefore, smoking cessation is recommended for the older senior as well as for the older patient. There is evidence that one year of cessation increases the BMD in the femoral trochanter and total hip (Vondracek and Linnebur 2009).

In general a healthy lifestyle including regular activity and healthy nutrition helps to prevent osteoporosis or its progression (International Osteoporosis Foundation 2008).

1.6.1.4 Nutritional Counselling

A healthy and balanced diet helps to keep our bones healthy and to prevent other chronic diseases like obesity, cardiovascular disease, cancer and diabetes. Calcium and vitamin D are especially important for the bone formation, but there is also a need for other substances like potassium, proteins, vitamin D, etc. (Weichselbaum and Dorner 2007).

From a closer look at hip fracture patients it has been shown that up to 63% have a low nutritional status at the time of hospitalisation, which can negatively influence the healing process. Although there is a clear link between nutritional status and the risk of sustaining a hip fracture, there is still a lack of evidence concerning the benefit of various types of nutritional intervention. Supplementation of nutrients is the simplest intervention , but many patients are non-compliant (Wyers, Breedveld-Peters et al. 2010).

In 2006 Duncan et al. were able to show that the support of a dietetic assistant has a positive impact on the mortality of hip fracture patients. After four months of intervention this positive effect still lasted. The researchers were of the opinion that nutritional counselling should be introduced across the NHS because of its potential to improve quality of patient care (Duncan, Beck et al. 2006).

1.6.1.5 Hip protectors

More than 90% of hip fractures are associated with falls. The highest incidence has been reported in nursing home residents who fell to the side. Therefore so called 'hip protectors' were designed in order to reduce the fracture risk (Kiel, Magizer et al. 2007). Whether they are really effective or not is still discussed controversially and seems to depend on multiple factors (Bulat, Applegarth et al. 2008).

Several types of hip protectors are available:

- hard shell (Kiel, Magizer et al. 2007; Bulat, Applegarth et al. 2008)
- soft shell (= foam type) (Kiel, Magizer et al. 2007; Bulat, Applegarth et al. 2008)
- hybrid (Bulat, Applegarth et al. 2008)

Hard shell hip protectors aim to divert the energy of fall into surrounding tissues, whereas, soft shell hip protectors absorb the energy of fall (Kiel, Magizer et al. 2007; Bulat, Applegarth et al. 2008). Hybrids combine both principles (Bulat, Applegarth et al. 2008).

Patients tend to low compliance concerning hip protectors, which might contribute to the fact that in many studies they were found to be ineffective in preventing fractures. A study by Bulat et al. showed that hip protectors do degrade with a rising number of impacts but most remain effective in shielding patients from hip fractures (Bulat, Applegarth et al. 2008).

1.6.1.6 Osteoporosis knowledge and preventative behaviour

The knowledge about osteoporosis is an important contributor to preventative behaviour- meaning performing regular exercise and a sufficient calcium intake (Winzenberg, Oldenburg et al. 2003).

1.6.2 Pharmacological interventions

Neither the NICE guidelines nor the SIGN guidelines cover the treatment of osteopenia, but the Canadian guidelines state that the use of bisphosphonates can help to prevent fractures in women who have a diagnosis of osteopenia (Brown J.P and Fortier M. 2006). As osteopenia is the preliminary stage of osteoporosis it is suitable to conclude that an adequate treatment of osteopenia

can help to prevent osteoporosis.

Administering bisphosphonates is also necessary if the long-term use of other substances leads to osteoporosis. The most popular example is the use of oral glucocorticoids (Scottish Intercollegiate Guideline Network 2003), but there are also a variety of other medications that increase the fracture risk- e.g. antiepileptics or anastrozol.

Knowledge about secondary causes for osteoporosis is necessary for pharmacists to identify patients at risk and to recommend starting adequate pharmacological interventions (Mauck and Clarke 2006).

1.7 Symptoms

Osteoporosis often remains undiagnosed until the first fracture occurs (Mauck and Clarke 2006). The loss of bone though is progressive and silent (International Osteoporosis Foundation 2008).

The most common sites for osteoporotic fractures are hip, spine and wrist. All injuries influence quality of life of the patients and are a burden on health care budgets, when both the acute and chronic medical costs are taken into account (International Osteoporosis Foundation 2008).

1.7.1 Hip fractures

A majority of hip fractures that occur over the age of 50 are due to osteoporosis. (International Osteoporosis Foundation 2008). They are of notable concern as they are a major cause of mortality and morbidity (McColl, Roderick et al. 1998). After a year of sustaining the fracture up to 24% of patients die (Cooper, Atkinson et al. 1993). Of those who survive only 50% will walk again, but often not to the same degree before the fracture happened (International

Osteoporosis Foundation 2008).

1.7.2 Vertebral fractures

Although vertebral fractures cause pain and a loss of quality of life, they often remain undetected and undiagnosed - less than 10% lead to hospitalisation. The first vertebral fracture needs to be seen as a warning sign. After a year one in five women experiences another fracture - resulting potentially in a so called 'fracture cascade' (Kanis, Johnell et al. 2004).

The consequences of vertebral fractures are pain, physical changes and impairments and psychosocial declines (Hallberg, Ek et al. 2010) well as enormous costs that mostly arise from outpatient care (International Osteoporosis Foundation 2008).

Patients describe two types of back pain - constant pain and activity related pain. Constant back pain is experienced as horrible and life-dominating, whereas activity-related pain eases when activity stops. Nevertheless, continuous movement stays impossible for a lot of patients (Hallberg, Ek et al. 2010).

Psychosocial decline often results in those constantly suffering pain. Many patients avoid coming together with friends and relatives as they are unable to sit down in an ordinary chair and feel like a burden to others (Hallberg, Ek et al. 2010).

1.8 Diagnosis

The current gold standard for the diagnosis of osteoporosis is the measurement of bone mineral density by performing a DEXA scan. In clinical practice the disease is very often diagnosed in an already progressed state, when a low-

trauma fracture or a fragility fracture occurs. A fragility fracture occurs without the presence of a trauma, that is spontaneously or due to coughing. A fracture is defined as 'low-traumatic' if it occurs after a fall from standing height or less (Mauck and Clarke 2006).

Since 1994 DEXA scan opens the possibility to diagnose osteoporosis in an earlier stage - before the patient has sustained a fracture (Mauck and Clarke 2006). Therefore it is necessary that healthcare professionals identify people at risk and refer them for a DEXA scan. According to the NICE and SIGN guidelines for osteoporosis, a DEXA scan should be performed at two specific sites - the hip and the spine (Scottish Intercollegiate Guideline Network 2003; National Institute of Health and Clinical Excellence 2008).

The technique is non- invasive and available throughout all the member states of the European Union. In 2007 though many countries, including the UK, Bulgaria, Romania, Luxembourg, Spain and Sweden, did not reach the recommended number of scanners for their respective populations. This means that quite a lot of people could not be referred to a DEXA scan within recent years (International Osteoporosis Foundation 2008).

The World Health Organisation (WHO) defines that someone suffers from osteoporosis if the measured BMD is 2.5 standard deviations or more below the average value for young healthy women (WHO 2004).

1.9 Treatment options

Osteoporosis treatment involves acute care (treatment of fractures and acute pain), pharmacological and non-pharmacological interventions to increase bone density and decrease the risk of sustaining future fractures (Mauck and Clarke 2006). This section focuses mainly on pharmacological treatment as this knowledge is the basis for future understanding of MATosteo.

The universal basis for the management of osteoporosis is an adequate calcium and vitamin supplementation. At the moment pharmacological treatment options, thereafter, fit into one of two categories: antiresorptive or osteoanabolic (Mauck and Clarke 2006).

1.9.1 Antiresorptive agents

Antiresorptive agents reduce bone resorption- bone loss decreases. Bisphosphonates, raloxifene, strontium ranelate, calcitonin and estrogen belong to this group (Mauck and Clarke 2006).

1.9.1.1 Bisphosphonates

Bisphosphonates alter the function of osteoclasts and thereby reduce bone resorption (National Institute of Health and Clinical Excellence 2008). Oral administration and intravenous application are possible. Although NICE and SIGN guidelines only deal with oral ones, the intravenous administration can be seen as a good alternative for patients who cannot tolerate oral bisphosphonates (Sunyecz 2008).

Oral bisphosphonates are poorly absorbed and should be taken with a glass of water in the morning after overnight fasting on an empty stomach. For the 30 minutes after oral administration it is necessary for the patient to keep upright and to avoid food. All bisphosphonates have a potential to cause gastrointestinal side-effects. As the protocol for ingestion is quite complicated, oral bisphosphonates might not be the best option for patients who are confused and do not have help with coping with their medication (Scottish Intercollegiate Guideline Network 2003).

When this project was started the national guidelines in the UK did not include i.v. bisphosphonates (zoledronic acid, ibandronic acid and pamidronate). Nevertheless those agents have some benefits, like an easy dose regimen or

the reduction of gastrointestinal side-effects compared to oral bisphosphonates. Zoledronic acid is administered once a year, ibandronic acid every three months. All i.v. bisphosphonates may cause minor flu symptoms for about one to three days, but are otherwise generally tolerated well (Sunyecz 2008).

The guidelines used for the development of MATosteo include alendronic acid, risedronate and etidronate.

An American study by Tosteson et al showed that the use of bisphosphonates is cost-effective as women sustain fewer fractures and gain more QALYs from treatment compared with those untreated or who are treated with PTH. Treatment costs increased in the following order: no treatment, risedronate, alendronate, ibandronate and PTH. The high risk group was analysed for cost effectiveness and it included women aged 75 years who had a previous fracture. In this group the administration of any treatment offset additional costs of inpatient, outpatient and long-term care. The authors also stated that their results are comparable with those of studies in European countries, like the UK or Belgium (Tosteson, Burge et al. 2008).

A common problem in osteoporosis therapy is non-compliance. Several studies show that only 40 to 50% of patients are compliant (obtain their prescription refills and take their pills regularly) (Rackoff 2009).

1.9.1.1.1 Alendronic acid

Alendronate is authorised at the UK market as a once weekly preparation (70 mg) and as well as a daily dose (10mg) (National Institute of Health and Clinical Excellence 2008). It is effective for the secondary prevention of vertebral and non-vertebral fractures by increasing bone mineral density and decreasing bone turnover. A retrospective study by Jun Iwamoto evaluated the outcome of Alendronate and showed that the increase of lumbar BMD after seven years is about 12.8%. Within this period no serious side-effects, like osteonecrosis of jaw or artrial fibriallation were observed. It was possible to prove changes in

bone metabolism by monitoring serum alkaline phosphatase and N-terminal telopeptides of type I collagen (Iwamotot, Sato et al. 2010).

A cross-sectional Japanese study by Hisaya Kawate et al, showed that Alendronate significantly improves QOL in postmenopausal women after four months of treatment (Kawate, Ohnaka et al.).

1.9.1.1.2 Risedronate

Risedronate is authorised at the UK market as a once weekly preparation (35 mg) and as well as a daily dose (5mg) for the treatment of postmenopausal osteoporosis (NICE). A study by Tahir Masud et al showed that orally administered risedronate reduces the risk of sustaining a hip fracture by 46% in elderly women with established osteoporosis compared to placebo (35). Risedronate is also effective in vertebral fractures and is beneficial in both women and men and also for glucocorticoid-induced osteoporosis. It has a good safety profile like all bisphosphonates – furthermore atrial fibrillation was not shown (Rackoff 2009).

1.9.1.1.3 Etidronate

Etidronate is an oral bisphosphonate administered in 90 day cycles. The patient takes 400mg/day for 14 days and 1.25g calcium carbonate for the last 76 days (National Institute of Health and Clinical Excellence 2008).

1.9.1.2 Raloxifene

Raloxifene is a selective estrogen receptor modulator. It increases BMD and decreases cholesterol but does not increase the risk of breast cancer. Raloxifene is licensed for the prevention and treatment of postmenopausal osteoporosis. There is evidence for the reduction in the risk of vertebral fractures by about 50%, but currently there is no evidence to be found

concerning hip fractures. It is contraindicated for women with a history of venous thromboembolism and is not recommended in women on HRT (Mauck and Clarke 2006). Raloxifene is authorised for the UK market with a recommended dose of 60mg/day (National Institute of Health and Clinical Excellence 2008).

1.9.1.3 Strontium ranelate

Strontium ranelate has a UK market authorisation for the treatment of postmenopausal osteoporosis and prevents both vertebral and non-vertebral fractures. The recommended dose is 2g/day. The patient needs to swallow the product as a suspension with water. As food and milk products reduce the resorption of the agent, it should be administered 2 hours after eating and preferably at bedtime (National Institute of Health and Clinical Excellence 2008).

1.9.1.4 Calcitonin

Calcitonin cannot be recommended as first-line therapy for osteoporosis. It prevents vertebral fractures and may reduce pain in vertebral fractures, but there is no evidence for non-vertebral fractures. Calcitonin is licensed as an intranasal preparation (200 IU/day) (Scottish Intercollegiate Guideline Network 2003). The only side effect known is rhinitis. Besides intolerance no contraindications are listed (Mauck and Clarke 2006).

1.9.1.5 Oestrogen

The decrease in oestrogen levels after the menopause leads to an increased bone loss. Though still controversially discussed, one treatment option is hormone replacement therapy (HRT) in which estrogen is administered alone or in combination. Possible adverse effects if oestrogen alone is used are stroke and venous thromboembolism (Mauck and Clarke 2006). When this project was started, neither the national nor the local guidelines recommended HRT for the

prevention or therapy of osteoporosis.

1.9.2 Osteoanabolic agents

Osteoanabolic agents stimulate bone formation (Mauck and Clarke 2006). When this project was started guidelines included only one preparation- Forsteo® (Teriparatide).

1.9.2.1 Teriparatide

Teripartide is a fragment of the human parathyroid hormone, which is recombinant produced and consists of the first 34 amino acids of the natural hormone. It is authorised for the UK market as an injectable preparation. The recommended dose is 20 micrograms/day for 18 months. After this period there is a need for treatment pause. Teriparatide is recommended for women with established osteoporosis only and rather expensive compared to the other treatment options on the market (National Institute of Health and Clinical Excellence 2008). Known side-effects are dizziness, leg cramps, arthralgia and post-injection hypercalcaemia (Mauck and Clarke 2006).

1.10 Frequent challenges in osteoporosis treatment

As evidence shows mostly people aged 50 years or older suffer from osteoporosis. The majority of patients are female and postmenopausal. As the disease is silent until the first fractures occur, it is very often diagnosed in a quite progressed stage.

Thinking about these facts already makes clear that within this patient sample pharmacological therapy might become quite complicated.

Inappropriate prescribing is quite common in people aged 65 years or older. Possible reasons are a higher prevalence for chronic diseases, disability and

dependency. Additionally about 29% of older people are polymedicate - meaning they take five or more medication prescriptions and many take at least one over-the counter medication and supplements.

Using medication starts with prescribing and continues with dispensing, drug administration and monitoring. The patient needs to be instructed about the drugs used. Each step is potentially tricky and may present health risks. Medication use problems may often be preventable and so need to be addressed by the principles of pharmaceutical care (Page, Linnebur et al. 2010).

Literature review identified some possible challenges, which might occur if osteoporosis patients are treated (renal impairment, non-compliance, inappropriate prescribing and adverse drug reactions). Knowledge about these challenges is necessary for the purposes of this project. Lack of such factual knowledge by the investigator may lead to wrong judgements concerning justifications of observed non-adherence to guidelines.

1.10.1.1 Renal impairment

The prevalence for both osteoporosis and chronic kidney disease (CKD) increases with age and always renal diseases increase the risk for skeletal abnormalities. The treatment for such patients is necessary but challenging, because there is a lack of data and evidence concerning the administration of antiresorptive agents. The safety and appropriateness of bisphosphonates in CKD patients is uncertain.

The majority of manufacturers recommend not to prescribe bisphosphonates in patients with a creatinine clearance less than 30 ml/min. Courtney et al recommend to avoid alendronic acid if creatinine clearance is less than 35 ml/min and to avoid ibandronic acid and risedronate acid if creatinine clearance is less than 30 ml/min. For those with a creatinine clearance betwenn 10 and 30 ml/min it is suitable to administer 50% of the usual dose of sodium clodronate.

They stated that it was safe to use bisphosphonates under these conditions (Courtney, Leonard et al. 2009).

1.10.1.2 Non-compliance

The risk of non-compliance is high in patients with asymptomatic chronic diseases, like osteoporosis. It depends on several factors like tolerability or the scheme of administration (Stevenson, Jones et al. 2005). There is conflicting evidence concerning the link between osteoporosis knowledge or beliefs and the osteoporosis preventative behaviour of patients. Some studies show that an increased knowledge about the disease significantly increases preventative behaviour, some state that the increase of knowledge does not necessarily lead to changes in preventative behaviour (Winzenberg, Oldenburg et al. 2003).

1.10.1.3 Inappropriate prescribing

Inappropriate prescribing encompasses the following fields:

- use of drugs that have a higher risk of adverse effects than alternative ones which are equal or more effective but less risky according to evidence
- over- use of medication
  - longer duration than clinically indicated
  - higher frequency of administration
- under-use of medication
- use of multiple medication although there is evidence of drug-drug interactions
- use of drugs that negatively interact with the disease

However, inappropriate medication is associated with an increase in adverse drug events, morbidity and mortality (Page, Linnebur et al. 2010).

Osteoporosis patients are at risk of inappropriate prescribing due to their age. In addition natural changes in the constitution of the human body increases the

risk of adverse drug events mostly due to changes in pharmacokinetics.

1.10.1.4 Adverse drug events

An adverse drug event (Yood, Mazor et al.) is an injury that results from a medical intervention related to a drug. It can be preventable or non preventable and due to loss of control of a disease or due to underuse (Bates, Miller et al. 1999; Bates, Cullen et al. 2005). Most of the preventable ADEs occur because drugs are used incorrectly. Most of these errors occur in the prescribing stage, the second highest risk for mistakes was found in the administration stage. ADEs potentially bring harm to the patients and are costly (Bates, Cullen et al. 2005).

Risk factors for ADEs are high age, high number of drugs received and factors that alter drug distribution or metabolism (Bates, Miller et al. 1999). The typical patient suffering from osteoporosis is elderly and therefore at higher risk of an ADE. They are important causes for morbidity and hospitalisations in this age group (Malhotra, Karan et al. 2001) and it is worthwhile to develop strategies to avoid such events. Therefore a pharmacist should be aware of drugs and situations with a high potential for ADEs.

Moreover, Mahotra et al found that 7.6 % of ADEs were related to non-compliance- mostly due to underuse, followed by overuse and misuse. Women were more likely to be non-compliant than men. Complicated treatment regimens, inability to properly recall one's medication increased the risk of non-compliance (Malhotra, Karan et al. 2001).

1.11 Pharmaceutical care

Pharmaceutical care is the quality of medication use. It is a discipline to do with the quality assurance of medication use and it seeks to improve health-outcomes of patients by, among other things, reducing adverse drug events, including side-effects and interactions. Pharmaceutical care can be provided by

the development of documentation (such as protocols and care plans) for patients or patient groups with special needs. Therefore, to help improve pharmaceutical care, the pharmacist unites the knowledge about pharmacology, medicinal chemistry, physiology, pathophysiology and technology for the benefit of the patient. Pharmacist's actions involve the prevention, identification and resolution of drug-related problems (Hepler and Strand 1990). Pharmacists can achieve those goals by working together with members of other medical professions in multidisciplinary team.

MATosteo has the potential to identify patients who are not treated according to the guidelines to evaluate the use of pharmaceutical initiatives on quality of medication use.

1.12 Clinical guidelines

Guidelines are supposed to form a bridge between evidence-based medicine and clinical practice. Applying guidelines aims to improve quality of care, reduce inappropriate variations in practice and provide cost- effective care (Rogers 2002).

Adherence to guidelines impacts on how effective medicines are in healthcare. A study by J S Burgers et al suggests that guidelines are effective if the following characteristics are fulfilled:

Table 3: Effectiveness of guidelines

Evidence based recommendations
Compatible with existing norms and values
Easy to follow and not requiring new skills and knowledge

(Burgers, Grol et al. 2003)

Nevertheless, ethical considerations should be taken into account in order to realise the potential of guidelines to improve the health of both individuals and populations. Ethical issues arise as well during the development of guidelines as when guidelines are used in clinical practice (Rogers 2002). The following

ethical principles have to be implemented in healthcare and therefore as well in guidelines:

Table 4: Ethical principles for guidelines

To act for the good of the patients
Non-maleficence
Fairness in healthcare
To respect patient's autonomy

(Burgers, Grol et al. 2003)

1.12.1 Guidelines used in MATosteo

The 19 criteria of MATosteo are derived from three national (UK) guidelines provided by the 'National Institute for Health and Clinical Excellence' (NICE) and the 'Scottish Intercollegiate Guidelines Network' (SIGN). They where considered to be the most actual available standard and to be broadly accepted by healthcare professionals. All three include information which considerations where made when forming the recommendations and where thought to fulfil the ethical expects of healthcare.

1.13 National Health Service Scotland (NHSScotland)

In Scotland health services are delivered by the NHS through 14 health boards. The Scottish Government Health Directorate is responsible for the NHS and several other services.

Each health board develops local health care strategies and is responsible for an effective and efficient performance of the services delivered. The field of duties includes the management of hospitals and General Practices in the area as well as all other health services. Glasgow belongs to the Greater Glasgow and Clyde Health Board (NHSScotland 2010).

Most NHS services are free, but there are charges for some things like medicines. Each patient gets a community health index number (CHI), which

aims to make it easier for NHS staff to find medical information and provide the best treatment possible. Whenever possible it is used for records the NHS keeps (NHS 2009).

People in Scotland are asked to register in a GP surgery, health centre or medical practice as an NHS patient. The family doctor then helps them to look after their health and decides whether it is necessary or not to see another health care professional or not. The term general medical practitioner (GP) is equal to the term family doctor (NHS 2008). The GP is the contact point for the patient.

Emergency care in a hospital, emergency transport in an ambulance, sexual health services and treatment for some infectious diseases and sexual transmitted diseases is free for everyone (NHS 2009).

1.14 Important pharmacy services

Pharmacies in Scotland offer several services to their costumers, which are co-ordinated by the NHS. The services explained below seemed to be the most important in the understanding of the Scottish healthcare system.

1.14.1 NHS minor ailment service (Masud, McClung et al.)

In Scotland people who a registered with a GP surgery, and who do not live in a nursing home and do not pay for their prescriptions can register for the MAS. They register in a community pharmacy and can come and see a qualified pharmacist whenever it is suitable for them. The pharmacist can decide to give an over the counter or pharmacy only medicine or product to treat the symptoms or can decide to ask the patient to see a GP if the patient's condition needs that (if it needs a medical assessment or a medicine that needs a prescription) (NHSScotland.).

1.14.2 NHS chronic medication service (CMS)

The CMS is about to be made available in community pharmacies all over Scotland. Patients with long-term conditions will be able register in a pharmacy or via their GP. A qualified pharmacist will then review the use of medicines, discuss any problems that might occur with the patients and develop a care plan if necessary within a treatment period of 24-38 weeks during which their medicines are dispensed on a serial prescription (repeated dispensing). The patient won't need to see his doctor or get a new prescription within this period. The GP however is allowed to decide whether the medication is suitable for this type of prescription or not (NHSScotland 2010).

1.15 Role of pharmacists in the Scottish healthcare system

In 2004 there were around 4000 pharmacists working in Scotland. They aim to work in partnerships with patients and other professionals to ensure the safest and best use of medicines - an approach called pharmaceutical care.

Community pharmacists fulfil an important part in health improvement - they are ambassadors of public health. For quite a lot of patients they are the first and only contact with a healthcare professional. Pharmacies are an important link between the NHS and public.

Hospital pharmacists specialise in clinical pharmacy, drug procurement, the safe preparation and dispensing of medicines, medicines information, radiopharmacy, manufacturing and quality assurance. Clinical pharmacists are specialised in certain therapeutic areas, which has been made possible because technicians and other staff were allowed to undertake some of pharmacists' traditional duties.
A small group of pharmacists works in academia or industry (Scottish Executive 2004).

1.15.1.1 Non-Medical Prescribing and Prescribing by Pharmacists

Pharmacists can become recognised as non-medical prescribers, a term which also applies to nurses recognised as such. This widening of prescribing was initiated by a supplementary prescribing role in the UK in 2003. The NHS defines supplementary prescribing as follows: “a voluntary partnership between an independent prescriber and a supplementary prescriber to implement an agreed patient specific Clinical Management Plan (CMP) with the patient's agreement”. The independent prescriber makes decisions about their clinical management including prescribing. The CMP includes guidelines to recognise or individually listed medicines and has to be accessible for the supplementary prescriber, who is allowed to administer doses, frequency of administration and products used. The early wave of supplementary prescribers has now been replaced by non-medical prescribers functioning as ‘independent prescribers’ who while now requiring a CMP do need to work within a guideline framework and to record their actions within the patients’ notes and within their own care plans to ensure they can defend their decisions when necessary.

Non-medical prescribing aims to use the best of skills of healthcare professionals and encourages teamwork. Only pharmacists, who successfully completed an approved programme for supplementary prescribing, can be a supplementary prescriber (NHSScotland 2004).

1.16 GPASS

The General Practice Administrative System for Scotland (GPASS) is a computer software system that was developed in the 1980s by Dr. David Ferguson. It is used for registration, prescribing, patient recall and practice audit by GPs. Around 20 years ago some practitioners stored all data in the system but some only had selective data on their system (Taylor, Ritchie et al. 1990)- a fact that I could still observe in 2009. However each patient has his own patient key, which can be used instead of his/ her name to get the record on the

screen. Similar to Microsoft Access® GPASS® allows staff to run queries and thanks to the patient key it is possible to do this anonymously.

For the purposes of this project three GPs were asked for permission to access their GPASS system in order to download medical histories and prescriptions of osteoporosis patients for analysing purposes.

1.17 Osteoporosis management in Greater Glasgow and Clyde

The health board of Greater Glasgow and Clyde offers several services for patients at high risk of sustaining a fracture, including primary (patients who did not yet sustain a fracture) and secondary prevention (patients who already sustained a fracture). The services are managed by the 'Osteoporosis and Falls' Strategy Group.

1.17.1 Fracture liaison service (FLS)

The FLS aims to re-assess people aged 50 years or older for their re-fracture risk, their need of treatment and prevention of secondary fractures.

1.17.2 Direct Access DXA service (DADS)

Some healthcare professional can refer patients to the DADS for assessing their fracture risk. Therefore at least one specific referral criterion has to be present.

1.17.3 Secondary Care DXA service (SCDS)

The SCDS offers an osteoporosis assessment for patients who are referred by a secondary care clinic and meet at least one specific referral criterion.

1.17.4 Bone/ Mineral Metabolism Clinics

These clinics offer an assessment for patients who are not suitable for the services described above or present a very complex and severe form of osteoporosis. They also cover other metabolic bone diseases (NHS GGC 2010).

1.17.5 Community Falls Prevention Program (CFPP)

Community pharmacies work together with pharmacist, who specialised on substances that might cause falls, and offer medication reviews for patients who have recently fallen and are on regular medication. If necessary suggestions for changes in the regular medication are made to the GP of the patient, who can accept or not (NHS GGC 2010).

1.18 MAT

A MAT is a 'Medication Assessment Tool' that focuses on the evidence base of treatment. It can be used as a clinical audit tool or as a research tool. When used as a clinical audit tool the intention is to examine prescribing. In research a MAT can be used to evaluate changes in prescribing associated to pharmaceutical care initiatives (McAnaw, Hudson et al. 2003).

This project is about a MAT for osteoporosis (MATosteo). It consists of 19 criteria measuring the quality of osteoporosis prescribing in Greater Glasgow and Clyde.

2 AIMS AND OBJECTIVES

Aim

This project aims to demonstrate the use of a Medication Assessment Tool for Osteoporosis (MATosteo) in the evaluation of adherence to Osteoporosis guidelines. As well inter-rater reliability has to be proved.

Objectives

1. To undertake a literature review of the management of osteoporosis and the role of specialists in the use of treatment alternatives
2. To revise a MATosteo (designed by previous researchers) and redesign database protocols and evaluate inter-rater reliability
3. Test the sensitivity of MATosteo in a comparison of patient samples drawn from two clinical settings and further revise the tool as necessary
4. Test on a larger scale audit the revised MATosteo. Take one patient sample and compare with the result of another researcher
5. Validate the revised MATosteo and critically review and critically review its potential value as a clinical and research tool

A full version of the project protocol can be found in the appendices.

3 Methods

3.1 Literature research and project planning

For the purpose of this project background information was gathered by using PubMed®, MedlinePlus® and Clinicaltrials.gov®. The number of articles was narrowed down by using a combination of certain keywords. Useful articles were identified by reading abstracts.

To learn about the local habits and Scotland's healthcare system the official homepage of the health board "Greater Glasgow and Clyde" was searched. For information about local initiatives on osteoporosis leaflets were collected and the homepage of the "National Osteoporosis Society" was searched.

As this project is based on projects of former researchers it was necessary to read the work of MSc pharmacist Johanna Schlais, Mag[a].pharm. Eva Past and the unpublished work of Anton Luf.

After finishing collection of necessary information a project protocol was written, which was supposed to be the main-thread during the whole process of working.

3.2 Study design

The survey was designed as a retrospective study combined with an assessment for proofing interrater reliability and interviews for validating MATosteo.

3.2.1 Inclusion criteria

Patients alive who were registered with the participating general practice on date and had a diagnosis of osteoporosis or osteopenia were included in the study.

As the purpose of this project was to assess the actual adherence to guidelines only medication records meeting the following criteria were included:

- Is Acute 0 and Is Active 1 or
- Is Acute 1 and Is Active 1 and
- Recorded within the last 6 months (time count starting at the day the data was downloaded from GPASS®)

3.2.2 Exclusion criteria

Patients with an unclear diagnosis for inclusion were excluded of the study as well as patients with Paget's disease. If the download from the GPASS® system was incomplete inclusion was considered to be useless as well.

3.3 Data collection

To do the first round of applying MATosteo only data collected by previous researchers was used. It was already stored in Microsoft Access® data bases and partly pre-sorted.

For enlarging the patient scale in a later phase of the project additional data was collected in a health centre (C). The backup file of GPASS® was accessed in order to guarantee privacy and keep patient records anonymous. As a first step the programme was linked to Microsoft Access® for filtering patients with a diagnosis of osteoporosis or osteopenia. The resulting patient keys were used for downloading medical history, medication records and patients' characteristics by running queries. As a tribute to lack of time no data collection form was developed. Instead the final version of MATosteo was used to make sure all data needed was collected as far as possible. As access to paper records was not permitted and so collection of T-scores was not possible. Downloaded data however, were stored in Microsoft Excel® and saved on two flash sticks.

3.4 Revising MATosteo

When first trying to apply MATosteoLuf several of its' statements turned out to require further definition to render them more explicit. In order to clarify these questions the guidelines and BNF were reviewed. Suggestions for changes were discussed within the research group. Some criteria were deleted or summarised into one. For some of them a change in wording was necessary. Both MATosteLuf and the final version of the MAT (MAToste19), which was applied to all of the 3 patient samples as explained below, can be found in the appendix.

3.5 Data analysis

For analysing the data the Microsoft Access® form "Query Builder" developed by Tobias Dreischulte and Ian Thompson at the University of Strathclyde was used in combination with Microsoft Excel®. Although it is necessary to pre-sort the data carefully and design data items the advantage of this method is clear. It guarantees reliable and reproducible results even when large patient samples are audited. MATosteo was applied criterion by criterion by using the form. Results were transferred to Microsoft Excel® for final calculation.

3.5.1 First step: pre-sorting data

Before beginning with the analysis certain decisions had to be made. Data collected in practice A or B by a previous researcher was checked to make sure that none of the patients would meet exclusion criteria. This was done by running queries in the existing databases. Decision making about inclusion or exclusion of patients collected in health centre C was more time consuming. Collected patient keys and general information had to be imported into Microsoft Access® and searched for exclusion criteria. Finally a list containing patient keys of included patients was made for each practice.

In order to be able to apply the "Query Builder" later on for each GP further pre-

sorting was necessary. Therefore three databases were created- one for each practice- containing tables for diagnosis, general information, BMI and DEXA scans.

3.5.2 Second step: creating data items and main tables for the Query Builder"

Each field of the "Query Builder" depends on either a table and a query or two tables. For the purpose of this audit only the "Read code" field and the "Drugs" field were use. Therefore only the information for three tables had to be searched and stored in Microsoft Excel® files which were finally imported in the main tables of the "Query Builder".

It is best to create main tables in Microsoft Excel® before importing them into the form.

The "Read Code" field accesses to the table "Patients: NHS Read codes_QOF and MAT data items_tbl" and the query "qry_MAT". "qry_MAT" is already predesigned – so no further attention has to be paid to it in this phase. The table "Patients: NHS Read codes_QOF and MAT data items-tbl" has to be filled with information. The first thing needing to be decided is what data items will be needed for applying the MAT later on. The purpose of a data item is to summarise slightly different terms, e.g.:

Term to summarise	**Data item**
Glucocorticoid induced osteoporosis	Osteoporosis
Osteoporosis in spine	Osteoporosis

After creating a list of data items based on MATosteo the table can be filled with information. Therefore the orginal "Query Builder" was copied, the old data

deleted and the tables exported to Microsoft Excel®. Data to assess was copied in the columns “Patient key”, “Read Code” and “Date recorded”. Then the matching data items were added. As a last step the data had to be imported again in Microsoft Access ®. After saving the table and running the query “qry_mat” the field “Read Code” was ready for use.

The “Drugs” field accesses to two tables- “Patients: Drug History_tbl” and “Master: Drug list_tbl”.

In “Patients: Drug History_tbl” the following columns were filled with original data: “patient key”, “drug name”, “preparation”, “dose” and “frequency”. The column “drug_category” was filled with invented names fulfilling the same sense as the data_items.

In “Master: Drug list_tbl” the column ‘drug’ has to contain the same data, which is stored in the column ‘drug_name’ in, the ‘Patient: Drug History_tbl’. The column ‘drug_catagory’ has to contain the same data, which is stored in the column ‘drug_category’ in, the ‘Patient: Drug History_tbl’. “Brand name” and “Drug group” can be invented, the rest of the columns do not necessarily need to conatain information.

It is important not to change the name of columns and to fill relevant information by copying or running queries.

3.5.3 Third step: Importing main tables into the query builder

As mentioned above the main tables had to be imported into the “query builder” after creating them in Microsoft Excel®. This was done by copying the original “Query Builder”, deleting all old data in the main tables of the copy and importing the Microsoft Excel® files by using the “Import into an existing table” function.

3.5.4 Applying MATosteo

For developing a reliable method of applying the form the smallest patient sample was analysed first. Each criterion was done manually and by using the query builder. The method was accepted when the agreement between the two methods was 100%. Then a database protocol was written for enabling other researchers to apply MATosteo by using the Query Builder.

When writing the database protocol high effort was made to make the use of the form as easy as possible. This was done by structuring the protocol and paying attention to a clear layout. Finally the database protocol was shown to other students and lecturers for testing it in terms of validating its meaningfulness (clinical rationale). Where necessary further adaptation was done. The database protocol was finally used for applying MATosteo for all patient samples.

MATosteo was applied criterion by criterion by using the “Read Code” field of the “Query Builder” alone or in combination with the “Drugs” field.

3.5.4.1 Using the “Read Code” field only

For very simple criteria it was feasible to use the Read Code field only. Therefore only the matching data items had to be selected. After pressing the “view” button a result table containing 1 and 0 appeared. 1 always stands for “yes”, 0 always stands for “no”. For further analysis of the results different methods were used.

To filter patients meeting a certain combination of 1 and 0 the easiest way was to run a further query using the temporary table resulting for the form.

Another possibility was to use the sort function and delete unneeded results directly in the result table.

Finally all results were exported to Microsoft Excel® and used for calculation.

For some criteria it was also necessary to export partial steps- either for the purpose of final calculation or for being able to list the results on a per patient base.
A full version of the data base protocol can be found in the appendix.

3.5.4.2 Using the "Read Code" field in combination with the "Drugs" field

For some criteria it was necessary to combine information of the Read Code field and the Drugs field. When this was necessary the first query had to be built and exported to Microsoft Excel®, as it is not possible to safe the temporary table. After exporting the results of the first query, they were imported and saved as a new table. Then it was possible to use the other field of the "Query Builder" without missing the results of the first run. In an additional step the results stored in the imported table could be combined with the results of the temporary table.

Again all necessary information for calculation was exported to Microsoft Excel®.

3.5.5 Calculation of Adherence and Applicabiltiy

For calculating of applicability and adherence on a per patient base, on a per criterion base and overall Microsoft Excel® was used. The following formulas were applied:

$$\text{Applicability} = \frac{\sum Yes, No(U), IDS}{n} * 100$$

n … Total number of patients

$$\text{Adherence} = \frac{Yes}{\sum Yes, No(U), IDS} * 100$$

Resulting percentages of adherence were categorised arbitrarily as follows:

≥ 70 %	High level of Adherence
50- 69.9%	Intermediate level of Adherence
< 50%	Low level of Adherence

3.6 Demonstration of inter-rater reliability

For Clydebank and Paisley another student also applied the MATosteo[21] by using the “Query Builder”. Results were compared by calculating the standard deviation and the percentage of discrepancy. For calculating the standard deviation the following formula was used:

$$\text{Standard deviation} = \sqrt{\frac{(xi - \overline{x})}{n}}$$

Xi	Actual value
$\overline{X}$	Mean
n	Total number

3.7 Adaptation to local needs and validation of MATosteo[19]

Local guidelines were collected and experts on osteoporosis were interviewed in order to validate MATosteo[19]. Only specialist nurses on osteoporosis, rheumatologist or doctors working in an osteoporosis unit were considered to be experts and were contacted.

3.7.1 Invitation to interviews

For getting easier access to such experts where possible a contact pharmacist was asked to help with organising appointments. Whenever this was not

possible an email containing major information about the project and the purpose of the interview was sent directly to the expert. Once interest in participating in the interview was expressed the interview questions were sent in advance in order to give the interviewee the possibility to get familiar with the subject and to save time in performing the interview.

3.7.2 Interview technique and follow up

The semi-structured interview technique was chosen in order to being able to validate MATosteo[19] criterion by criterion. When using this technique the interviewer has a framework to stick to but nevertheless the possibility to come up with additional questions to clarify statements.

At the beginning of the interview a short overview over the project was given and the purpose of the interview was explained. To warm- up a view general questions were asked before assessing the MAT criterion by criterion. Interviewees were asked to give their permittance to tape-recording. If tape recording was not possible for some reason, a second investigator was used for note taking. Some interviewees asked to restrict the interview time to 30 minutes. In this case only the most important questions were asked.

Interviews were summarised. The most important were highlighted and can be used to adapt MATosteo in the future.

4 Results

4.1 Revised MATosteo

Reviewing of MATosteoLuf resulted in some changes. Criteria 1- 5 remained the same. Several criteria were reworded and for better practicability of the electronic data analysis the order of criteria was changed. Whereas MATosteoLuf contained 21 criteria, the new version of MATostoe contains only 19 criteria. The table compares the two MATs.

Table 5: Changes in MATosteo

MatosteLuf	Matosteo[19]	Action/ Comment
Criterion 6 **A patient with osteoporosis and NOT prescribed any of the following: bisphosphonates, raloxifene, strontium ranelate, calcitonin or teriparatide** has a recorded contra-indication to each agent (see below) Contraindications to bisphosphonates are: ☐ oesophageal strictures or achalasia ☐ inability to remain upright for > 30 min after ingestion ☐ hypocalcaemia ☐ osteomalacia (etidronate) ☐ moderate renal impairment (CrCl < 35 mL/min) ☐ pregnancy and breast feeding] Contraindications to raloxifene are: ☐ past/present venous thromboembolic events ☐ hepatic impairment ☐ cholestasis ☐ severe renal impairment (CrCl < 10 mL/min) ☐ endometrial cancer ☐ uterine bleeding ☐ pregnancy and breast feeding	Criterion 10 **A patient with osteoporosis and NOT prescribed any of the following: bisphosphonates, raloxifene, strontium ranelate, calcitonin or teriparatide** has a recorded contra-indication to each agent (see below) Contraindications to bisphosphonates are: ☐ oesophageal strictures or achalasia ☐ inability to remain upright for > 30 min after ingestion ☐ hypocalcaemia ☐ osteomalacia (etidronate) ☐ moderate renal impairment (CrCl < 35 mL/min) ☐ pregnancy and breast feeding] Contraindications to raloxifene are: ☐ past/present venous thromboembolic events ☐ hepatic impairment ☐ cholestasis ☐ severe renal impairment (CrCl < 10 mL/min) ☐ endometrial cancer ☐ uterine bleeding ☐ pregnancy and breast feeding	Change of order Criterion 6 of MATosteoLuf is criterion 10 in MATosteo [19]. The research group aimed to simplify the process of electronic data analysis.

Table 5: Changes in MATosteo

MatosteLuf	**Matosteo[19]**	**Action/ Comment**
Contraindications to strontium ranelate are: ☐ pregnancy and breast feeding ☐ hypersensitivity Contraindications to calcitonin are: ☐ hypocalcaemia ☐ hypersensitivity Contraindications to teriparatide are: ☐ pre-existing hypercalcaemia ☐ skeletal malignancies or bone metastases ☐ metabolic bone diseases ☐ including Paget's disease and hyperparathyroidism ☐ unexplained raised alkaline phosphatase previous radiation therapy to the skeleton	Contraindications to strontium ranelate are: ☐ pregnancy and breast feeding ☐ hypersensitivity Contraindications to calcitonin are: ☐ hypocalcaemia ☐ hypersensitivity Contraindications to teriparatide are: ☐ pre-existing hypercalcaemia ☐ skeletal malignancies or bone metastases ☐ metabolic bone diseases ☐ including Paget's disease and hyperparathyroidism ☐ unexplained raised alkaline phosphatase previous radiation therapy to the skeleton	
Criterion 7 **A patient prescribed supplementary calcium** is prescribed a daily dose of 500 – 1500 mg calcium.	Criterion 6 **A patient prescribed supplementary calcium** is prescribed a daily dose of 500 – 1500 mg calcium**.**	Change of order Criterion 7 of MATosteoLuf is criterion 6 in MATosteo[19]. The research group aimed to simplify the process of electronic data analysis. The topic 'calcium and vitamin D' should be analysed as a whole.
Criterion 8 **A patient prescribed vitamin D** is prescribed a daily dose of 10 – 20 µg (400 - 800 IU) vitamin D.	Criterion 7 **A patient prescribed vitamin D** is prescribed a daily dose of 10 – 20 µg (400 - 800 IU) vitamin D.	Change of order Criterion 8 of MATosteoLuf is criterion 7 in MATosteo[19]. The research group aimed to simplify the process of electronic data analysis. The topic 'calcium and vitamin D' should be analysed as a whole.

Table 5: Changes in MATosteo

MatosteLuf	Matosteo[19]	Action/ Comment
Criterion 9 **A patient with osteoporosis and NOT prescribed any of the following: bisphosphonates, raloxifene, strontium ranelate or calcitonin** is prescribed ≥1000mg calcium plus 800 IU vitamin D per day	Criterion 11 **A patient with osteoporosis and NOT prescribed any of the following: bisphosphonates, raloxifene, strontium ranelate or calcitonin** is prescribed ≥1000mg calcium plus 800 IU vitamin D per day	Change of order Criterion 9 of MATosteoLuf is criterion 11 in MATosteo[19]. The research group aimed to simplify the process of electronic data analysis.
Criterion 10 **A patient with a recorded diagnosis of osteoporosis** is prescribed an oral bisphosphonate as first-line therapy. Recorded reasons for non-conformance (justification):	Criterion 10 **A patient with a recorded diagnosis of osteoporosis** is prescribed an oral bisphosphonate as first-line therapy. Recorded reasons for non-conformance (justification):	Change of order Criterion 10 of MATosteoLuf is criterion 8 in MATosteo[19]. The research group aimed to simplify the process of electronic data analysis.
Criterion 14, 15, 16 **A postmenopausal woman when started on bisphosphonate therapy** was initiated on alendronate. **A postmenopausal woman diagnosed with osteoporosis/osteopenia and not treated with alendronate** is prescribed risedronate. **A postmenopausal woman with ≥ 2 vertebral fractures and NOT treated with alendronate or risedronate** is prescribed intermittent cyclical etidronate.	Criterion 14 **A patient with osteoporosis on bisphosphonate therapy** is on the **preferred choice*** *** 1- Alendronate, 2-risedronate, 3-intermittent cyclical etidronate** **[Preferred order as shown in the drug history**]	Rewording Criterion 14,15, 16 of MATosteoLuf were summarised in criterion 14 of MATosteo[19]. The term 'a postmenopausal woman' was changed to 'a patient'. The auditor is advised to look the order of choice up in the drug history

Table 5: Changes in MATosteo

MatosteLuf	Matosteo[19]	Action/ Comment
Criterion 11 **A patient with a recorded diagnosis of osteoPENIA** is prescribed an oral bisphosphonate as first-line therapy. Recorded reasons for non-conformance (justification): _____	Criterion 9 **A patient with a recorded diagnosis of osteoPENIA** is prescribed an oral bisphosphonate as first-line therapy. Recorded reasons for non-conformance (justification): _____	Change of order Criterion 11 of MATosteoLuf is criterion 9 in MATosteo[19]. The research group aimed to simplify the process of electronic data analysis.
Criterion 17 **A patient who is on long-term glucocorticoid therapy (≥ 7.5 mg prednisolone or equivalents for ≥ 3 months)** is prescribed a bisphosphonate.	Criterion 15 **A patient who is on long-term glucocorticoid therapy (≥ 7.5 mg prednisolone or equivalents for ≥ 3 months)** is prescribed a bisphosphonate.	Change of order Criterion 17 of MATosteoLuf is criterion 15 in MATosteo[19]. The research group aimed to simplify the process of electronic data analysis.
Criterion 18 **A postmenopausal woman with a diagnosis of osteoporosis, who has an identifiable reason for not being prescribed a bisphosphonate** is prescribed strontium ranelate. [Reasons for non-use of bisphosphonates are Contraindications to bisphosphonates ❑ contraindication to bisphosphonates (see 12) ❑ inability to comply with the recommendations for use of bisphosphonates (see 12) ❑ intolerance to bisphosphonates (see12)]	Criterion 16 **A postmenopausal woman prescribed strontium ranelate** has an identifiable reason for not being prescribed a bisphosphonate Reasons for non-use of bisphosphonates are ❑ contraindication to bisphosphonates (see 12) ❑ inability to comply with the recommendations for use of bisphosphonates (see 12) ❑ intolerance to bisphosphonates (see12)]	Rewording, Change of order The criterion was reworded in order to simplify the process of electronic data analysis. The research group chose a phrasing that did not change the meaning of the criterion.

Table 5: Changes in MATosteo

MatosteLuf	**Matosteo[19]**	**Action/ Comment**
Criterion 19 **A postmenopausal woman diagnosed with osteoporosis with at least one osteoporotic fracture who has an identifiable reason for not being prescribed a bisphosphonate** is prescribed strontium ranelate or raloxifene. [Reasons for non-use of bisphosphonates are Contraindications to bisphosphonates ❑ contraindication to bisphosphonates (see 12) ❑ inability to comply with the recommendations for use of bisphosphonates (see 12) ❑ intolerance to bisphosphonates (see 12)]	Criterion 17 **A postmenopausal woman prescribed raloxifene** is receiving it for secondary prevention and has an identifiable reason for not being prescribed a bisphosphonate [Reasons for non-use of bisphosphonates are ❑ contraindication to bisphosphonates (see 12) ❑ inability to comply with the recommendations for use of bisphosphonates (see 12) ❑ intolerance to bisphosphonates (see 12)]	Rewording, Change of order The criterion was reworded in order to simplify the process of electronic data analysis. The research group chose a phrasing that did not change the meaning of the criterion
Criterion 20 **A postmenopausal woman diagnosed with osteoporosis and at least one osteoporotic fracture who has either** ❑ **a reason to avoid bisphosphonates (See 12)** ❑ **an intolerance to strontium ranelate** o persistent nausea o persistent diarrhoea **and who is either** ❑ **aged ≥ 65 years with a T-Score ≤ -4 SD** ❑ **aged ≥ 65 years with a T-Score ≤ -3.5 SD and has more than two fractures** ❑ **aged 55-64 years with a T-Score ≤ -4 and has more than two fractures** is prescribed teriparatide.	Criterion 18 **A patient prescribed teriparatide is prescribed it for secondary prevention and meets at least one of the following 2 criteria** ❑ **has a reason to avoid bisphosphonates (See 12)** ❑ **has an intolerance to strontium ranelate** o persistent nausea o persistent diarrhoea And has DEXA scan assessment that puts them in one the following groups ❑ **aged ≥ 65 years with a T-Score ≤ -4 SD** ❑ **aged ≥ 65 years with a T-Score ≤ -3.5 SD and has more than two fractures** ❑ **aged 55-64 years with a T-Score ≤ -4 and has more than two fractures**	Rewording, Change o order The criterion was reworded in order to simplify the process of electronic data analysis. The research group chose a phrasing that did not change the meaning of the criterion.

Table 5: Changes in MATosteo

MatosteLuf	Matosteo[19]	Action/ Comment
Criterion 21 **A postmenopausal woman diagnosed with osteoporosis with at least one vertebral fracture and NOT treated with a bisphosphonate, raloxifene or strontium ranelate** is prescribed calcitonin.	Criterion 19 **A patient prescribed calcitonin** is prescribed it for secondary prevention after bisphosphonate, raloxifene or strontium ranelate have been tried or have reasons for excluding from consideration [Reasons for non-use of bisphosphonates are ❑ contraindication to bisphosphonates (see 12) ❑ inability to comply with the recommendations for use of bisphosphonates (see 12) ❑ intolerance to bisphosphonates (see 12)] [Reasons for non-use of strontium ranelate are: ▪ Contraindication to strontium ranelate (see 10)] [Reasons for non-use of raloxifene are: ▪ Contraindication to raloxifene]	Rewording, Change of order The criterion was reworded in order to simplify the process of electronic data analysis. The research group chose a phrasing that did not change the meaning of the criterion.

4.2 Revised database protocol

The original database protocol was completely redesigned for the use of the query builder. For each criterion a work instruction can be found. The work instruction presents as a table. Each row explains a single working step. The very left column names the step of the procedure; the second column tells the auditor what to do and the third one how to process.

Example of a work instruction:

CRITERION 7

Patient prescribed supplementary calcium *Is prescribed a daily dose of 500-1500 mg calcium*

Step	**What?**	**How?**
Step 1	Identify patients prescribed supplementary calcium	**Use** form 'Query maker' in Microsoft Access® **Select** in 'Drug' field/ 'group': • 'supplement' for criterion 1 **Press** 'view' **Create** new query by using 'design view' **Select** 'tbl_temp' **Apply** 'patientKey', c1, d1[not like "0"], c2, d2, c3 **Run** query 1
Step 2	Identify number of Yes, No(J), No(U), IDS	**Export** results of 'step 1' to Microsoft Excel® **Inspect** on the results ➔ Patient prescribed a daily dose of 500-1500 mg calcium= Yes ➔ Patient not prescribed a daily dose of 500-1500 mg calcium= No(U) ➔ documentation concerning dose, preparation and frequency not clear= IDS

A full version of the new data base protocol can be found in Appendix 4.

4.3 Demonstration of inter-rater reliability

The inter-rater testing of MATosteo by two independent students (X, Y) showed 99.1% agreement for applicability. Highest percentage of discrepancy was 10.4%, but for 16/21 (76.2%) criteria 100.0% agreement was shown. For Adherence the mean agreement was 99.6%. Discrepancy was minimal and only shown for 3/21 (14.3%) criteria. The following table shows the results of the assessment for criterion 1 to 21, as the test was done in an early phase of the project.

Table 6: Demonstration of the interrater reliability

Criterion	Applicability$_X$	Applicability$_Y$	Agreement (%)	Adherence$_X$	Adherence$_Y$	Agreement (%)
1	40.2	40.2	100.0	78	78	100.0
2	30.8	27.6	89.6	32	32	100.0
3	50.0	50.0	100.0	100	100	100.0
4	56.3	56.3	100.0	9	9	100.0
5	59.1	58.8	99.5	101	100	99.0
6	0.0	0.0	100.0	0	0	100.0
7	99.2	99.2	100.0	118	118	100.0
8	98.2	97.3	99.1	109	109	100.0
9	22.6	23.5	96.2	19	20	95.0
10	56.0	56.0	100.0	112	112	100.0
11	56.3	56.3	100.0	9	9	100.0
12	85.9	85.9	100.0	116	116	100.0
13	82.1	84.1	97.6	119	122	97.5
14	86.1	86.1	100.0	105	105	100.0
15	12.4	12.4	100.0	12	12	100.0
16	nr	nr	100.0	0	0	100.0
17	nr	nr	100.0	0	0	100.0
18	0.0	0.0	100.0	0	0	100.0
19	0.0	0.0	100.0	0	0	100.0
20	nr	nr	100.0	0	0	100.0
21	0.0	0.0	100.0	0	0	100.0
Mean (%) SD			99.1 (2.4)			99.6 (1.2)

4.4 Total

The results presented in the following section are a summary of test population A, B and C. Larger amount of patients make them more representative.

4.4.1 Demographics

90.3% of the patients with a diagnosis of osteoporosis or osteopenia are female. 97.9% of female patients are postmenopausal. 81.5% of the assessed population are diagnosed with osteoporosis. Age range is quite broad, but when calculating the mean age it turns out that only a few patients are less than 50 years old. % of all patients have a low BMI, which is a risk factor for osteoporosis.

Table 7: Characteristics of test population GP A+B+C

Patient sample	**n =319**
Gender	
Female	288/319 (90.3%)
Male	31/319 (9.7%)
Diagnosis	
Osteoporosis	260
• Female	232
• Postmenopausal	227
• Male	28
Osteopenia	59
• Female	56
• Postmenopausal	55
• Male	3

Table 7: Characteristics of test population GP A+B+C

Patient sample	**n =319**
Age Age range (years)	24-96
Age range osteoporotic patients (years) • Female • Male	24-96 24-96 36-91
Mean age osteoporotic patients (years) • Female • Male	74.0 (13.1) 74.4 (12.9) 70.8 (14.5)
Age range osteopenic patients (years) • Female • Male	39-92 43-92 39-72
Mean age osteopenic patients (years) • Female • Male	66.8 (13.1) 67.2 (12.9) 59.7 (18.0)
BMI range (kg/ m^2) Osteoporosis • Female • Male	14.1-40.8 14.1-40.8 14.1-40.8 16.7-32.5
Osteopenia • Female • Male	16.2-39.0 16.2-39.0 26.1-31.7
BMI <22	6/49 (12.2%)

4.4.2 Adherence per criterion

For 3/19 criteria no result can be presented as they were not applicable to any patient. Overall adherence calculated on a per criterion base is 61.7 98% CI (59.8- 63.6), which is an intermediate level of adherence. The following table shows applicability and percentage of adherence for each criterion and overall in total for GP A, B and C.

Table 8: Adherence and applicability per criterion GP A, B and C

Criterion n= 2926	N/A (%)	Yes	No (J)	No (U)	IDS	IDQ	**Applicable (%)**	**Adherence (CI 95%)**
1 Patient with a diagnosis of OS has a recorded DEXA scan	66/115 20.7%	115	7	126	12	0	253/319 79.3%	115/253 45.5% (44.3-46.7)
2 Patient with measured BMD by DEXA scan has measures taken at spine and hip	178/319 20.7%	36	0	89	16	44	141/319 44.2%	36/141 25.5% (23.6-27.4)
3 Patient with OS is prescribed supplementary calcium	59/319 81.5%	138	0	122	0	0	260/319 81.5%	138/260 53.1% (47-59.2)
4 Osteopenic patient is prescribed supplementary calcium	260/319 81.5%	22	0	37	0	0	59/319 18.5%	22/59 37.3% (25-59.6)
5 Patient with confirmed vitamin D deficiency or age ≥ 65years is prescribed vitamin D	79/319 24.8%	142	0	98	0	0	240/319 75.2%	142/240 59.2% (53-65.4)
6 Patient with osteoporosis is treated with antiresorptive/ osteoanabolic agent	64/319 20.1%	153	5	97	5	0	255/319 79.6%	153/255 60.0% (54.0-66.0)
7 Patient prescribed calcium is prescribed 500-1500 mg	149/319 46.7%	169	0	1	0	0	170/319 55.3%	169/170 99.4% (98.2-100.0)
8 Patient prescribed vitamin D is prescribed 400-800 IU	157/319 49.2%	159	0	3	0	0	162/319 50.8%	159/162 98.1% (96.0-100.0)

Table 8: Adherence and applicability per criterion GP A, B and C

Criterion **n= 2926**	N/A (%)	Yes	No(J)	No(U)	IDS	IDQ	**Applicable (%)**	**Adherence (CI 95%)**
9 Patient with osteoporosis untreated by antiresorptive/ anabolic agent is prescribed >=1000mg calcium plus 800 IU vitamin D	212/319 66.5 %	32	0	74	1	0	107/319 33.5%	32/107 29.9% (27.2-32.6)
10 Patient with OS is prescribed an oral BP as first-line therapy	65/319 20.4 %	149	6	100	5	0	254/319 79.6%	149/254 58.6% (52.5-64.7)
11 Osteopenic patient is prescribed an oral BP as first-line therapy	260/319 81.5 %	19	0	40	0	0	59/319 18.5%	19/59 32.2% (20.3-44.1)
12 Patient treated with antiresorptive/ osteoanabolic agent has no contra-indication on record	146/319 45.8 %	144	0	23	36	0	173/319 54.2%	114/173 65.9% (58.8-73.0)
13 Patient receiving treatment for osteopenia/osteoporosis is prescribed a standard dose regimen	126/319 39.5 %	150	0	30	13	0	193/319 60.5%	150/319 77.7% (71.0-84.4)
14 A patient with osteoporosis on bisphosphonate therapy is on the preferred choice* * 1- Alendronate, 2- risedronate, 3- intermittent cyclical etidronate	169/319 53.0 %	130	0	20	0	0	150/319 47.0%	130/150 86.7% (81.3-92.1)
15 A patient who is on long-term glucocorticoid therapy (≥ 7.5 mg prednisolone or equivalents for ≥ 3 months) is prescribed a bisphosphonate.	318/319 99.7 %	1	0	0	0	0	1/319 0.3%	1/1 100.0%
16 A postmenopausal woman prescribed strontium ranelate has an identifiable reason for not being prescribed a bisphosphonate	316/319 99.1 %	3	0	0	0	0	3/319 0.9%	3/3 100.0%

Table 8: Adherence and applicability per criterion GP A, B and C

Criterion **n= 2926**	N/A (%)	Yes	No(J)	No(U)	IDS	IDQ	**Applicable (%)**	**Adherence (CI 95%)**
17 A postmenopausal woman prescribed raloxifene is receiving it for secondary prevention	319/319 100.0%	0	0	0	0	0	0/319 0.0%	nr
18 A patient prescribed teriparatide is prescribed it for secondary prevention and meets specific criteria	319/319 100.0%	0	0	0	0	0	0/319 0.0%	nr
19 A patient prescribed calcitonin is prescribed it for secondary prevention after bisphosphonate, raloxifene or strontium ranelate have been tried or have reasons for excluding from consideration	319/319 100.0%	0	0	0	0	0	0/319 0.0%	nr
Overall	3581/6061 59.1%	1532	18	860	88	44	2480/6061 40.9%	1532/2480 61.7% (59.8-63.6)

N/A: not applicable; **No(J):** justified non-adherence to the guideline; **No(U):** unjustified non-adherence to the guideline; **IDS:** insufficient data on the standard; **IDQ:** insufficient data on the qualifier; **CI:** confidence interval; **OS:** Osteoporosis

4.4.3 Levels of Adherence

Levels of adherence was ranked as low for 5/19 criteria, intermediate for 5/19 criteria and high for 6/19 criteria. The following table shows level of adherence ranked from lowest to highest percentage.

Table 9: Level of adherence GP A, B and C

Level	Criterion	Adherence (%)
Low	**2** **Patient with measured BMD by DEXA scan** has measures taken at spine and hip	25.5
	9 **Patient with osteoporosis untreated by antiresorptive/ anabolic agent** is prescribed >=1000mg calcium plus 800 IE vitamin D	29.9
	11 **Osteopenic patient** is prescribed an oral BP as first-line therapy	32.2
	4 **Osteopenic patient** is prescribed supplementary calcium	37.3
	1 **Patient with a diagnosis of OS** has a recorded DEXA scan	45.5
Intermediate	**3** **Patient with OS** is prescribed supplementary calcium	53.1
	10 **Patient with OS** is prescribed an oral BP as first-line therapy	58.2
	5 **Patient with confirmed vitamin D deficiency or age ≥ 65years** is prescribed vitamin D	59.2
	6 **Patient with osteoporosis** is treated with antiresorptive/ osteoanabolic agent	60.0
	12 **Patient treated with antiresorptive/ osteoanabolic agent** has no contra-indication on record	65.9
	13 **Patient receiving treatment for osteopenia/osteoporosis** is prescribed a standard dose regimen	77.7
	14 **A patient with osteoporosis on bisphosphonate therapy** is on the preferred choice* * 1- Alendronate, 2-risedronate, 3-intermittent cyclical etidronate	86.7
	7 **Patient prescribed calcium** is prescribed 500-1500 mg	99.4
	8 **Patient prescribed vitamin D** is prescribed 400-800 IU	98.1
	15 A patient who is on long-term glucocorticoid therapy (≥ 7.5 mg prednisolone or equivalents for ≥ 3 months) is prescribed a bisphosphonate.	100.0
	16 A postmenopausal woman prescribed strontium ranelate has an identifiable reason for not being prescribed a bisphosphonate	100.0

4.4.4 Main findings

4.4.4.1 Patients with osteoporosis

152/260 (58.5 %) of patients with osteoporosis received an antiresorptive treatment. 149/260 (57.3%%) patients were treated with a bisphosphonate. Mainly alendronic acid was prescribed. Only 3/85 (3.5%) of the patients received an alternative treatment (strontium ranelate). Standard dose was mainly used.

108/260 (41.5%) patients did not receive an osteoanabolic or an antiresorptive treatment. 32/260 (12.3%) were only prescribed calcium and vitamin D. 29.2% of all osteoporotic patients neither received a treatment nor a supplement.

Calitonin, raloxifene and teriparatide were not prescribed at all.

4.4.4.2 Patients with osteopenia

19/59 (32.2%) of patients with osteopenia received an antiresorptive treatment. 13 of them were prescribed alendronic acid and 6 received risedronate sodium. Both substances were prescribed in the dose licensed for osteoporosis but not for the indication osteopenia.

40/59 (67.8%) patients did not receive an antiresorptive treatment. Only 8/40 (20.0%) of those patients were prescribed calcium and vitamin D. Respectively, 33/59 (55.9%) of all osteoporotic patients neither received a treatment nor a supplement.

4.5 Practice A

Data were downloaded from the GPASS® system of a practice in Glasgow.

4.5.1 Demographics

92% of the patients with a diagnosis of osteoporosis or osteopenia are female. 97% of female patients are postmenopausal. 90% of the assessed population are diagnosed with osteoporosis. Age range is quite broad, but when calculating the mean age it turns out that only a few patients are less than 50 years old. 32% of all patients have a low BMI, which is a risk factor for osteoporosis.

The following table shows the demographic characteristics of test population A.

Table 10: Characteristics of test population GP A

Patient sample	**n =154**
Gender	
Female	141/ 154 (91.6%)
Male	13/ 154 (8.4%)
Diagnosis	
Osteoporosis	138
• Female	126
• Postmenopausal	122
• Male	12
Osteopenia	16
• Female	15
• Postmenopausal	15
• Male	1
Age	

Age range (years)	24-96
Age range osteoporotic patients (years)	24-96
• Female	24-96
• Male	48-84

Table 10: Characteristics of test population GP A

Patient sample	**n =154**
Mean age osteoporotic patients (years)	74
• Female	75
• Male	67
Age range osteopenic patients (years)	48-92
• Female	48-92
• Male	72-72
Mean age osteopenic patients (years)	
• Female	73
• Male	72
BMI range (kg/ m^2)	
Osteoporosis	17.3-39.1
• Female	17.3-39.1
• Male	17.8-32.0
Osteopenia	25.9-31.2
• Female	25.9-31.2
• Male	No record
BMI <22	22/68 (32%)

4.5.2 **Adherence per Criterion**

For 7/19 criteria no result can be presented as no patient was applicable. Overall adherence calculated on a per criterion base is 52.1 ± 3.5%, which is an intermediate level of adherence. The following table shows applicability and percentage of adherence for each criterion and overall for GP B.

Table 11: Adherence and applicability per criterion GP A

Criterion **n= 2926**	**N/A (%)**	**Yes**	**No(J)**	**No(U)**	**IDS**	**IDQ**	**Applicable (%)**	**Adherence (CI 95%)**
1 Patient with a diagnosis of OS has a recorded DEXA scan	22/154 14.3%	77	6	55	0	0	132/154 85.7%	77/132 58.3% (57.2-59.4)
2 Patient with measured BMD by DEXA scan has measures taken at spine and hip	61/154 39.6%	32	0	55	6	0	93/154 60.4%	32/93 34.4% (32.9-35.9)
3 Patient with OS is prescribed supplementary calcium	16/154 10.4%	76	0	62	0	0	138/154 89.6%	76/138 55.1% (54.0-56.2)
4 Osteopenic patient is prescribed supplementary calcium	138/216 89.6%	9	0	7	0	0	16/154 10.4%	9/16 56.3% (50.0-65.6)
5 Patient with confirmed vitamin D deficiency or age ≥ 65years is prescribed vitamin D	30/154 19.5%	73	0	51	0	0	124/154 80.5%	73/124 58.9% (57.7-60.1)
6 Patient with osteoporosis is treated with antiresorptive/ osteoanabolic agent	16/154 10.4%	84	0	54	0	0	138/154 89.6%	84/138 60.8% (59.7-61.9)
7 Patient prescribed calcium is prescribed 500-1500 mg	69/154 44.8%	84	0	1	0	0	85/154 55.2%	84/85 98.8% (98.4-99.1)
8 Patient prescribed vitamin D is prescribed 400-800 IU	76/154 49.4%	77	0	1	0	0	78/154 50.6%	77/78 98.7% (98.3-99.1)

Table 11: Adherence and applicability per criterion GP A

Criterion **n= 2926**	N/A (%)	Yes	No(J)	No(U)	IDS	IDQ	**Applicable (%)**	**Adherence (CI 95%)**
9 Patient with osteoporosis untreated by antiresorptive/ anabolic agent is prescribed >=1000mg calcium plus 800 IE vitamin D	100/154 64.9%	11	0	42	1	0	54/154 35.1%	11/54 20.4% (18.1-22,6)
10 Patient with OS is prescribed an oral BP as first-line therapy	16/154 10.4%	81	0	57	0	0	138/154 89.6%	81/138 58.7% (57.6-59.8)
11 Osteopenic patient is prescribed an oral BP as first-line therapy	138/154 89.6%	9	0	7	0	0	16/154 10.4%	9/16 56.3% (47.0-65.6)
12 Patient treated with antiresorptive/ osteoanabolic agent has no contra-indication on record	60/154 39%	78	0	16	0	0	94/154 61%	78/94 83% (81.8-84.2)
13 Patient receiving treatment for osteopenia/osteoporosis is prescribed a standard dose regimen	60/154 39%	81	0	10	3	0	94/154 61%	81/94 86.2% (85.1-87.3)
14 A patient with osteoporosis on bisphosphonate therapy is on the preferred choice* * 1- Alendronate, 2-risedronate, 3-intermittent cyclical etidronate	72/154 46.8%	72	0	10	0	0	82/154 53.2%	72/82 87.8% (86.6-89.0)
15 A patient who is on long-term glucocorticoid therapy (≥ 7.5 mg prednisolone or equivalents for ≥ 3 months) is prescribed a bisphosphonate.	154/154 100%	0	0	0	0	0	0/154 0%	nr
16 A postmenopausal woman prescribed strontium ranelate has an identifiable reason for not being prescribed a bisphosphonate	152/154 98.7%	2	0	0	0	0	2/154 1.3%	2/2 100%

Table 11: Adherence and applicability per criterion GP A

Criterion **n= 2926**	N/A (%)	Yes	No(J)	No(U)	IDS	IDQ	**Applicable (%)**	**Adherence (CI 95%)**
17 A postmenopausal woman prescribed raloxifene is receiving it for secondary prevention	154/154 100%	0	0	0	0	0	0/154 0%	nr
18 A patient prescribed teriparatide is prescribed it for secondary prevention and meets specific criteria	154/154 100%	0	0	0	0	0	0/154 0%	nr
19 A patient prescribed calcitonin is prescribed it for secondary prevention after bisphosphonate, raloxifene or strontium ranelate have been tried or have reasons for excluding from consideration	154/154 100%	0	0	0	0	0	0/154 0%	nr
Overall	1642	846	6	428	10	0	1284	846/1284 65.8% (62.3-69.3)

N/A: not applicable; **No(J):** justified non-adherence to the guideline; **No(U):** unjustified non-adherence to the guideline; **IDS:** insufficient data on the standard; **IDQ:** insufficient data on the qualifier; **CI:** confidence interval; **OS:** Osteoporosis

4.5.3 Level of Adherence

Level of adherence was ranked as low for 2/19 criteria, intermediate for 7/19 criteria and high for 6/19 criteria. The following table shows level of adherence ranked from lowest to highest percentage.

Table 12: Level of adherence for GP A

Level	Criterion	Adherence (%)
Low	**9** **Patient with osteoporosis untreated by antiresorptive/ anabolic agent** is prescribed >=1000mg calcium plus 800 IE vitamin D	20.4
	2 **Patient with measured BMD by DEXA scan** has measures taken at spine and hip	34.4
Intermediate	**3** **Patient with OS** is prescribed supplementary calcium	55.1
	4 **Osteopenic patient** is prescribed supplementary calcium	56.3
	11 **Osteopenic patient** is prescribed an oral BP as first-line therapy	56.3
	1 **Patient with a diagnosis of OS** has a recorded DEXA scan	58.3
	10 **Patient with OS** is prescribed an oral BP as first-line therapy	58.7
	5 **Patient with confirmed vitamin D deficiency or age ≥ 65years** is prescribed vitamin D	58.9
	6 **Patient with osteoporosis** is treated with antiresorptive/ osteoanabolic agent	60.8
High	**12** **Patient treated with antiresorptive/ osteoanabolic agent** has no contra-indication on record	83.0
	13 **Patient receiving treatment for osteopenia/osteoporosis** is prescribed a standard dose regimen	86.2
	14 **A patient with osteoporosis on bisphosphonate therapy** is on the preferred choice: 1- Alendronate, 2-risedronate, 3-intermittent cyclical etidronate	87.8
	8 **Patient prescribed vitamin D** is prescribed 400-800 IU	98.7
	7 **Patient prescribed calcium** is prescribed 500-1500 mg	98.8
	16 **A postmenopausal woman prescribed strontium ranelate** has an identifiable reason for not being prescribed a bisphosphonate	100.0

4.5.4 **Adherence per patient**

80/154 (52.0%) patients treated showed a high level of adherence. Those patients are marked green in the table below. Some 16 (23.0%) of patients (25/154) showed an intermediate level of adherence. For 49/154 (31.8%) patients less than 49.9% guideline adherence was calculated. Intermediate levels were marked yellow and low levels are red.

Table 13: Adherence per patient GP A

Pat	YES	NO(U)	NO(J)	IDS	APPLICABILITY %	ADHERENCE %	CI min	CI max
1	3	4	0	0	36.84	42.9	41.3	44.5
2	10	1	0	0	57.89	90.9	90.2	91.7
3	5	2	1	0	36.84	71.4	70.0	72.9
4	9	1	0	0	52.63	90.0	89.2	90.8
5	9	0	1	0	47.37	100.0	100.0	100.0
6	2	5	0	0	36.84	28.6	27.1	30.0
7	9	1	0	0	52.63	90.0	89.2	90.8
8	6	3	0	0	47.37	66.7	65.3	68.0
9	7	2	0	0	47.37	77.8	76.6	79.0
10	10	1	0	0	57.89	90.9	90.2	91.7
11	8	2	0	0	52.63	80.0	78.9	81.1
12	5	4	0	0	47.37	55.6	54.1	57.0
13	0	6	0	0	31.58	0.0	0.0	0.0
14	1	6	0	0	36.84	14.3	13.2	15.4
15	7	3	0	0	52.63	70.0	68.8	71.2
16	8	3	0	0	57.89	72.7	71.6	73.9
17	3	6	0	0	47.37	33.3	32.0	34.7
18	7	2	0	0	47.37	77.8	76.6	79.0
19	8	1	0	0	47.37	88.9	88.0	89.8
20	0	6	0	0	31.58	0.0	0.0	0.0
21	0	6	0	0	31.58	0.0	0.0	0.0
22	9	1	0	0	52.63	90.0	89.2	90.8
23	9	1	0	0	52.63	90.0	89.2	90.8
24	4	4	0	0	42.11	50.0	48.5	51.5
25	5	4	0	0	47.37	55.6	54.1	57.0
26	11	0	0	0	57.89	100.0	100.0	100.0
27	6	3	0	0	47.37	66.7	65.3	68.0

Table 13: Adherence per patient GP A

Pat	YES	NO(U)	NO(J)	IDS	APPLICABILITY	ADHERENCE	CI min	CI max
28	3	4	0	0	36.84	42.9	41.3	44.5
29	9	1	0	0	52.63	90.0	89.2	90.8
30	3	4	0	0	36.84	42.9	41.3	44.5
31	5	3	0	0	42.11	62.5	61.0	64.0
32	10	1	0	0	57.89	90.9	90.2	91.7
33	9	1	0	0	52.63	90.0	89.2	90.8
34	0	6	0	0	31.58	0.0	0.00	0.0
35	0	6	0	0	31.58	0.0	0.00	0.0
36	0	5	0	0	26.32	0.0	0.00	0.0
37	6	3	0	0	47.37	66.7	65.3	68.0
38	8	1	0	0	47.37	88.9	88.0	89.8
39	10	1	0	0	57.89	90.9	90.2	91.7
40	5	4	0	0	47.37	55.6	54.1	57.0
41	6	3	0	0	47.37	66.7	65.3	68.0
42	7	2	0	0	47.37	77.8	76.59	79.0
43	0	6	0	0	31.58	0.0	0.0	0.0
44	9	1	0	0	52.63	90.0	89.2	90.8
45	0	6	0	0	31.58	0.0	0.0	0.0
46	10	1	0	0	57.89	90.9	90.2	91.7
47	8	1	0	1	52.63	80.0	78.9	81.1
48	1	6	0	0	36.84	14.3	13.2	15.4
49	0	6	0	0	31.58	0.0	0.0	0.0
50	5	2	0	0	36.84	71.4	70.0	72.9
51	0	6	0	0	31.58	0.0	0.0	0.0
52	1	5	0	0	31.58	16.7	15.4	18.0
53	2	4	0	0	31.58	33.3	31.7	35.0
54	0	5	1	0	26.32	0.0	0.0	0.0
55	5	3	0	0	42.11	62.5	61.0	64.0
56	9	1	0	0	52.63	90.0	89.2	90.8
57	0	6	0	0	31.58	0.0	0.0	0.0
58	6	3	0	0	47.47	66.7	65.3	68.0
59	9	1	0	0	52.63	90.0	89.2	90.8
60	5	3	0	0	42.11	62.5	61.0	64.0
61	5	3	0	0	42.11	62.5	61.0	64.0
62	5	4	0	0	47.37	55.6	54.1	57.0
63	1	6	0	0	36.84	14.3	13.2	15.4

Table 13: Adherence per patient GP A

Pat	YES	NO(U)	NO(J)	IDS	APPLICABILITY	ADHERENCE	CI min	CI max
64	7	2	0	0	47.37	77.8	76.6	79.0
65	8	2	0	0	52.63	80.0	78.9	81.1
66	0	6	0	0	31.58	0.0	0.00	0.0
67	7	2	0	0	47.37	77.8	76.6	79.0
68	7	2	0	0	47.37	77.8	76.6	79.0
69	0	5	1	0	26.32	0.0	0.0	0.0
70	10	1	0	0	57.89	90.9	90.2	91.7
71	9	1	0	0	52.63	90.0	89.2	90.8
72	6	3	0	0	47.37	66.7	65.3	68.0
73	10	1	0	0	57.89	90.9	90.2	91.7
74	0	6	0	0	31.58	0.0	0.00	0.0
75	10	1	0	0	57.89	90.9	90.2	91.7
76	10	1	0	0	57.89	90.9	90.2	91.7
77	10	1	0	0	57.89	90.9	90.2	91.7
78	9	0	1	0	47.37	100.0	100.0	100.0
79	8	2	0	0	52.63	80.0	78.9	81.1
80	4	3	0	1	42.11	50.0	48.5	51.5
81	0	5	0	0	26.32	0.0	0.0	0.0
82	10	1	0	0	57.89	90.9	90.2	91.7
83	6	2	0	0	42.11	75.0	73.7	76.3
84	10	1	0	0	57.89	90.9	90.2	91.7
85	8	2	0	0	52.63	80.0	78.9	81.1
86	10	1	0	0	57.89	90.9	90.2	91.7
87	5	3	0	0	42.11	62.5	61.0	64.0
88	1	5	0	0	31.58	16.7	15.4	18.0
89	11	0	0	0	57.89	100.0	100.0	100.0
90	0	6	0	0	31.58	0.0	0.0	0.0
91	11	0	0	0	57.89	100.0	100.0	100.0
92	10	1	0	0	57.89	90.9	90.2	91.7
93	6	3	0	0	47.37	66.7	65.3	68.0
94	9	1	0	0	52.63	90.0	89.2	90.8
95	5	3	0	0	42.11	62.5	61.0	64.0
96	10	1	0	0	57.89	90.9	90.2	91.7
97	10	1	0	0	57.89	90.9	90.2	91.7
98	0	6	0	0	31.58	0.0	0.0	0.0
99	1	6	0	0	36.84	14.3	13.2	15.4

Table 13: Adherence per patient GP A

Pat	YES	NO(U)	NO(J)	IDS	APPLICABILITY	ADHERENCE	CI min	CI max
100	10	0	0	1	57.89	90.9	90.17	91.7
101	9	2	0	0	57.89	81.8	80.82	82.8
102	6	3	0	0	47.37	66.7	65.3	68.0
103	0	6	0	0	31.58	0.0	0.00	0.0
104	10	1	0	0	57.89	90.9	90.2	91.7
105	9	2	0	0	57.89	81.8	80.8	82.8
106	11	0	0	0	57.98	100.0	100.0	100.0
107	0	6	0	0	31.58	0.0	0.0	0.0
108	10	0	0	1	57.89	90.9	90.2	91.7
109	10	1	0	0	57.89	90.9	90.2	91.7
110	0	6	0	0	31.58	0.0	0.00	0.0
111	9	2	0	0	57.89	81.8	80.8	82.8
112	10	0	0	0	52.63	100.0	100.0	100.0
113	4	4	0	0	42.11	50.0	48.5	51.5
114	4	4	0	0	42.11	50.0	48.5	51.5
115	2	0	0	0	42.11	75.0	73.7	76.3
116	5	3	0	0	42.11	62.5	61.0	63.4
117	0	5	0	0	23.32	0.0	0.0	0.0
118	10	1	0	0	57.89	90.9	90.2	91.7
119	6	2	0	0	42.11	75.0	73.7	76.3
120	0	5	0	0	26.32	0.0	0.0	0.0
121	8	1	1	1	47.37	88.9	88.0	89.8
122	5	4	0	0	47.37	55.6	54.1	57.0
123	0	6	0	0	31.58	0.0	0.0	0.0
124	1	5	0	0	31.58	16.7	15.4	18.0
125	9	1	0	0	52.63	90.0	89.2	90.8
126	10	1	0	0	57.89	90.9	90.2	91.7
127	7	2	0	0	47.37	77.8	76.6	79.0
128	4	4	0	0	42.11	50.0	48.5	51.5
129	10	1	0	0	57.89	90.9	90.2	91.7
130	6	2	0	0	42.11	75.0	73.7	76.3
131	0	5	0	0	26.32	0.0	0.0	0.0
132	11	0	0	0	57.98	100.0	100.0	100.0
133	7	2	0	0	47.37	77.8	76.6	79.0
134	5	3	0	0	42.11	62.5	61.0	64.0
135	9	2	0	0	57.89	81.8	80.8	82.8

Table 13: Adherence per patient GP A

Pat	YES	NO(U)	NO(J)	IDS	APPLICABILITY	ADHERENCE	CI min	CI max
136	0	6	0	0	31.58	0.0	0.0	0.0
137	0	5	0	0	26.32	0.0	0.0	0.0
138	5	4	0	0	47.37	55.6	54.1	57.0
139	7	0	0	0	36.84	100.0	100.0	100.0
140	0	2	0	1	15.79	0.0	0.0	0.0
141	7	0	0	1	42.11	87.5	86.5	88.5
142	5	1	0	0	31.58	83.3	82.0	84.6
143	7	0	0	1	42.11	87.5	86.5	88.5
144	2	4	0	0	31.58	33.3	31.7	35.0
145	2	4	0	0	31.58	33.3	31.7	35.0
146	4	1	0	1	31.58	66.7	65.0	68.3
147	6	2	0	0	42.11	75.0	73.7	76.3
148	0	3	0	1	21.05	0.0	0.0	0.0
149	0	3	0	1	21.05	0.0	0.0	0.0
150	7	1	0	0	42.11	87.5	86.5	88.5
151	3	2	0	0	26.32	60.0	58.1	61.9
152	3	3	0	0	31,58	50.0	48.3	51.7
153	1	0	0	0	36.84	85.	84.6	86.8
154	0	3	0	0	15.79	0.0	0.0	0.0
Total	**846**	**428**	**6**	**10**	**43.9 %**	**89.7 %**	**88.8**	**90.6**

4.5.5 Main findings

4.5.5.1 Patients with osteoporosis

85/138 (61.6 %) of patients with osteoporosis received an antiresorptive treatment. 1 of those patients received ibandronic acid, which is not covered by the guidelines but a legal treatment option. Osteoanabolic substances were not prescribed at all. 82/85 (96.5%) patients who received a treatment were treated with a bisphosphonate. Mainly alendronic acid was prescribed. Only 3/85 (3.5%) of the patients received an alternative treatment (strontium ranelate). Standard dose was mainly used.

53/138 (38.4%) patients did not receive an osteoanabolic or an antiresorptive treatment. Only 20.8% of those patients were prescribed calcium and vitamin d. Respectively, 30.4% of all osteoporotic patients neither received a treatment nor a supplement.

Calitonin, raloxifene and teriparatide were not prescribed at all.

4.5.5.2 Patients with osteopenia

9/16 (56.25%) of patients with osteopenia received an antiresorptive treatment. 7 of were prescribed alendronic acid and 2 received risedronate sodium. Both substances were prescribed in the dose licensed for osteoporosis but not for the indication osteopenia.

7/16 (43.8%) patients did not receive an antiresorptive treatment. Only 42.9% of those patients were prescribed calcium and vitamin D. Respectively, 25% of all osteoporotic patients neither received a treatment nor a supplement.

4.6 Practice B

4.6.1 Demographics

89% of the patients with a diagnosis of osteoporosis or osteopenia are female. 98% of female patients are postmenopausal. 100% of the assessed population are diagnosed with osteoporosis. Age range is quite broad, but when calculating the mean age it turns out that only a few patients are less than 50 years old.

The following table shows the demographic characteristics of test population B.

Table 14: Characteristics of test population GP B

Patient sample	**n =62**
Gender	
Female	55/62 (88.7%)
Male	7/62 (11.3%)
Diagnosis	
Osteoporosis	62
• Female	55
• Postmenopausal	54
• Male	7
Age	
Age range osteoporotic patients (years)	29-92
• Female	29-92
• Male	36-88
Mean age osteoporotic patients (years)	72.4 (13.2)
• Female	73.5 (12.0)
• Male	63 (19.3)
BMI range (kg/ m^2)	
Osteoporosis	14.8-39.6
• Female	24-34.6
• Male	14.7-23.7
BMI <22	3/15 (20%)

4.6.2 Adherence per Criterion

For 4/19 criteria no result can be presented as no patient was applicable. Overall adherence calculated on a per criterion base is 65.8 ± 3.5%, which is an intermediate level of adherence. The following table shows applicability and percentage of adherence for each criterion and overall for GP A.

Table 15: Adherence and applicability per criterion GP B

Criterion n= 1178	N/A (%)	Yes	No(J)	No(U)	IDS	IDQ	**Applicable (%)**	**Adherence (CI 95%)**
1 Patient with a diagnosis of OS has a recorded DEXA scan	0/62 0.0%	1	0	54	7	0	62/62 100.0%	1/62 1.6% (0-4.7)
2 Patient with measured BMD by DEXA scan has measures taken at spine and hip	51/62 82.3%	0	0	1	10	39	11/62 17.7%	0/11 0.0%
3 Patient with OS is prescribed supplementary calcium	0/62 0.0%	24	0	38	0	0	62/62 100.0%	24/62 38.7% (26.5-50.9)
4 Osteopenic patient is prescribed supplementary calcium	62/62 100.0%	0	0	0	0	0	0/62 0.0%	nr
5 Patient with confirmed vitamin D deficiency or age ≥ 65years is prescribed vitamin D	15/62 24.2%	28	0	19	0	0	47/62 75.8%	28/47 59.6% (45.5-73.7)
6 Patient with osteoporosis is treated with antiresorptive/ osteoanabolic agent	0/62 0.0%	31	0	31	0	0	62/62 100.0%	31/62 50.0% (37.6-62.4)

Table 15: Adherence and applicability per criterion GP B

Criterion n= 1178	N/A (%)	Yes	No(J)	No(U)	IDS	IDQ	**Applicable** **(%)**	**Adherence** **(CI 95%)**
7 Patient prescribed calcium is prescribed 500-1500 mg	28/62 45.2%	34	0	0	0	0	34/62 54.8%	34/34 100.0%
8 Patient prescribed vitamin D is prescribed 400-800 IU	28/62 45.2%	32	0	2	0	0	34/62 54.8%	32/34 94.1% (86.2-100.0)
9 Patient with osteoporosis untreated by antiresorptive/ anabolic agent is prescribed >=1000mg calcium plus 800 IE vitamin D	31/62 50.0%	12	0	19	0	0	31/62 50.0%	12/31 38.7% (21.6-55.8)
10 Patient with OS is prescribed an oral BP as first-line therapy	0/62 0.0%	31	0	31	0	0	62/62 100.0%	31/62 50.0% (37.6-62.4)
11 Osteopenic patient is prescribed an oral BP as first-line therapy	62/62 100.0%	0	0	0	0	0	0/62 0.0%	nr
12 Patient treated with antiresorptive/ osteoanabolic agent has no contra-indication on record	31/62 50.0%	13	0	5	13	0	31/62 50.0%	13/31 41.9% (24.5-59.3)
13 Patient receiving treatment for osteopenia/osteoporosis is prescribed a standard dose regimen	11/62 17.7%	38	0	5	8	0	51/62 82.3%	38/51 74.5% (62.5-86.5)
14 A patient with osteoporosis on bisphosphonate therapy is on the preferred choice* * 1- Alendronate, 2-risedronate, 3-intermittent cyclical etidronate	31/62 50.0%	26	0	5	0	0	31/62 50.0%	26/31 83.9% (71-96.8)
15 A patient who is on long-term glucocorticoid therapy (≥ 7.5 mg prednisolone or equivalents for ≥ 3 months) is prescribed a bisphosphonate.	62/62 100.0%	0	0	0	0	0	0/62 0.0%	nr

Table 15: Adherence and applicability per criterion GP B

Criterion n= 1178	N/A (%)	Yes	No(J)	No(U)	IDS	IDQ	**Applicable** **(%)**	**Adherence** **(CI 95%)**
16 A postmenopausal woman prescribed strontium ranelate has an identifiable reason for not being prescribed a bisphosphonate	62/62 100.0%	0	0	0	0	0	0/62 0.0%	nr
17 A postmenopausal woman prescribed raloxifene is receiving it for secondary prevention	62/62 100.0%	0	0	0	0	0	0/62 0.0%	nr
18 A patient prescribed teriparatide is prescribed it for secondary prevention and meets specific criteria	62/62 100.0%	0	0	0	0	0	0/62 0.0%	nr
19 A patient prescribed calcitonin is prescribed it for secondary prevention after bisphosphonate, raloxifene or strontium ranelate have been tried or have reasons for excluding from consideration	62/62 100.0%	0	0	0	0	0	0/62 0.0%	nr
Overall	660/1178 56.1%	270	0	210	38	39	518/1178 43.9%	270/518 52.1% (47.8-56.4)

4.6.3 Level of Adherence

Level of adherence was ranked as low for 5/19 criteria, intermediate for 3/19 criteria and high for 4/19 criteria. The following table shows level of adherence ranked from lowest to highest percentage.

Table 16: Level of adherence GP B

Level	Criterion	Adherence (%)
Low	**2** **Patient with measured BMD by DEXA scan** has measures taken at spine and hip	0.0
	1 **Patient with a diagnosis of OS** has a recorded DEXA scan	1.6
	3 **Patient with OS** is prescribed supplementary calcium	38.7
	9 **Patient with osteoporosis untreated by antiresorptive/ anabolic agent** is prescribed >=1000mg calcium plus 800 IE vitamin D	41.9
Intermediate	**12** **Patient treated with antiresorptive/ osteoanabolic agent** has no contra-indication on record	50.0
	6 **Patient with osteoporosis** is treated with antiresorptive/ osteoanabolic agent	50.0
	5 **Patient with confirmed vitamin D deficiency or age ≥ 65years** is prescribed vitamin D	59.6

Table 16: Level of adherence GP B

High	**10** **Patient with OS** is prescribed an oral BP as first-line therapy	100.0
	13 **Patient receiving treatment for osteopenia/osteoporosis** is prescribed a standard dose regimen	74.5
	14 **A patient with osteoporosis on bisphosphonate therapy** is on the preferred choice: 1- Alendronate, 2-risedronate, 3-intermittent cyclical etidronate	83.9
	8 **Patient prescribed vitamin D** is prescribed 400-800 IU	100.0
	7 **Patient prescribed calcium** is prescribed 500-1500 mg	94.1

4.6.4 Adherence per patient

21/62 (33.87%) patients treated showed a high level of adherence. Those patients are marked green in the table below. 29.03% of patients (18/62) showed an intermediate level of adherence. For 23/62 (37.10%) patients less than 49.9% guideline adherence was calculated. Intermediate levels were marked yellow and low levels are red.

Table 17: Adherence per patient GP B

Pat	YES	NO(U)	NO(J)	IDS	IDQ	APPLICABILITY	ADHERENCE	CI min	CI max
1	4	2	0	1	0	36.84	57.1	55.5	58.7
2	8	1	0	1	0	52.63	80.0	78.9	81.1
3	0	6	0	0	0	31.58	0.0	0.0	0.0
4	0	6	0	0	0	31.58	0.0	0.0	0.0
5	7	1	0	2	1	52.63	70.0	68.8	71.2
6	0	6	0	0	0	31.58	0.0	0.0	0.0
7	7	2	0	1	0	52.63	70.0	68.8	71.2
8	7	2	0	1	0	52.63	70.0	68.8	71.2

Table 17: Adherence per patient GP B

Pat	YES	NO(U)	NO(J)	IDS	IDQ	APPLICABILITY	ADHERENCE	CI min	CI max
9	5	3	0	0	0	42.11	62.5	61.0	64.0
10	8	0	0	2	1	52.63	80.0	78.9	81.1
11	3	4	0	1	0	42.11	37.5	36.0	39.0
12	0	6	0	0	0	31.58	0.0	0.0	0.0
13	7	2	0	1	0	52.63	70.0	68.8	71.2
14	8	1	0	1	0	52.63	80.0	78.9	81.1
15	4	3	0	1	0	42.11	50.0	48.5	51.5
16	3	3	0	1	0	36.84	42.9	41.3	44.5
17	5	3	0	1	0	55.56	55.6	54.1	57.0
18	0	4	0	1	1	26.32	0.0	0.0	0.0
19	3	4	0	1	0	42.11	37.5	36.0	39.0
20	8	2	0	0	0	52.63	80.0	78.9	81.1
21	0	6	0	0	0	31.58	0.0	0.0	0.0
22	5	3	0	0	0	42.11	62.5	61.0	64.0
23	5	3	0	0	0	42.11	62.5	61.0	64.0
24	0	5	0	0	0	26.32	0.0	0.0	0.0
25	9	0	0	1	1	52.63	90.0	89.2	90.8
26	2	5	0	1	0	42.11	25.0	24.0	26.3
27	0	6	0	0	0	31.58	0.0	0.0	0.0
28	8	2	0	0	0	52.63	80.0	78.9	81.1
29	8	2	0	0	0	52.63	80.0	78.9	81.1
30	8	0	0	2	1	52.63	80.0	78.9	81.1
31	4	3	0	0	0	36.84	57.1	55.5	58.7
32	9	1	0	0	0	52.63	90.0	89.2	90.8
33	5	3	0	0	0	42.11	62.5	61.0	64.0
34	5	3	0	0	0	42.11	62.5	61.0	64.0
35	5	3	0	0	0	42.11	62.5	61.0	64.0
36	0	6	0	0	0	31.58	0.0	0.0	0.0
37	0	6	0	0	0	31.58	0.0	0.0	0.0
38	4	2	0	1	1	36.84	57.1	55.5	58.7
39	4	2	0	1	0	36.84	57.1	55.5	58.7
40	7	1	0	2	0	52.63	70.0	68.8	71.2
41	0	6	0	0	0	31.58	0.0	0.0	0.0
42	4	3	0	0	0	36.84	57.1	55.5	58.7
43	7	1	0	2	0	52.63	70.0	68.8	71.2
44	0	6	0	0	0	31.58	0.0	0.0	0.0

Table 17: Adherence per patient GP B

Pat	YES	NO(U)	NO(J)	IDS	IDQ	APPLICABILITY	ADHERENCE	CI min	CI max
45	0	6	0	0	0	31.6	0.0	0.0	0.0
46	9	1	0	0	0	52.6	90.0	89.2	90.8
47	5	3	0	0	0	42.1	62.5	61.0	64.0
48	7	3	0	0	0	52.6	70.0	68.8	71.2
49	0	5	0	0	0	26.3	0.0	0.0	0.0
50	0	5	0	0	0	26.3	0.0	0.0	0.0
51	8	2	0	0	0	52.6	80.0	78.9	81.1
52	1	5	0	0	0	31.6	16.7	15.4	18.0
53	8	2	0	0	0	52.6	80.0	78.9	81.1
54	4	3	0	0	0	36.8	57.1	55.5	58.7
55	1	4	0	0	0	26.3	20.0	18.5	21.5
56	7	1	0	1	0	47.4	77.8	76.6	79.0
57	8	1	0	0	0	47.4	89.0	88.0	89.8
58	5	3	0	0	0	42.1	62.5	61.0	64.0
59	4	4	0	0	0	42.1	50.0	48.5	51.5
60	4	4	0	0	0	42.1	50.0	48.5	51.5
61	0	5	0	0	0	26.3	0.0	0.0	0.0
62	3	4	0	1	1	42.1	37.5	36.0	39.0
Total	**260**	**200**	**0**	**28**	**7**	**41.7%**	**53.3%**	**51.8**	**55.0**

4.6.5 Main findings

31/62 (50.0 %) of patients with osteoporosis received an antiresorptive treatment. All patients received an oral bisphosphonate. 87.1% were on alendronic acid. Although a legal treatment option, ibandronic acid, zoledronic acid, strontium ranelate, raloxifene, teriparatde and calcitonin were not used at all.

31/62(50%) patients did not receive an osteoanabolic or an antiresorptive treatment. Only 38.7% of those patients were prescribed calcium and vitamin D. Respectively 19/ 61 (31.1%) patients were neither received an osteoanabolic or antiresorptive treatment nor supplementary calcium and vitamin D.

4.7 Practice C

Data were downloaded from the GPASS® system in a practice of a general practitioner in Springburn

4.7.1 Demographics

89.3% of the patients with a diagnosis of osteoporosis or osteopenia are female. 98.9% of female patients are postmenopausal. 58.3% of the assessed population are diagnosed with osteoporosis. Age range is quite broad, but when calculating the mean age it turns out that only a few patients are less than 50 years old.

The following table shows the demographic characteristics of test population C.

Table 18: Characteristics of test population GP C

Patient sample	**n =103**
Gender	
Female	92/103 (89.3%)
Male	11/103 (10.7%)
Diagnosis	
Osteoporosis	60/103 (58.3%)
• Female	51/60 (85.0%)
• Postmenopausal	51/60 (85.0%)
• Male	9/60 (15.0%)
Osteopenia	43/103 (41.7%)
• Female	41/43 (95.3%)
• Postmenopausal	40/43 (93.0%)
• Male	2/43 (4.7%)

Table 18: Characteristics of test population GP C

Patient sample	**n =103**
Age	
Age range (years)	39-92
Age range osteoporotic patients (years)	43-93
• Female	43-93
• Male	67-91
Mean age osteoporotic patients (years)	75.9 (10.6)
• Female	75.0 (10.9)
• Male	80.8 (7.6)
Age range osteopenic patients (years)	39-92
• Female	43-92
• Male	39-68
Mean age osteopenic patients (years)	64.5 (12.5)
• Female	65.0 (12.10)
• Male	53.5 (20.5)
BMI range (kg/ m^2)	14-41
Osteoporosis	14-41
• Female	14-41
• Male	17-33

Table 18: Characteristics of test population GP C

BMI range (kg/ m^2)	
Osteopenia	16-40
• Female	16-40
• Male	26-32

4.7.2 Adherence per Criterion

For 3/19 criteria no result can be presented as no patient was applicable. Overall adherence calculated on a per criterion base is 61.4 ± 3.7%, which is an intermediate level of adherence. The following table shows applicability and percentage of adherence for each criterion and overall for GP C.

Table 19: Adherence and applicability GP C

Criterion n= 1178	N/A (%)	Yes	No(J)	No(U)	IDS	IDQ	**Applicable (%)**	**Adherence (CI 95%)**
1 Patient with a diagnosis of OS has a recorded DEXA scan	44/103 42.7%	37	1	17	5	0	59/103 57.3%	37/59 62.7% (50.4-75.0)
2 Patient with measured BMD by DEXA scan has measures taken at spine and hip	66/103 64.1%	4	0	33	0	5	37/103 35.9%	4/37 10.8% (0.8-20.8)
3 Patient with OS is prescribed supplementary calcium	43/103 41.7%	38	0	22	0	0	60/103 58.3%	38/60 63.3% (51.1-75.5)
4 Osteopenic patient is prescribed supplementary calcium	60/103 58.3%	13	0	30	0	0	43/103 41.7%	13/43 30.2% (16.5-43.9)
5 Patient with confirmed vitamin D deficiency or age ≥ 65years is prescribed vitamin D	34/103 33%	41	0	28	0	0	69/103 67%	41/69 59.4% (47.8-70.8)

Table 19: Adherence and applicability GP C

Criterion n= 1178	N/A (%)	Yes	No(J)	No(U)	IDS	IDQ	**Applicable (%)**	**Adherence (CI 95%)**
6 Patient with osteoporosis is treated with antiresorptive/ osteoanabolic agent	48/103 46.6%	38	5	12	5	0	55/103 53.4%	38/55 69.1% (56.9-81.3)
7 Patient prescribed calcium is prescribed 500-1500 mg	52/103 50.5%	51	0	0	0	0	51/103 49.5%	51/51 100.0%
8 Patient prescribed vitamin D is prescribed 400-800 IU	53/103 51.5%	50	0	0	0	0	50/103 48.5%	50/50 100.0%
9 Patient with osteoporosis untreated by antiresorptive/ anabolic agent is prescribed >=1000mg calcium plus 800 IE vitamin D	81/103 78.6%	9	0	13	0	0	22/103 21.4%	9/22 40.9% (20.4-61.4)
10 Patient with OS is prescribed an oral BP as first-line therapy	49/103 47.6%	37	6	12	5	0	54/103 52.4%	37/54 68.5% (56.1-80.9)
11 Osteopenic patient is prescribed an oral BP as first-line therapy	60/103 58.3%	10	0	33	0	0	43/103 41.7%	10/43 23.3% (10.7-35.9)
12 Patient treated with antiresorptive/ osteoanabolic agent has no contra-indication on record	55/103 53.4%	23	0	2	23	0	48/103 46.6%	23/48 47.9% (33.8-62.0)
13 Patient receiving treatment for osteopenia/osteoporosis is prescribed a standard dose regimen	55/103 53.4%	31	0	15	2	0	48/103 46.7%	31/48 64.6% (51.1-78.1)
14 A patient with osteoporosis on bisphosphonate therapy is on the preferred choice* * 1- Alendronate, 2- risedronate, 3- intermittent cyclical etidronate	66/103 64.1%	32	0	5	0	0	37/103 35.9%	23/37 86.5% (75.5-97.5)

Table 19: Adherence and applicability GP C

Criterion n= 1178	N/A (%)	Yes	No(J)	No(U)	IDS	IDQ	**Applicable (%)**	**Adherence (CI 95%)**
15 A patient who is on long-term glucocorticoid therapy (≥ 7.5 mg prednisolone or equivalents for ≥ 3 months) is prescribed a bisphosphonate.	102/103 99.0%	1	0	0	0	0	1/103 1.0%	1/1 100.0%
16 A postmenopausal woman prescribed strontium ranelate has an identifiable reason for not being prescribed a bisphosphonate	102/103 99.0%	1	0	0	0	0	1/103 1.0%	1/1 100.0%
17 A postmenopausal woman prescribed raloxifene is receiving it for secondary prevention	103/103 100.0%	0	0	0	0	0	0/103 0.0%	nr
18 A patient prescribed teriparatide is prescribed it for secondary prevention and meets specific criteria	103/103 100.0%	0	0	0	0	0	0/103 0.0%	nr
19 A patient prescribed calcitonin is prescribed it for secondary prevention after bisphosphonate, raloxifene or strontium ranelate have been tried or have reasons for excluding from consideration	103/103 100.0%	0	0	0	0	0	0/103 0.0%	nr
Overall	**1279/ 1957 65.4%**	**416**	**12**	**222**	**40**	**5**	**678/1957 34.6%**	**416/678 61.4% (57.7-65.1)**

4.7.3 Level of Adherence

Level of adherence was ranked as low for 5/19 criteria, intermediate for 6/19 criteria and high for 5/19 criteria. The following table shows level of adherence ranked from lowest to highest percentage.

Tablel 20: Level of adherence GP C

Level	Criterion	Adherence (%)
Low	**2** **Patient with measured BMD by DEXA scan** has measures taken at spine and hip	10.8
	11 **Osteopenic patient** is prescribed an oral BP as first-line therapy	23.3
	4 **Osteopenic patient** is prescribed supplementary calcium	30.2
	9 **Patient with osteoporosis untreated by antiresorptive/ anabolic agent** is prescribed >=1000mg calcium plus 800 IE vitamin D	40.9
	12 **Patient treated with antiresorptive/ osteoanabolic agent** has no contra-indication on record	47.9
Intermediate	**5** **Patient with confirmed vitamin D deficiency or age ≥ 65years** is prescribed vitamin D	59.4
	1 **Patient with a diagnosis of OS** has a recorded DEXA scan	62.7
	3 **Patient with OS** is prescribed supplementary calcium	63.3
	13 **Patient receiving treatment for osteopenia/osteoporosis** is prescribed a standard dose regimen	64.6
	10 **Patient with OS** is prescribed an oral BP as first-line therapy	68.5
	6 **Patient with osteoporosis** is treated with antiresorptive/ osteoanabolic agent	69.1

Tablel 20: Level of Adherence GP C

High	**7** **Patient prescribed calcium** is prescribed 500-1500 mg	100.0
	8 **Patient prescribed vitamin D** is prescribed 400-800 IU	100.0
	15 **A patient who is on long-term glucocorticoid therapy (≥ 7.5 mg prednisolone or equivalents for ≥ 3 months)** is prescribed a bisphosphonate.	100.0
	16 **A postmenopausal woman prescribed strontium ranelate** has an identifiable reason for not being prescribed a bisphosphonate	100.0
	14 **A patient with osteoporosis on bisphosphonate therapy** is on the preferred choice* * 1- Alendronate, 2-risedronate, 3-intermittent cyclical etidronate	86.5

4.7.4 Adherence per patient

42/103 (40.78%) patients treated showed a high level of adherence. Those patients are marked green in the table below. 17.48% of patients (18/103) showed an intermediate level of adherence. For 43/103 (41.75%) patients less than 49.9% guideline adherence was calculated. Intermediate levels were marked yellow and low levels are red.

Table 21: Adherence per patient GP C

Pat	YES	NO(U)	NO(J)	IDS	IDQ	APPLICABILITY	ADHERENCE	CI min	CI max
1	5	3	0	0	0	42.11	62.5	61.0	64.0
2	5	3	0	0	0	42.11	62.5	61.0	64.0
3	3	4	0	1	0	42.11	37.5	36.0	39.0
4	9	1	0	1	0	57.89	81.8	80.8	81.8
5	8	1	0	1	0	52.63	80.0	78.9	81.1
6	7	1	1	1	0	47.37	77.9	76.6	78.6
7	9	0	0	1	0	52.63	90.0	89.2	90.8
8	5	4	1	0	0	47.37	55.6	54.1	56.9
9	7	0	0	2	0	47.37	77.9	75.6	78.6
10	6	3	0	0	0	47.37	66.7	65.3	68.0
11	0	4	2	0	0	21.05	0.0	0.0	0.0
12	1	5	0	0	0	31.58	16.7	15.4	18.0
13	10	1	0	0	0	57.89	90.9	90.2	91.7

Table 21: Adherence per patient GP C

Pat	YES	NO(U)	NO(J)	IDS	IDQ	APPLICABILITY	ADHERENCE	CI min	CI max
14	1	6	0	0	0	36.84	14.3	13.2	15.4
15	8	1	0	1	0	52.63	80.0	78.9	81.1
16	4	2	0	2	0	42.11	50.0	48.5	50.5
17	9	1	0	0	0	52.63	90.0	89.2	90.8
18	1	5	0	0	0	31.58	16.7	15.4	17.9
19	6	3	0	0	0	47.37	66.7	65.3	68.0
20	9	2	0	0	0	57.89	81.8	80.8	82.8
21	1	4	2	0	0	26.32	20.0	18.5	21.5
22	10	0	0	1	0	47.89	90.9	90.2	91.7
23	4	3	0	1	0	42.11	50.0	48.5	51.5
24	4	2	0	2	0	42.11	50.0	48.5	51.5
25	10	0	0	1	0	57.89	90.9	90.2	91.7
26	2	4	2	0	0	31.58	33.3	31.7	35.0
27	8	2	0	1	0	57.39	72.7	71.6	74.0
28	5	1	2	0	0	31.58	83.3	82.0	84.6
29	5	2	0	1	1	42.11	62.5	61.0	64.0
30	6	2	0	2	1	52.63	60.0	58.7	61.3
31	9	1	0	1	0	57.89	81.8	80.8	82.8
32	6	1	2	0	0	36.84	85.7	84.6	86.8
33	0	4	0	2	0	31.58	0.0	0.0	0.0
34	0	5	0	0	0	26.32	0.0	0.0	0.0
35	5	3	0	1	0	47.37	55.6	54.1	57.0
36	0	3	0	2	0	26.32	0.0	0.0	0.0
37	9	1	0	1	0	57.89	81.8	80.8	82.8
38	5	3	0	1	0	55.56	55.6	54.1	57.0
39	10	1	0	0	0	57.89	90.9	90.2	91.6
40	8	1	0	1	0	52.63	80.0	78.9	81.1
41	8	2	0	0	0	52.63	80.0	78.9	81.1
42	7	2	0	1	0	52.63	70.0	68.8	71.2
43	6	2	0	1	0	47.37	66.7	65.3	68.0
44	9	2	0	0	0	57.89	81.8	80.8	82.8
45	8	3	0	0	0	57.89	72.7	71.6	73.9
46	8	0	0	1	1	47.37	88.9	88.0	89.8
47	4	3	0	1	0	42.11	50.0	48.5	51.5
48	9	1	0	1	0	57.89	81.8	80.8	82.8
49	10	1	0	0	0	57.89	90.9	90.2	91.6

Table 21: Adherence per patient GP C

Pat	YES	NO(U)	NO(J)	IDS	IDQ	APPLICABILITY	ADHERENCE	CI min	CI max
50	10	1	0	0	0	57.9	90.9	90.2	91.6
51	10	1	0	0	0	57.9	90.9	90.2	91.6
52	1	6	0	0	0	36.8	14.3	13.2	15.4
53	1	6	0	0	0	36.8	14.3	13.2	15.4
54	9	1	0	0	0	52.6	90.0	89.2	90.8
55	5	3	0	0	0	42.1	62.5	61.0	64.0
56	1	5	0	0	0	31.6	16.7	15.4	18.0
57	5	0	0	2	0	36.8	71.4	69.7	72.9
58	9	0	0	1	0	52.6	90.0	89.2	90.8
59	8	1	0	0	0	47.4	88.9	88.0	89.8
60	9	1	0	0	0	52.6	90.0	89.2	90.8
61	0	3	0	0	0	15.8	0.0	0.0	0.0
62	0	2	0	0	0	10.5	0.0	0.0	0.0
63	0	2	0	0	0	10.5	0.0	0.0	0.0
64	5	1	0	0	0	31.6	83.3	82.0	84.6
65	0	3	0	0	0	15.8	0.0	0.0	0.0
66	5	1	0	0	0	31.6	83.3	82.0	84.6
67	0	3	0	0	0	15.8	0.0	0.0	0.0
68	5	1	0	1	0	36.8	71.4	70.0	72.9
69	5	1	0	1	0	36.8	71.4	70.0	72.9
70	0	2	0	0	0	10.5	0.0	0.0	0.0
71	4	1	0	0	0	26.3	80.0	78.5	81.5
72	0	3	0	0	0	15.8	0.0	0.0	0.0
73	5	1	0	0	0	31.6	83.3	82.0	84.6
74	0	2	0	0	0	10.5	0.0	0.0	0.0
75	0	2	0	0	0	15.8	0.0	0.0	0.0
76	0	2	0	0	0	10.5	0.0	0.0	0.0
77	3	1	0	0	0	21.1	75.0	73.2	76.9
78	4	1	0	0	0	26.3	80.0	78.5	81.5
79	0	2	0	0	0	10.5	0.0	0.0	0.0
80	2	3	0	0	0	26.3	40.0	38.1	41.9
81	5	1	0	1	0	36.8	71.4	70.0	72.9
82	6	1	0	0	0	36.8	85.7	84.6	86.8
83	0	2	0	0	0	10.5	0.0	0.0	0.0
84	0	2	0	0	0	10.5	0.0	0.0	0.0
85	0	2	0	0	0	10.5	0.0	0.0	0.0
86	0	2	0	0	0	10.5	0.0	0.0	0.0

Table 21: Adherence per patient GP C

Pat	YES	NO(U)	NO(J)	IDS	IDQ	APPLICABILITY	ADHERENCE	CI min	CI max
87	0	3	0	0	0	15.8	0.0	0.0	0.0
88	5	1	0	0	0	31.6	83.3	82.0	84.6
89	0	3	0	0	0	15.79	0.0	0.0	0.0
90	0	2	0	0	0	10.53	0.0	0.0	0.0
91	0	2	0	0	0	10.53	0.0	0.0	0.0
92	0	3	0	0	0	1579	0.0	0.0	0.0
93	0	2	0	0	0	10.53	0.0	0.0	0.0
94	1	1	0	0	0	10.53	50.0	47.0	53.0
95	2	3	0	0	0	26.32	40.0	38.2	41.9
96	0	2	0	0	0	10.53	0.0	0.0	0.0
97	0	2	0	0	0	10.53	0.0	0.0	0.0
98	3	1	0	1	0	26.32	60.0	58.1	61.9
99	1	2	0	0	0	15.79	33.3	31.0	35.7
100	**0**	2	0	0	0	10.53	0.0	0.0	0.0
101	**1**	1	0	0	0	10.53	50.0	47.0	53.0
102	**2**	3	0	0	0	1579	0.0	0.0	0.0
103	**0**	2	0	0	0	10.53	0.0	0.0	0.0
Total	**416**	**218**	**12**	**40**	**5**	**35.73**	**61.7**	**60.1**	**63.3**

4.7.5 Main findings

4.7.5.1 Patients with osteoporosis

38/60 (63.3%) of patients with osteoporosis received an antiresorptive treatment. 37/38 (97.4%) patients received an oral bisphosphonate. 29/37 (78.4%) were on alendronic acid. Although a legal treatment option, ibandronic acid, zoledronic acid, raloxifene, teriparatde and calcitonin were not used at all. Only one patient was treated with an alternative to bisphosphonates (strontium ranelate).

22/60(36.7%) patients did not receive an osteoanabolic or an antiresorptive

treatment. Only 40.9% of those patients were prescribed calcium and vitamin D. Respectively 13/22 (59.1%) patients were neither received an osteoanabolic or antiresorptive treatment nor supplementary calcium and vitamin D.

4.7.5.2 Patients with osteopenia

10/43 (23.3%) of patients with osteopenia received an antiresorptive treatment. 6 of were prescribed alendronic acid and 4 received risedronate sodium. Both substances were prescribed in the dose licensed for osteoporosis but not for the indication osteopenia.

33/43 (76.7%) patients did not receive an antiresorptive treatment. Only 4/33 (12.1%) of those patients were prescribed calcium and vitamin D. Respectively, 67.4% of all osteoporotic patients neither received a treatment nor a supplement.

4.8 Comparison between practices

4.8.1 Applicability to each criterion per practice

The chart below shows that applicability to criteria varies strongly between the three GP practices. Criteria 17,18 and 19 were not applicable to any patients . Criterion 15 was applicable to only one patient. Criteria 4 and 11 deal with osteopenia- therefore were applicable to no patients in Practice B.

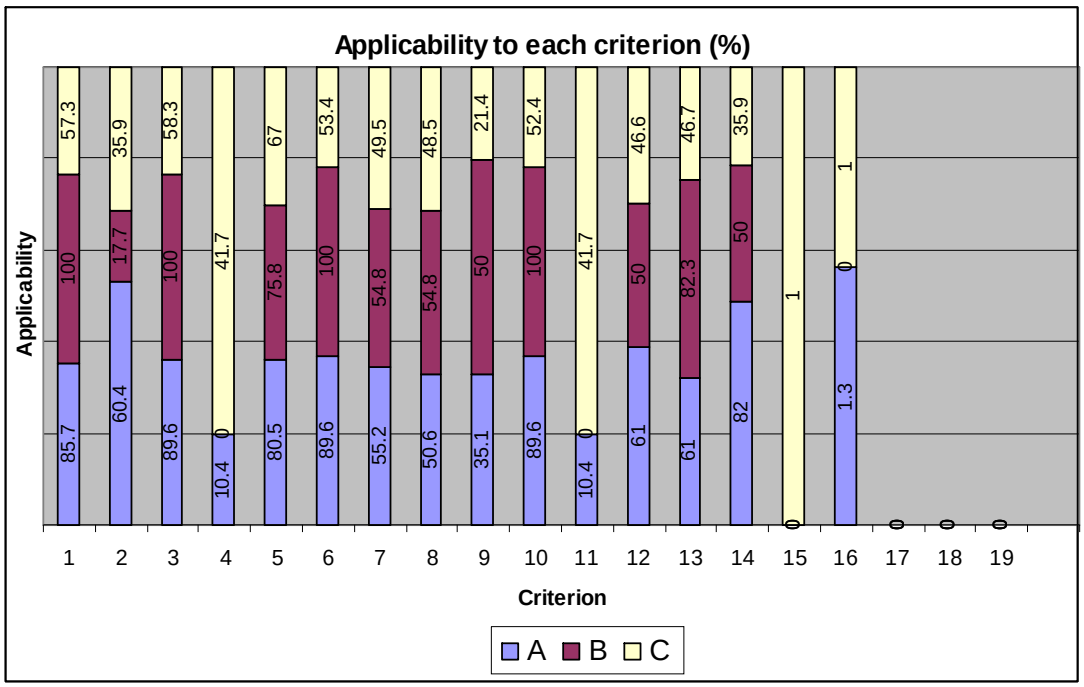

Figure 1: Applicability to each criterion

4.8.2 Clinical guideline adherence to each criterion per practice

The chart above shows the adherence to each criterion for each GP Practice. Major differences of the level of adherence between practice A, B and C are recorded for criteria 1, 2, 3, 4, 6, 9, 10, 11 and 12. The highest agreement was assessed for the use of standard dose regimen of supplements. For criterion 15 comparison between practices was not possible as only in one GP Practice were applicable patients found.

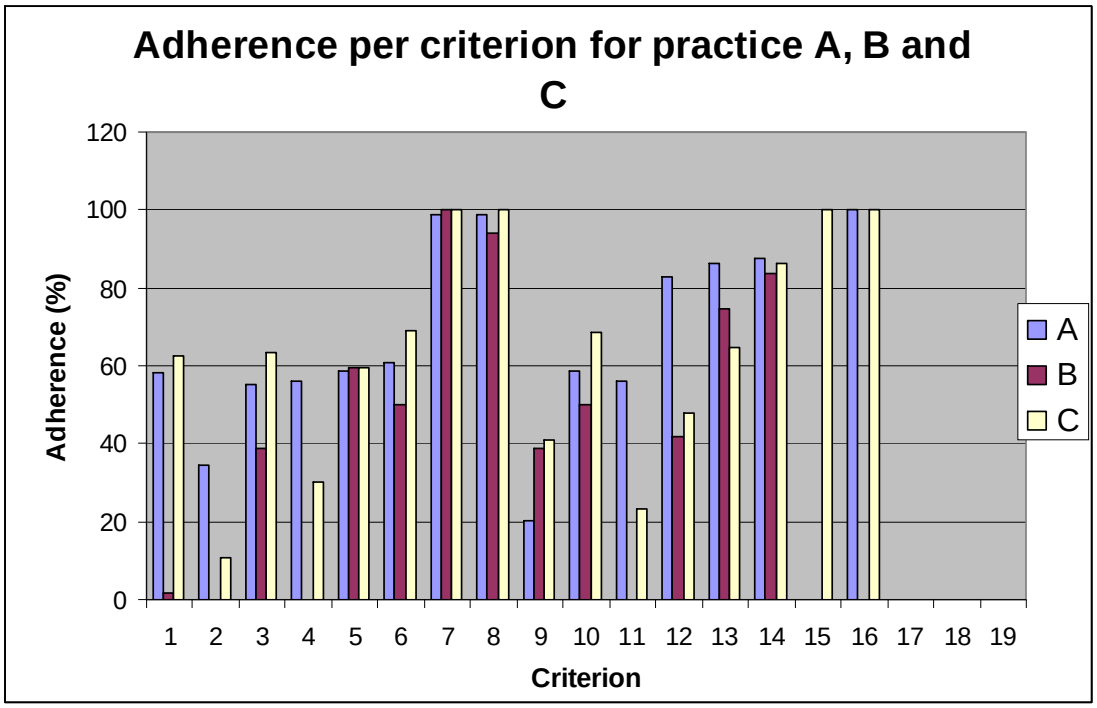

Figure 2: Adherence per criterion for practice A, B and C

Applying Fisher's exact test showed that prescribing and diagnostic behaviour differed between the three GP Practices. This of course also means that MATosteo is able to detect such differences. The following table shows the results of Fisher's exact test overall and per criterion. The higher the p-Value the less significant is the link in "behaviour" between the compared GPs. Non significant results are marked red.

Table 22:: Comparison between A, B and C; Fisher's exact test

Overall adherence	**GP A** (%) (95% CI)	**GP B** (%) (95% CI	**GP C** (%) (95% CI	p (A, B)	p (A, C)	p (B, C)
Applicability	1284/2926 **43.8%**	518/1178 **44.0%**	678/1957 **34.6%**			
Adherence	846/1284 **65.8%** (62.3-69.3)	270/518 **52.1%** (47.8-56.4)	416/678 **61.4%** (57.7-65.1)	< 0.0001	0.0298	< 0.0001
1						
Applicability	132/154 **85.7%**	62/62 **100%**	59/103 **57.3%**			
Adherence	77/132 **58.3%** (49.9-66.7)	1/62 **1.6%** (-1.5.-4.7)	37/59 **62.7%** (50.4-75.0)	<0.0001	0.6333	<0.0001
2						
Applicability	93/154 **60.4%**	11/62 **17.7%**	37/103 **35.9%**			
Adherence	32/93 **34.4%** (24.7-44.1)	0/11 **0.0%**	4/37 **10.8%** (0.8-20.8)	<0.0001	0.0028	0.0401
Adherence	76/138 **55.1%** (46.8-63.4)	24/62 **38.7%** (26.5-50.9)	41/69 **59.4%** (47.8-70.8)			

Table 22: Comparison between A, B and C; Fisher's exact test

3						
Applicability	138/154 **89.6%**	62/62 **100.0%**	60/103 **58.3%**	0.0464	0.3480	0.0072
Adherence	76/138 **55.1%** (46.8-63.4)	24/62 **38.7%** (26.5-50.9)	41/69 **59.4%** (47.8-70.8)			
4						
Applicability	16/154 **10.4%**	0/62 **0.0%**	43/103 **41.7%**	nr	0.0785	nr
Adherence	9/16 **56.3%** (32-80.6)	nr	13/43 **30.2%** (16.5-43.9)			
5						
Applicability	124/154 **80.5%**	47/62 **75.8%**	69/103 **67.0%**	0.99	0.99	0.99
Adherence	73/124 **58.9%** (50.2-67.6)	28/47 **59.6%** (45.5-73.7)	41/69 **59.4%** (47.8-70.8)			
6						
Applicability	138/154 **89.6%**	62/62 **100.0%**	55/103 **53.4%**	0.1660	0.3236	0.0404
Adherence	84/138 **60.8%** (52.7-68.9)	31/62 **50.0%** (37.6-62.4)	38/55 **69.1%** (56.9-81.3)			
7						
Applicability	85/154 **55.2%**	34/62 **54.8%**	51/103 **49.5%**	0.99	0.99	0.99
Adherence	84/85 **98.8%** (96.5-101.1)	34/34 **100.0%**	51/51 **100.0%**			
8						
Applicability	78/154 50.6%	34/62 54.8%	50/103 48.5%	0.2182	0.99	0.1609
Adherence	77/78 98.7% (96.2-101.2)	32/34 94.1% (86.2-100.2)	50/50 100.0%			
9						
Applicability	54/154 **35.1%**	31/62 **50%**	22/103 **21.4%**	0.0800	0.0866	1.0000
Adherence	11/54 **20.4%** (9.7-31.1)	12/31 38.7% (21.6-55.8)	9/22 **40.9%** (20.4-61.4)			
10						
Applicability	138/154 **89.6%**	62/62 **100%**	54/103 **52.4%**	0.2826	0.2494	0.0587
Adherence	11/54 **20.4%** (9.7-31.1)	12/31 **38.7%** (21.6-55.8)	9/22 **40.9%** (20.4-61.4)			
11						
Applicability	16/154 **10.4%**	0/62 **0.0%**	43/103 **41.7%**	nr	0.0270	nr
Adherence	9/16 **56.3%** (32-80.6)	nr	10/43 **23.3%** (10.7-35.9)			
12						
Applicability	94/154 **61%**	31/62 **50%**	48/103 **46.6%**	< 0.0001	< 0.0001	0.6491
Adherence	78/94 **83.0%** (75.4-90.6)	13/31 **41.9%** (24.5-59.3)	23/48 **47.9%** (33.8-62.0)			
13						
Applicability	94/154 **61%**	51/62 **82.3%**	48/103 **46.7%**	0.1116	0.0044	0.3818
Adherence	81/94 **86.2%** (79.2-93.2)	38/51 **74.5%** (62.5-86.5)	31/48 **64.6%** (51.1-78.1)			

Table 22: Comparison between A, B and C; Fisher's exact test

14						
Applicability	82/154 **53.2%**	31/62 **50%**	37/103 **35.9%**			
Adherence	72/82 **87.8%** (80.8-94.8)	26/31 **83.9%** (71-96.8)	32/37 **86.5%** (75.5-97.5)	0.5508	0.99	0.99
16						
Applicability	2/154 **1.3%**	0/62 **0.0%**	1/103 **1.0%**			
Adherence	2/2 **100.0%**	nr	1/1 **100.0%**	nr	0.99	nr

4.9 Validation of MATosteo and adaptation to local needs

4.9.1 Summary Interview I

Interviewee: head of an osteoporosis unit

General statements

Value of MATosteo

The interviewee thought that MATosteo could be valuable but probably more for pharmacy because from the doctor's point of view the decision-making was completely different. In Glasgow there are other criteria for referring to DEXA scans and for risk assessment mostly FRAX is used. However there is a controversy going on whether FRAX leads to an over- or under-estimation of fracture risk or not.

Possible benefits/ obstacles

The interviewer thought that it might be difficult to perform such an audit. He thought that the standard used is already a bit behind, which might lower the adherence although people are treated correctly if newest evidence considered. In addition he thought that the guidelines do not really cover the needs of people with certain co-morbidities (like CKD), which might make things complicated.

Auditor

The audit should definitely be performed by somebody with a medical background- probably a specialist nurse.

Inclusion of relevant issues

All in all the tool covers the relevant issues of osteoporosis care. Maybe a criterion about HRT in men could be added.

Handling of results

The interviewer was not a hundred percent sure how to handle the results of such an audit.

Comments on criteria

Criteria 1/ 2 (DEXA scans):

Referring to DEXA is handled totally different in Glasgow. There is a service called DADS that suggests the use of other criteria may be necessary. What NICE suggests is not incorrect but probably there is need for adaptation if this tool is going to be used in Glasgow.

Criteria 3 and 4 (Calcium and vitamin D supplementation):

Before prescribing calcium it is important to know about the baseline calcium. One reason for the finding of low adherence to this criterion could be that usually doctors do not document in the system if they discover hyperglycaemia and therefore do not prescribe calcium. In most cases patients are simply non-compliant to the supplementation of calcium and vitamin D. Nevertheless it should be part of the standard treatment. The criteria were thought to be straight forward.

Criteria 6/7 (dosing of calcium and vitamin D):

The interviewee agreed with the criteria and mentioned that there is no need of dose adaptation in case of very low or very high BMI.

Criterion 9 (contraindications to agents):

It is possible that some patients have contraindications to all agents. Mostly they suffer from GI problems (malabsorption or ulcers).

Criteron 10/11 (bisphosphonates as first-line therapy):

The interviewee agreed with the content but suggested to reword as follows: "... prescribed an oral bisphosphonate most likely alendronic acid". He did not think it would be feasible to add i.v. BPs.

Criterion 13 (standard dose regimen for pharmacological treatment):

There is no reason for prescribing alendronic acid or risedronate sodium as a daily dose. Ibandronic acid is not used at all in Glasgow. Preoctat should be added. Zoledronic acid i.v. and teriparatide are for secondary care only. Dose adaptation is not common practice in Glasgow. There is only one exception-impaired renal function. Unfortunately - there is no rule how to do that.

Criterion 15 (use of BPs in patients on long-term glucocorticoids):

The interviewee asked to reword to "... **≥ 5 mg** prednisolone ...".

To the other criteria of MATosteo no suggestions for changing or important comments were made in this interview.

4.9.2 Summary Interview II

Interviewee: specialist nurse

General statements

Value of MATosteo

The interviewee thought that the tool was valuable but probably more community based.

Possible benefits/ obstacles

The interviewee would be concerned about maybe upsetting the prescribers, but could not think of any other obstacles.

Auditor

In the interviewees opinion this audit could be done by anybody.

Inclusion of relevant issues

All in all the tool covers the relevant issues of osteoporosis care. Maybe a criterion measuring compliance should be added.

Handling of results

The interviewer was not sure how to handle the results of such an audit.

Comments on criteria

Criteria 1/ 2 (DEXA scans):

The interviewee stated that she agreed with both criteria and mentioned some differences to the handling in Glasgow. In Glasgow people are referred either by GPs or by a physician working in a hospital. The service is called 'direct access to DEXA scan' (DADS). Patients are not targeted on the basis of risk factors- a DEXA scan is preferred. The nurse thought that it was possible to diagnose somebody over 60 with two or more vertebral fractures without a DEXA scan but would not do this with a postmenopausal woman over 75.

Criteria 3 and 4 (Calcium and vitamin D supplementation):

It is not necessary to prescribe calcium, if the dietary intake is very good. There is as well no need for prescribing vitamin D, if the levels measured are high enough. This is not common though.

The interviewee did not fully agree with criterion 4. She stated that the need for calcium and vitamin D supplementation depends on whether the dietary intake is sufficient or not and on the measured T-score.

Criteria 6/7 (dosing of calcium and vitamin D):

The interviewee agreed with the criteria and mentioned that there is only a need for dose adaptation in case of renal impairment. This is done by renal

physicians and nurses do not routinely get involved with that.

Criterion 12 (reasons to avoid bisphosphonates):
The interviewee was not sure if the wording 'another fracture occurs' should be kept. In clinical practice the substance would not necessarily be changed if the patient sustained a fracture when recently started on a bisphosphonate.

Criterion 14 (preferred choice of oral bisphosphonates):
The interviewee thought that the wording was probably not totally correct. If somebody could not tolerate alendronic acid or risedronate sodium, then strontium would be the next oral option. If somebody suffers from problems with the GI, one might want to go straight to i.v. BPs- preferably zoledronic acid.

Criterion 15 (use of BPs in patients on long-term glucocorticoids):
In Glasgow there is another way of dealing with such patients. If they are less than 55 years old a DEXA scan is arranged and whether BPs are administer or not depends on the result. If the patients are older than 55 it works the other way round.

To the other criteria of MATosteo no suggestions for changing or important comments were made in this interview.

4.9.3 Summary Interview III

Interviewee: specialist nurse

General statements

Possible benefits/ obstacles
The interviewee thought that the tool could be beneficial for patients. She considered it to be feasible for the use in a professional environment. She underlined the importance of using an actual standard when applying such an audit and stated that the performance might be too time consuming for using it

routinely.

Auditor

The audit should not be done by doctors or pharmacists as they are far to expensive. Students or technicians would be a good choice.

Inclusion of relevant issues

All in all the tool covers the relevant issues of osteoporosis care. Maybe a criterion measuring compliance should be added.

Handling of results

As time is limited it was suggested to discuss only the worst cases with the prescribers.

Suggestions

If MATosteo is used as a clinical audit tool it is necessary to adapt it to local guidelines.

Comments on criteria

Criterion 1 (DEXA scans)

Agrees. Also about the fact **that** we included age in the criterion. Issue is not too common. Wording is ok. DEXAs are age-dependent.

Criterion 2 (DEXA scans)

Does not fully agree. There are also other sites for performing a DEXA scan. Also thinks that we should include things like:

Always use the same machine for performing the scan

Always go to the same hospital

Perform a scan regularly (according to local guidelines- they use the guidelines of Greater Glasgow and Clyde. In general she thinks that most health boards have their own guideline. They are more or less about the same. SIGN guidelines are a bit old hat.)

Criterion 3 (calcium and vitamin D supplementation)

Thinks it is important to think about the fact that it might be necessary for some patients to measure calcium and vitamin D levels first. Thinks like vitamin D deficiency or sufficient intake of calcium and vitamin D would not be documented in the system of her hospital.

Criterion 11 (treatment of osteopenia)

Does not agree. An osteopenic patient does not necessarily need a treatment. Dependent on age, fractures, etc.

Criterion 13 (correct dosing):

Concerning osteopenia: see 11

Osteoporosis: Disodium etidronate is not used at all. To complicated. Bad for compliance. Ibandronic acid is sometimes prescribed by general practitioners, but rarely considered by her ward.

Calcitonin rarely and more additional.

Teriparatide is very rare but effecitive.

Dose is ok in general

14 (prefered choice of BPs)

Does not agree with the preferred choice.

Thinks it would rather be Alendronic acid, risedronate sodium, i.v. bisphosphonates. Exclude etidronate

15 (patients on long-term glucocorticoids)

There are guidelines they use. It is age dependent. Would like to change 7.5mg to 5mg prednisolone. Thinks we should think about this criterion again.

Inhaled steroids: grey zone. No evidence. Hard to say.

To the other criteria of MATosteo no suggestions for changing or important comments were made in this interview.

4.9.4 Summary Interview IV

Interviewee: specialist nurse

General statements

Possible benefits/ obstacles

The interviewee thought that the tool could be beneficial it the standard used is not old hat and adapted to local needs. She thought it might be most useful for specialised clinics.

Auditor

The audit should someone with a medical background.

Inclusion of relevant issues

All in all the tool covers the relevant issues of osteoporosis care.

Handling of results

As time is limited it is not possible to discuss every case with the prescriber.

Suggestions

If MATosteo is used as a clinical audit tool it is necessary to adapt it to local guidelines.

Criterion 1/2 (DEXA scans)

DEXA scans are age dependent.

Criterion 3/4 (calcium and vitamin D supplementation)

Does not fully agree with that. Also not with 4. Thinks in certain cases measurement of calcium levels is necessary, e.g. if the patient shows signs of hypercalcemia.

Criterion 10 (oral BPs as first-line therapy):

Does not fully agree- i.v. BPs should be added.

Criterion 11 (treatment of osteopenia)

An osteopenic patient should be treated like an osteoporotic patient.

Criterion 13 (correct dosing):

Agrees although there are substances included that are not really used in Glasgow- e.g. raloxifene.

15 (patients on long-term glucocorticoids)

Change prednisolone dose to 5 mg.

To the other criteria of MATosteo no suggestions for changing or important comments were made in this interview.

4.9.5 Main findings

General statements

All interviewees thought that MATosteo was valuable or beneficial for the patients.

3/4 stated that the tool covers the most important issues of osteoporosis care. 2/4 suggested to add a criterion measuring compliance. 1/4 asked for a criterion covering HRT.

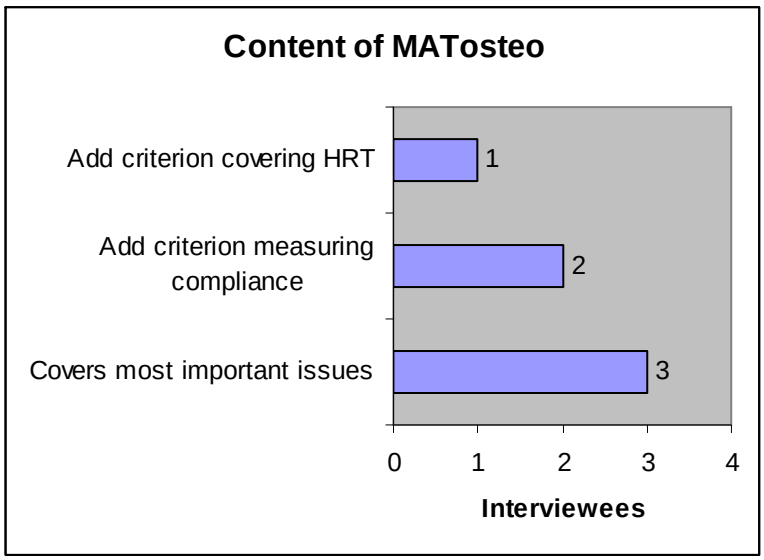

Figure 3 Content of MATosteo

2/4 stated that the standard used is old hat- although it is consistent with the most actual guidelines.

3/4 thought it was necessary to adapt the tool to local guidelines if used as a clinical audit tool.

Other possible problems mentioned were:

- Upsetting the prescriber
- Too time-consuming for implementation in daily routine
- Guidelines do not cover needs of people with co-morbidities

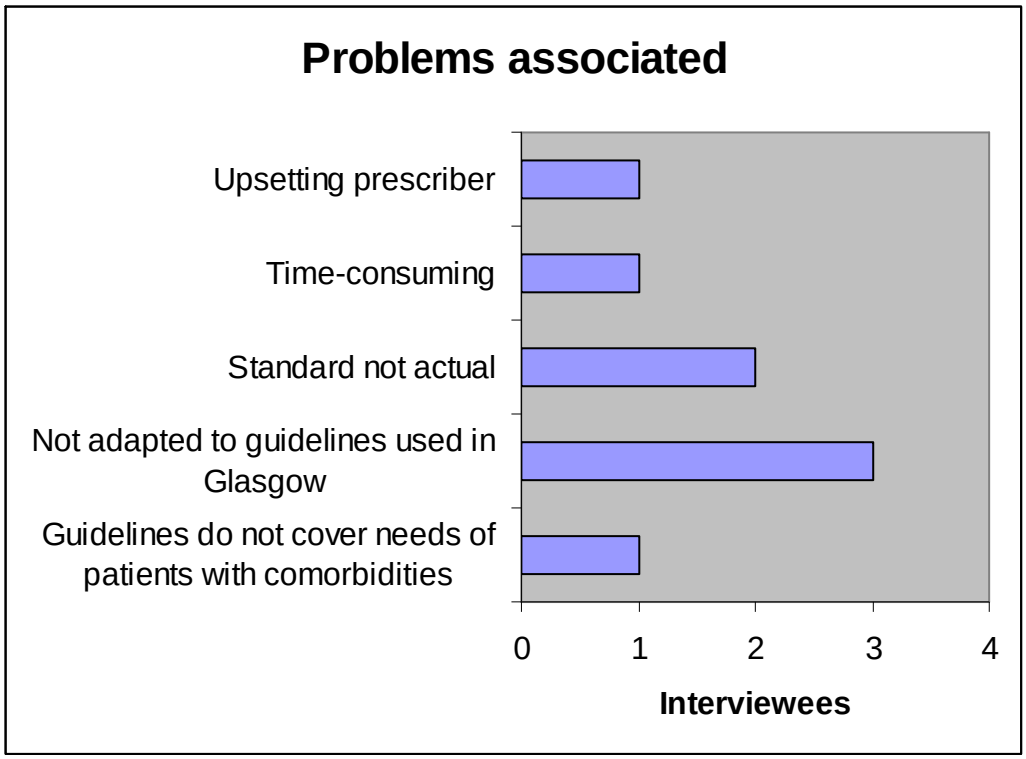

Figure 4: Problems that might occur when performing the audit

3/4 thought the auditor should have a medical education. 1 stated anybody could perform MATosteo.

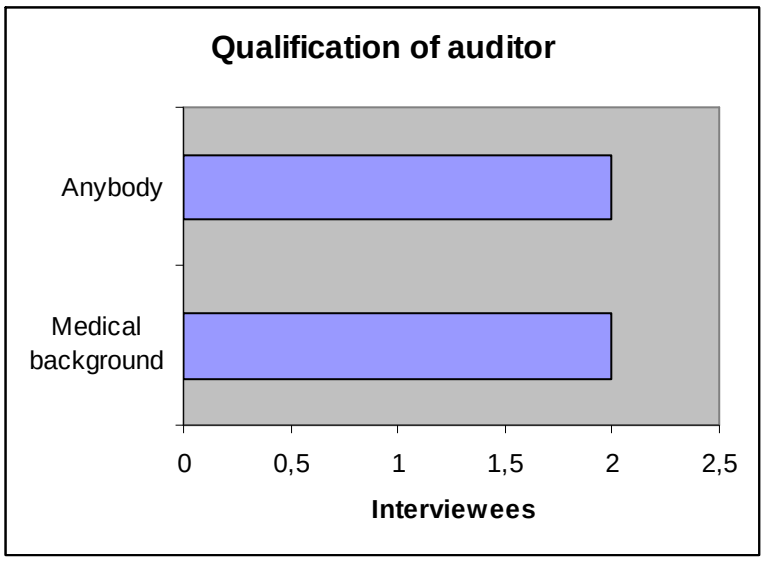

Figure 5: Qualification of the auditor

2/4 interviewees were not sure how to handle the results of such an audit. 2/4 suggested to discuss only the worst cases with the prescribers.

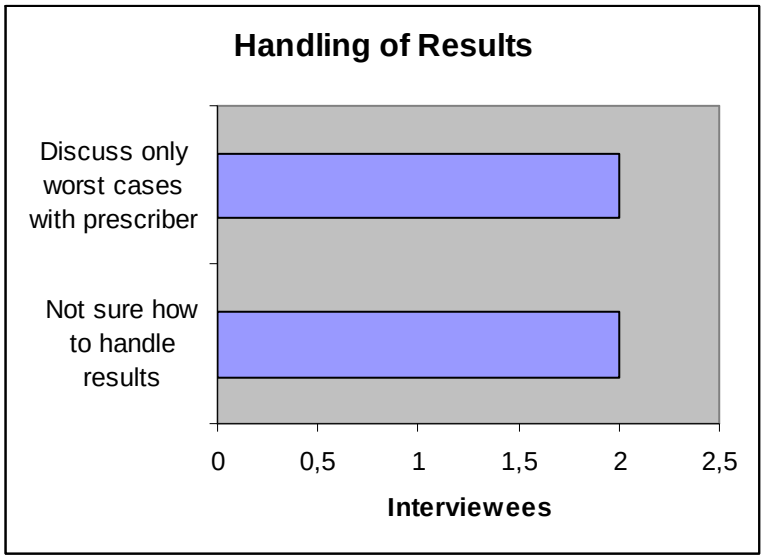

Figure 6: Handling of results

4.10 Guidance for the prescriber- summary of the guidelines

The following figures can be used by prescribers 'quick guide' for supporting their prescribing decision. They do not replace basic knowledge about substances and safe use of drug, but summarise the guidelines used for the development of MATosteo.

4.10.1 Osteopenia

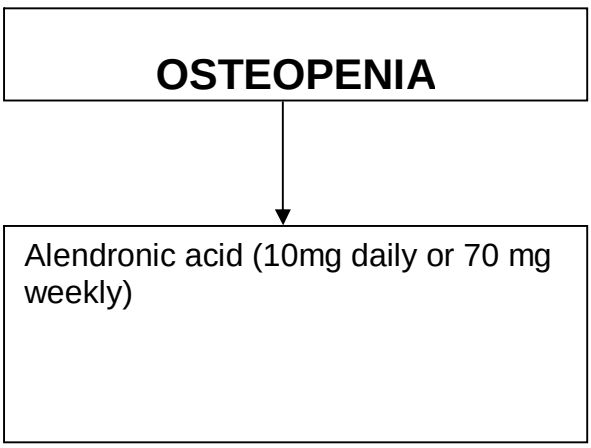

Figure: 7 Treatment of osteopenia

The treatment of osteopenia is only covered by the Summary of the 2002 Canadian Guidelines for the Diagnosis and Management of Osteoporosis (2005 Update).

4.10.2 Osteoporosis primary prevention

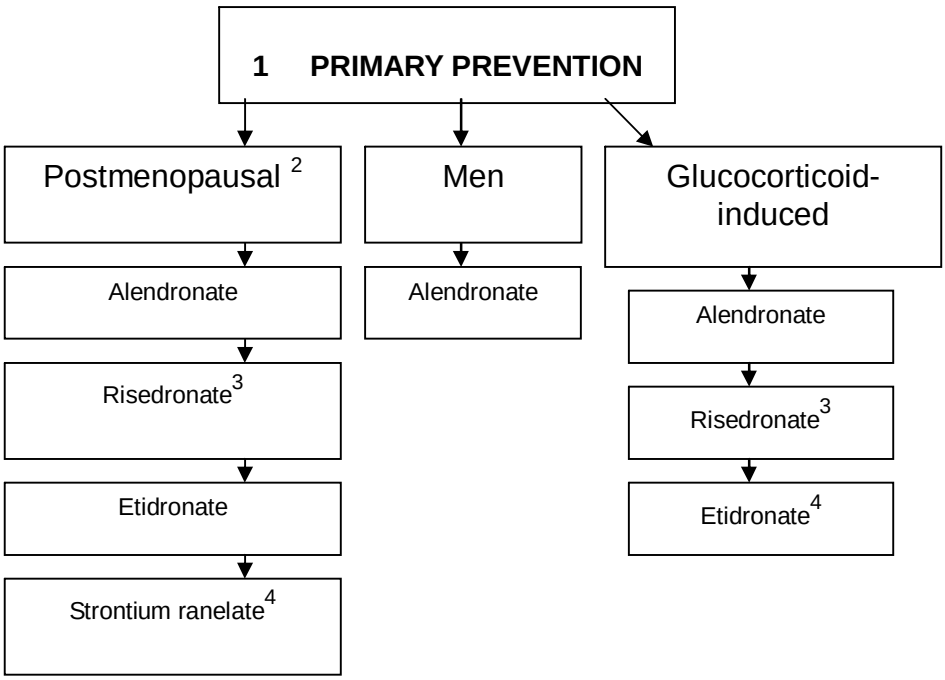

Figure 8: Treatment of osteoporosis primary prevention

4.10.3 Osteoporosis secondary prevention

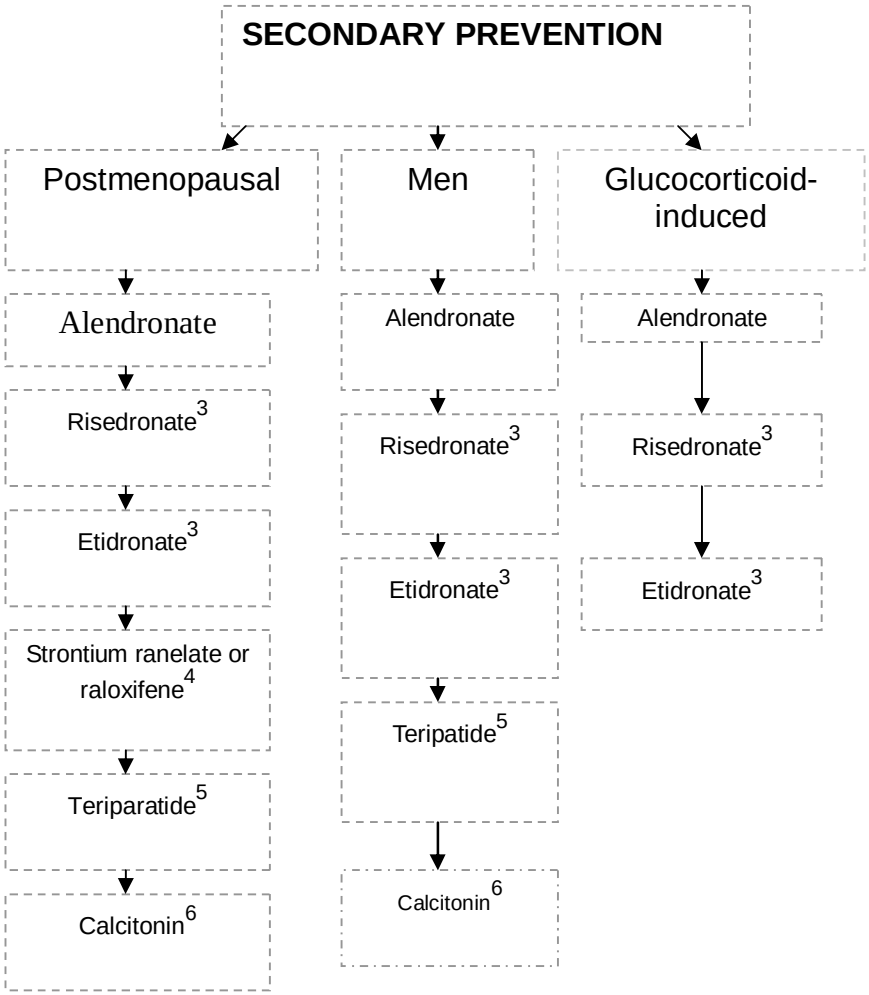

Figure 9: Treatment of osteoporosis secondary prevention

5 DISCUSSION

5.1 General observations

As mentioned at the beginning of this thesis osteoporosis is an age-associated disease and a big burden on healthcare budgets and on patient's quality of life. Therefore introducing an evidenced based standard for screening, diagnosis and therapy is enormously important. To reach this goal healthcare professionals should work together as a multi professional team.

As there is always room for mistakes and improvement in life, each system, method, tool etc. should regularly be undertaken a review, control or assessment in order to keep standards high or to even improve them. This is also valid for medical processes like diagnosing or prescribing and ideally leads to benefits for the patient and our healthcare budgets. At University of Strathclyde Professor Stephen Hudson and John McAnaw had an idea of how pharmacists could contribute in the process of assessing quality of prescribing- the so called Medication Assessment Tool (MAT) was born. The method was adapted for many diseases- as well for osteoporosis.

This thesis aimed to demonstrate the use of a Medication Assessment Tool for osteoporosis (MATosteo) in the evaluation of adherence to the osteoporosis guidelines. Scientifically, I was able to demonstrate that the tool is systematic and reliable, by analysing GPASS® records of 319 patients and performing an inter-rater test. Clinical experts on osteoporosis agreed in interviews that MATosteo is valid as a clinical audit tool as well.

Before working on this thesis it seemed enormously important to me to be familiar with the current literature and guidelines about osteoporosis and with the Scottish healthcare system. As a foreign student I had to learn about the National Health Care System (NHS), local guidelines and of course- maybe the

most important thing- local initiatives on Osteoporosis. I also tried to get familiar with the work of previous researchers, which was planned to be the base for my future work.

5.2 Reviewing MATosteo

After finishing the first step of gathering as many information as possible, I was finally able to start of with my project. A very time consuming but necessary part was to review MATosteo. For this purpose the actuality of the applied standard, the practicability for electronic data analysis and a clear wording were taken into consideration. The standard applied- meaning the 19 criteria of MATosteo, each representing a guideline recommendation- had to be perfectly up to date. It is senseless to measure quality of prescribing by using an incorrect standard. It will draw a wrong picture and probably present things worse than they are. Another thing is to use the correct standard for the correct period of time. Four the purposes of MATosteo it does not make sense to apply the most actual standard for 20 year old data.

The wording of MATosteo had to be clear and unequivocal. Therefore ideas were collected and over and over revised again by the help of my collaborator and my supervisors, who were native speakers. The challenge of rewording criteria is not to loose the original sense of a guideline recommendation and to keep them simple for applying electronic data analysis. Electronic data analysis was thought to be necessary in order to be able to produce more representative results for Scotland's population by scaling up number of patients included in the survey.

5.3 Data

For the purpose of this study only electronic data was used. This seemed to be feasible as in Scotland an IT system called 'GPASS®' is used in more than 80%

of general medical practices for storing all relevant information about a patient, like medical history and prescriptions. It was also seen as chance to get away from the manual performance of MATosteo and speeding up the process of analysing.

The problem with GPASS® data is, that it is sometimes confusing, as a lot of information is stored as a so called 'Read Code'. Read Codes replace technical terms like e.g. 'osteoporosis' and are quite complicated to understand- especially if you never worked with them before. Sometimes different codes are used for the same term.

After data collection it is hardly possible to clarify unclear records, which highers the number of IDQs and IDS in the results. Some general practitioners use written records in combination with GPASS®- there was no access to them.

Last but not least the results of an audit like MATosteo, can only be as good as the documentation evaluated. This means that if the prescriber does not document all his interventions in the system, the tool shows a low adherence although in reality the patient is treated correctly. Therefore, I would like to suggest to conduct this audit directly in the practice in the future. This offers the possibility to talk to the prescriber if lack of clarity appears and maybe improves access to data.

5.3.1 Collection

For the purpose of this study three electronic patient samples were drawn from the GPASS® system in three general medical practices in Glasgow. Two of them were put on my disposal by a previous researcher. The third one was collected with the support of Mr Ian Towle. In order to collect all information needed MATosteo was used as an aid to orientation for running queries in the system. To copy the full patient records would of course be more complete but

as well cost to much EDV storage space. Collecting the data of one GP the way we did takes about a working day, but runs the risk of missing data after

collection. To avoid this it would be good to carefully design a data collection form- because of a lack of time I was not able to do that. The form should contain a check-list of data needed for the audit and if possible a field to write down the most important details about the sample, like GP and collection date, number of patients. For the process of data collection it is necessary to be familiar with the software that is worked with.

5.3.2 Creation of a database protocol

The creation of a database protocol is the prerequisite to getting reliable results no matter who conducts the audit. The purpose of such a protocol is to guide the researcher threw the process of analysing. Therefore it has to be written in a way that lets no doubts how to process.

In collaboration with my collaborator and our supervisors I tried to design the database protocol logical and clear. The protocol consists of 19 little guides- one for each criterion. On the top of those the criterion is placed in a little grey box. This helps knowing what is actually worked on and separating the 'headline' from the technical part of the guide. A full version of the database protocol can be found in the appendix. It is only of use in combination with the query builder.

5.4 Analysis

For data analysis several methods were tested. They are discussed below.

5.4.1 Manually

The manual way of analysing is time-consuming but very exact. It is perfect for

proving the correctness of other methods of auditing, for small patient samples or for screening the prescriptions of a single patient. Maybe it could be chosen for a public pharmacy service. The manual way of analysing is not the most economic one when it comes to audits on bigger patient samples, as it takes far to long. For scientific purposes or for a general prescribing audit, I would suggest to use at least Microsoft Access® in terms of building queries manually.

5.4.2 Microsoft Access®- classical query building

This way of data analysis presupposes basic knowledge about Microsoft Access®. It is for sure much quicker than the manual method, but not perfectly reliable. Little variations in creating a query- even in spelling single words- can make big differences in the results received. Therefore I would like to suggest to use the Microsoft Access® form 'Query builder'. It is discussed in the following section and the method that was finally used in this project for final data analysis.

5.4.3 Query builder

The 'Query builder' is a Microsoft Access® form developed by Tobias Dreischulte and collaborators. It can be used for the purposes of any MAT if correctly adapted, but it takes some time to get familiar with storing data for final analysis. To make this process easier for future researchers I wrote a guide that can be found in the appendix.

Storing data, however is tricky and takes a bit of time. If it is not done correctly the form will constantly give you an error or you will reproduce the same mistake over and over again- most likely even without taking notice of that. It is recommendable to take some time to organise and store the data. Once this is done a quick method of analysing data is available.

In combination with the database protocol I was able to prove that the audit is reliable. My personal experience is that it is possible to finish the process of

analysing within one third of the time compared to the methods prescribed above.

The design of the tool also allows to ask your database a lot of additional questions in a very easy and understandable way. I used this function for rechecking the demographics of my survey.

5.5 Results

Results of the retrospective survey were expressed as the percentage of adherence to osteoporosis guidelines. They were ranked as low (<50%), intermediate (50.0-69.95%) or high (>70%). Before interpreting the results it might be useful to be aware of some general facts about guidelines.

The use of guidelines for medical purposes is still discussed controversially. Mostly they are seen as a tool for providing consistent and efficient care and for closing the gap between science and clinical practice. Potential benefits of clinical guidelines are:

- to improve patient's quality of life
- to reduce morbidity and mortality
- to educate patients about their diseases and therapies
- calling attention to mostly unrecognised diseases, services, etc.
- to free resources by providing efficient and economic care
- to support healthcare providers in making clinical decisions
- to highlight gaps in evidence
- to raise new research questions
- to safe money by providing health care in a sufficient and economic way

Nevertheless the value of guidelines is limited- they can even be harmful under certain circumstances. The probably most important limitation of clinical guidelines is that the standard recommended might be wrong or correct for most of the patients but harmful for individuals. Recommendations are often based on lacking evidence or influenced by personal opinions of experts. Additionally the motivation for giving a recommendation is not always necessarily providing best care for the individual patient- aims like cost reduction might turn the balance. A potential harm of guidelines is that they don't leave enough room to adapt care to patient's needs and circumstances. Guidelines providing a bad standard can lead to harmful practices and inefficient car and raise the deficit of health care budgets (BMJ Article, Use of guidelines).

Adherence to guidelines can be seen as a marker for quality of prescribing. One should keep in mind that percentage of adherence is only meaningful if enough people are applicable to the criterion analysed. For instance, 100% adherence to a certain criterion is not representative if only 3/ 319 patients were applicable. For 3/19 criteria no results could be presented- nobody was applicable. This shows impressively that at least general practitioners in Glasgow apparently do not prescribe the treatment alternatives raloxifene, teriparatide and calcitonin.

MATosteo can help to identify weak points in prescribing and to target high risk patient groups or patients who need special or individualised treatment.

5.5.1 Demographics

Demographics do not show any unexpected things to someone who is familiar with osteoporosis. The age range is very broad (24-96 years), but a mean age of 74.0 years (osteoporotic patients) and 66.8 years (osteopenic patients) makes clear that only a few very young patients already suffer from osteoporosis or osteopenia.

Osteopenia can be seen as the preliminary stage of osteoporosis- in this patient sample as well osteopenic patients are younger than osteoporotic ones on average.

BMI was not recorded for all patients. Therefore, it is not possible to discuss BMI properly. Most of the patients, who had a BMI recorded, tended to have a slightly raised BMI or were obese. Only a few patients (6/49) were registered with very low BMI of <22. If this facts are representative for the whole patient sample or not, can not be stated.

5.5.2 Weak points of osteoporosis care in Glasgow

Criterions for DEXA scan show a low adherence. Surprisingly less than 50% of the patients diagnosed with osteoporosis have a recorded DEXA scan. I can think of two possible reasons for that:

- not all DEXA scan are recorded in GPASS
- different guidelines for referring to DEXA scans are used in Glasgow

DEXA scan records also showed, that the scans are seldom performed according to guidelines. In only 25.5% they were performed at two specific sites. I was not able to find out the reason for that.

Strikingly, osteopenic patients are hardly ever treated according to guidelines. During performing the interviews with experts on osteoporosis I got the feeling that this might have something to do with a lack of evidence and acceptance of the treatment guidelines for this patient group.

Although the basic therapy of osteoporosis is calcium and vitamin D supplementation, only 53.1% of patients received those supplements. There were no possible justifications documented in the electronic system.

Interviewees conjectured the reason for this lack in treatment might be non-compliance, as patients have to take care of their refillings on their own.

Only 60% of patients diagnosed with osteoporosis received an antiresorptive or an osteoanabolic agent. A possible reason for that might be that a lot of the untreated patients were patients with additional diseases and that it was hard to tailor the treatment standard to their circumstances. I got the impression that a lot of these patients suffered from renal impairment and that it might be useful to develop pharmaceutical care initiatives in order to support the prescribers in their treatment decision. As this is just a personal impression this question should be subject of further research.

Only 65.9% of patients who received an antiresorptive or an osteoanabolic agent had no contraindication on record. Against the background that only 3/ 319 patients received an alternative to bisphosphonates (strontium ranelate) this seems to be avoidable by bringing treatment options home to prescribers.

5.5.3 Strengths of osteoporosis care in Glasgow

All criteria dealing with dose regimens reached high level of adherence. For the masses of patients this is something very positive and helps in avoiding side effects. Nevertheless this is a good example for a field where the non-critical use of guidelines can lead to potential harm for patients. Firstly I was impressed by the high standard of dosing in Glasgow but after having a closer look on the results I recognised that the standard regimen is as well used for patients were dose adaptation is needed. Especially people with renal impairment and very low BMI should benefit from lowering doses. Because of basic pharmacokinetic principles one should also think of administering higher doses in patients, who are obese as long as their kidney and liver function is normal.

Bisphosphonates are used as first-line therapy and mostly Alendronate is

prescribed. Only in two cases Risedronate is used. This goes along with current evidence and economic principles.

5.5.4 Handling of results

MATosteo can be used as a research tool or as a clinical audit tool. Depending on the purpose of the audit different handling of results will become necessary.

Using MATosteo as a research tool only will probably make things easier after receiving the results. After making anonymous original data, general statements about patient groups or the whole patient sample can be made and used as a starting-point for the development of pharmaceutical care initiatives. There will be no direct or intermediate benefit for the patients included in the study but probably long-term benefits for future patients.

Using MATosteo as a clinical research tool might become challenging when it comes to presenting negative results to the prescriber. Nevertheless it offers the possibility to directly influence osteoporosis care of certain patients in certain practices.

In my opinion prerequisite to the performance of a clinical audit is an accurate enlightenment of the prescriber. The best thing would be to decide together what exactly the audit aims for and how possible results of low or intermediate adherence will be handled. The prescriber should be asked how much time he/she can spend for this audit and if he/ she would prefer an informative discussion or a written presentation of the results. It should be clear that the aim of performing MATosteo is not to harm the prescriber and offers the chance to turn already good clinical practice into best clinical practice.

I would like to suggest to train the communicational skills of the auditor before having the first talks with the prescribers.

5.6 Interviews

Experts on osteoporosis were interviewed in order to evaluate MATosteo as a clinical audit tool. Unfortunately, it was not possible to perform more than four interviews within the remaining time, but nevertheless I was able to identify several points in which all interviewees agreed on as regards content.

All participants worked within Greater Glasgow and Clyde and were specialised on osteoporosis care. General practitioners were excluded from the interviews as one of the aims of the interviews was to evaluate content and wording of the criteria of MATosteo and the research group decided that this should be done by experts.

The most frequent reason given for denying the participation in the interviews was a lack of time. Some of the candidates invited who worked outside Greater Glasgow and Clyde asked to invite Glasgow' experts in order to save time for writing up my project.

Interviews were carefully planned. The semi-structured technique was chosen, as it seems to potentially be the most beneficial one. It offers the possibility to immediately clarify unclear statements, but prevents the interviewer from losing the thread.

Interviews were audio recorded with the permission of the interviewees and transcribed later on. This was important for me and made it easier to concentrate on the interview itself instead of writing down the comments. Furthermore, it helped me to remember exactly what was said during the interviews and to avoid mistakes in reproducing the content. Additionally, audio recording helps to make the situation more comfortable for all participants as the interviewer is able to face the interviewee while talking and to pay full attention to the opposite.

To make it easier to find out agreement of all interviews were summarised. Main outcomes were listed in a box and discussed within the research group.

The interviewees thought that the wording and the content of the criteria were good, with the exception of the criteria for DEXA scans. All stated that within Glasgow other guidelines were used for referring. A copy of those can be found in the appendix. The decision if MATosteo will be adapted to those if used for further audits in Glasgow was not yet made, when I finished this thesis. One must take into consideration the fact that the local guidelines contradict the national ones in this point. Based on the assumption that the guidelines MATosteo is derived from are evidence based and actual, the sense of an adaptation to local needs in this case is questionable. On the other hand both DEXA scan criteria showed a low guideline adherence and therefore also reduce the overall adherence to guidelines.

5.7 Strengths of the project

- MATosteo was updated according to the newest national osteoporosis guidelines. Therefore, the standard used for analysis can be seen as appropriate.
- 3/ 4 experts on osteoporosis totally agreed with the statement above. 1 thought that most of the criteria were acceptable.
- MATosteo covers both diagnosis and therapy.
- Embedding of MATosteo in a model of care developed by Anton Luf (unpublished work) offers the possibility of covering the field of risk assessment as well.
- The wording of MATosteo's criteria was simplified for the purpose of data analysing, but kept the original sense of the guidelines. All experts agreed with the wording.

- Number of patients included was scaled up from previous work. The method chosen for electronic data analysis was shown to be reliable by an inter-rater test.
- The study was thought to be of interest for the presentation at the ESCP conference in Geneva in 2010.

5.8 Limitations of the project

- Access to data was limited. Therefore more IDS or IDQ than necessary appeared. This might also have minor influence on the percentage of adherence resulting calculations.
- Storing the data in the Microsoft Access® form 'Query builder' is time consuming and as well complicated for someone who is not yet familiar with the tool. Additionally, mistakes that happen during this process, are at high risk of remaining undiscovered and being reproduced over and over again.
- The number of interviews conducted was too few.
- The tool does not measure compliance or cover pain management of acute fractures.
- A standard for handling results of such an audit is not yet developed.

6 PROPOSALS FOR THE FUTURE

The method of analysing electronic data is systematic and reliable but not yet perfect enough. Storing data in the tool is still too time consuming. The process of analysing itself is valid. I would like to suggest to start a project in collaboration with the IT department to further improve this method of using a Microsoft Access® form for applying MATs. Another, maybe even better, possibility would be to try to get the permission to work directly in the GP in GPASS®. This could kill two birds with one stone, as it has also the potential to improve access to data.

The number of patients included in the MATosteo audit should further be enlarged. The aim is to get representative results for Glasgow or even the whole of Scotland that can be presented to the NHS. It would be possible to impressively show weak points of osteoporosis care. In combination with a study showing the impact they have on healthcare budgets and patient's quality of life, it would be hard for politicians to refuse to free research money.

Enlarging the patient sample would also enable researchers to conduct subgroup analyses in order to identify patient groups, which are at high risk of not being treated according to the guidelines. As well it would be possible to verify some hypothesises that appeared while performing this study. The most interesting patient group in this context is the 'renal impairment' one. I had the impression that patients suffering from renal diseases are at high risk of not being treated against osteoporosis at all or of not being treated the best way.

Once patient groups with special needs or circumstances are identified it is time for the development of pharmaceutical care initiatives. Pharmacist can contribute in making prescriptions safer for those patients and support prescribers in their clinical decisions this way.

I also think it is necessary to develop a standard for handling the results of clinical audits. The ethical responsibility is high. Ignoring negative outcomes of

such a study is no option, as they are, dramatically spoken, the connecting factor for reducing harm to patients and for reducing costs in the healthcare system. A good standard for handling the results of such an audit can also help to keep the good relationship between auditor and prescriber and to keep the possibility for further productive teamwork.

Last but not least it would be good to implement such audits in real working life of healthcare providers. This process might be the trickiest one, as it is always hard to get acceptance for new things- especially if they somehow evaluate the quality of people's work, like MATosteo does in the end. I think this process is a whole project itself and probably the researcher will need the help of the psychology department for the development of a suitable strategy.

7 CONCLUSION

Prerequisites to the performance of a systematic and reliable audit using MATosteo are full data access and sufficient medical and pharmaceutical knowledge of the auditor. Full data access is equal for the correct interpretation of treatment documentation and consequently for the correct calculation of the percentage of guideline adherence. For the decision whether the criteria of a guideline recommendation are fulfilled or not, medical and pharmaceutical knowledge is necessary- someone without an appropriate education won't even be able to understand most of the terms documented.

For the analysis of larger patient samples, basic knowledge about software programs like Microsoft Access® and GPASS® is equally valuable.

The Microsoft Access® form 'Query builder' is a promising method for analysing GPASS® data, that is already able to produce quickly reliable results, but still needs further development now and there. Especially the process of storing data is open to improvement.

MATosteo can only produce reliable results, if the single parts of the audit are perfectly linked and co-ordinated. The data collected has to be total and accurate - free of input error - a feasible standard for this process can help to fulfil this criterion. The audit itself should be performed according to an explicitly defined procedure - a database protocol, which should be designed in a clear and understandable way. Different and independent raters will be able to produce correct results under this circumstances. Last but not least the auditors themselves have to be appropriately qualified for the work as discussed above.

The results can only be as reliable as the doctor documents and the standard used for analysis. An old or bad standard will give a distorted impression about quality of prescribing as well as a poor performance of MATosteo.

Nevertheless the results of MATosteo can disclose lacks in osteoporosis care- depending on the patient sample- for single patients, GPs or even areas. The results are a first stage in addressing pharmaceutical care issues. How exactly the results of medication assessment should be handled should be topic of further research. The vision however is, to discuss results of low or intermediate adherence with the prescriber and then to develop methods to improve the integration of an evidence based standard in osteoporosis care. Pharmacists and prescribers should be in the same boat.

Interviewing experts suggested that MATosteo is valuable as a clincial research tool.

Mainly, the experts were of the opinion that the content of the criteria and the wording were good. Some suggestions were made for measuring additional parts of osteoporosis care. All in all they thought the tool was beneficial for the patients. The number of interviews conducted though was little. Therefore conducting further interviews might change this impression gained.

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9 APPENDICES

9.1 Appendix 1

Project Protocol

A Pharmaceutical Care Model on Osteoporosis: Targeting Patient Groups

Project Protocol

Investigator	Karin Doblhammer
Supervisor	Prof Steven Hudson
Co-Supervisors	Dr Julienne Johnson, Ao. Univ. Prof. - Dr. Oskar Hoffmann
Collaborators	MSc Ian Towle, Susan McKellar, Katharina Bergmann, Anton Luf

Proposed duration of the project

The project should be completed within 6 months

1. Introduction

“Osteoporosis is a systemic skeletal disorder characterized by a low BMD and microarchitectural deterioration of bone tissue, leading to enhance bone fragility and a consequent increase of fracture risk.” (Brown J.P and Fortier M., 2006)

As its prevalence increases with age and as it is particularly common in postmenopausal patients one could think, it is a disease of elderly women(Scottish Intercollegiate Guideline Network 2003). Nevertheless, there are several secondary causes of osteoporosis and clinicians should be aware of the fact that it can also occur in younger people and men (National Osteoporosis Foundation, 2008).

In the European Union, someone suffers an osteoporotic fracture every 30 seconds(International Osteoporosis Foundation 2008). In Scotland around 240 000 people are affected by the disease(Scottish Intercollegiate Guideline Network 2003). Osteoporosis-related fractures are a big burden on both healthcare-budgets and patients (International Osteoporosis Foundation 2008; National Osteoporosis Foundation, 2008). These statistics and the fact that population ages show clearly, why osteoporosis should be declared a national healthcare priority (International Osteoporosis Foundation, 2008; National Osteoporosis Foundation, 2008).

Healthcare professionals should work together in a multidisciplinary team and develop strategies in order to stop the progression of osteoporosis before fractures occur and provide optimised treatment and support to each individual. In the European Union, more than 36 billion euros are spent annually for the treatment of osteoporotic fractures(International Osteoporosis Foundation 2008). In the United Kingdom osteoporotic fractures cost the government and the NHS around 1.7 billion £ every year(Scottish Intercollegiate Guideline, Network 2003). Therefore, improving risk assessment strategies and quality of individual treatment and support would as well be a big benefit for the society as a hole in terms of saving thousands of pounds for treatment and social care (International Osteoporosis Foundation 2008).

2. Research questions, Aims and Objectives

Research questions

- Can a medication assessment tool for osteoporosis (MAT_{Osteo}) reliably be administered to computerised medical records?
- Is the MAT_{Osteo} a sensitive tool for comparing prescribing practices in different clinical settings?
- Is the MAT_{Osteo} a clinically valid tool and what are its limitations?

Aims

To demonstrate the use of a medical assessment tool for osteoporosis (MAT_{Osteo}) in the evaluation of the level of adherence to osteoporosis guidelines. To demonstrate the inter-rater reliability of such a tool.

Objectives:

- To undertake a literature review of the management of osteoporosis and the role of specialists in the use of treatment alternatives
- To revise a MAT_{Osteo} (originally designed by previous researchers) and redesign database protocols. Test the protocols on a GPASS® database and evaluate inter-rater reliability.
- Test the sensitivity of the MAT_{Osteo} in a comparison of patient samples drawn from two clinical settings and further revise the tool as necessary.
- Test on a larger scale audit the revised $MAT_{Osteo.}$ Take one patient sample and compare with the results of another researcher.
- Validate a revised MAT_{Osteo} and critically review its potential value as a clinical and research tool.

3. Study design, Subjects and Settings

Study design

Retrospective survey including the application of a tool designed for medication assessment in the field of osteoporosis

Subjects

1 Patients from two practices in Clydebank and Paisley previously used in an earlier project to design the MAT_{Osteo}

2 Patients recruited from a third practice to be compared with those from a fourth

3 Interviewees (4-6) representing osteoporosis specialists in secondary care

The inclusion criteria for patients for whom specific guideline criteria are applicable are:

- Patients alive who are registered with the GP practice on date
- Patients who are diagnosed with osteoporosis or osteopenia

Settings

- GP practices offering permission for the audit. The patients should be situated in general medical practice within Community Health Partnerships in Renfrewshire and/or Greater Glasgow.
- Interviewees who have been nominated to participate and accepted the invitation.

4. Methods

To undertake a literature review of the management of osteoporosis and the role of specialists in the use of treatment alternatives

For the purpose of this project background information will be gathered by using PubMed®, Medlineplus® and ClincialTrials.gov®. The number of articles presented will be narrowed down by using a combination of certain keywords. Useful articles will be identified by reading abstracts. MAT_{Osteo}, which will be tested concerning reliability, is based on SIGN and NICE guidelines and on the British National Formulary.

To revise a MAT_{Osteo} (originally designed by previous researchers) and redesign database protocols. Test the protocols on a GPASS® database and evaluate inter-rater reliability.

A Microsoft Access® form, the 'query maker', will be applied to analyse electronic data. Therefore, it will be necessary to decide which data to include and which not, which will be done by discussing within a research group. For each criterion of the MAT a strategy of analysing will be developed by manipulating the tool. Each strategy will be validated by analyzing the dataset manually. The database protocol will be redesigned in Microsoft Word® in order to be understandably for everybody with basic knowledge of Microsoft Excel® and Microsoft Access®. It should lead through the analyzing process in a clear way. Once the database protocol is finished it will be shown to supervisors and other students to validate it. The inter-rater reliability will be tested by calculating the percentage of discrepancy and the percentage of agreement.

Test the sensitivity of the MAT_{Osteo} in a comparison of patient samples drawn from two clinical settings and further revise the tool as necessary

Results will be interpreted, discussed and used to revise the MAT_{Osteo}.

Test on a larger scale audit the revised $MAT_{Osteo.}$ Take one patient sample and compare with results of another researcher..

The revised MAT_{Osteo} will be applied on another patient sample drawn from the GPASS® system. The results will be compared with the results of another student's data analysis.

Validate a revised MAT_{Osteo} and critically review its potential value as a clinical and research tool.

Interviewees will be given a short overview about the project and asked if they give their permission to be recorded. The semi-structured interview technique was chosen in order to validate the MAT criterion by criterion. The interview will be started and ended by using open-ended questions. Closed-ended questions will be used to clarify the statements. In the main part of the interview, specific questions for each criterion will be asked. Once the MAT is modified it will be sent back to all interviewees and they will be asked for written comments.

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9.2 Appendix 2

MATosteoLuf

Medication Assessment Tool for use in osteoporosis/osteopenia (MAT_{Osteo}) – Draft 1

Patient Code:

Date and setting:

Key for the six answer categories:

NA	Not applicable
Yes	Standard is adhered to in eligible patients
No(J)	No, but justified
No(U)	No, unjustified
ID_Q	Insufficient data to address the qualifying statement
ID_S	Insufficient data to address the standard statement

Definitions:

Osteoporosis	… is defined as a value of bone mineral density at least 2.5 standard deviations below the young adult mean (T-score $\leq$ - 2.5).
Osteopenia	… is defined as a value of bone mineral density between 1 and 2.5 standard deviations below the young adult mean (T-score < - 1 and > - 2.5).
DEXA scan	Dual-energy X-ray absorptiometry is a method to assess the bone mineral density. The result is expressed in relation to the young adult mean (T-score) in standard deviation units.
BMD	Bone mineral density (g/cm^2) = Bone mineral content (g/cm) / width at the scanned line (W)

References:

1 Scottish Intercollegiate Guidelines Network (SIGN). Management of Osteoporosis 71 (April 2004 Update)

2 National Institute for Clinical Excellence (NICE). Alendronate, etidronate, risedronate, raloxifene, strontium ranelate for the primary prevention of osteoporotic fragility fractures in postmenopausal women Technology Appraisal TA160, October 2008

3 National Institute for Clinical Excellence (NICE). Alendronate, etidronate, risedronate, raloxifene, strontium ranelate and teriparatide for the secondary prevention of osteoporotic fragility fractures in postmenopausal women Technology Appraisal TA161, October 2008

4 Summary of the 2002 Canadian Guidelines for the Diagnosis and Management of Osteoporosis (2005 Update)

5 British National Formulary (BNF) 56, September 2008

		NA	Yes	No (J)	No (U)	IDQ	IDs	Ref
Diagnosis of osteoporosis/osteopenia								
1	**A patient with a diagnosis of osteoporosis** has a recorded DEXA Scan to confirm osteoporosis [Justification for not being assessed by DEXA scan to confirm osteoporosis Patient ≥ 60 years and ≥ 2 vertebral fractures imply a diagnosis of osteoporosis or a postmenopausal woman ≥ 75 years and two or more independent clinical risk factors for fracture or indicators of low BMD] **Independent clinical risk factors** ❑ low body mass index defined as less than 22 kg/m² ❑ ankylosing spondylitis ❑ Crohn's disease ❑ conditions that result in prolonged immobility ❑ untreated premature **Indicators for low BMD** ❑ parental history of hip fracture, ❑ alcohol intake of 4 or more units/d ❑ rheumatoid arthritis	☐	☐	☐	☐	☐	☐	1,2,3
2	**Measurement of the BMD by DEXA scan** is performed at least at the two specific sites – namely, anteroposterior spine and hip.	☐	☐	☐	☐	☐	☐	1
Calcium and vitamin D supplementation								
3	**A patient with a recorded diagnosis of osteoporosis** is prescribed supplementary calcium (☐ vitamin D). **[Justification for non-prescribing calcium and vitamin D: There is a record that the patient has an adequate dietary intake of calcium and no vitamin D deficiency.]**	☐	☐	☐	☐	☐	☐	1
4	**A patient with a recorded diagnosis of osteoPENIA** is prescribed supplementary calcium (☐ vitamin D) for the prevention of osteoporosis. [Justification for non-prescribing calcium and vitamin D: There is a record that the patient has an adequate dietary intake of calcium and no vitamin D deficiency.]	☐	☐	☐	☐	☐	☐	4

		NA	Yes	No (J)	No (U)	IDQ	IDs	Ref
5	**A patient with confirmed vitamin D deficiency or aged ≥ 65** is prescribed vitamin D.	☐	☐	☐	☐	☐	☐	1
6	**A patient with osteoporosis and NOT prescribed any of the following: bisphosphonates, raloxifene, strontium ranelate, calcitonin or teriparatide** has a recorded contra-indication to each agent (see below) [Contraindications to bisphosphonates are: ☐ oesophageal strictures or achalasia ☐ inability to remain upright for > 30 min after ingestion ☐ hypocalcaemia ☐ osteomalacia (etidronate) ☐ moderate renal impairment (CrCl < 35 mL/min) ☐ pregnancy and breast feeding] ☐Contraindications to raloxifene are: ☐ past/present venous thromboembolic events ☐ hepatic impairment ☐ cholestasis ☐ severe renal impairment (CrCl < 10 mL/min) ☐ endometrial cancer ☐ uterine bleeding ☐ pregnancy and breast feeding☐ ☐Contraindications to strontium ranelate are: ☐ pregnancy and breast feeding ☐ hypersensitivity☐ ☐Contraindications to calcitonin are: ☐ hypocalcaemia ☐ hypersensitivity☐ [Contraindications to teriparatide are: ☐ pre-existing hypercalcaemia ☐ skeletal malignancies or bone metastases ☐ metabolic bone diseases ☐ including Paget's disease and hyperparathyroidism ☐ unexplained raised alkaline phosphatase ☐ previous radiation therapy to the skeleton]	☐	☐	☐	☐	☐	☐	1,2,5
7	**A patient prescribed supplementary calcium** is prescribed a daily dose of 500 – 1500 mg calcium.	☐	☐	☐	☐	☐	☐	1,4
8	**A patient prescribed vitamin D** is prescribed a daily dose of 10 – 20 µg (400 - 800 IU) vitamin D.	☐	☐	☐	☐	☐	☐	1
9	**A patient with osteoporosis and NOT prescribed any of the following: bisphosphonates, raloxifene, strontium ranelate or calcitonin**	☐	☐	☐	☐	☐	☐	1

	is prescribed ≥1000mg calcium plus 800 IU vitamin D per day							
		NA	**Yes**	**No (J)**	**No (U)**	**IDQ**	**IDs**	**Ref**
10	**A patient with a recorded diagnosis of osteoporosis** is prescribed an oral bisphosphonate as first-line therapy. Recorded reasons for non-conformance (justification): _____	☐	☐	☐	☐	☐	☐	**1,4**
11	**A patient with a recorded diagnosis of osteoPENIA** is prescribed an oral bisphosphonate as first-line therapy. Recorded reasons for non-conformance (justification): _____	☐	☐	☐	☐	☐	☐	**4**
12	**A patient who is prescribed a bisphosphonate** has no reason *on record* to avoid bisphosphonates. ☐Reasons to avoid bisphosphonates are: ❑ **contraindication to bisphosphonates** o oesophageal strictures or achalasia o inability to remain upright for > 30 min after ingestion o hypocalcaemia o osteomalacia (etidronate) o moderate renal impairment (CrCl < 35 mL/min) o pregnancy and breast feeding ❑ inability to comply with the instructions for use of bisphosphonates o ingestion on an empty stomach o washing the medication down with 250 ml water o avoidance of food for 30 min o avoidance of lying flat within 30 min of ingestion ❑ unsatisfactory response to bisphosphonates o another fracture occurs o decrease in BMD despite adherence to treatment ❑ intolerance to bisphosphonates o oesophageal ulceration o erosion or stricture o severe lower GI symptoms]	☐	☐	☐	☐	☐	☐	**1,2,5**

		NA	Yes	No (J)	No (U)	IDQ	IDs	Ref
13	**A patient receiving treatment for osteoporosis/osteopenia** is prescribed a standard dose regimen.	☐	☐	☐	☐	☐	☐	**1,5**

❑ **Prevention (in osteopenia)**	❑ **Treatment (of osteoporosis)**
Postmenopausal Osteoporosis	
❑ Alendronic acid	
☐ 5 mg daily PO	☐ 10 mg daily or 70 mg once weekly PO
❑ Disodium etidronate	
☐ 400 mg for 14 days PO; 1,25 g calcium carbonate for 76 days PO	☐ 400 mg for 14 days PO, 1,25 g calcium carbonate for 76 days PO
❑ Ibandronic acid (not in guidelines)	
	☐ 150 mg once a month PO or 3 mg every 3 months IV
❑ Risedronate sodium	
☐ 5 mg daily PO	☐ 5 mg daily PO or 35 mg weekly PO
❑ Calcitonin	
	☐ 200 units daily intranasally
❑ Raloxifene	
☐ 60 mg daily PO	☐ 60 mg daily PO
❑ Strontium ranelate	
	☐ 2 g daily PO
❑ Teriparatide	
	☐ 20 micrograms daily, for a maximum duration of treatment of 18 months
Osteoporosis in men	
❑ Alendronic acid	
	☐ 10 mg daily PO
Glucocorticoid-induced Osteoporosis	
❑ Alendronic acid	
☐ 5 mg daily PO	☐ 5 mg daily PO

		NA	Yes	No (J)	No (U)	IDQ	IDs	Ref
14	**A postmenopausal woman when started on bisphosphonate therapy** was initiated on alendronate.	☐	☐	☐	☐	☐	☐	**2,3**
15	A postmenopausal woman diagnosed with osteoporosis/osteopenia and not treated with alendronate is prescribed risedronate.	☐	☐	☐	☐	☐	☐	**1**

		NA	Yes	No (J)	No (U)	IDQ	IDs	Ref
16	**A postmenopausal woman with ≥ 2 vertebral fractures and NOT treated with alendronate or risedronate**	☐	☐	☐	☐	☐	☐	**1**

	is prescribed intermittent cyclical etidronate[1].							
17	**A patient who is on long-term glucocorticoid therapy (≥ 7.5 mg prednisolone or equivalents for ≥ 3 months)** is prescribed a bisphosphonate.	☐	☐	☐	☐	☐	☐	**1**
18	**A postmenopausal woman with a diagnosis of osteoporosis, who has an identifiable reason for not being prescribed a bisphosphonate** is prescribed strontium ranelate. [Reasons for non-use of bisphosphonates are Contraindications to bisphosphonates ❑ contraindication to bisphosphonates (see 12) ❑ inability to comply with the recommendations for use of bisphosphonates (see 12) ❑ intolerance to bisphosphonates (see12)]	☐	☐	☐	☐	☐	☐	**2**
19	**A postmenopausal woman diagnosed with osteoporosis with at least one osteoporotic fracture who has an identifiable reason for not being prescribed a bisphosphonate** is prescribed strontium ranelate or raloxifene. [Reasons for non-use of bisphosphonates are Contraindications to bisphosphonates ❑ contraindication to bisphosphonates (see 12) ❑ inability to comply with the recommendations for use of bisphosphonates (see 12) ❑ intolerance to bisphosphonates (see 12)]	☐	☐	☐	☐	☐	☐	**3**
20	**A postmenopausal woman diagnosed with osteoporosis and at least one osteoporotic fracture who has either** ❑ **a reason to avoid**	☐	☐	☐	☐	☐	☐	**3**

[1] standard dose regimen see criterion 13

bisphosphonates (See 12)

- ❑ **an intolerance to strontium ranelate**
  - o persistent nausea
  - o persistent diarrhoea

and who is either

- ❑ **aged ≥ 65 years with a T-Score ≤ -4 SD**
- ❑ **aged ≥ 65 years with a T-Score ≤ -3.5 SD and has more than two fractures**

- ❑ **aged 55-64 years with a T-Score ≤ -4 and has more than two fractures**

is prescribed teriparatide.

21	**A postmenopausal woman diagnosed with osteoporosis with at least one vertebral fracture and NOT treated with a bisphosphonate, raloxifene or strontium ranelate**	□ □ □ □ □ □	**1**

is prescribed calcitonin.

9.3 Appendix 3

MATosteo[19]

Medication Assessment Tool for use in osteoporosis/osteopenia (MAT_{Osteo}) – Draft 1

Patient Code:

Date and setting:

Key for the six answer categories:

NA	Not applicable
Yes	Standard is adhered to in eligible patients
No(J)	No, but justified
No(U)	No, unjustified
ID_Q	Insufficient data to address the qualifying statement
ID_S	Insufficient data to address the standard statement

Definitions:

Osteoporosis	… is defined as a value of bone mineral density at least 2.5 standard deviations below the young adult mean (T-score $\leq$ - 2.5).
Osteopenia	… is defined as a value of bone mineral density between 1 and 2.5 standard deviations below the young adult mean (T-score < - 1 and > - 2.5).
DEXA scan	Dual-energy X-ray absorptiometry is a method to assess the bone mineral density. The result is expressed in relation to the young adult mean (T-score) in standard deviation units.
BMD	Bone mineral density (g/cm^2) = Bone mineral content (g/cm) / width at the scanned line (W)

References:

1 Scottish Intercollegiate Guidelines Network (SIGN). Management of Osteoporosis 71 (April 2004 Update)

2 National Institute for Clinical Excellence (NICE). Alendronate, etidronate, risedronate, raloxifene, strontium ranelate for the primary prevention of osteoporotic fragility fractures in postmenopausal women Technology Appraisal TA160, October 2008

3 National Institute for Clinical Excellence (NICE). Alendronate, etidronate, risedronate, raloxifene, strontium ranelate and teriparatide for the secondary prevention of osteoporotic fragility fractures in postmenopausal women Technology Appraisal TA161, October 2008

4 Summary of the 2002 Canadian Guidelines for the Diagnosis and Management of Osteoporosis (2005 Update)

5 British National Formulary (BNF) 56, September 2008

	NA	Yes	No (J)	No (U)	ID Q	ID s	Ref
Diagnosis of osteoporosis/osteopenia							
1 A patient with a diagnosis of osteoporosis has a recorded DEXA scan to confirm osteoporosis [Justification for not being assessed by DEXA scan to confirm osteoporosis Patient ≥ 60 years and ≥ 2 vertebral fractures imply a diagnosis of osteoporosis or a postmenopausal woman ≥ 75 years and two or more independent clinical risk factors for fracture or indicators of low BMD]							
Independent clinical risk factors ❑ low body mass index defined as less than 22 kg/m² ❑ ankylosing spondylitis ❑ Crohn's disease ❑ conditions that result in prolonged immobility ❑ untreated premature **Indicators for low BMD** ❑ parental history of hip fracture, ❑ alcohol intake of 4 or more units/d ❑ rheumatoid arthritis	☐	☐	☐	☐	☐	☐	**1,2,3**
2 Measurement of the BMD by DEXA scan is performed at least at the two specific sites – namely, anteroposterior spine and hip.	☐	☐	☐	☐	☐	☐	**1**
Calcium and vitamin D supplementation							
3 A patient with a recorded diagnosis of osteoporosis is prescribed supplementary calcium (☐ vitamin D). **[Justification for non-prescribing calcium and vitamin D: There is a record that the patient has an adequate dietary intake of calcium and no vitamin D deficiency.]**	☐	☐	☐	☐	☐	☐	**1**

4	**A patient with a recorded diagnosis of osteoPENIA** is prescribed supplementary calcium (☐ vitamin D) for the prevention of osteoporosis. [Justification for non-prescribing calcium and vitamin D: There is a record that the patient has an adequate dietary intake of calcium and no vitamin D deficiency.]	☐	☐	☐	☐	☐	☐	**4**
5	**A patient with confirmed vitamin D deficiency or aged ≥ 65** is prescribed vitamin D.	☐	☐	☐	☐	☐	☐	**1**
6	**A patient with osteoporosis** is treated with an antiresorptive/ osteoanabolic agent (bisphosphonate, strontium ranelate, raloxifene, teriparatide, calcitonin)	☐	☐	☐	☐	☐	☐	**1,2,5**
7	**A patient prescribed supplementary calcium** is prescribed a daily dose of 500 – 1500 mg calcium.	☐	☐	☐	☐	☐	☐	**1,4**
8	**A patient prescribed vitamin D** is prescribed a daily dose of 10 – 20 µg (400 - 800 IU) vitamin D.	☐	☐	☐	☐	☐	☐	**1**
9	**A patient with osteoporosis and NOT prescribed any of the following: bisphosphonates, raloxifene, strontium ranelate, teriparatide or calcitonin** is prescribed ≥1000mg calcium plus 800 IU vitamin D per day	☐	☐	☐	☐	☐	☐	**1**
10	**A patient with a recorded diagnosis of osteoporosis** is prescribed an oral bisphosphonate as first-line therapy. Recorded reasons for non-conformance (justification): _____	☐	☐	☐	☐	☐	☐	**1,4**
11	**A patient with a recorded diagnosis of osteoPENIA** is prescribed an oral bisphosphonate as first-line therapy. Recorded reasons for non-conformance (justification): _____	☐	☐	☐	☐	☐	☐	**4**

12 **A patient prescribed any of the following: bisphosphonates, raloxifene, strontium ranelate, calcitonin or teriparatide**
has no contraindication on record (see below)

[Contraindications to bisphosphonates are:
- ☐ oesophageal strictures or achalasia
- ☐ inability to remain upright for > 30 min after ingestion
- ☐ hypocalcaemia
- ☐ osteomalacia (etidronate)
- ☐ moderate renal impairment (CrCl < 35 mL/min)
- ☐ pregnancy and breast feeding]

☐Contraindications to raloxifene are:
- ☐ past/present venous thromboembolic events
- ☐ hepatic impairment
- ☐ cholestasis
- ☐ severe renal impairment (CrCl < 10 mL/min)
- ☐ endometrial cancer
- ☐ uterine bleeding
- ☐ pregnancy and breast feeding☐

☐ ☐ ☐ ☐ ☐ ☐ **1,2,5**

☐Contraindications to strontium ranelate are:
- ☐ pregnancy and breast feeding
- ☐ hypersensitivity☐

☐Contraindications to calcitonin are:
- ☐ hypocalcaemia
- ☐ hypersensitivity☐

[Contraindications to teriparatide are:
- ☐ pre-existing hypercalcaemia
- ☐ skeletal malignancies or bone metastases
- ☐ metabolic bone diseases
- ☐ including Paget's disease and hyperparathyroidism
- ☐ unexplained raised alkaline phosphatase
- ☐ previous radiation therapy to the skeleton]

13 **A patient receiving treatment for osteoporosis/osteopenia**
is prescribed a standard dose regimen.

❑ **Prevention (in osteopenia)**	❑ **Treatment (of osteoporosis)**
Postmenopausal Osteoporosis	
❑ Alendronic acid	
☐ 5 mg daily PO	☐ 10 mg daily or 70 mg once weekly PO
❑ Disodium etidronate	
☐ 400 mg for 14 days PO; 1,25 g calcium carbonate for 76 days PO	☐ 400 mg for 14 days PO, 1,25 g calcium carbonate for 76 days PO
❑ Ibandronic acid (not in guidelines)	
	☐ 150 mg once a month PO or 3 mg every 3 months IV
❑ Risedronate sodium	
☐ 5 mg daily PO	☐ 5 mg daily PO or 35 mg weekly PO
❑ Calcitonin	
	☐ 200 units daily intranasally
❑ Raloxifene	
☐ 60 mg daily PO	☐ 60 mg daily PO
❑ Strontium ranelate	
	☐ 2 g daily PO
❑ Teriparatide	
	☐ 20 micrograms daily, for a maximum duration of treatment of 18 months
Osteoporosis in men	
❑ Alendronic acid	
	☐ 10 mg daily PO
Glucocorticoid-induced Osteoporosis	
❑ Alendronic acid	
☐ 5 mg daily PO	☐ 5 mg daily PO

☐ ☐ ☐ ☐ ☐ ☐ **1,5**

14 **A patient with osteoporosis on bisphosphonate therapy**
is on the preferred choice*
* 1- Alendronate, 2-risedronate, 3-intermittent cyclical etidronate
[Preferred order as shown in the drug history]

☐ ☐ ☐ ☐ ☐ ☐ **2,3**

15	**A patient who is on long-term glucocorticoid therapy (≥ 7.5 mg prednisolone or equivalents for ≥ 3 months)** is prescribed a bisphosphonate.	☐	☐	☐	☐	☐	☐	**1**
16	**A postmenopausal woman prescribed strontium ranelate** has an identifiable reason for not being prescribed a bisphosphonate Reasons for non-use of bisphosphonates are ❑ contraindication to bisphosphonates (see 12) ❑ inability to comply with the recommendations for use of bisphosphonates (see 12) ❑ intolerance to bisphosphonates (see12)]	☐	☐	☐	☐	☐	☐	**2**
17	A postmenopausal woman prescribed raloxifene is receiving it for secondary prevention and has an identifiable reason for not being prescribed a bisphosphonate [Reasons for non-use of bisphosphonates are ❑ contraindication to bisphosphonates (see 12) ❑ inability to comply with the recommendations for use of bisphosphonates (see 12) ❑ intolerance to bisphosphonates (see 12)]	☐	☐	☐	☐	☐	☐	**3**

18 **A patient prescribed teriparatide is prescribed it for secondary prevention and meets at least one of the following 2 criteria**

- ❑ **has a reason to avoid bisphosphonates (See 12)**
- ❑ **has an intolerance to strontium ranelate**
  - o persistent nausea
  - o persistent diarrhoea

And has DEXA scan assessment that

puts them in one the following groups

☐ ☐ ☐ ☐ ☐ ☐ **3**

- ❑ **aged ≥ 65 years with a T-Score ≤ -4 SD**
- ❑ **aged ≥ 65 years with a T-Score ≤ -3.5 SD and has more than two fractures**
- ❑ **aged 55-64 years with a T-Score ≤ -4 and has more than two fractures**

19 **A patient prescribed calcitonin** is prescribed it for secondary prevention after bisphosphonate, raloxifene or strontium ranelate have been tried or have reasons for excluding from consideration

[Reasons for non-use of bisphosphonates are
- ❑ contraindication to bisphosphonates (see 12)
- ❑ inability to comply with the recommendations for use of bisphosphonates (see 12)
- ❑ intolerance to bisphosphonates (see 12)]

☐ ☐ ☐ ☐ ☐ ☐ **1**

[Reasons for non-use of strontium ranelate are:
- Contraindication to strontium ranelate (see 10)]

[Reasons for non-use of raloxifene are:
- Contraindication to raloxifene]

9.4 Appendix 4

Database protocol

CRITERION 1

A patient with a diagnosis of osteoporosis has
been assessed by DEXA scan

Step	**What?**	**How?**
Step 1	Identify patients with a diagnosis of osteoporosis who have been assessed by DEXA scan	**Use** form 'Query maker' in Microsoft Access® **Select** in 'Read code' field: • 'Osteoporosis' for criterion 1 • 'DXA' for criterion 2 • 'DEXA IDS' for criterion 3 **Press** 'view' **Sort** patients by 'Osteoporosis' **Delete** patients who are not osteoporotic (0)
Step 2	Store results in a Microsoft Excel® spreadsheet	**Export** results to Microsoft Excel® **Sort** all results by applying the 'sort descending' function **Delete** first row (containing 'c1', 'd1', 'c2'…)
Step 3	Create a new table in Microsoft Access® containing results from step 2	**Select '**Tables', 'new', 'import table' in order to import the table created in step 2 **Select** 'First Row Contains Headings' during the process of importing **Name** table 'OS and DEXA'
Step 4	Prepare justification search for "No"-results	**Use** form 'Query maker' in Microsoft Access® **Select** in 'Read code' field: • 'Osteoporosis' for criterion 1 • '>=60 years' for criterion 2 • 'Vertebral' for criterion 3 • '>=75 years' for criterion 4 • 'Female' for criterion 5 • 'ICR IND BMD LOW' for criterion 6 **Press** 'view'

Step 5	Identify patients with osteoporosis, no DEXA scan, >= 60 years and at least two vertebral fractures (Justification A)	**Create** new query by using 'design view' **Link '**tbl_temp' and table 'OS and DEXA' via patientKey. **Apply** 'patientKey', c1[1], c2 [0] (table 'OS an DEXA'), c1 [1], c2 [1],c3 [1] ('tbl_temp') **Run** query 1 **Export** results to Microsoft Excel® For patients with '1' in field c3 ('tbl_temp'): **Check manually** if they sustained more than 2 vertebral fractures by inspecting on the table 'Patients: NHS Read codes_QOF and MAT data items_tbl' (use the search function) ➔ 0 or 1 vertebral fractures: No(U) ➔ 2 or more vertebral fractures No(J)
Step 6	Identify patients with osteoporosis, no DEXA scan, >=75 years, female and at least 2 ICRF or IND for low BMD (Justification B)	**Create** new query by using 'design view' **Link '**tbl_temp' and table 'OS and DEXA' via patient keys **Apply** 'patientKey', c2 [0] (table 'OS an DEXA'), c4 [1], c5 [1], c6 [1] ('tbl_temp') **Run** query 2 **Export** data to Microsoft Excel® For patients with '1' in field c3 ('tbl_temp'): **Check manually** if they show 2 or more ICRF IND BMD by inspecting on the table 'Patients: NHS Read codes_QOF and MAT data items_tbl' (use the search function) ➔ 0 or 1 ICRF IND BMD: No(U) ➔ 2 or more ICRF IND BMD No(J) Remaining patients with osteoporosis but no DEXA scan: No(U)
Step 7	Interpret results from step 2 (stored in Microsoft Excel®)	➔ Osteoporosis 1, DXA 0 and DEXA IDS 1: =IDS ➔ Osteoporosis 1, DXA 1 and DEXA IDS 0: =YES ➔ Osteoporosis 1, DXA 0 and DEXA IDS 0: See step 5 and 6 for justifications

CRITERION 2

Measurement of the BMD by DEXA scan
Is performed at least at the two specific sites – namely anteroposterior spine

Step	**What?**	**How?**
Step 1	Identify patients with a measured BMD by DEXA scan measured on two specific sites	**Use** form 'Query maker' in Microsoft Access® **Select** in 'Read code' field: • 'Hip scan' for criterion 1 • 'Lumbar scan' for criterion 2 **Press** 'view' **Create** a new query by using 'design view' **Select '**tbl_temp' **Apply '**patientKey', c1[1], c2[1], d1, d2 **In 'SQL view' change '**and' to 'or' → [(((tbl_temp.c1)="1")) **OR** (((tbl_temp.c2)="1"));]
Step 2	Identify Yes, No(U)	**Export** results to Microsoft Excel® ➔ Patients with a DEXA scan performed on two specific sites at the *same day!*= Yes ➔ Patients with a DEXA scan performed on only one site or with DEXA scans performed on two specific sites but not at the same day= No(U) ➔ No(J)=0 (there is no justification for non-adherence)
Step 3	Identify IDS, IDQ	**Use** form 'Query maker' in Microsoft Access® **Select** in 'Read code' field: • 'C2IDSdxa' for criterion 1 • 'DEXA IDS' (is IDQ for this criteria!) for criterion 2 **Press** 'view' **Create** a new query by using 'design view' **Select '**tbl_temp' **Apply '**patientKey', c1[1], c2[1] **In 'SQL view' change '**and' to 'or' → [(((tbl_temp.c1)="1")) **OR** (((tbl_temp.c2)="1"));] **Export** results to Microsoft Excel® ➔ IDS= number of patients marked with 1 in column c1 ➔ IDQ= number of patients marked with 1 in column c2

CRITERION 3

Patient with a recorded diagnosis of osteoporosis
Is prescribed supplementary calcium (vitamin D)

Step	**What?**	**How?**
Step 1	Identify patients with a diagnosis of osteoporosis	**Use** form 'Query maker' in Microsoft Access® **Select** in 'Read code' field: • 'Osteoporosis' for criterion 1 **Press** 'view' **Sort** patients by 'Osteoporosis' **Delete** patients who are not osteoporotic (0) **Export** results to Microsoft Excel®. **Name** document 'CLY OS'
Step 2	Create a table containing patients with a diagnosis of osteoporosis	**Use** Microsoft Access® **Select '**Tables', 'New', 'Import Table' **Import** Microsoft Excel® document 'CLY OS' and rename field c1 to 'Osteoporosis' (Table 'CLY OS')
Step 3	Identify patients with a diagnosis of osteoporosis who are prescribed supplementary calcium	**Use** form 'Query maker' in Microsoft Access® **Select** in 'Drug' field/ 'group': • 'Supplement' for criterion 1 **Press** 'view' **Create** new query by using 'desing view' **Select '**tbl_temp' and table 'CLY OS' **Link** tables via 'patientKey' **Apply** 'patientKey', osteoporosis [1] (Table 'CLY OS') and d1 [not like "0"] ('tbl_temp') **Run** query 1 ➔ Number of 'Yes' results

Step 4	Identify patients with a diagnosis of osteoporosis who are not prescribed supplementary calcium	**Create** new query by using 'Find Unmatched Query Wizard' **Select** table 'CLY OS' **Press** 'next' **Select** 'Queries' / 'query 1' **Press** 'next' **Link** tables via 'patientKey' **Press** 'next' **Select** 'patientKey' **Press** 'next' ➔ Number of total 'No' results
Step 5	Search for justifications of non-adherence	**Use** form 'Query maker' in Microsoft Access® **Select** in 'Read code' field: • 'Adequate dietary intake of calcium' for criterion 1 • 'Adequate dietary intake of vitamin D' for criterion 2 **Create** new query by using 'desing view' **Select '**tbl_temp' and 'CLY_OS Without Matching Query 2' **Link** via 'patientKey' **Apply** 'patientKey', c1[1], c2[1] In 'SQL view' change AND to OR between c1 and c2 **Run** query 3 ➔ Number of justified non-adherence= No(J) ➔ Number of unjustified non-adherence= Number of total No-results- No(J)= No(U)

CRITERION 4

Patient with a recorded diagnosis of osteopenia
Is prescribed supplementary calcium (vitamin D)

Step	**What?**	**How?**
Step 1	Identify patients with a diagnosis of osteopenia	**Use** form 'Query maker' in Microsoft Access® **Select** in 'Read code' field: • 'Osteopenia' for criterion 1 **Press** 'view' **Sort** patients by 'Osteopenia' **Delete** patients who are not osteopenic (0) **Export** results to Microsoft Excel®. **Name** document 'CLY ON'
Step 2	Create a table containing patients with a diagnosis of osteopenia	**Use** Microsoft Access® **Select '**Tables', 'New', 'Import Table' **Import** Microsoft Excel® document 'CLY ON' and rename field c1 to 'Osteopenia' (Table 'CLY ON')
Step 3	Identify patients with a diagnosis of osteopenia who are prescribed supplementary calcium	**Use** form 'Query maker' in Microsoft Access® **Select** in 'Drug' field/ 'group': • 'Supplement' **Press** 'view' **Create** new query by using 'desing view' **Select '**tbl_temp' and table 'CLY ON' **Link** tables via 'patientKey' **Apply** 'patientKey', osteopenia [1] (Table 'CLY ON') and d1 [not like "0"] ('tbl_temp') **Run** query 1 ➔ Number of 'Yes' results

Step 4	Identify patients with a diagnosis of osteopenia who are not prescribed supplementary calcium	**Create** new query by using 'Find Unmatched Query Wizard' **Select** table 'CLY ON' **Press** 'next' **Select** queries/ 'query 1' **Press** 'next' **Link** tables via 'patientKey' **Press** 'next' **Select** 'patientKey' **Press** 'next' ➔ Number of total 'No' results
Step 5	Search for justifications of non-adherence	**Use** form 'Query maker' in Microsoft Access® **Select** in 'Read code' field: • 'Adequate dietary intake of calcium' for criterion 1 • 'Adequate dietary intake of vitamin D' for criterion 2 **Create** new query by using 'design view' **Select '**tbl_temp' and 'CLY_ON Without Matching Query 2' **Link** via 'patientKey' **Apply** 'patientKey', c1[1], c2[1] In 'SQL view' change AND to OR between c1 and c2 **Run** query 3 ➔ Number of justified non-adherence= No(J) ➔ Number of unjustified non-adherence= Number of total No-results- No(J)= No(U)

CRITERION 5

A patient with confirmed vitamin D deficiency or aged 65 or older
is prescribed vitamin D

Step	**What?**	**How?**
Step 1	Identify patients with confirmed vitamin D deficiency or aged over 65 *who are prescribed vitamin D*	**Use** form 'Query maker' in Microsoft Access® **Select** in 'Read code' field: • '>=65 years' for criterion 1 • 'Vitamin D deficiency' for criterion 2 **Press** 'view' **Create** new query by using 'design view' **Select '**tbl_temp' **Apply** 'patientKey', c1[1], c2 [1] In 'SQL view' change AND to OR between c1 and c2 **Run** query 1 **Export** results to Microsoft Excel®. **Name** document 'CLY patients over 65 or vitamin D deficiency'
Step 2	Create a table containing patients aged 65 or older	**Use** Microsoft Access® **Select '**Tables', 'New', 'Import Table' **Import** Microsoft Excel® document 'CLY patients over 65' and rename field c1 to '>=65 years' and c2 to 'vd deficiency' (table 'CLY patients over 65 or vitamin deficiency')
Step 3	Identify patients aged 65 years or older or with a confirmed vitamin d deficiency who are prescribed vitamin d	**Use** form 'Query maker' in Microsoft Access® **Select** in 'Drug' field/ 'group': • 'Supplement' **Press** 'view' **Create** new query by using 'design view' **Select '**tbl_temp' and table 'CLY patients over 65 or vitamin deficiency' **Link** tables via 'patientKey' **Apply** 'patientKey' ('CLY patients over 65 or vitamin deficiency') and d1 [not like "0"] ('tbl_temp') **Run** query 2 Number of Yes results

Step 4	Identify patients aged 65 years or older or with a confirmed vitamin D deficiency who are not prescribed vitamin d	**Create** new query by using 'Find Unmatched Query Wizard' **Select** table 'CLY patients over 65 or vitamin D deficiency' **Press** 'next' **Select** queries/ query 2 **Press** 'next' **Link** tables via 'patientKey' **Press** 'next' **Select** 'patientkey' **Press** 'next' ➔ Number of total No results= No(U) as there is no justification for not prescribing vitamin d in this case

CRITERION 6

A patient with osteoporosis
is treated with an antiresorptive/ osteoanabolic agent (bisphosphonate, strontium ranelate, raloxifene, teriparatide, calcitonin)

Step	What?	How?
Step 1	Identify patients treated with bisphosphonate, raloxifene, strontium ranelate, OR calcitonin	**Use** form 'Query maker' in Microsoft Access® **Select** ➔ 'Osteoporosis' for criterion 1 ➔ 'Bisphosphonate' for criterion 2 ➔ 'strontium ranelate' for criterion 3 ➔ 'raloxifene' for criterion 4 ➔ 'calcitonin' for criterion 5 **Sort** patients by 'Osteoporosis' **Delete** patients who are not osteoporotic (0) **Sort** patients by different treatments (bisphosphonates, strontium ranelate, raloxifene, calcitonin) **Delete** patients who are not receiving treatment (0)

CRITERION 7

Patient prescribed supplementary calcium
Is prescribed a daily dose of 500-1500 mg calcium

Step	**What?**	**How?**
Step 1	Identify patients prescribed supplementary calcium	**Use** form 'Query maker' in Microsoft Access® **Select** in 'Drug' field/ 'group': • 'supplement' for criterion 1 **Press** 'view' **Create** new query by using 'design view' **Select** 'tbl_temp' **Apply** 'patientKey', c1, d1[not like "0"], c2, d2, c3 **Run** query 1
Step 2	Identify number of Yes, No(J), No(U), IDS	**Export** results of 'step 1' to Microsoft Excel® **Inspect** on the results ➔ Patient prescribed a daily dose of 500-1500 mg calcium= Yes ➔ Patient not prescribed a daily dose of 500-1500 mg calcium= No(U) ➔ documentation concerning dose, preparation and frequency not clear= IDS

CRITERION 8

Patient prescribed vitamin D
Is prescribed a daily dose of 10 – 20 microgram (400 – 800 IU) vitamin D

Step	**What?**	**How?**
Step 1	Identify patients who are prescribed vitamin D	**Use** Microsoft Access® **Create** new query by using 'design view' **Select** table: 'Patients: Drug History_tbl' **Apply** 'drug name': [like *Adcal D3* or like *Calceos* or like *Calcichew D_3* or like *Cacit D_3* or like *Calfovit D_3* or like *colecalciferol* or like *vitamin d*] Also show dose and frequency. **Run** query 1 **Export** results to Microsoft Excel®
Step 2	Identify patients who are prescribed a daily dose of 10 – 20 microgram (400 – 800 IU) vitamin D (Standard) Possible drugs containing 10 micrograms (400 units) colecalciferol are the following: Adcal D_3®, Calceos®, Calcichew D_3® forte Possible drugs containing 11 micrograms (500 units) colecalciferol are the following: Cacit D_3® Possible drugs containing 5 micrograms (200 units) colecalciferol are the following: Calcichew D_3® Possible drugs containing 20 micrograms (800 units) colecalciferol are the following: Calfovit®	**Check manually** if patients are receiving the appropriate dose regimen (especially focus on Calcichew D3, it is necessary to take it twice a day!)

CRITERION 9

A patient with osteoporosis and NOT prescribed any of the following: bisphosphonates, raloxifene, strontium ranelate or calcitonin
Is prescribed 1000 mg calcium plus 800 IU vitamin D per day.

Step	**What?**	**How?**
Step 1	Identify patients with osteoporosis and NOT prescribed bisphosphonates, raloxifene, strontium ranelate or calcitonin	**Use** form 'Query maker' in Microsoft Access® **Select** in 'Read Code' field: ➔ 'Osteoporosis' for criterion 1 ➔ 'Bisphosphonate' for criterion 2 ➔ 'strontium ranelate' for criterion 3 ➔ 'raloxifene' for criterion 4 ➔ 'calcitonin' for criterion 5 **Press** 'view' **Create** new query by using 'design view' **Select** 'tbl_temp' **Apply** 'patientKey', c1 [1], c2 [0], c3 [0], c4 [0], c5 [0] **Run** query 1
Step 2	Preparation for step 3	**Export** results to Microsoft Excel® **Select '**File', 'Export' and follow the process. **Name** document 'Patient OS no (BP_ ralox_ stront_ calc)'
Step 3	Create a table in Microsoft Access® containing data exported in step 2	**Use** Microsoft Access® **Select '**Tables', 'New', 'Import Table' **Import** Microsoft Excel® document 'Patient OS no (BP_ ralox_ stront_ calc)'and rename field c1 to 'osteoporosis', c2 to 'bp (ex ibandro)', c3 to 'strontium', c4 to 'raloxi' and c5 to 'calcito' (table 'Criterion 9 search excluding ibandronic acid')

Step 4	Identify osteoporotic patients who are prescribed calcium and/ or vitamin D	**Use** form 'Query maker' in Microsoft Access® **Select** in 'Drug' field/ 'group': • 'supplement' for criterion 1 **Press** 'view' **Create** new query by using 'design view' **Select '**tbl_temp' and table 'CLY OS' (was created in Criterion 3, Step 2) **Link** tables via 'patientKey' **Apply** 'patientKey', osteoporosis [1] (Table 'CLY OS') and d1 [not like "0"] ('tbl_temp') **Run** query 2 (query 'CLY OS on supplement')
Step 5	Identify patients with a diagnosis of osteoporosis and not treated bisphosphonates, raloxifene, strontium ranelate or calcitonin who are prescribed >=1000 mg calcium 800 IU vitamin D per day	**Create** new query by using 'design view' **Select** table 'Criterion 9 search excluding ibandronic acid' and query 'CLY OS on supplement' **Link** tables via 'patientKey' **Apply** 'patientKey' (table 'Criterion 9 search excluding ibandronic acid') and d1, c2, c3, d2 **Run** query 3 (query 'Criterion 9 Yes Results') **Export** data to Microsoft Excel® and **check manually** if the correct dose is prescribed. ➔ only calcium is prescribed or only vitamin d is prescribed or the wrong dose is prescribed= No(U) ➔ the correct dose is prescribed= Yes ➔ documented date is not clear concerning dose, preparation, frequency= IDS
Step 6	Identify patients with a diagnosis of osteoporosis and not treated bisphosphonates, raloxifene, strontium ranelate or calcitonin who are not prescribed >=1000 mg calcium 800 IU vitamin d per day	**Create** new query by using 'Find Unmatched Query Wizard' **Select** table 'Criterion 9 Search excluding ibandronic acid' **Press** 'next' **Select** queries/ query 'Criterion 9 Yes Results' **Press** 'next' **Link** tables via 'patientKey' **Press** 'next' **Select** 'patientKey' **Press** 'next' ➔ Number additional No results= No(U) as there is no justification for not prescribing calcium and or vitamin d in this case or prescribing it in another dose

CRITERION 10

Patient with a recorded diagnosis of osteoporosis
Is prescribed an oral bisphosphonate as first-line therapy

Step	**What?**	**How?**
Step 1	Identify patients with a diagnosis of osteoporosis who are prescribed an oral bisphosphonate (alendronic acid, disodium etidronate, risedronate sodium) as first-line therapy Drugs containing oral bisphosphonates are the following: Alendronic acid (Fosamax®, Fosavance®), disodium etidronate (Didronel PMO®), risedronate sodium (Actonel®)	**Use** form 'Query maker' in Microsoft Access® **Select** ➔ 'Bisphosphonate' for criterion 1 ➔ **'**Osteoporosis' for criterion 2 ➔ 'raloxifene' for criterion 3 ➔ 'strontium ranelate' for criterion 4 ➔ 'calcitonin' for criterion 5 ➔ 'teriparatide' for criterion 6 **Sort** patients by 'osteoporosis' **Delete patients** who are not osteoporotic (0) **Sort** patients by each treatment **Delete** patients who are not receiving any treatment (0) **Export** results to Microsoft Excel® **Inspect** on results, focus on the date: identify patients who were prescribed a bisphosphonate <u>at first</u>

CRITERION 11

Patient with a recorded diagnosis of osteopenia
Is prescribed an oral bisphosphonate as first-line therapy

Step	**What?**	**How?**
Step 1	Identify patients with a diagnosis of osteopenia who are prescribed an oral bisphosphonate (alendronic acid, disodium etidronate, risedronate sodium) as first-line therapy Drugs containing oral bisphosphonates are the following: Alendronic acid (Fosamax®, Fosavance®), disodium etidronate (Didronel PMO®), risedronate sodium (Actonel®)	**Use** form 'Query maker' in Microsoft Access® **Select** ➔ 'Bisphosphonate' for criterion 1 ➔ **'**Osteopenia' for criterion 2 ➔ 'raloxifene' for criterion 3 ➔ 'strontium ranelate' for criterion 4 ➔ 'calcitonin' for criterion 5 ➔ 'teriparatide' for criterion 6 **Sort** patients by 'osteopenia' **Delete patients** who are not osteopenic (0) **Sort** patients by each treatment **Delete** patients who are not receiving any treatment (0) **Export** results to Microsoft Excel® **Inspect** on results, focus on the date: identify patients who were prescribed a bisphosphonate <u>at first</u>

CRITERION 12

A patient prescribed any of the following: bisphosphonates, raloxifene, strontium ranelate, calcitonin or teriparatide
has no contraindication on record

Step	What?	How?
Step 1	Identify patients who are prescribed bisphosphonates, raloxifene, strontium ranelate, cacitonin or teriparatide	**Use** form 'Query maker' in Microsoft Access® **Select** ➔ 'Osteopenia' for criterion 1 ➔ 'Bisphosphonate' for criterion 2 ➔ 'strontium ranelate' for criterion 3 ➔ 'raloxifene' for criterion 4 ➔ 'calcitonin' for criterion 5 ➔ 'teriparatide' for criterion 6 **Sort** patients by 'Osteopenia'' **Delete** patients who are not osteopenic (0) **Sort** patients by different treatments (bisphosphonates, strontium ranelate, raloxifene, calcitonin) **Delete** patients who are not receiving treatment (0) **Export** results to Microsoft Excel ® **Add** patients receiving treatment and identified in criterion 6

Step 2	Check for contraindications	**Use** form 'Query maker' in Microsoft Access® **Select** ➔ 'Contraindication to Bisphosphonate' for criterion 1 ➔ 'Contraindication to strontium ranelate' for criterion 2 ➔ 'Contraindication to raloxifene' for criterion 3 ➔ 'Contraindication to calcitonin' for criterion 4 ➔ 'Contraindication to teriparatide' for criterion 5 **Delete** '0' results **Check** patients with '1' results if they receive the agent for which a contraindication was recorded. If necessary mark them as No(U)

CRITERION 13

A patient receiving treatment for osteoporosis/ osteopenia
is prescribed a standard dose regimen

Step	**What?**	**How?**
Step 1	Prepare for identifying main patient groups (female+ osteoporosis, postmenopausal+ osteoporosis, postmenopausal+ osteopenia, male+ osteoporosis)	**Use** form 'Query maker' in Microsoft Access® **Select** in 'Read Code' field: ➔ 'Postmenopausal' for criterion 1 ➔ 'Osteoporosis' for criterion 2 ➔ 'Osteopenia' for criterion 3 ➔ 'Female' for criterion 4 ➔ 'Male' for criterion 5 **Press** 'view'
Step 2	Identify female patients with a diagnosis of osteoporosis and create a table in Microsof Access® containing these patients	**Create** new query by using 'design view' **Select** 'tbl_temp' **Apply** 'patientKey', c4 [1], c2 [1] **Run** and save query 1 ('Female Osteoporosis') **Select '**File', 'Export' to Microsoft Excel® by following the process. Name document 'Female OS' **Select '**Tables', 'New', 'Import Table' **Import** Microsoft Excel® document 'Female OS'and rename field c4 to 'female' and c2 to 'Osteoporosis' (table 'Female Osteoporosis')
Step 3	Identify postmenopausal patients with a diagnosis of osteoporosis and create a table in Microsoft Access® containing these patients	**Create** new query by using 'design view' **Select** 'tbl_temp' **Apply** 'patientKey', c1 [1], c2 [1] **Run** and save query 2 ('postmenopausal osteoporosis') **Select '**File', 'Export' to Microsoft Excel® by following the process. Name document 'Postmenopausal OS'

		Select ‘Tables’, ‘New’, ‘Import Table’ **Import** Microsoft Excel® document ‘Postmenopausal OS’and rename field c1 to ‘postmenopausal’ and c2 to ‘Osteoporosis’ (table ‘Postmenopausal Osteoporosis’)
Step 4	Identify postmenopausal patients with a diagnosis of osteopenia and create a table in Microsof Access® containing these patients	**Create** new query by using ‘design view’ **Select** ‘tbl_temp’ **Apply** ‘patientKey’, c1 [1], c3 [1] **Run** and save query 3 (‘Postmenopausal Osteopenia’) **Select ‘**File’, ‘Export’ to Microsoft Excel® by following the process. **Name** document ‘Postmenopausal ON’ **Select ‘**Tables’, ‘New’, ‘Import Table’ **Import** Microsoft Excel® document ‘Postmenopausal ON’ and rename field c1 to ‘postmenopausal’ and c3 to ‘osteopenia’ (table ‘Postmenopausal Osteopenia’)
Step 5	Identify male patients with a diagnosis of osteoporosis and create a table in Microsof Access® containing these patients	**Create** new query by using ‘design view’ **Select** ‘tbl_temp’ **Apply** ‘patientKey’, c5 [1], c2 [1] **Run** and save query 4 (‘male osteoporosis’) **Select ‘**File’, ‘Export’ to Microsoft Excel® by following the process. **Name** document ‘Male OS’ **Select ‘**Tables’, ‘New’, ‘Import Table’ **Import** Microsoft Excel® document ‘Male OS’ and rename field c5 to ‘Male’ and c2 to ‘Osteoporosis’ (table ‘Male Osteoporosis’)
Step 6	Identify patients prescribed daily 2g PO strontium ranelate	**Use** form ‘Query maker’ in Microsoft Access® **Select** in ‘drug’ field/ ‘group’: ➔ ‘Strontium ranelate’ for criterion 1 **Press** ‘view’ **Create** new query by using ‘design view’ **Select** ‘tbl_temp’ **Apply** ‘patientKey’, c1 [not like “0”], d1, c2, d2, c3 **Run** query 5 (query ‘Patient prescribed strontium ranelate’) **Export** data to Microsoft Excel® and check

		manually if they are prescribed 2g PO daily. **Create** new query by using design view **Select** table 'Postmenopausal Osteoporosis' and query 'Patient prescribed strontium ranelate' **Link** tables via 'patientKeys' **Apply** patient keys **Run** query 6 **Apply '**patientKey' ➔ prescribed 2g PO daily and postmenopausal woman with osteoporosis= Yes ➔ not prescribed 2g PO daily or not postmenopausal woman with osteoporosis= No(U) ➔ recorded data not clear=IDS ➔ No(J)=0… there is no justification for prescribing another dose or prescribing to another patient group
Step 7	Identify patients prescribed daily 60mg PO raloxifene	**Use** form 'Query maker' in Microsoft Access® **Select** in 'drug' field/ 'group': ➔ 'Raloxifene' for criterion 1 **Press** 'view' **Create** new query by using 'design view' **Select** 'tbl_temp' **Apply** 'patientKey', c1 [not like "0"], d1, c2, d2, c3 **Run** query 7 (query 'Patient prescribed raloxifene') **Export** data to Microsoft Excel® and check manually if they are prescribed 60mg PO daily. **Create** new query by using 'design view' **Select** table 'Postmenopausal Osteoporosis' and query 'Patient prescribed raloxifene' **Link** tables via 'patientKey' **Apply** 'patientKey' **Run** query 8 ➔ prescribed 60mg PO daily and postmenopausal woman with osteoporosis= Yes ➔ not prescribed 60mg PO daily or not postmenopausal woman with osteoporosis= No(U) ➔ recorded data not clear=IDS

Step 8	Identify patients prescribed teriparatide (20 micrograms daily, for a maximum duration of treatment of 18 months)	**Use** form 'Query maker' in Microsoft Access® **Select** in 'drug' field/ 'group': ➔ 'Teriparatide' for criterion 1 **Press** 'view' **Create** new query by using 'design view' **Select** tbl_temp **Apply** 'patientKey', c1 [not like "0"], d1, c2, d2, c3 **Run** Query 9 (Query 'Patient prescribed teriparatide') Export data to Microsoft Excel® and check manually if they are prescribed 20 micrograms daily, for a maximum duration of treatment of 18 months. **Create** new query by using design view **Select** Table 'Patients: NHS Read codes_QOF and MAT data items_tbl' and Query 'Patient prescribed teriparatide' **Link** tables via patient keys **Apply** 'patient keys' and 'mat data item' [male] **Run** Query 10 ➔ prescribed 20 micrograms daily, for a maximum duration of treatment of 18 months and not male = Yes ➔ not prescribed 20 micrograms daily, for a maximum duration of treatment of 18 months or male= No(U) ➔ recorded data not clear=IDS
Step 9	Identify patients prescribed calcitonin (200 units daily intranasally)	**Use** form 'Query maker' in Microsoft Access® **Select** in drug field/ group: ➔ Calcitonin for criterion 1 **Press** 'view' **Create** new query by using 'design view' **Select** 'tbl_temp' **Apply** 'patientKey', c1 [not like "0"], d1, c2, d2, c3 **Run** query 11 (query 'Patient prescribed calcitonin') Export data to Microsoft Excel® and check manually if they are prescribed 200 units intranasally. **Create** new query by using 'design view' **Select** table 'Postmenopausal Osteoporosis' and query 'Patient prescribed calcitonin' **Link** tables via 'patientKey'

		Apply 'patientKey' **Run** query 12 ➔ prescribed 200 units intranasally and postmenopausal woman with osteoporosis= Yes ➔ not prescribed 200 units intranasally or not postmenopausal woman with osteoporosis= No(U) ➔ recorded data not clear=IDS
Step 10	Identify patients prescribed a standard dose regimen for bisphophonates	**Use** form 'Query maker' in Microsoft Access® **Select** in 'drug' field/ 'group': ➔ BP **Press** 'view' **Create** new query by using 'design view' **Select** 'tbl_temp' and 'Patients: NHS Read codes_QOF and MAT data items_tbl' **Apply** 'patientKey', c1, c2, c3,d3 ('tbl_temp') and mat data item [male] (table 'Patients: NHS Read codes_QOF and MAT data items_tbl') **Run** query 13 **Export** results to Microsoft Excel® and check manually if patients are prescribed the correct dose regimen: ➔ Alendronic acid: 10mg po. Justification for not being prescribed 10mg:glucocorticoid induced osteoporosis and prescribed 5mg po ➔ Disodium etidronate: 400mg for 14 days PO, 1.25g calcium carbonate for 76 days PO (only if glucocorticoid induced osteoporosis) ➔ Risedronate sodium 5mg daily PO (only if glucocorticoid induced osteoporosis) **Create** new query by using 'design view' **Select** 'tbl_temp' and 'Patients: NHS Read codes_QOF and MAT data items_tbl' **Apply** 'patientKey', c1, c2, c3,d3 ('tbl_temp') and mat data item [female] (table 'Patients: NHS Read codes_QOF and MAT data items_tbl') **Run** query 14 **Export** results to Microsoft Excel® and check manually if patients are prescribed the correct dose regimen: ➔ Alendronic acid: 10mg po daily, or 70 mg one weekly PO. Justification for not being prescribed 10mg or 70 mg once

		weekly PO: glucocorticoid induced osteoporosis or osteopenia and prescribed 5mg PO. ➔ Disodium etidronate: 400mg for 14 days PO, 1.25g calcium carbonate for 76 days PO ➔ Risedronate sodium 5mg daily PO or 35 mg weekly PO (only if osteoporosis) **Count** only one result per patient. Delete results for ibandronic acid.

CRITERION 14

A patient with osteoporosis on bisphosphonate therapy
is on the preferred choice*
* 1- Alendronate, 2-risedronate, 3-intermittent cyclical etidronate
[Preferred order as shown in the drug history]

Step	What?	How?
Step 1	Drugs containing bisphosphonates are the following: Alendronic acid (Fosamax®, Fosavance®), disodium etidronate (Didronel PMO®), risedronate sodium (Actonel®)	**Use** form 'Query maker' in Microsoft Access® **Select** in 'Read Code' field ➔ 'Osteoporosis' for criterion 1 ➔ 'Bisphosphonate' for criterion 2 **Press** 'view' **Delete** patients who are not osteoporotic (0) **Delete** patients who are not prescribed a bisphosphonate (0) **Sort** patients by alendronate **Export** results to Excel® **Check** patients receiving a bisphosphonate if they are on the preferred choice by searching the 'general information' table

CRITERION 15

Patient who is on long-term glucocorticoid therapy (≥ 7.5 mg prednisolone or equivalents for ≥ 3 months)
Is prescribed a bisphosphonate

Step	**What?**	**How?**
Step 1	Identify patients who are on long-term glucocorticoid therapy and prescribed a bisphosphonate	**Use** form 'Query maker' in Microsoft Access® **Select** in 'Read Code' field: ➔ 'long-term steroid' for criterion 1 ➔ 'bisphosphonates' for criterion 2 **Press** 'view' **Sort** patients by 'long-term steroids' **Delete** patients who do not receive a long-term treatment with steroids (0) **Export** results to Microsoft Excel **Inspect** on 'Bisphosphonates' column: ➔ '1'= YES ➔ '0'= NO (possible justification: see criterion 12 'reasons to avoid bisphoshonates)

CRITERION 16

A postmenopausal woman prescribed strontium ranelate has an identifiable reason for not being prescribed a bisphosphonate

Step	What?	How?
Step 1	Identify postmenopausal women receiving strontium ranelate Check if there is a reason recorded for not receiving a bisphosphonate	**Use** form 'Query maker' in Microsoft Access® **Select** in 'Read Code' field: ➔ 'postmenopausal' for criterion 1 ➔ 'strontium ranelate' for criterion 2 **Press '**view' **Sort** patients by 'postmenopausal' **Delete** those who are not postmenopausal (0) **Delete** patients who do not receive strontium **ranelate** (0) **Export** results to Microsoft Excel **and check** if patients, who are prescribed strontium ranelate have an identifiable reason for not being prescribed a bisphosphonate **by searching** the 'general information' table.

CRITERION 17

A postmenopausal woman prescribed raloxifene
is receiving it for secondary prevention and has an identifiable reason for not being prescribed a bisphosphonate

Step	What?	How?
Step 1	Identify postmenopausal women receiving raloxifene Check if there is a reason recorded for not receiving a bisphosphonate	**Use** form 'Query maker' in Microsoft Access® **Select** in 'Read Code' field: ➔ 'postmenopausal' for criterion 1 ➔ 'raloxifene' for criterion 2 **Press '**view' **Sort** patients by 'postmenopausal' **Delete** those who are not postmenopausal (0) **Delete** patients who do not receive raloxifene (0) **Export** results to Microsoft Excel **and check** if patients, who are prescribed raloxifene have an identifiable reason for not being prescribed a bisphosphonate **by searching** the 'general information' table.

CRITERION 18

A patient prescribed teriparatide is prescribed it for secondary prevention and meets at least one of the following 2 criteria

- **has a reason to avoid bisphosphonates (See 12)**
- **has an intolerance to strontium ranelate**
  - persistent nausea
  - persistent diarrhoea

And has DEXA scan assessment that puts them in one the following groups

- **aged ≥ 65 years with a T-Score ≤ -4 SD**
- **aged ≥ 65 years with a T-Score ≤ -3.5 SD and has more than two fractures**
- **aged 55-64 years with a T-Score ≤ -4 and has more than two fractures**

Step	What?	How?
Step 1	Identify patients receiving teriparatide Check if the standard is adhered to	**Use** form 'Query maker' in Microsoft Access® **Select** in 'Read Code' field: ➔ 'teriparatide' for criterion 1 **Press '**view' **Sort** patients by 'teriparatide' **Delete** those who do not receive teriparatide (0) **Export** results to Microsoft Excel **and check** if patients, who are prescribed teriparatide meet the criteria listed above **by searching** the patient record

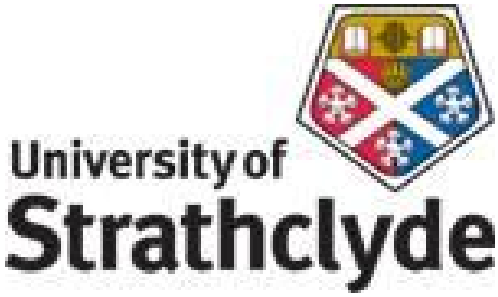
CRITERION 19

A patient prescribed calcitonin is prescribed it for secondary prevention after bisphosphonate, raloxifene or strontium ranelate have been tried or have reasons for excluding from consideration

Step	What?	How?
Step 1	Identify patients receiving calcitonin Check if standard is adhered to	**Use** form 'Query maker' in Microsoft Access® **Select** in 'Read Code' field: ➔ 'calcitonin' for criterion 1 **Press '**view' **Sort** patients by 'calcitonin' **Delete** those who do not receive calcitonin (0) **Export** results to Microsoft Excel **and check** if patients, who are prescribed calcitonin meet the criteria listed above **by searching** the patient record

9.5 Appendix 5

Instructions query builder



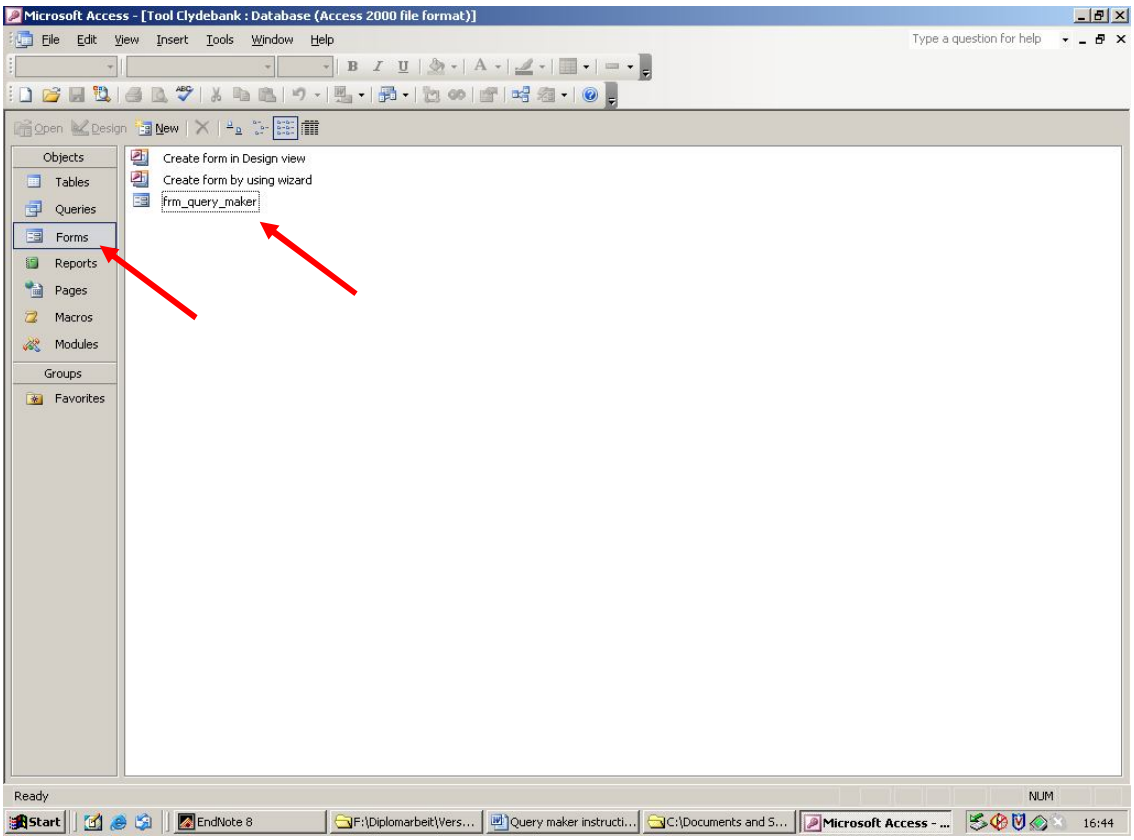
Instructions Query maker

What is the query maker?

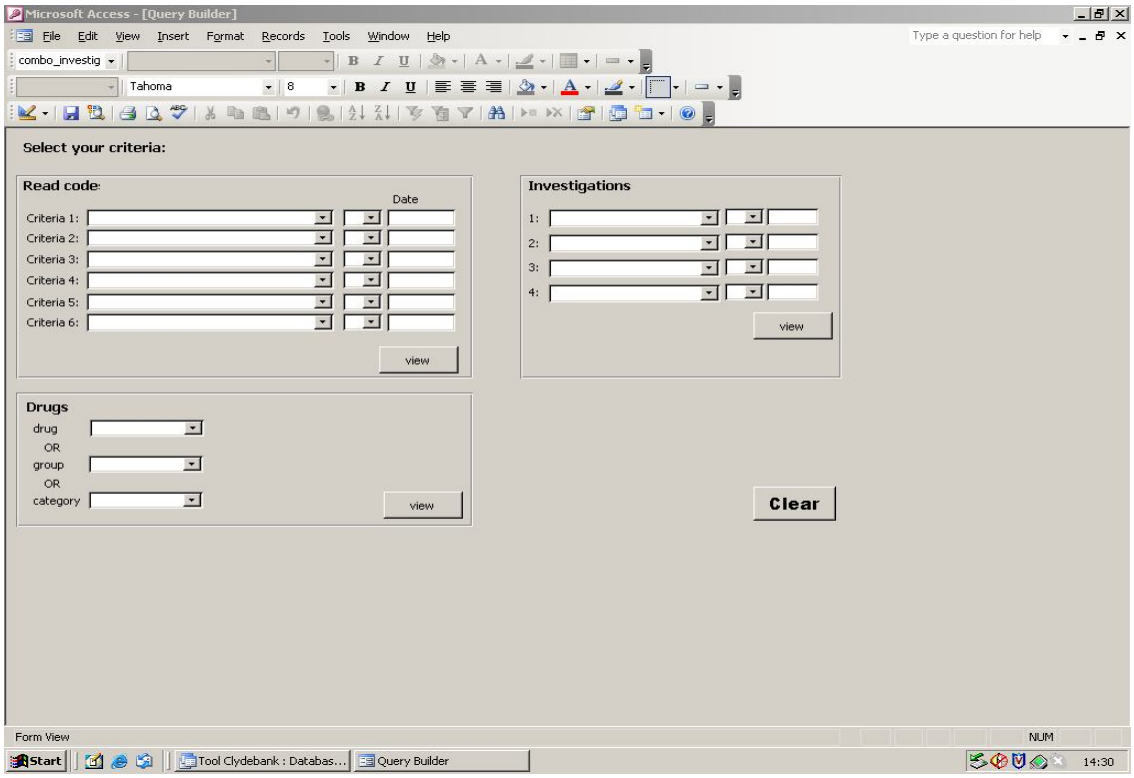
The query maker is a Microsoft Access® form developed by Tobias Dreischulte and Ian Thompson. Its' purpose is to simplify and accelerate the process of data analysis when applying a MAT.

How to use the query maker:

When you open the database, the 'Database window' will appear. To open the query maker click on 'Forms' in the 'object bar' and double-click on 'frm_query_maker':



When you open the form, three fields (Read code, Investigation, Drugs) with drop down menus appear:



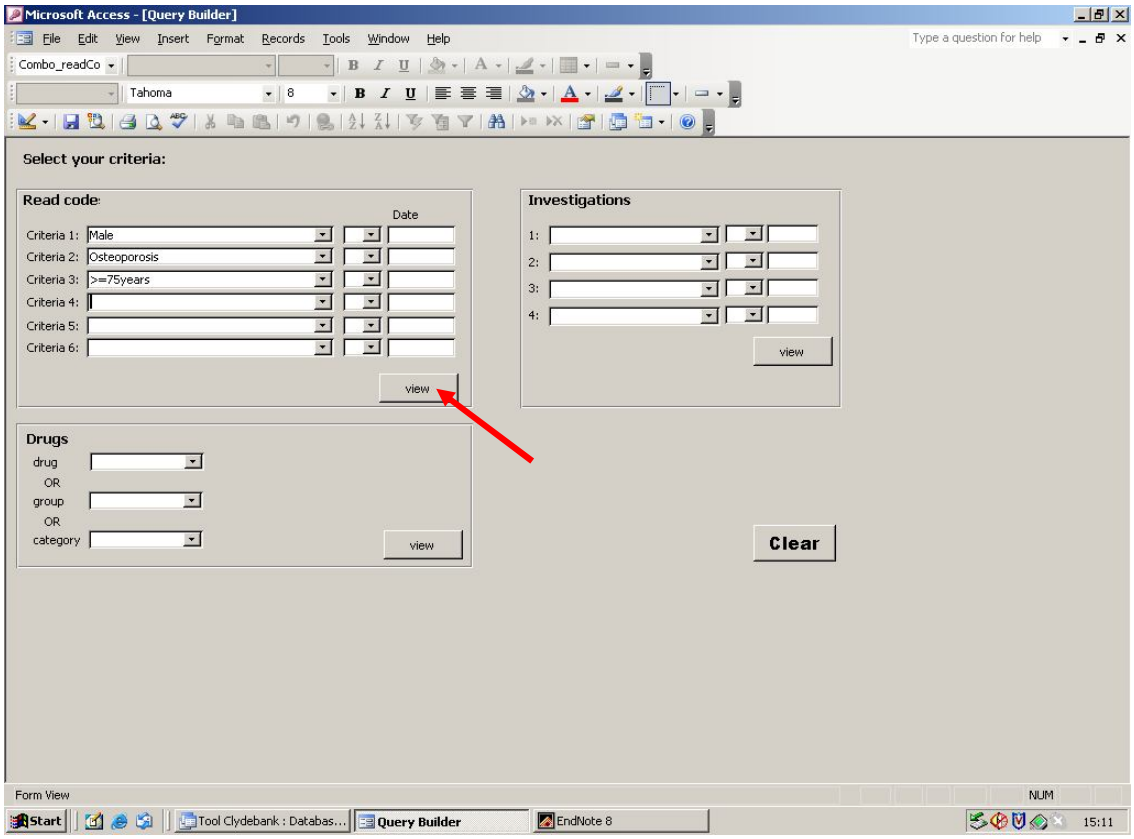
For building a query just select your criteria in the drop down menu. It is not possible to use more than one field at the same time.

Example 1

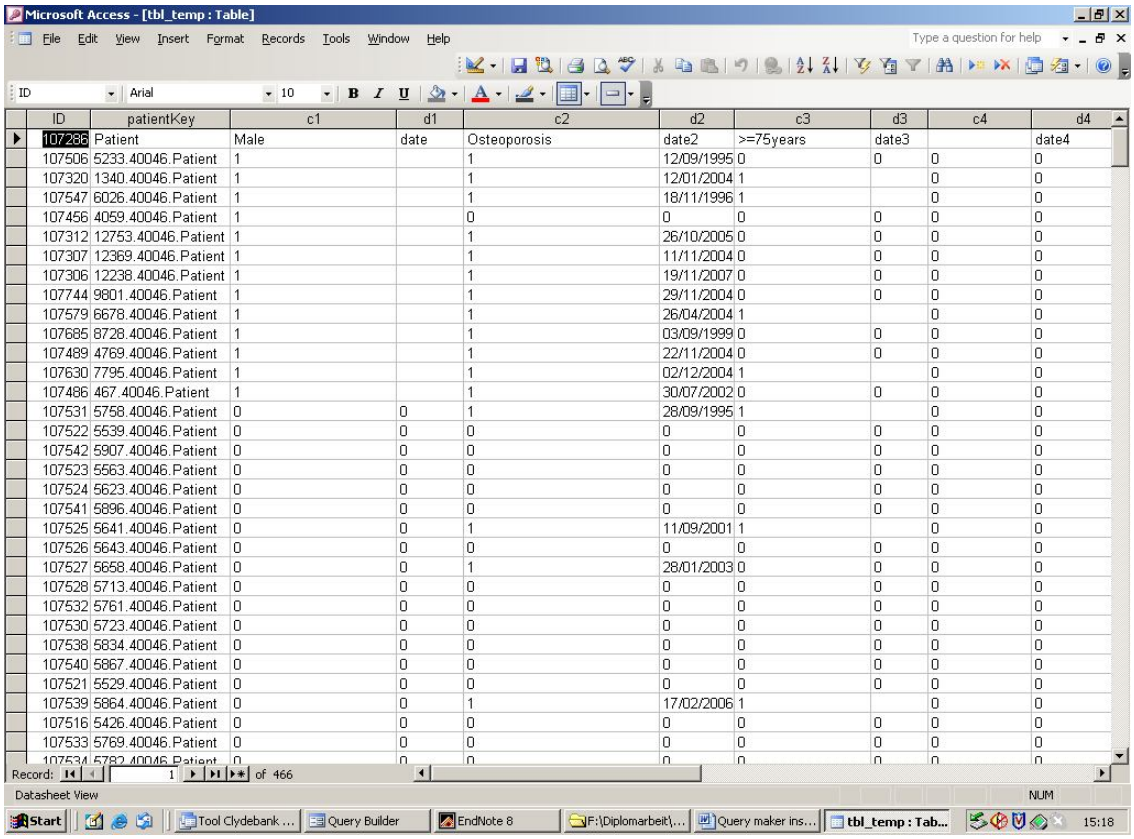
Your question is:

"How many men in the examined population are diagnosed with osteoporosis and 75 years or older?"

Look in the drop down menus in which field the information you need is provided (in our example it is provided in the Read Code field.) Then select 'Male' for criterion 1, 'Osteoporosis' for criterion 2 and >= 75 years (for criterion 3) and click on the 'view' button:



A table will appear showing the results of your question. The table will automatically be named ‘tbl_temp: Table’ and contain 1 and 0 for each criteria selected in the previous step. 1 means ‘Yes’ and 0 means ‘No’. That means you can also tell which patient is not male, is not suffering from osteoporosis or is not older than 75 years:



Microsoft Access - [tbl_temp : Table]

File Edit View Insert Format Records Tools Window Help

ID	patientKey	c1	d1	c2	d2	c3	d3	c4	d4
107286	Patient	Male	date	Osteoporosis	date2	>=75years	date3		date4
107506	5233.40046.Patient	1		1	12/09/1995	0	0	0	0
107320	1340.40046.Patient	1		1	12/01/2004	1		0	0
107547	6026.40046.Patient	1		1	18/11/1996	1		0	0
107456	4059.40046.Patient	1		0	0	0	0	0	0
107312	12753.40046.Patient	1		1	26/10/2005	0	0	0	0
107307	12369.40046.Patient	1		1	11/11/2004	0	0	0	0
107306	12238.40046.Patient	1		1	19/11/2007	0	0	0	0
107744	9801.40046.Patient	1		1	29/11/2004	0	0	0	0
107579	6678.40046.Patient	1		1	26/04/2004	1		0	0
107685	8728.40046.Patient	1		1	03/09/1999	0	0	0	0
107489	4769.40046.Patient	1		1	22/11/2004	0	0	0	0
107630	7795.40046.Patient	1		1	02/12/2004	1		0	0
107486	467.40046.Patient	1		1	30/07/2002	0	0	0	0
107531	5758.40046.Patient	0	0	1	28/09/1995	1		0	0
107522	5539.40046.Patient	0	0	0	0	0	0	0	0
107542	5907.40046.Patient	0	0	0	0	0	0	0	0
107523	5563.40046.Patient	0	0	0	0	0	0	0	0
107524	5623.40046.Patient	0	0	0	0	0	0	0	0
107541	5896.40046.Patient	0	0	0	0	0	0	0	0
107525	5641.40046.Patient	0	0	1	11/09/2001	1		0	0
107526	5643.40046.Patient	0	0	0	0	0	0	0	0
107527	5658.40046.Patient	0	0	1	28/01/2003	0	0	0	0
107528	5713.40046.Patient	0	0	0	0	0	0	0	0
107532	5761.40046.Patient	0	0	0	0	0	0	0	0
107530	5723.40046.Patient	0	0	0	0	0	0	0	0
107538	5834.40046.Patient	0	0	0	0	0	0	0	0
107540	5867.40046.Patient	0	0	0	0	0	0	0	0
107521	5529.40046.Patient	0	0	0	0	0	0	0	0
107539	5864.40046.Patient	0	0	1	17/02/2006	1		0	0
107516	5426.40046.Patient	0	0	0	0	0	0	0	0
107533	5769.40046.Patient	0	0	0	0	0	0	0	0

Record: 1 of 466

Datasheet View NUM

Start | Tool Clydebank ... | Query Builder | EndNote 8 | F:\Diplomarbeit\... | Query maker ins... | tbl_temp : Tab... | 15:18

The second column shows the patient identifier (patient key). Columns c1, c2, c3, etc. present the results of the criteria selected in the previous step for each patient. In our example c1 shows if a patient is male, c2 if the patient has a diagnosis of osteoporosis and c3 the age of the patient. Columns d1, d2, d3, etc. present the date of the data entry.

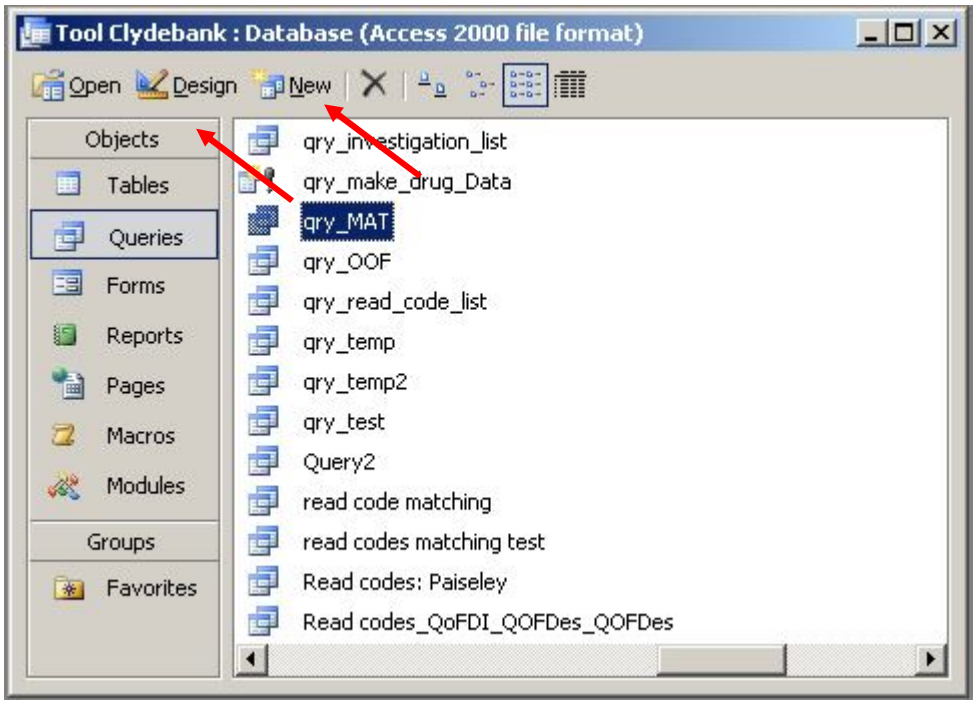
You can now sort the data in 'tbl_temp: Table' by selecting a column and clicking on the 'Sort Ascending' or the 'Sort Descending' icon. You can find those icons in the toolbar above:

Results without use for your question can be deleted by selecting the row and pressing the 'Delete Record' icon. You can find this icon in the toolbar above:

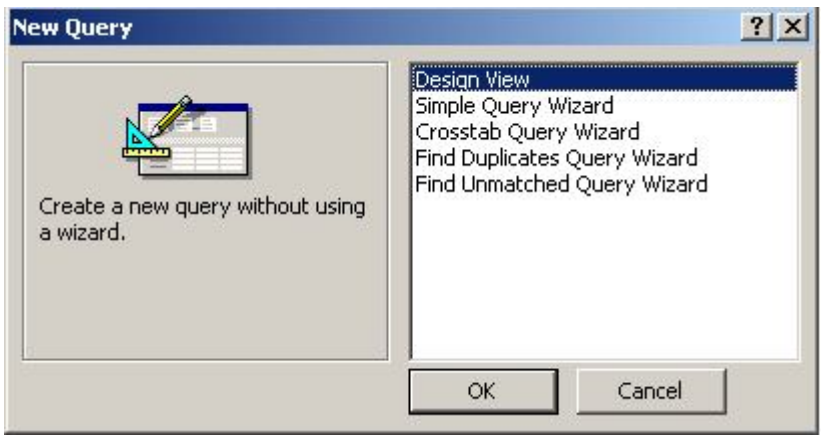
It is also possible to export the results to Microsoft Excel® by selecting 'File' and 'Export'.

To show only the patients who fully adhere to your question (how many of my patients are

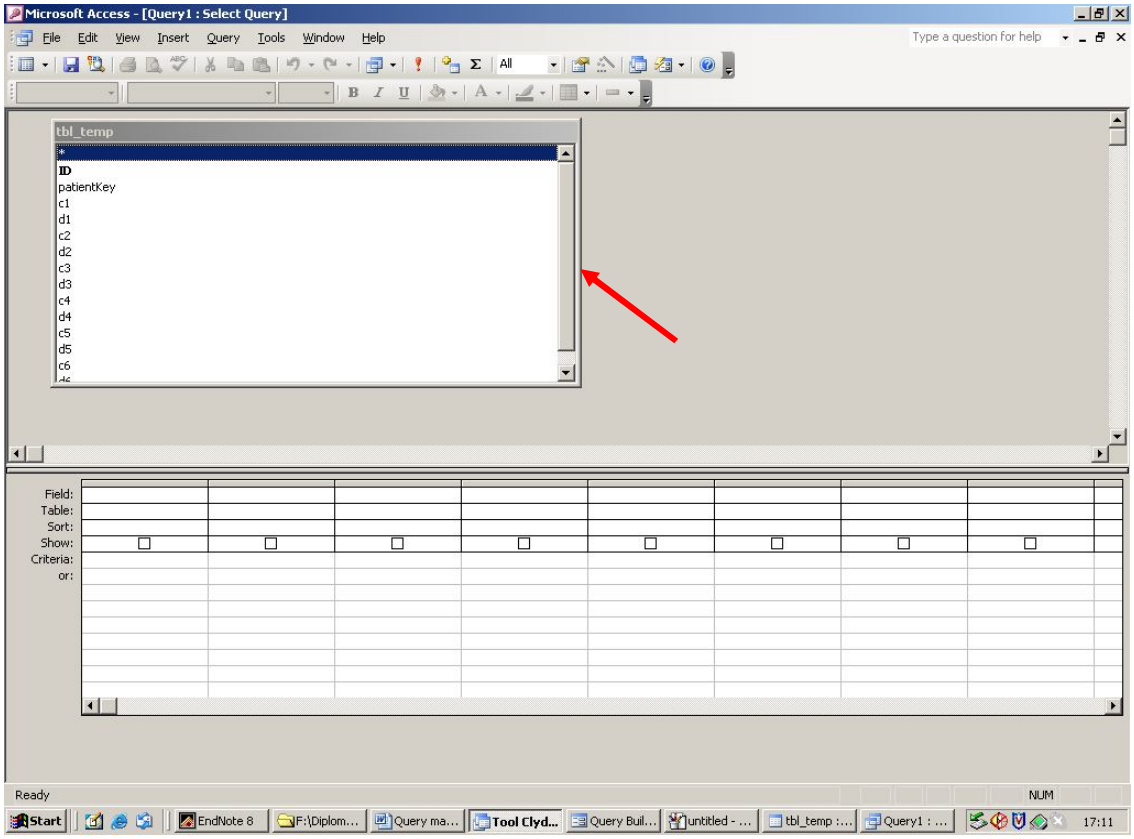
male, 75 years or older and suffer from osteoporosis?) you can run a query. Therefore, minimize ‘tbl_temp: Table’ and the form and open the ‘database window’. Then select ‘Queries’ and ‘New’ by clicking on the icons.



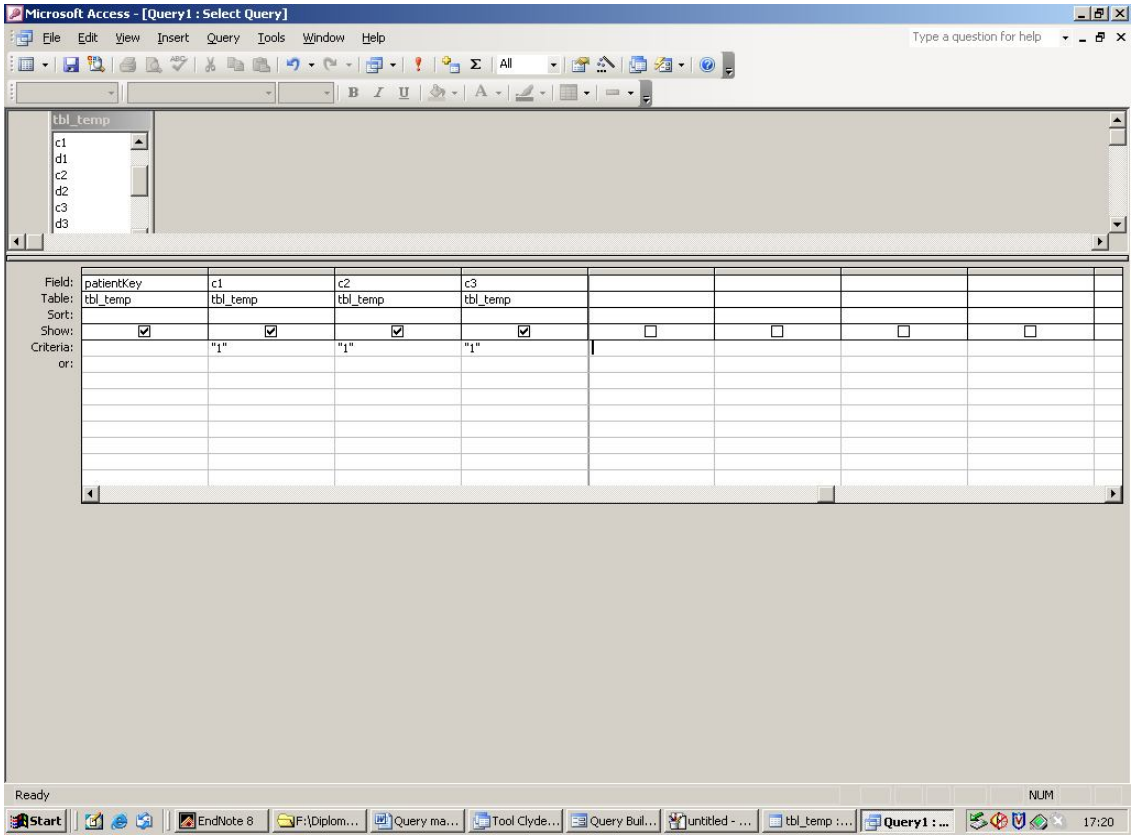
A dialog field will appear. Select ‘Desing View’ and ‘OK’.



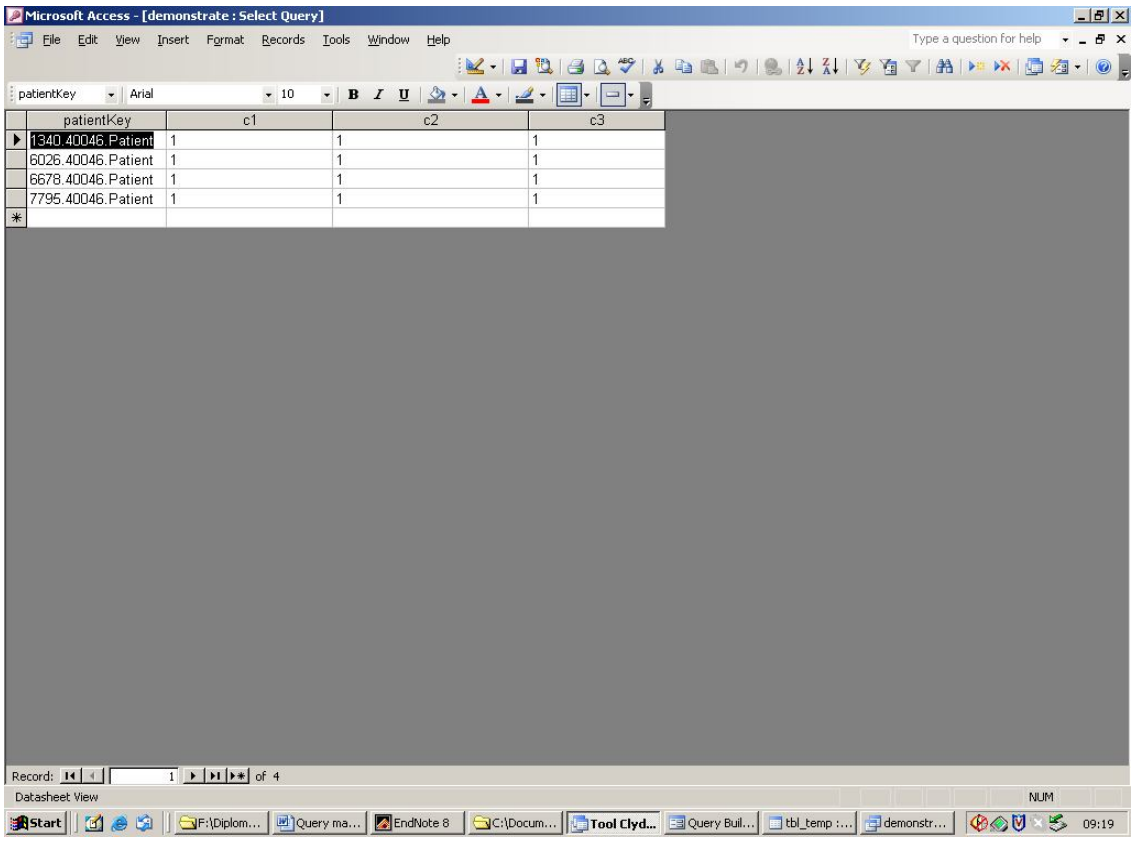
Add tbl_temp. The following window will appear:



In the small ‘tbl_temp’ field you can tell the program what to show after running the query. For solving our example (Example 1) we would select patientKey, c1 (male), c2 (osteoporosis) and c3 (75 years or older) by double clicking and writing 1 in the ‘criteria’ row to tell the software that it shall only show the ‘yes- results’. Then run the query by pressing the ‘Run’ icon, which you can find in the toolbar above:



Your results could for example look like this:



It means the dataset contains of 4 male patients with osteoporosis and 75 years or older.
It is important to now save your results and export them to Microsoft Excel®. Be aware that once you built a new query with the query maker (means select criteria in the drop down menu of the form and press view) tbl_ temp changes- the results of your former question will not be there anymore.

How does the query maker work?

There are four important tables and two important queries, which are necessary for the function of the fields.
The 'Read Code' field accesses to the table 'Patients: NHS Read codes_QOF and MAT data items_tbl' and the query 'qry_MAT'.
The 'Investigations' field accesses to the table 'Patients: Investigations_tbl' and the query 'qry_investigation_list'.
The 'Drugs' field accesses to the table 'Patients: Drug History_tbl' and the table 'Master: Drug list_tbl'.

If you change anything in the format of this tables and queries, the tool will not work anymore! It is important no to rename columns, etc.!

What do I have to do to before importing my dataset into the tool?

Go threw your MAT criterion by criterion and identify the terms you will have to ask for when doing your analysis (e.g. in the example above this terms would be male, osteoporosis and 75 years or older). Make a list of those and decide which data should be shown in which field afterwards. Then produce your three main tables.

How to produce the main tables and import them into the tool

For the 'Read Code' field:

1. **Identify READ Codes for diagnosis, clinical conditions, drugs and investigations which will be included in the project and create a table in Microsoft Excel®:**

   Draw them from a complete list of READ Codes (provided in the research standard folder on your desktop). Also, check http://www.scimp.scot.nhs.uk/coding_guidance.html. At this website, you can find out if a QOF (Quality outcome

framework) for the disease your MAT is about exist. If so Read Codes for use are defined, you have to adopt them for creating MAT data items.

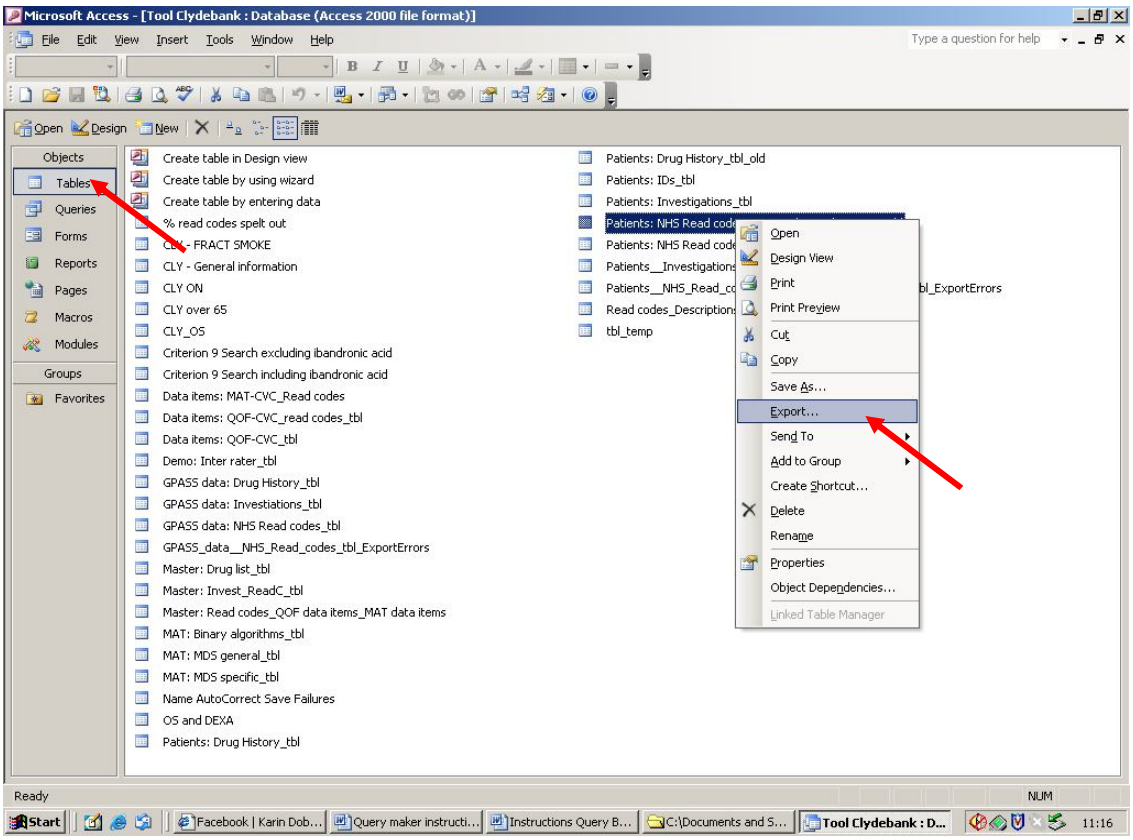
Inspect the READ Codes of the dataset you want to analyze and add additional ones to your table.

Create MAT Data item (term summarizing different READ Codes with the same meaning) for each subset of READ Codes, e.g.:

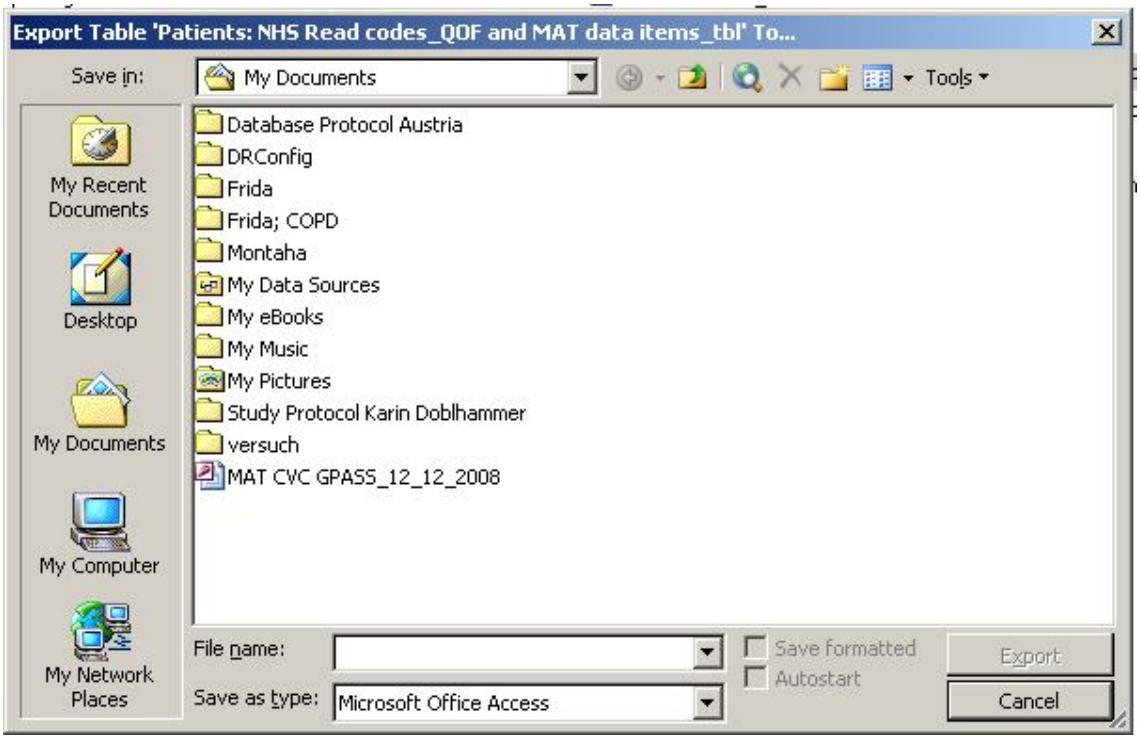
READ Code	Description	MAT Data item
N3305	Drug-induced osteoporosis	Osteoporosis
N330C	Osteoporosis localized spine	Osteoporosis

2. Create the Table 'Patients: NHS Read codes_QOF and MAT data items_tbl'

Copy the training tool and rename it for your purposes. Open your tool and select 'Tables' in the 'object bar'. Click with the right mouse button at 'Patients: NHS Read codes_QOF and MAT data items_tbl' and select 'Export…':



The following dialog field will appear:



Choose where you want to save the table and select in the ‘Save as type’ drop down ‘Microsoft Excel 97-2003’. Click ‘Export’. Go back to your tool in Microsoft Access and open the table ‘Patients: NHS Read codes_QOF and MAT data items_tbl’. Then mark all the data stored in this table and click the ‘Delete Record’ icon:

Click the ‘Save’ icon and close the table.

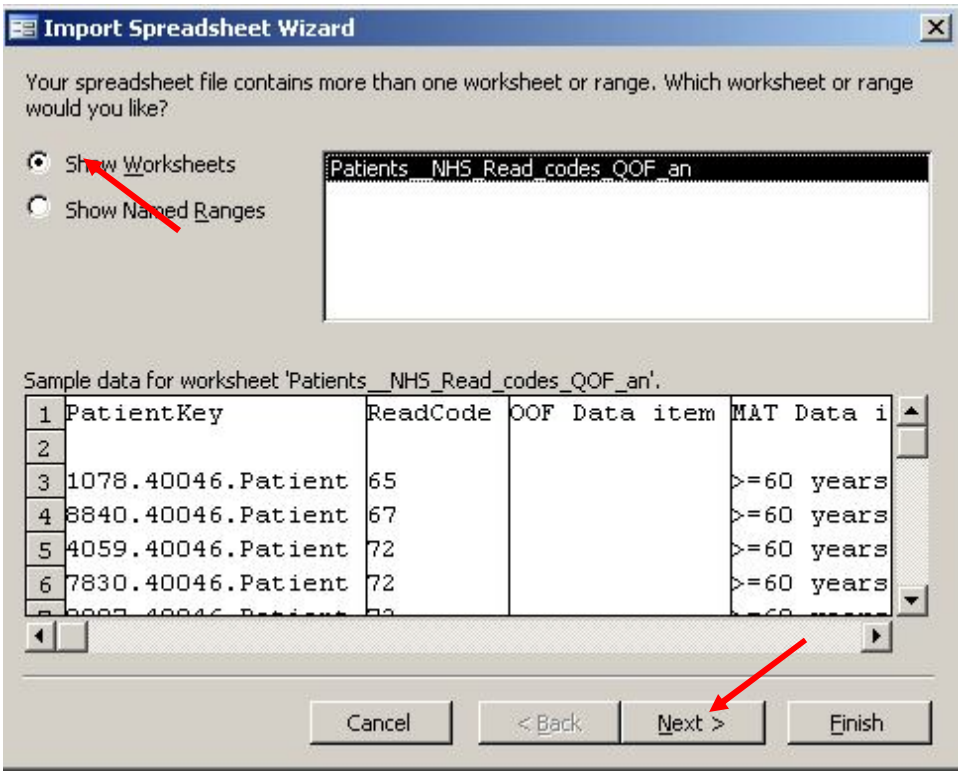
Open the Microsoft Excel® document containing your exported table. Mark all the date stored in this document and delete it, but keep the row headings as they are. Now store the date you want to analyze in your table by copying and pasting. It might be necessary to put data other than Read Codes, like age or sex, in the ReadCode column. If you have to use the same data for more data items you will have to add a letter in the Read Code field, e.g.:

PatientKey	ReadCode	MAT Data item	DateRecorded
1103.C8746.Patient	21	10 years or older	24/01/2005
1105.C8746.Patient	21+	20 years or older	17/07/2002

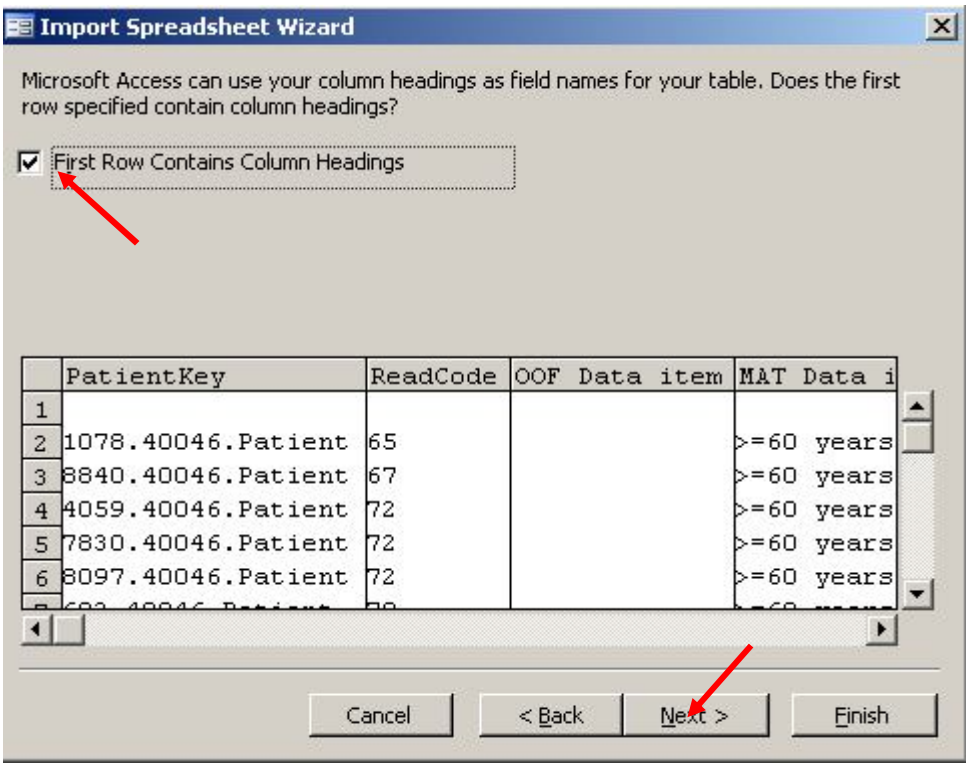
The important columns are patient key, READ Code, MAT Data item and date. The DateRecorded column does not necessarily have to contain data.

Save the table when you are finished and go back to your tool. Select ‘Tables’ in the ‘object bar’. Then select ‘New’ by clicking on the icon in the toolbar above. The following dialog field will appear:

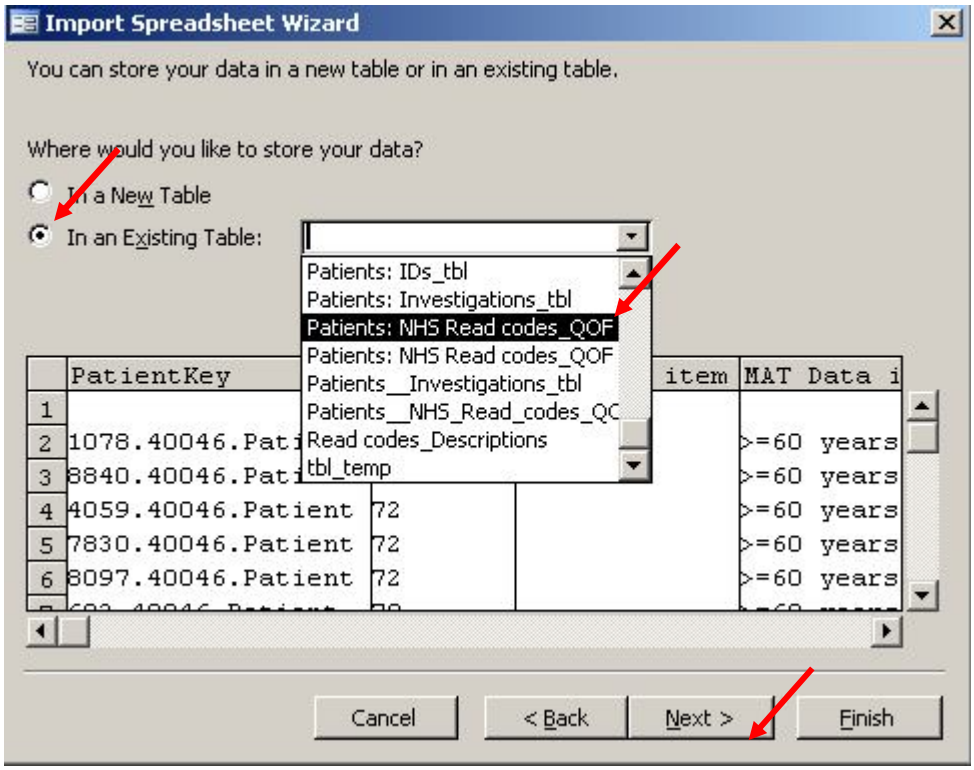
Select ‘Import Table’ and click ok. Chose the table you created in Microsoft Excel. The following dialog field will appear:



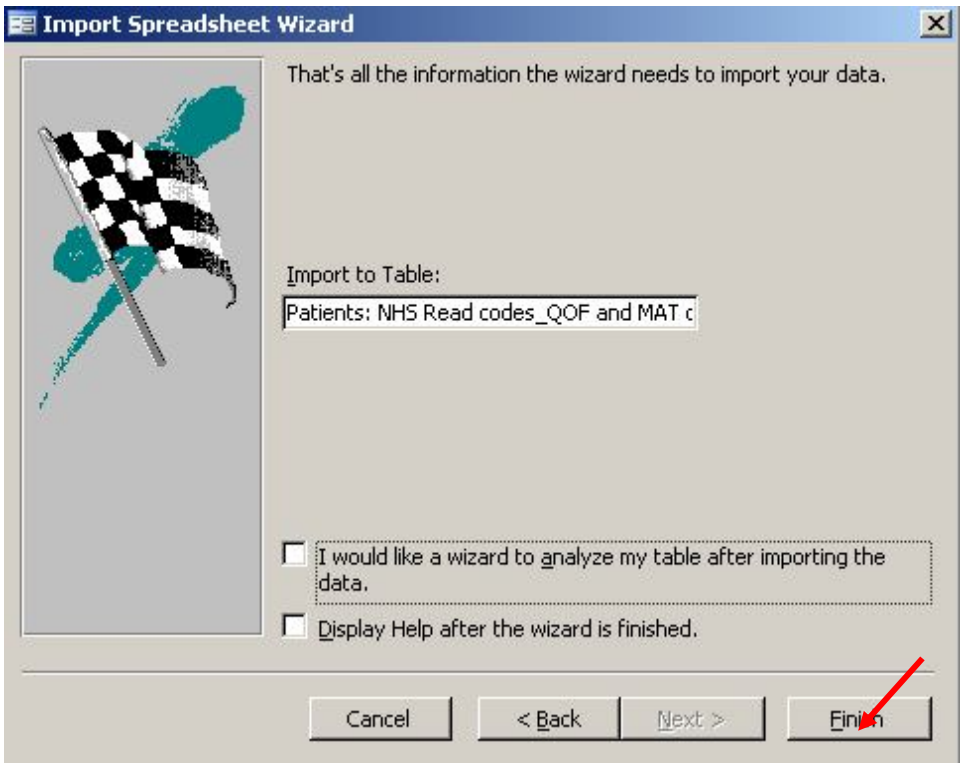
Select ‘Show Worksheets’ and ‘Next’. The following dialog field will appear:



Select ‘First Row Contains Column Headings’ and ‘Next’. The following dialog field will appear:



Select 'In an Existing Table' and in the drop down menu 'Patients: NHS Read codes_QOF and MAT data items_tbl'. Then click 'Next'. The following dialog field will appear:



Select 'Finish'.

For the ‘Drugs’ field:

1. Create the Table ‘Patients: Drug History_tbl’

Export the ‘Patients: Drug History_tbl’ like explained above. Then delete all the records in both the exported document and the table in Microsoft Access®.

Create the table in Microsoft Excel® by storing the data into the exported document.

PatientKey	drug_name	drug_category	preparation	dose	frequency
1035.C8746.Patient	Omeprazole	PPI	CAPS 10MG	1 Cap	In the morning
1033.C8746.Patient	Furosemide	Loop diuretics	TABS 40MG	2 Tabs	In the morning

Import the data into your tool the same way you did it for the table before. Import it into the table ‘Patients: Drug History_tbl’.

2. Create the Table ‘Master: Drug list_tbl’

Export the ‘Master: Drug list_tbl’ like explained above. Then delete all the records in both the exported document and the table in Microsoft Access®.

Create the table in Microsoft Excel® containing brand, drug, drug group drug category, disease surrogate and data source like explained above. The column ‘drug’ has to contain the same data, which is stored in the column ‘drug_name’ in, the ‘Patient: Drug History_tbl’. The column ‘drug_catagory’ has to contain the same data, which is stored in the column ‘drug_category’ in, the ‘Patient: Drug History_tbl’.

For importing the data into your tool follow the same procedure than before. Import into the table ‘Master: Drug list_tbl’.

For the ‘Investigations’ field:

1. Create the table ‘Patients: Investigations_tbl’

Export the ‘Patients: Investigations_tbl’ like explained above. Then delete all the records in both the exported document and the table in Microsoft Access®.

Create MAT Data item for each subset of values.

Create the table in Microsoft Excel® data item, value, unit of measure, date recorded.

e.g.:

The data stored in the ‘value’ column has to be a value- otherwise the tool will not work anymore. For importing the data into your tool follow the same procedure than before. Import into the table ‘Patients: Investigations_tbl’.

Before using the tool the first time

Open and close ‘Master: Drug list_tbl’, ‘qry_MAT’ and ‘qry_investigations_list’ once. Now you are ready to start. Good luck with your data analysis!

10 CURRICULUM VITAE

Personal data

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Education

Since 10/ 2003	Pharmacy School	University of Vienna
1995-2003	Matura	WRG Körnerschule, Linz
1991-1995	Volksschule	VS 46, Linz

Research Experience (undergraduate)

03-08/ 2009	Clinical Pharmacy Project for diploma thesis	University of Strathclyde, Glasgow

Professional Experience

09/ 2003- 09/2007	Belladonna Apotheke, Vienna
07/ 2006	Einhornapotheke, Linz
07/2007	Eisenwerkapotheke, Linz
02/2010	Anstaltsapotheke Landesnervenklinik, Linz

Languages

German (native language), English, French

Memberships

Since 2004	Member of the Austrian Red Cross and voluntary work as an ambulance woman