

# Metabolic bone disorders in geriatric patient

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# 1 Osteoporosis

## 1.1 Definitions

Osteoporosis is a systemic skeletal disorder characterised by low bone mass and microarchitectural deterioration of bone tissue, with consequent increase in bone fragility and susceptibility to fracture. Thus the density and the quality of the bone is reduced.

Osteoporosis is the most common metabolic bone disease that typically develops in women after transition, it also affects men at older ages, but can also occur in younger individuals with an accumulation of risk factors. The clinical manifestation of osteoporosis is fracture. The first osteoporotic fracture is usually a fracture of the distal parts of the forearm bones. The most common is the Colles fracture, where the radius breaks 2-3 cm proximal to the wrist joint and the distal fragment of the radius is dislocated dorsally and radially. It occurs due to a fall on the dorsally flexed hand most commonly in younger seniors. Typically this fracture affects women in early postmenopause, usually still in the osteopenia zone. Another osteoporotic fracture is the vertebral body compression fracture and the most serious is the fracture of the proximal part of the femur. In a broader sense, with the exception of fractures of the bones of the skull, ankle and the small bones of the hands and feet, any fracture that has been caused by an inadequately small traumatic event or even atraumatically can be considered osteoporotic. Another definition considers an osteoporotic fracture to be one that occurs as a result of a fall from a standing height or from a lesser height. It is clear from the above that the definition of a fracture as osteoporotic, in addition to the type of fracture, is conditioned by the assessment of the mechanism of injury.

## 1.2 Epidemiology

Currently, it is estimated that osteoporosis affects 5-8% of the population. In the Czech Republic, the prevalence of osteoporosis may be as high as 750 000 inhabitants. Osteoporosis affects one in three women and one in five men over the age of 50. At the age of 70 and over, it is already every second woman.

Osteoporosis is an epidemiologically serious disease which, in addition to the suffering of patients, has social and economic consequences. The costs of treating osteoporosis, both for the treatment of the acute phase of clinical osteoporotic fractures and the subsequent costs of caring for patients with proximal femur fractures, are considerable.

In the Czech Republic, an average of 65,000 fractures that meet the criteria of an osteoporotic fracture have occurred in recent years. However, only a small percentage of patients are subsequently diagnosed and treated. (Diagnostic gap 84% vertebrae to 94% proximal femur, Treatment gap 84% vertebrae to 95% proximal femur). More education of physicians, introduction of screening tests and informing the general public could be the solution.

## 1.3 Characteristics

Osteoporosis can be divided into primary osteoporosis, which includes mainly postmenopausal and involutional (senile) osteoporosis and secondary osteoporosis, which is slightly less common, results from a specific clinical situation or disease, is often multifactorial and potentially reversible. However, it should be kept in mind that up to 30% of postmenopausal and 50% of male OPs may have another hidden cause.

## **Metabolic bone disorders in geriatric patient**

The development of bone mass is 60-80% genetically determined, other important factors include nutrition (sufficient Ca, P) and mechanical stimuli- sufficient physical activity. Peak bone mass is reached around the age of 25-30 years, in the next period we lose bone mass, the more, the less optimal our lifestyle is.

### **1.4 Risk factors for fractures and osteoporosis:**

#### **Uncontrollable risk factors**

- Age over 50 years
- Female gender ( menopause)
- History of osteoporotic fracture
- History of osteoporosis or proximal femur fracture in 1 parent
- History of repeated falls

#### **Influenceable risk factors**

- BMI less than 20
- Decreased mobility
- Vit D deficiency
- Low Ca intake ( below 500 mg per day)
- Smoking, COPD
- Alcohol

### **1.5 Diseases associated with the risk of osteoporosis**

- Cushing's syndrome
- Hyperparathyroidism
- Hyperthyroidism
- Diabetes mellitus
- Hypopituitarism
- Sexagen deficiency
- Celiac sprue
- Gastrectomy
- Rheumatoid arthritis
- MGUS and multiple myeloma

### **1.6 Drugs associated with osteoporosis and increased fracture risk**

- glucocorticoids
- aromatase inhibitors in women with breast cancer
- androgen deprivation therapy for prostate cancer in men
- benzodiazepines and antidepressants
- proton pump inhibitors
- warfarin
- antiepileptic drugs
- glitazones

## 1.7 Clinical signs of osteoporosis

- initially inconspicuous - osteoporosis as the "silent bone thief"
- the first symptom may be a fracture
- chronic back pain
- decrease in height
- thoracic kyphosis, decrease in vital lung capacity
- difficult venous return, compression of the upper GIT

## 1.8 Diagnostics of osteoporosis

**Medical history** (fractures, diseases associated with OP, physical activity, diet, Ca+D intake, pharmacological and gynecological history)

**Clinical examination** (body height, hyperkyphosis TH p, symptoms of previously undiagnosed diseases leading to OP)

### Imaging methods

- X-ray - thoracic and lumbar spine - anteroposterior+ lateral view (important for assesment of vertebral compression fractures)
- DXA- Dual Energy X-Ray Absorptiometry

### Laboratory methods

- CBC (complete blood count), Ca, P, ALP, ev. GGT, creat, GF, Alb, protein elfo, TSH, PTH, vit D, a-tTG, calciuria
- marker of bone resorption (osteoclast activity) - CTx
- marker of bone formation (osteoblast activity) - PINP

## 1.9 Bone densitometry- DXA:

- Determines bone mineral density BMD (Bone Mineral Density) g/cm<sup>2</sup>
- Low dose radiation 2-12 μS
- Areas measured: L1-L4, femoral neck, total proximal femur area, distal forearm

**T-score** - WHO basic dg criterion - comparison of measured BMD values with the reference BMD value of young healthy women; difference expressed as number of standard deviations (SD)

**Z-score** - number of SDs from the reference value (average BMD value of persons of the same age and sex) - preferred in premenopausal women and men <50 years

- T-score > -1.0: normal
- T-score between -1.0 and -2.5: osteopenia
- T-score ≤ -2.5: osteoporosis

### Indications for DXA:

- history of atraumatic or low-trauma fracture (except for fractures of the skull, ankle, small bones of the extremities and fingers and toes)
- accumulation of fracture risk factors
- history of diseases with a negative effect on bone mass
- ongoing or planned treatment with glucocorticoids

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- decrease in body height by  $\geq 2$  cm (compared with previous regular measurements) or by  $\geq 6$  cm (compared with maximum height attained in youth)

### 1.10 Prevention of osteoporosis

- Creating sufficient peak bone mass
- Regular physical activity, walking
- Varied diet, Ca, vit D
- Achieve and maintain optimal BMI
- Prevention of falls
- Detection of patients at risk of fracture
- Individual fracture risk estimation

#### FRAX - Fracture Risk Assessment Tool

The Czech version of the calculator is available at: <https://frax.shef.ac.uk/FRAX/tool.aspx?lang=cz>

### 1.11 Treatment of osteoporosis

#### Calcium

- recommended total daily intake 1200-1500 mg
- diet 800 mg (dairy products, poppy seeds, nuts, greens and fish are recommended)
- supplementation 500-600 mg

#### Vitamin D

- recommended dose of supplementation 800- 2000IU per day
- target serum 25OHD concentration 75-110 nmol/l
- vitamin D3 (cholecalciferol) preferred
- better shorter intervals, daily or weekly, not bolus (high bolus doses increase the risk of falls in the elderly)

#### Antiresorptive drugs

- Bisphosphonates - the most common group of drugs for the treatment of osteoporosis
  - Alendronate - p.o., once a week
  - Risedronate - p.o., once a week
  - Ibandronate - p.o., 1x per month, i.v. 1x /3 months
  - Zoledronic acid - i.v., 1x/year
- Denosumab inj., sc, á 6 months
- CAVE rebound phenomenon on discontinuation: rapid decline in BMD, transient but significant rise in bone remodeling markers above baseline
- Estrogens- HRT- only for gynaecological indication in case of expressed postclimacteric syndrome

#### Anabolic therapy

- Teriparatide - indicated for patients with severe osteoporosis after failure of previous treatment or for patients with glucocorticoid-induced osteoporosis
- Romosozumab - used in postmenopausal women with severe osteoporosis at high risk of recurrent fractures

## 2 Geriatrics

Geriatrics or geriatric medicine is a medical discipline focused on the care of the specific health needs of the elderly. In the Czech Republic, geriatric care is currently reserved for patients over 65 years of age. According to the calendar age, the elderly can be divided into 3 categories:

- young seniors: 65-74 years old
- old seniors: 75-84 years old
- very old seniors: 85 years and older.

## Falls in geriatric patients

### 2.1 Definitions

A fall can be characterized as a change in position that ends with the body contacting the ground and may be accompanied by a loss of consciousness and injury.

### 2.2 Epidemiology

According to statistics, **30% of seniors over 65 years of age fall at least once a year**, and in half of the cases the falls are repeated. In the **85+ age group, 50% of seniors fall at least once a year**. Approximately one in ten falls leads to serious consequences such as hip fractures, subdural hematoma, other intracranial injuries or other serious injuries. Falls account for 10% of emergency department visits and 6% of sudden hospital admissions in the elderly. Half to two-thirds of falls occur in the patient's home and/or in the patient's immediate surroundings. **25% of seniors fall repeatedly and half have a solvable cause of falls.**

### 2.3 Characteristics

Most falls have multiple underlying factors. Only 15% have specific unipathologies. The causes can be categorised by the mnemonic DAME:

- **D**rugs and alcohol
- **A**geing process
- **M**edical causes
- **E**nvironmental factors

**Drugs and alcohol** – e.g. chemically impaired concentration, balance, reaction times.

**Ageing process** – impaired reflexes and reduced muscle power to recover from a 'trip', decreased visual acuity, impaired vestibular function and central processing

**Medical causes** – Remember atypical presentation of common diseases such as:

- heart and circulation (abnormal heart rhythm, heart attack, orthostatic syndrome, heart failure)
- neurological (Parkinson's disease, stroke, sensory impairment due to diabetes, epilepsy)
- metabolic (e.g. low sugar level in a treated diabetic)
- musculoskeletal disorders (osteoarthritis, osteoporosis, conditions after orthopaedic surgery)
- psychiatric diseases (depression, cognitive disorders)
- visual disorders (cataract, retinopathy)
- atypical presentation of common infections such as chest infection (pneumonia) and urinary tract infection.

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- visual disorders (cataract, retinopathy)

**Environmental causes** – such as tripping over carpets or rugs, falling from chairs, poor lighting and tripping over kerbs of irregular paving.

## 2.4 Diagnostics

**Medical history** - need to have information not only from the patient but also from the immediate participant of the fall. Find out the circumstances of the fall, the symptoms that precede the fall (nausea, vertigo, convulsions, palpitations, loss of consciousness), the disease the patient is being treated for (cardiovascular, neurological, psychiatric and others) and the use of risky medications (e.g. benzodiazepines, diuretics, nitrates, opiates, hypnotics, antihistamines) are also important.

**Physical examination** - signs of trauma, measurement of BP in supine and standing position, nystagmus, HR, heart murmurs, gait examination, neurological deficit, lateralization

**Functional geriatric assessment** - evaluates self-sufficiency using the Barthel ADL test, gait and balance assessment can be determined using the Tinetti test (sitting and standing balance, standing with eyes closed, gait initiation, stride length and symmetry, trunk balance).

**Laboratory methods** - biochemical and haematological examination (ions, including Ca, Mg, nitrogenous substances, glycaemia, liver enzymes, CRP, vitamin D, CBC, basic coagulation)

### ECG

**Imaging** - Doppler examination of carotid and vertebral arteries, EEG, CT or MRI of the brain

**Other investigations** - ECG Holter, ECHO, tilt-up test, neurological examination, psychiatric examination

## 2.5 Complications of falls

They can be divided into early (soft tissue injuries and fractures) and late (development of immobilization syndrome and its complications).

Possible complications include:

- fractures (femoral neck fractures, Colles fracture of the forearm, compression fractures, vertebral fractures and skull fractures)
- soft tissue contusion, development of crush syndrome
- hypothermia to possible rhabdomyolysis
- immobilization syndrome, development of decubitus, pneumonia and thromboembolic disease
- loss of self-sufficiency with subsequent institutionalization
- psychiatric disorders (anxiety, depression)
- death (most common causes of pneumonia, decubitus sepsis, intracranial haemorrhage)

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Causes of fall	Physical signs associated with each cause
<p><b>Cardiac arrhythmia:</b> Fast (tachycardia) and slow (bradycardia) rhythms may cause dizziness or loss of consciousness.</p>	<p>Examine pulse – rate and rhythm.</p>
<p><b>Heart valve lesions:</b> Aortic stenosis is associated with syncope – sudden loss of consciousness.</p> <p>Mitral regurgitation and associated heart failure</p> <p>Each lesion has a typical murmur(s) associated with it.</p>	<p>Examination of pulse for abnormal signs (eg slow rising pulse in aortic stenosis)</p> <p>Blood pressure (narrow pulse pressure in aortic stenosis, low BP in heart failure)</p> <p>Auscultation of heart sounds for murmurs and abnormal signs.</p> <p><i>Mitral regurgitation: pan-systolic murmur</i></p> <p><i>Aortic stenosis: ejection systolic murmur</i></p>
<p><b>Postural hypotension:</b> This describes a reduction in blood pressure on positional change from lying (or sitting) to standing. This is abnormal- normally the blood pressure will rise when standing.</p>	<p>Measure blood pressure on lying and then after the patient has been standing for at least 1 minute. A reduction of more than 10 mmHg diastolic (lower blood reading) or 20 mmHg systolic (higher reading) is diagnostic of postural hypotension</p>
<p><b>Pneumonia</b></p>	<p>Examination of the chest – inspection, palpation, auscultation.</p>
<p><b>Neurological pathology</b> Common impairments pre-disposing to fall include stroke, abnormal balance, Parkinson’s disease, diabetes, alcohol.</p>	<p>Examination of neurological system for relevant findings</p>
<p><b>Musculoskeletal disease:</b> Osteoarthritis; gout or inflammatory arthropathies; cervical spondylosis (osteoarthritis of the cervical vertebrae causing disruption of proprioceptors (position sense receptors) in the cervical joints).</p>	<p>Painful, swollen or unstable joints; reduced muscle power; examine feet – toes, nails and footwear; neck movements causing dizziness; watch the patient walking.</p>



## Geriatric testing

As the population ages, the number of patients with severe memory disorders, even dementia, is increasing. Screening is an appropriate method for early diagnosis of cognitive impairment. Therefore, an orientation examination of cognitive function should be part of the regular general preventive check-up every two years for the population over 65 years of age.

**The MiniCOG test**, which is a combination of memorising three words and drawing a clock, is considered to be an appropriate test for early detection. The MiniCOG test should be performed under the guidance of a general practitioner as part of a preventive examination or at the time of examination when the disease is suspected.

**The Mini Mental State Examination (MMSE)** is a tool that can be used to systematically and thoroughly assess mental status. It is an 11- question measure that tests five areas of cognitive function: orientation, registration, attention and calculation, recall, and language. The maximum score is 30. A score of 25 or lower is indicative of cognitive impairment. The MMSE takes only 10 minutes to administer and is therefore practical to use repeatedly and routinely.

**Barthel Index for Activities of Daily living (ADL)** is used to assess the degree of dependence in basic activities of daily living and refers to activities oriented toward taking care of one's own body. These activities are fundamental to living in a social world; they enable basic survival and well-being, such as bathing, toileting, dressing and eating.

**Instrumental Activities of Daily Living (IADL)** refers to activities to support daily life within the home and community that often require more complex interactions than those used in ADLs. Examples of such activities include financial management, housekeeping, shopping for groceries, making telephone calls, and taking medication.

The ADL and IADL functions are important to older adults, and IADL autonomy plays an important role in "successful" aging.

**The Geriatric Depression Scale** can be used to diagnose depressive disorder in geriatric patients.

## Depressive disorder

Depressive disorder is a complex condition characterized by a combination of emotional, cognitive, and biological symptoms.

**Emotional manifestations** commonly include a persistently depressed mood, heightened irritability, frequent tearfulness, difficulty concentrating, and an overall sense of fatigue or lack of energy.

**Cognitive symptoms** often involve negative and pessimistic thinking patterns, self-blame leading to low self-esteem, pervasive anxious thoughts, and, in some cases, worries about real or imagined physical symptoms (hypochondriasis). Severe cases might even experience suicidal ideation.

Alongside these psychological symptoms, depressive disorder also presents with several **biological symptoms**. Disturbed sleep patterns are common, often characterized by early morning awakenings after just three or four hours of sleep. Affected individuals may also exhibit decreased appetite leading to weight loss, a daily mood rhythm that typically worsens in the morning but improves slightly throughout the day (diurnal variation), reduced sexual interest, and occasional constipation. Some individuals may also experience an inability to cry.

Together, these diverse symptoms paint a comprehensive picture of the multifaceted impact of depressive disorder on an individual's life.

## Annex 1

**Mini-Cog<sup>®</sup>**

### Instructions for Administration & Scoring

ID: \_\_\_\_\_ Date: \_\_\_\_\_

#### Step 1: Three Word Registration

Look directly at person and say, "Please listen carefully. I am going to say three words that I want you to repeat back to me now and try to remember. The words are [select a list of words from the versions below]. Please say them for me now." If the person is unable to repeat the words after three attempts, move on to Step 2 (clock drawing).

The following and other word lists have been used in one or more clinical studies.<sup>1-3</sup> For repeated administrations, use of an alternative word list is recommended.

Version 1	Version 2	Version 3	Version 4	Version 5	Version 6
Banana	Leader	Village	River	Captain	Daughter
Sunrise	Season	Kitchen	Nation	Garden	Heaven
Chair	Table	Baby	Finger	Picture	Mountain

#### Step 2: Clock Drawing

Say: "Next, I want you to draw a clock for me. First, put in all of the numbers where they go." When that is completed, say: "Now, set the hands to 10 past 11."

Use preprinted circle (see next page) for this exercise. Repeat instructions as needed as this is not a memory test. Move to Step 3 if the clock is not complete within three minutes.

#### Step 3: Three Word Recall

Ask the person to recall the three words you stated in Step 1. Say: "What were the three words I asked you to remember?" Record the word list version number and the person's answers below.

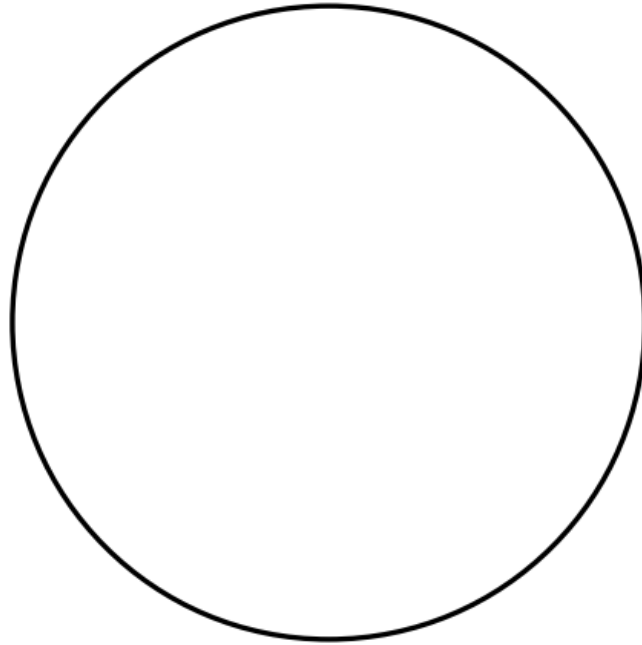
Word List Version: \_\_\_\_\_ Person's Answers: \_\_\_\_\_

#### Scoring

Word Recall: _____ (0-3 points)	1 point for each word spontaneously recalled without cueing.
Clock Draw: _____ (0 or 2 points)	Normal clock = 2 points. A normal clock has all numbers placed in the correct sequence and approximately correct position (e.g., 12, 3, 6 and 9 are in anchor positions) with no missing or duplicate numbers. Hands are pointing to the 11 and 2 (11:10). Hand length is not scored. Inability or refusal to draw a clock (abnormal) = 0 points.
Total Score: _____ (0-5 points)	Total score = Word Recall score + Clock Draw score. A cut point of <3 on the Mini-Cog™ has been validated for dementia screening, but many individuals with clinically meaningful cognitive impairment will score higher. When greater sensitivity is desired, a cut point of <4 is recommended as it may indicate a need for further evaluation of cognitive status.

**Clock Drawing**

ID: \_\_\_\_\_ Date: \_\_\_\_\_



Annex

**The Mini-Mental State Exam**

Patient \_\_\_\_\_ Examiner \_\_\_\_\_ Date \_\_\_\_\_

Maximum	Score	
		<b>Orientation</b>
5	( )	What is the (year) (season) (date) (day) (month)?
5	( )	Where are we (state) (country) (town) (hospital) (floor)?
		<b>Registration</b>
3	( )	Name 3 objects: 1 second to say each. Then ask the patient all 3 after you have said them. Give 1 point for each correct answer. Then repeat them until he/she learns all 3. Count trials and record. Trials _____
		<b>Attention and Calculation</b>
5	( )	Serial 7's. 1 point for each correct answer. Stop after 5 answers. Alternatively spell "world" backward.
		<b>Recall</b>
3	( )	Ask for the 3 objects repeated above. Give 1 point for each correct answer.
		<b>Language</b>
2	( )	Name a pencil and watch.
1	( )	Repeat the following "No ifs, ands, or buts"
3	( )	Follow a 3-stage command: "Take a paper in your hand, fold it in half, and put it on the floor."
1	( )	Read and obey the following: CLOSE YOUR EYES
1	( )	Write a sentence.
1	( )	Copy the design shown.



\_\_\_\_\_ Total Score  
 ASSESS level of consciousness along a continuum \_\_\_\_\_  
 Alert Drowsy Stupor Coma

"MINI-MENTAL STATE." A PRACTICAL METHOD FOR GRADING THE COGNITIVE STATE OF PATIENTS FOR THE CLINICIAN. *Journal of Psychiatric Research*, 12(3): 189-198, 1975. Used by permission.

- MMSE rating
- 30-28 points: standard
  - 27-25 points: mild cognitive impairment
  - 24-18 points: mild dementia
  - 17-13 points: moderate dementia
  - 12 points or less: severe dementia

## Annex 3

### Geriatric Depression Scale (short form)

**Instructions:** Circle the answer that best describes how you felt over the past week.

- |   |     |    |
|---|-----|----|
| 1. Are you basically satisfied with your life?                            | yes | no |
| 2. Have you dropped many of your activities and interests?                | yes | no |
| 3. Do you feel that your life is empty?                                   | yes | no |
| 4. Do you often get bored?  | yes | no |
| 5. Are you in good spirits most of the time?                              | yes | no |
| 6. Are you afraid that something bad is going to happen to you?           | yes | no |
| 7. Do you feel happy most of the time?                                    | yes | no |
| 8. Do you often feel helpless?  | yes | no |
| 9. Do you prefer to stay at home, rather than going out and doing things? | yes | no |
| 10. Do you feel that you have more problems with memory than most?        | yes | no |
| 11. Do you think it is wonderful to be alive now?                         | yes | no |
| 12. Do you feel worthless the way you are now?                            | yes | no |
| 13. Do you feel full of energy?   | yes | no |
| 14. Do you feel that your situation is hopeless?                          | yes | no |
| 15. Do you think that most people are better off than you are?            | yes | no |

**Total Score** \_\_\_\_\_

## Geriatric Depression Scale (GDS) Scoring Instructions

**Instructions:** Score 1 point for each bolded answer. A score of 5 or more suggests depression.

- |   |            |           |
|---|------------|-----------|
| 1. Are you basically satisfied with your life?                            | yes        | <b>no</b> |
| 2. Have you dropped many of your activities and interests?                | <b>yes</b> | no        |
| 3. Do you feel that your life is empty?                                   | <b>yes</b> | no        |
| 4. Do you often get bored?  | <b>yes</b> | no        |
| 5. Are you in good spirits most of the time?                              | yes        | <b>no</b> |
| 6. Are you afraid that something bad is going to happen to you?           | <b>yes</b> | no        |
| 7. Do you feel happy most of the time?                                    | yes        | <b>no</b> |
| 8. Do you often feel helpless?  | <b>yes</b> | no        |
| 9. Do you prefer to stay at home, rather than going out and doing things? | <b>yes</b> | no        |
| 10. Do you feel that you have more problems with memory than most?        | <b>yes</b> | no        |
| 11. Do you think it is wonderful to be alive now?                         | yes        | <b>no</b> |
| 12. Do you feel worthless the way you are now?                            | <b>yes</b> | no        |
| 13. Do you feel full of energy?   | yes        | <b>no</b> |
| 14. Do you feel that your situation is hopeless?                          | <b>yes</b> | no        |
| 15. Do you think that most people are better off than you are?            | <b>yes</b> | no        |

*A score of  $\geq 5$  suggests depression*

**Total Score** \_\_\_\_\_

Ref. Yes average: The use of Rating Depression Series in the Elderly, in Poon (ed.): Clinical Memory Assessment of Older Adults, American Psychological Association, 1986