

Preventing fractures in elderly people

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Preventing fractures in elderly people is a priority, especially as it has been predicted that in 20 years almost a quarter of people in Europe will be aged over 65. This article describes the factors contributing to fracture, interventions to prevent fracture, and the various treatments.

Fractures in elderly people are an important public health issue, especially as incidence increases with age, and the population of elderly people is growing. Evidence based interventions do exist to prevent fractures, but they are not being applied.^{1,2} The challenges are to identify those most risk and to ensure that treatment is cost effective. Elderly people should be taught to improve their bone health and to reduce the risk of injury, but these measures are not restricted to this age group, as prevention should be throughout the life.³

Sources and methods

Recommendations are made following a comprehensive review of the literature, concentrating on systematic reviews and evidence based guidelines on fracture prevention that have been identified by a standardised search strategy as part of the European Bone and Joint Health Strategies Project. Priority was given to those systematic reviews and guidelines that met quality criteria, including criteria for guidelines from the Appraisal of Guidelines Research and Evaluation (AGREE).⁴

A universal problem

Around 310 000 fractures occur each year in elderly people in the United Kingdom. The cost of providing social care and support for these patients is £1.7b (\$2.8b; €2.4b). Hip fractures place the greatest demand on resources and have the greatest impact on patients because of increased mortality, long term disability, and loss of independence. Although less common, vertebral fractures are also associated with long term morbidity and increased mortality.⁵ By 2025 it has been predicted that almost a quarter of the population in Europe will be aged over 65 years. The mean age of hip fracture in women is 81 years, and as the expected additional lifetime for an 80 year old women in England is 8.7 years, there is still a significant time for elderly women to benefit from fracture prevention.⁶

Summary points

Prevention of fractures includes reducing the number of falls, reducing the trauma associated with falls, and maximising bone strength at all ages

Pharmacological treatment is most clinically effective and cost effective when targeted at those who are at highest risk

Previous fracture and low bone density are strong risk factors for future fracture, and those at highest risk can be identified by combining these with other risk factors

Reasons for previous falls and unsteadiness in aged patients should be investigated

Treatment of concomitant conditions should be optimised

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Bone fragility, falls, and people at high risk

Fractures occur in elderly people because of skeletal fragility. Appendicular fractures are usually precipitated by a fall. Falls account for 90% of hip fractures, and the risk of falling increases with age.⁷ Around a third of people aged 65 or over fall at least once a year, but only 1% of falls in women result in hip fracture.^{8,9} Whether fracture occurs depends on the impact from the fall and bone strength. Bone strength is related to mineral content, as assessed by bone densitometry, with the risk of fracture increasing proportionately with decrease in bone mineral density.¹⁰ Strategies to prevent fracture in an elderly population must therefore ensure maximum bone strength, reduce the occurrence of falls, and reduce the trauma associated with falls.

Compared with a younger woman, a 70 year old woman is five times more likely to sustain a hip fracture and three times more likely to incur any fracture during the rest of her life.^{11,12} However, there are some elderly people for whom the risk is much greater, and



Tables and references of trials showing effects of pharmacological treatment appear on bmj.com

Box 1: Risk factors (excluding falls) for bone loss, osteoporosis, and fracture in elderly people (adapted from various sources^{5 16 46 47})

- Age over 75 years
- Female
- Previous fracture after low energy trauma
- Radiographic evidence of osteopenia, vertebral deformity, or both
- Loss of height, thoracic kyphosis (after radiographic confirmation of vertebral deformities)
- Low body weight (body mass index <19)
- Treatment with corticosteroids
- Family history of fractures owing to osteoporosis (maternal hip fracture)
- Reduced lifetime exposure to oestrogen (primary or secondary amenorrhoea, early natural or surgical menopause (<45 years))
- Disorders associated with osteoporosis (previous low bodyweight; rheumatoid arthritis; malabsorption syndromes, including chronic liver disease and inflammatory bowel disease; primary hyperparathyroidism; long term immobilisation)
- Behavioural risk factors
 - Low calcium intake (<700 mg/d)
 - Physical inactivity
 - Vitamin D deficiency (low exposure to sunlight)
 - Smoking (current)
 - Excessive alcohol consumption

for them specific treatments to prevent fracture are more cost effective.¹³

Factors can identify people most at risk of fracture, principally because of low bone mass (osteoporosis) or falls (boxes 1 and 2). Other factors include bone turnover and bone quality, assessed by bone markers and quantitative ultrasound, respectively.^{14 15} Frailty and comorbidity are also risk factors for poor outcome. Such factors could help determine whether bone densitometry is needed and choice of treatment.

Bone density has the strongest relation to fracture, but many fractures occur in women without osteoporosis. The possibility of fracture increases when low bone density is combined with other factors, but the exact interaction of these factors is unclear.¹⁶ Efforts are being made to describe the absolute risk for patients over the comprehensible time period of five to 10 years.¹³ This should help to indicate whether intervention is needed and to improve compliance.

Pharmacological interventions

Pharmacological agents increase bone mass either by decreasing bone resorption, with a secondary gain in bone mass, or by a direct anabolic effect. Preferably they also increase bone strength and quality. Randomised controlled trials of several of these drugs show a decrease in fractures within one to three years.

Drugs that specifically act on bone by decreasing resorption are bisphosphonates, calcitonin, selective oestrogen receptor modulators, and oestrogen. Combined calcium and vitamin D also has an antiresorptive action, and parathyroid hormone has become available as the first anabolic agent for bone (see table A on bmj.com).

Combined calcium and vitamin D

Combined calcium and vitamin D is the standard treatment for osteoporosis as well as a preventive measure, particularly in frail elderly people. In elderly institutionalised patients, further hip and non-vertebral fractures were decreased after three years' treatment with 1200 mg calcium and 20 µg (800 IU) vitamin D, with significant benefit at 18 months.¹⁷ A community based study found that vitamin D given once every four months decreased the overall risk of fracture by 39%, and in another study 800 IU of vitamin D given to elderly people (mean age 85) over a 12 week period increased muscle strength and decreased the number of falls by almost a half.^{18 19}

Box 2: Risk factors for falls in elderly people**Intrinsic factors**

- General deterioration associated with ageing
 - Poor postural control
 - Defective proprioception
 - Reduced walking speed
 - Weakness of legs
 - Slow reaction time
 - Various comorbidities
- Problems with balance, gait, or mobility
 - Joint disease
 - Cerebrovascular disease
 - Peripheral neuropathy
 - Parkinson's disease
 - Alcohol
 - Various drugs
- Visual impairment
 - Impaired visual acuity
 - Cataracts
 - Glaucoma
 - Retinal degeneration
- Impaired cognition or depression
 - Alzheimer's disease
 - Cerebrovascular disease
- "Blackouts"
 - Hypoglycaemia
 - Postural hypotension
 - Cardiac arrhythmia
 - Transient ischaemic attack, acute onset cerebrovascular attack
 - Epilepsy
 - Drop attacks ?vertebrobasilar insufficiency
 - Carotid sinus syncope
 - Neurocardiogenic (vasovagal) syncope

Extrinsic factors

- Personal hazards
 - Inappropriate footwear or clothing
- Multiple drug therapy
 - Sedatives
 - Hypotensive drugs

Environmental factors

- Hazards indoors or at home
 - Bad lighting
 - Steep stairs, lack of grab rails
 - Slippery floors, loose rugs
 - Pets, grandchildren's toys
 - Cords for telephone and electrical appliances
- Hazards outdoors
 - Uneven pavements, streets, paths
 - Lack of safety equipment
 - Snowy and icy conditions
 - Traffic and public transportation

Bisphosphonates

Bisphosphonates are potent antiresorptive agents that block osteoclast action with little effect on other organ systems (see table B on bmj.com). In large randomised controlled trials, the bisphosphonate alendronate reduced both vertebral and non-vertebral fractures.^{20 21} It is most beneficial in those at highest risk—women with at least one prevalent vertebral fracture or osteoporosis. Symptomatic vertebral fractures were decreased by 28-36% over four years' treatment, whereas the risk of hip fracture was reduced by just over a half.²⁰ Risedronate similarly reduces the incidence of vertebral fractures.^{22 23} A study of risedronate specifically designed to evaluate its effect on hip fracture showed that the incidence of hip fractures was decreased only in elderly women included because of a combination of low bone mass and risk factors.²⁴ The effect was not significant in women included because of risk factors alone.²⁴

The daily dosing regimens of bisphosphonates are complex, for reasons of absorption and gastric side effects. To maximise uptake, tablets must be taken after an overnight fast, with a full glass of water, and food avoided for half an hour. The need for such measures may be overcome with the new weekly dosing regimen for both agents.^{25 26}

Etidronate was the first available bisphosphonate. It is used cyclically to treat osteoporosis, as overdosage may cause defects in mineralisation. No randomised controlled trials have been primarily powered to evaluate the effect of this drug on fracture.^{27 28} New compounds based on the primary bisphosphonate structure are being developed. The interval between doses has been increased between two and 12 months, which would be beneficial, particularly in elderly frail patients. At least two of these compounds, zolendronate and ibandronate, given intravenously or orally, are undergoing clinical trials.

Selective oestrogen receptor modulators

Selective oestrogen receptor modulators selectively block conformational changes of the oestrogen receptor. In postmenopausal women treated with raloxifene, vertebral fractures were decreased by 30% over three years, whereas no effect was seen on non-vertebral fractures.²⁹ A significant decrease in the number of new cases of breast cancer was also seen.³⁰

Oestrogen

Preventing fractures in women with osteoporosis by giving oestrogen replacement therapy remains controversial. Large size studies of its effects on fracture have been lacking, and the indication for efficacy has relied on observational studies. The recent report from the Women's Health Initiative study on hormone replacement therapy is the first large scale randomised controlled trial in women aged 50-79. Hip and vertebral fractures were decreased by 34%, and the overall reduction in fracture risk was 24%.³¹ However long term side effects, particularly breast cancer, and absence of benefits for cardiovascular events limit the indications for use. The primary target group for oestrogen replacement therapy is therefore not elderly women with osteoporosis but women soon after menopause, to eliminate climacteric symptoms.

Calcitonin

Calcitonin is an endogenous inhibitor of bone resorption, which acts by suppressing osteoclasts. Salmon calcitonin is available as subcutaneous injections or a nasal spray. It is about 10 times more potent than normally produced human calcitonin. Although several studies have shown effects on bone mineral density in postmenopausal women, the effect on fracture has been less well studied. When salmon calcitonin 200 IU daily was, however, given to postmenopausal women, new vertebral fractures were decreased by 33% despite a small effect on lumbar bone mineral density.³² This has been interpreted as a quality effect of antiresorptive agents beyond the effect on bone mineral density.

Parathyroid hormone

Parathyroid hormone has a dual effect on bone. Continuous dosing or increased endogenous secretion leads to bone resorption, whereas intermittent dosing has a pronounced anabolic effect. Recombinant human parathyroid hormone given as subcutaneous injections is promising, decreasing vertebral and non-vertebral fractures by 65-69% and 53-54%, respectively, and markedly increasing bone mass in under two years.³³

Impact and prevention of falls

Measures to prevent falls should be implemented in elderly people.^{34 35} This has potential benefit against appendicular fractures. It is difficult to identify those at most risk; a previous fall is a strong indicator, and important determinants are weakness of the legs, poor gait, and impaired balance and coordination.³⁵ Recommendations have been made for assessing risk (box 3), although at present there is no fully evaluated tool for this. Effective prevention involves identifying and modifying where possible intrinsic, extrinsic, and environmental risk factors (see box 2).³⁶ Social service staff and healthcare workers should be aware of these

Box 3: Assessment of elderly people for risk of falls (adapted from guideline for the prevention of falls in older persons³⁵ with permission of Blackwell)

Approach as part of routine care (not presenting after falls)

- Elderly people should be asked at least once a year about falls
- Elderly people who report a single fall should be observed as they stand up from a chair without using their arms, walk several paces, and return (get up and go test). Those showing no difficulty or unsteadiness need no further assessment

Approach to those presenting after one or more falls, or with abnormalities of gait or balance, or who report recurrent falls

- Elderly people who present because of a fall, report recurrent falls in past year, or show abnormalities of gait or balance should undergo a fall evaluation. This should be performed by an experienced clinician, which may necessitate referral to a specialist
- A fall evaluation includes a history of circumstances around the fall, drugs, acute or chronic medical problems, and mobility levels; an examination of vision, gait and balance, and function of the leg joints; an examination of basic neurological function, including mental status, muscle strength, peripheral nerves of the legs, proprioception, reflexes, and tests of cortical, extrapyramidal and cerebellar function; assessment of basic cardiovascular status including heart rate and rhythm, postural pulse and blood pressure and, if appropriate, heart rate and blood pressure responses to carotid sinus stimulation

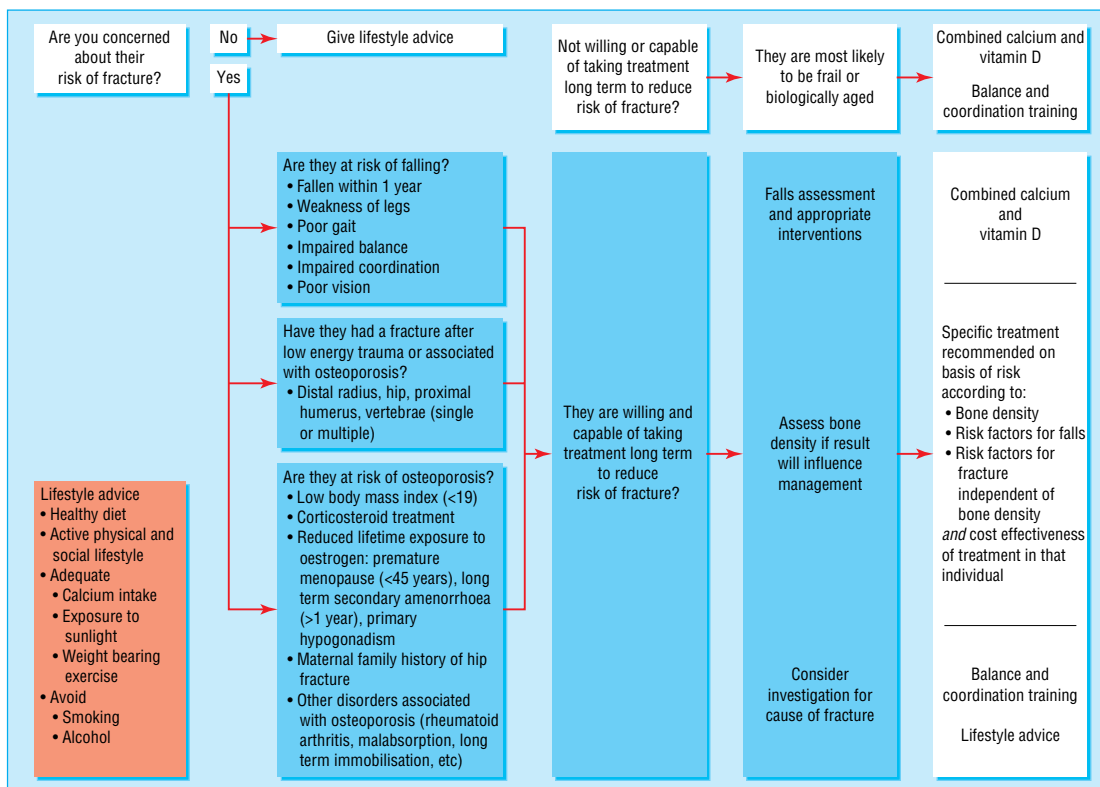


Fig 1 When and how to assess risk of future fracture in elderly people

factors. Individually tailored programmes or Tai Chi can help improve balance and steadiness.³⁶⁻³⁹ A meta-analysis of four controlled trials of 1016 community dwelling women and men aged 65 to 97 years found that individually prescribed programmes of muscle strengthening and balance retraining exercises reduced the number of falls by 35%, benefiting most those over 80.³⁹ However, there is little evidence as yet that fall prevention reduces the risk of fracture.

Externally applied devices can protect against the impact of falls. External hip protectors decreased hip fractures in institutionalised patients, although their role in frequent fallers in the community is still being evaluated.⁴⁰ The main limitation is compliance.

Lifestyle

A sedentary lifestyle, poor diet, smoking, and alcohol misuse are detrimental to bone health. Maintaining a strong skeleton at all ages relies on mechanical stimuli from weight bearing and physical activity. Programmes for physical exercise may increase bone mass by only a marginal amount,⁴¹ but loss of mobility results in a rapid decrease in bone mass and loss of physical fitness, particularly in elderly people.

Poor nutrition is common in elderly people, especially frail elderly people, and several studies show low body weight and body mass index associated with hip fracture.⁴² Protein supplementation has also improved outcome after hip fracture.⁴³ Adequate intake of all nutrients, including calcium and vitamin D, is important. Smoking carries a moderate and dose dependent risk for osteoporosis and fracture, which diminishes over time with cessation.⁴⁴

Selective case finding

A selective case finding approach is recommended to recognise and treat those elderly people most at risk, ideally before the first fracture.^{1 45} High risk individuals may be identified from risk factors for bone fragility or susceptibility to trauma. The key questions relate to previous fragility fracture, previous falls or unsteadiness, and risk factors for osteoporosis or low bone mass (fig 1). Positive responses should lead to a full assessment to confirm risk, provided the patient agrees to and is able to follow instructions for pharmacological treatment. Those at risk of osteoporosis should be assessed by bone mineral density measurement with dual energy X ray absorptiometry at the hip and spine if it will influence management (fig 2). Measurement of the calcaneus by ultrasonography may be used as an



Fig 2 Measurement of bone mineral density at the hip and lumbar spine by dual energy absorptiometry

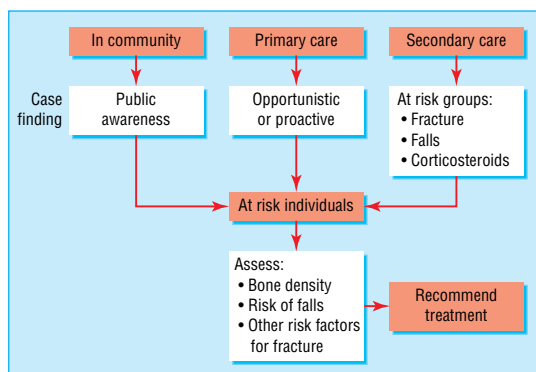


Fig 3 Prevention of fracture

intermediate assessment method if dual energy X ray absorptiometry is not feasible. Patients with low values can then be referred for full assessment.

A risk assessment may be performed opportunistically or proactively (fig 3). Increasing the awareness of health professionals to recognise those at risk is central to the implementation of selective case finding. In particular all patients after age 50 who sustain fractures that could relate to osteoporosis should be identified at the time of fracture treatment. Integrated care pathways should be jointly developed to ensure appropriate investigation, including assessment of possible causes of fracture and bone density measurements, followed by treatment. Elderly people themselves should be aware of their potential risk and be encouraged to ask appropriate questions.

Selection of treatment and monitoring response

Management of people at risk of fracture should be tailored to their risks and needs. Treatment should always couple any antiresorptive agent along with non-pharmacological interventions (box 4).

The prevention of fracture can be measured only at the population level. Measurement of bone density or biochemical bone markers can be used in the individual as an indicator of treatment effect, but in clinical practice lack of long term compliance is the principal reason for poor response. Good patient education with re-enforcement is necessary to improve this. If bone density is measured again, it is not meaningful until after two years because of the precision error of available bone densitometers and the low rate of change in bone mass. If the patient tolerates treatment well, the second measurement can be delayed for three or four years providing there is a pre-determined plan for continued treatment. Falls in the last year can be asked about to review effect of prevention. For those who have sustained a fracture, the impact on their quality of life can be monitored by a few simple questions, which could be used on a regular basis to provide a simple and rapid evaluation (box 5). It is also important to know if a local fracture prevention strategy is making a difference, and effectiveness can be measured by various indicators such as the success of case finding, numbers of fractures, and fracture outcome.³

With our current state of knowledge it will be possible to reduce the burden of osteoporosis in elderly

Box 4: Recommendations for prevention of fracture in elderly people based on risk assessment (adapted from Royal College of Physicians guidelines¹)

Indications

- Bone mineral density T score* ≥ 1 (normal)
Advise on lifestyle
- Bone mineral density T score -1 to -2.5 (osteopenia)
Advise on lifestyle
Consider combined calcium 1 g and vitamin D 800 IU, depending on intake
- Bone mineral density T score ≤ 2.5 (osteoporosis)
Investigate for causes of osteoporosis
Advise on lifestyle and ensure adequate intake of combined calcium and vitamin D
Consider pharmacological treatment
Interpret result in context of age in frail elderly people (Z score)
- Frail, biologically aged, or institutionalised
Consider intake of combined calcium 1 g and vitamin D 800 IU
Perform falls assessment
Consider hip protectors

Low bone mineral density and additional risk factors

- Bone mineral density T score -1 to -2.5 plus fracture after low energy trauma or high risk of falls or other risk factors for fracture (checklist)
- Investigate for causes of fracture
Perform falls assessment
Advise on lifestyle and ensure adequate intake of combined calcium and vitamin D
Consider pharmacological treatment
- Bone mineral density T score ≤ 2.5 plus fracture after low energy trauma
Investigate for causes of fracture
Investigate for causes of osteoporosis
Perform falls assessment
Advise on lifestyle and ensure adequate intake of combined calcium and vitamin D
Consider pharmacological treatment
- Multiple vertebral fractures
Investigate for causes of fracture
Investigate for causes of osteoporosis
Perform falls assessment
Advise on lifestyle and ensure adequate intake of combined calcium and vitamin D
Consider pharmacological treatment
In elderly people with multiple vertebral fractures and no access to bone densitometry, treatment may be initiated without measurement of bone density

*T score compares bone mineral density to peak bone mass.

people. Unfortunately, predicting and preventing all fractures is still beyond our abilities, but there has been progress in our understanding of what was until recently a silent epidemic.

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Box 5: Simple questionnaire used to monitor quality of life after fracture (adapted from Doherty et al⁴⁸)

- Have your daily activities been limited by pain during the past week?
- Are you able to wash and dress yourself?
- Have you walked outside during the past week?
- Are you content with your current state of health?

Additional educational resources

Cochrane Musculoskeletal Group—the group reviews science from an evidence based perspective, using rigorous criteria for evaluation of efficacy or risk (www.cochranelibrary.com)

International Osteoporosis Foundation—this international organisation assembles professionals, patient support groups, and industry with an interest in osteoporosis (www.osteofound.org)

International Bone and Mineral Society BoneKEy-Osteovision—this website is a central repository of knowledge in the field of bone, cartilage, and mineral metabolism

American Society for Bone and Mineral Research—this organisation focuses on research in musculoskeletal, including both basic and clinical science (www.asbmr.org)

Sambrook P, Woolf AD. Osteoporosis. *Best Pract Res Clin Rheumatol* 2001;335-515—an update on diagnosis and management of osteoporosis

Information for patients

International Osteoporosis Foundation—patient support groups and national societies for osteoporosis can be found through this website for most countries (www.osteofound.org)

National Osteoporosis Society—UK national charity dedicated to eradicating osteoporosis and promoting bone health in both men and women. Website provides useful information for the public, patients, and health professionals (www.nos.org.uk)

National Osteoporosis Foundation, USA—the leading US voluntary health organisation for osteoporosis, which provides information for patients and health professionals (www.nof.org)

NHS Direct—provides a wide range of information on osteoporosis, its prevention and treatment (www.nhsdirect.nhs.uk/en.asp?TopicID=340)

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Ongoing research

- Defining absolute risk over 5-10 years for different age groups in both women and men
- Evaluation of the effect of hip protectors in non-institutionalised people, including compliance
- Development of simple fall prevention strategies in the community and evaluation of their effect on fracture
- Long term studies evaluating the effect on falls of long term balance and coordination training in elderly and elderly frail people
- Evaluation of annual vitamin D supplementation
- Long term effectiveness of bisphosphonate therapy
- Development of pharmacological agents with more favourable dosing regimens, particularly for frail elderly people
- Understanding effects of pharmacological agents on bone quality to understand better how drugs prevent fracture
- Population based studies in men to define sex specific risk factors and intervention levels for bone mineral density

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Lesson of the week

Wegener's granulomatosis presenting as a pleural effusion

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Wegener's granulomatosis is one of the pauci-immune small vessel vasculitides. It classically presents with the triad of upper and lower respiratory tract granulomas and necrotising focal segmental glomerulonephritis. It is associated with the presence in the serum of autoantibodies against components of neutrophil cytoplasm—antineutrophil cytoplasmic autoantibodies (ANCA). The illness can develop at any age but is more common in patients in their 50s and 60s and in men. The incidence of vasculitis is increasing, with about 10-20 people per million affected. We present a case that in retrospect had many clues at the initial time of admission, but it took five months and six different hospital teams to make the diagnosis.

Case report

A 64 year old woman, who had had breast carcinoma that had been treated with wide local excision and radiotherapy six years previously, was admitted to her local hospital at the end of March 2001. She presented with a two week history of an influenza-like illness, including a blocked nose and right ear, dry cough, and intermittent sweats. She was feverish and had a left pleural effusion, which was confirmed radiologically. Her inflammatory markers were raised (total white cell count $13.1 \times 10^9/l$, C reactive protein 322 mg/l (normal range <5 mg/l)). Treatment was started with intravenous antibiotics for a possible empyema. Despite three different antibiotics, her symptoms failed to improve over the next two weeks. Ultrasound scanning of the chest confirmed a fluid collection, but several attempts at aspiration and drainage were unsuccessful. She was transferred to a teaching hospital under the care of the cardiothoracic surgeons, but she became increasingly breathless and developed atrial tachyarrhythmias and presumed acute pulmonary oedema. At this time there was evidence of renal impairment (serum creatinine concentration 130 $\mu\text{mol/l}$) and she was deemed unfit for surgery, so she was transferred back to the referring centre.

A computed tomogram of the thorax showed bilateral pleural effusions, and transthoracic echocardiography

showed a pericardial effusion. Owing to persisting fever and raised inflammatory markers, her antibiotic regimen was again altered and she was transferred to a different tertiary centre for a respiratory opinion. Soon after admission she developed respiratory failure and needed intubation and ventilation. She was found to have no empyema. She recovered slowly and was transferred back to her original team at the beginning of June without a uniform diagnosis. Repeat echocardiography at this time showed resolution of the pericardial effusion and her creatinine concentration was 124 $\mu\text{mol/l}$.

At the end of June she was transferred to a community hospital for rehabilitation. Over the next month she had recurrent episodes of syncope and bradycardia. Her serum potassium concentration was persistently raised and her renal function deteriorated markedly (creatinine concentration 618 $\mu\text{mol/l}$). She had a cardiac arrest, from which she was successfully resuscitated. She was subsequently transferred to the intensive care unit of our hospital, where she needed ventilation support and continuous venovenous haemofiltration for acute renal failure. She was found to be strongly seropositive for cytoplasmic ANCA (cANCA) (titre >2560 units) for antibodies to proteinase 3 with enzyme linked immunosorbent assay (ELISA), and was treated with pulsed intravenous methylprednisolone, followed by oral prednisolone and cyclophosphamide. Two weeks later she developed pulmonary haemorrhage and needed reintubation and treatment with plasma exchange for two weeks. She improved slowly over the next few weeks and was discharged at the end of October on a combination of prednisolone and azathioprine; her creatinine concentration at this time was 200 $\mu\text{mol/l}$.

Discussion

Vasculitis can be categorised by the size of vessel affected (small, medium, or large). Wegener's granulomatosis is a small vessel vasculitis classically involving the upper and lower respiratory tracts and kidneys. A limited form

Check ANCA (antineutrophil cytoplasmic autoantibodies) urgently in patients with respiratory symptoms and unexplained renal impairment

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