

<https://helda.helsinki.fi>

A comprehensive fracture prevention strategy in older adults : the European Union Geriatric Medicine Society (EUGMS) statement

Blain, H.

2016-08

Blain , H , Masud , T , Dargent-Molina , P , Martin , F C , Rosendahl , E , van der Velde , N , Bousquet , J , Benetos , A , Cooper , C , Kanis , J A , Reginster , J Y , Rizzoli , R , Cortet , B , Barbagallo , M , Dreinhofer , K E , Vellas , B , Maggi , S , Strandberg , T , EUGMS Falls & Fracture Interest Gr , IAGG-ER , EUMS , FFN , European Soc Clinical & Econ Aspec & IOF 2016 , ' A comprehensive fracture prevention strategy in older adults : the European Union Geriatric Medicine Society (EUGMS) statement ' , Aging Clinical and Experimental Research , vol. 28 , no. 4 , pp. 797-803 . <https://doi.org/10.1007/s40520-016-0588-4>

<http://hdl.handle.net/10138/224112>

<https://doi.org/10.1007/s40520-016-0588-4>

publishedVersion

Downloaded from Helda, University of Helsinki institutional repository.

This is an electronic reprint of the original article.

This reprint may differ from the original in pagination and typographic detail.

Please cite the original version.

A comprehensive fracture prevention strategy in older adults: the European Union Geriatric Medicine Society (EUGMS) statement

H. Blain^{1,22} · T. Masud² · P. Dargent-Molina³ · F. C. Martin⁴ · E. Rosendahl⁵ · N. van der Velde⁶ · J. Bousquet⁷ · A. Benetos⁸ · C. Cooper^{9,10} · J. A. Kanis¹¹ · J. Y. Reginster¹² · R. Rizzoli¹³ · B. Cortet¹⁴ · M. Barbagallo¹⁵ · K. E. Dreinhöfer^{16,17} · B. Vellas¹⁸ · S. Maggi¹⁹ · T. Strandberg^{20,21} · for the EUGMS Falls and Fracture Interest Group, · the International Association of Gerontology and Geriatrics for the European Region (IAGG-ER), · the European Union of Medical Specialists (EUMS), · the Fragility Fracture Network (FFN), · the European Society for Clinical and Economic Aspects of Osteoporosis and Osteoarthritis (ESCEO), and · the International Osteoporosis Foundation (IOF)

Received: 20 April 2016 / Accepted: 5 May 2016 / Published online: 14 June 2016
© The Author(s) 2016

Abstract Prevention of fragility fractures in older people has become a public health priority, although the most appropriate and cost-effective strategy remains unclear. In the present statement, the Interest Group on Falls and Fracture Prevention of the European Union Geriatric Medicine Society, in collaboration with the International Association of Gerontology and Geriatrics for the

European Region, the European Union of Medical Specialists, and the International Osteoporosis Foundation–European Society for Clinical and Economic Aspects of Osteoporosis and Osteoarthritis, outlines its views on the main points in the current debate in relation to the primary and secondary prevention of falls, the diagnosis and treatment of bone fragility, and the place of combined falls and fracture liaison services for fracture prevention in older people.

This article is being published concurrently by the European Geriatric Medicine and the Journal of nutrition, health & aging.

✉ H. Blain
h-blain@chu-montpellier.fr

¹ Department of Internal Medicine and Geriatrics, Montpellier University Hospital, EA 2991 Movement To Health, Euromov, MacVia-LR, EIP-AHA Reference Site, Montpellier University, Montpellier, France

² Department of Geriatric Medicine, Nottingham University Hospitals NHS Trust, Nottingham, UK

³ INSERM, U1153, ORCHARD Team, Centre of Research in Epidemiology and Statistics Sorbonne Paris Cité (CRESS), Paris Descartes University, Paris, France

⁴ Department of Ageing and Health, Guy's and St Thomas' NHS Trust, London, UK

⁵ Department of Community Medicine and Rehabilitation, Physiotherapy, Umeå University, Umeå, Sweden

⁶ Geriatrics Department, Academisch Medisch Centrum Geriatrie, Amsterdam, The Netherlands

⁷ Respiratory Diseases Department, Montpellier University Hospital, MacVia-LR, EIP-AHA Reference Site, Inserm U1018, Villejuif, France

⁸ Department of Geriatrics, University Hospital of Nancy, Inserm, U1116, CIC-P 1433, Université de Lorraine, Nancy, France

⁹ MRC Lifecourse Epidemiology Unit, University of Southampton, Southampton, UK

¹⁰ NIHR Musculoskeletal Biomedical Research Unit, University of Oxford, Oxford, UK

¹¹ WHO Collaborative Centre for Metabolic Bone Diseases, University of Sheffield Medical School, Beech Hill Road, Sheffield S10 2RX, UK

¹² Department of Public Health, Epidemiology and Health Economics, University of Liege, CHU Sart Tilman B23, 4000 Liège, Belgium

¹³ Service of Bone Diseases, Geneva University Hospitals and Faculty of Medicine, Geneva, Switzerland

¹⁴ Hôpital Roger Salengro, Lille, France

¹⁵ Geriatric Unit, University of Palermo, Palermo, Italy

Keywords Falls · Fragility fracture · Older people · Prevention · Position statement

Introduction

Three-quarters of all vertebral and non-vertebral fractures occur among adults aged 65 years or older, and over three-quarters of hip fractures occur in people aged 75 or over [1]. The major influence of ageing on fracture risk is mainly due to the strong impact of age and age-related conditions on bone strength and fall risk [2, 3]. Although fractures of the hip are the most serious and costly fractures, those at the spine, pelvis, distal femur, proximal tibia, proximal humerus, and ribs are also major fractures, associated with excess morbidity and mortality, increased hip fracture risk, decreased quality of life, and high healthcare costs [4–8]. With the global growth of the older population, prevention of fractures has become an international public health priority [4, 9, 10]. The most appropriate and cost-effective strategy to prevent major fractures in older people, however, remains a hotly debated topic [11–14]. In the present statement, the Interest Group on Falls and Fracture Prevention of the European Union Geriatric Medicine Society (EUGMS), in collaboration with the International Association of Gerontology and Geriatrics for the European Region (IAGG-ER), the European Union of Medical Specialists (EUMS), and the International Osteoporosis Foundation–European Society for Clinical and Economic Aspects of Osteoporosis and Osteoarthritis, outlines its views on the main points in the current debate.

Primary and secondary prevention related to falls

In adults, falls occur predominantly in older people. In populations over age 65, a third of community-dwelling people fall at least once per year, and in those aged 80 years or more, a half fall over the course of a year [15, 16]. More than 80 % of non-vertebral fractures result from a fall [2, 3]. Around 10 % of falls result in a fracture [17, 18] and 2 % in a hip fracture [19]. The efficacy of falls prevention interventions to reduce fractures is debated [13, 14], in part because it depends on the fall risk profile of people and the type of intervention programme [20, 21].

There is no international consensus for assessing the fall risk profile of older people, even if it is well understood that people at higher risk of future falls are those aged 75 or older, those who have fallen during the previous 12 months or those who have fear of falling or significant gait, muscle strength, or balance problems [16, 22–28]. The fall risk profile is also dependent on the setting and some other factors, including cognitive impairment which may be associated with increased risk taking. Even though balance, gait, and muscle function decline increase the risk of falling, the relationship is not completely linear since those with most problems (i.e. bedridden) usually have a lower falls risk, similar to those without such problems, presumably due to low exposure to risk [29].

Notwithstanding the lack of consensus in assessing fall risk profile, there is rather consistent evidence in subjects with low to moderate falls risk, usually community dwelling, that multicomponent exercise programmes, including progressive, challenging and regular exercises designed to improve balance, muscle strength, and protective responses in case of destabilization, are effective in the reduction of serious falls and non-vertebral fractures [21, 24, 30, 31]. The studies are, however, insufficiently powered to demonstrate a significant effect on hip fracture risk [21, 24, 30]. Single interventions including treatment of some vision problems or carotid sinus hypersensitivity, vitamin D supplementation in deficient patients, gradual withdrawal of psychotropic medication, or improving the safety of indoor activities and outdoor walking environments are also effective for suitable patient groups in the prevention of falls, but the effect on fracture risk is not clear [21, 32, 33]. Multifactorial interventions, a combination of interventions linked to the individual's risk profile, seem no more effective in preventing falls than single targeted interventions (e.g. community exercise or fall prevention programmes) [21, 34].

In people at high risk of falls, single targeted interventions seem less effective, e.g. in older nursing home residents, the only single intervention that has reduced falls is vitamin D supplementation [20]. Other interventions have

¹⁶ Department of Orthopedics and Traumatology Medical Park Berlin, Charité Universitätsmedizin, Berlin, Germany

¹⁷ Department of Orthopedics and Traumatology, Medical Park Berlin, Berlin, Germany

¹⁸ Gérontopôle, Institute of Ageing, University Hospital Toulouse, Toulouse, France

¹⁹ National Research Council, Aging Branch, Institute of Neuroscience, Padua, Italy

²⁰ University of Helsinki, and Helsinki University Central Hospital, Helsinki, Finland

²¹ Center for Life Course Health Research, University of Oulu, Oulu, Finland

²² Pôle de Gériatrie, Centre Antonin-Balmes, CHU de Montpellier, 39, Avenue Charles-Flahault, 34395 Montpellier Cedex 5, France

been ineffective or inconsistent for falls although the rate of recurrent falls may be reduced [35]. A multifactorial and interprofessional approach, determined by individual assessment of functional, medical, and social concerns, may be a more appropriate strategy to prevent falls in older people at high risk of falling [20, 22–34, 36]. Moreover, this tailored approach [37] may provide opportunities to address previously unidentified health problems (e.g. impaired cognition, diabetes, Parkinson's disease, osteoporosis) [9, 38], conferring benefits beyond falls prevention [39, 40]. People at high risk of fall are most often frail patients [40], and multifactorial approach in this population has been shown to improve the ability to live safely and independently [41].

Taken together, the EUGMS supports (1) the set-up of a working group that would develop consensus international operational definitions and diagnostic criteria for assessing the risk of falling to be used in clinical practice as well as in research studies, (2) the 2010 American Geriatrics Society/British Geriatrics Society joint guideline urging practitioners to screen, at least annually, older patients for risk of falling [42], (3) that above evidence-based measures, especially evidence-based community exercise fall prevention programmes, should be widely available to prevent non-vertebral fractures in older people at low or moderate risk of falling [9], and (4) that people at high risk should be able to access individually tailored multifactorial measures based on a comprehensive geriatric assessment. EUGMS recommends continued and expanded provision of evidence-based fall prevention programmes such as those being promoted by ProFouND (www.profound.eu.org).

Primary and secondary prevention related to bone health

It is widely recognized that lifestyle measures (regular weight-bearing exercises, balanced diet, including calcium intake, avoiding smoking and excessive alcohol consumption) and measures aimed at reducing adverse effects on bone of drugs and diseases, including renal diseases, have to be recommended throughout life in everyone. They are beneficial in optimizing skeletal development [43–46] and limiting bone loss during adulthood [47].

Whereas there are well-established definitions of osteoporosis [13, 14], there is much current debate on what is the target population that may potentially benefit from treatments acting on bone metabolism (TABM) [13, 14, 48–51].

Osteoporosis is currently defined by bone densitometry (densitometry osteoporosis) when the bone mineral density (BMD) is 2.5 SD or more below that of the mean level for a young adult reference population (T score ≤ -2.5 at the

lumbar spine or the hip, or at the distal radius when the hip and lumbar spine cannot be measured or are unusable or uninterpretable) [52–54]. Aortic calcification and osteoarthritis that increase progressively with age may be a source of accuracy error in the measurement of lumbar spine BMD in older people [55, 56]. However, for a given BMD, the risk of major fractures depends on other risk factors for bone fragility, of which age is the most important one, which are taken into account in different fracture prediction tools such as the most used FRAX[®] tool (www.shef.ac.uk/FRAX) or the Garvan Fracture Risk calculator (www.garvan.org.au/bone-fracture) or the Q-fracture Risk Calculator (www.qfracture.org). Fragility fracture risk should therefore take into account not only BMD but also other risk factors of bone fragility, by using fracture prediction tools, and falls risk [57]. Since falls and osteoporosis are independent risk factors of non-vertebral fractures, osteoporosis should be ascertained not only in patients with conditions known to induce bone fragility but also in patients at risk of falls and vice versa [58]. The prevalence of osteoporosis detected by DXA BMD measurement is high in fallers with sarcopenia, impaired mobility, and weight loss, which are risk factors for both falls and osteoporosis [58].

A fracture is considered a fragility or low-energy fracture when it is the result of a minimal trauma, such as a fall from a standing height or less. However, a fall from standing height without any protective response generates an amount of energy which is at least ten times the energy required to fracture the proximal femur of an elderly woman [59]. Diagnosis of fragility fracture should therefore be set after a careful comprehensive assessment including (1) fracture mechanism consideration (energy of the trauma) and (2) bone strength estimate, based on bone mineral density (BMD), considering that densitometry osteoporosis is observed in around 60 and 40 % hip fractured women and men, respectively [60], fracture type (comminuted or not, for example) and operator's subjective assessment of bone quality in the case of surgery.

The cost-effectiveness of the pharmacological approach of treating osteoporosis (and therefore on searching for osteoporosis by dual-energy X-ray absorptiometry (DXA)) is also debated [13]. However, several licensed TABM have shown their ability to prevent major fractures in people (most often women) with a T score ≤ -2.5 at the spine or the hip (raloxifene has only been shown effective in preventing vertebral fractures) [14, 61] or after a hip fracture [61]. Relative risk reductions of spine and non-vertebral fractures by TABM in subjects with bone densitometry-diagnosed osteoporosis are 40–60 and 20–40 %, respectively [14, 61]. Number needed to treat (NNT) to prevent a fracture is lower in people at high risk of fractures, especially in those with prior fragility fractures [13, 37, 61–73].

Taken together, EUGMS supports recommendations that (1) osteoporosis should be ascertained by DXA, at best combined with vertebral fracture assessment (VFA) or radiography examination to detect vertebral fractures, in individuals at risk of fracture, i.e. at risk of falling [58] or at risk of bone fragility (history of fracture, low body weight, parental history of hip fracture, use of glucocorticoids, excessive alcohol consumption, diseases with bone adverse effects) [74], (2) TABM should be considered after a careful assessment of the benefit/risk ratio in patients at high risk of fracture, i.e. with a prior fragility fracture or in those with densitometry-diagnosed osteoporosis associated with other risks factors of fractures, assessed both by fracture prediction scores and by risk of falling, and (3) TABM should not be initiated when the life expectancy is less than 6–12 months, the minimum time needed for drugs to be effective in fracture prevention [66].

EUGMS recommends that prospective studies be conducted in non-selected older people (particularly in those aged over 80 years) to determine whether this strategy is effective, considering that age and health status may modify compliance with treatments and the number to treat/number needed to harm (NNH) of TABM [61].

Fracture Liaison Services and screening for spine fragility

As the diagnosis of fragility fracture and the assessment of benefit/risk ratio of the above measures are complex, EUGMS recommends that patients aged 65 years or older with vertebral or non-vertebral fractures should be referred to a fracture liaison service (FLS) (as proposed by the International Osteoporosis Foundation in the Capture the Fracture initiative) [75], which should be linked to or have strong input from geriatric medicine services (combined fall and fracture liaison service). Such an approach will allow commencement of appropriate interventions and ensure locally agreed arrangements for follow-up of patients. This model of care has been shown to be cost-effective [76, 77].

EUGMS emphasizes that vertebral compression fractures are common and often unrecognized in older people. X-ray examination should be more systematically performed in older patients with back pain, significant height loss (e.g. 5 cm or more), or significant incident kyphosis. Radiologists should be encouraged to report on the presence or absence of vertebral deformities as “fractures” when assessing chest radiographs so as to identify patients who need referral to the combined fall and fracture liaison services [78], as these are mostly fragility fractures in older people [53].

Conclusion

EUGMS advocates a comprehensive and multidisciplinary fracture prevention strategy in individuals aged 65 or older requiring: (1) better education for both older people and healthcare professionals with regard to general lifestyle and medical measures to optimize bone health and prevent falls; (2) improved knowledge about screening and optimizing management of older people with bone fragility or high risk of falling in primary and community care as well as institutional settings; and (3) strong collaboration between fracture liaison services, geriatric medicine departments (combined falls and fracture liaison services), and primary care. Policy makers will need to play a major role in developing community and institutional programmes on falls prevention, to establish falls and fracture liaison services and appropriate pathways for fracture prevention that include both assessment and management of fallers and optimizing medical management in those with bone fragility to reduce fracture risk.

The EUGMS believes strongly that the focus for fracture prevention should not be polarized into either falls prevention or improving bone health camps. Rather the ideal strategy should be on optimizing bone health, especially in those with bone fragility, in addition to implementing measures to prevent falls.

Acknowledgments For the EUGMS Falls and Fracture Interest Group: Marta Neira Alvarez, Madrid, Spain; Cedric Annweiler, Angers, France; Pierre Louis Bernard, Montpellier, France; Natalie Beswetherick, London, UK; Heike A. Bischoff-Ferrari, Zurich, Switzerland; Frédéric Bloch, Paris, France; Jacques Boudaert, Paris, France; Marc Bonnefoy, Pierre-Bénite Cedex, France; Valérie Bousson, Paris, France; Isabelle Bourdel-Marchasson, Bordeaux, France; Ana Capisizu, Bucharest, Romania; Hélène Che, Montpellier, France; João Gorjão Clara, Lisbon, Portugal; Bernard Combe, Montpellier, France; Didier Delignieres, Montpellier, France; Patrik Eklund, Umeå, Sweden; Marielle Emmelot-Vonk, Utrecht, The Netherlands; Ellen Freiburger, Germany; Jean-Bernard Gauvain, Orléans, France; Nandu Goswami, Graz, Austria; Nick Guldemond, Utrecht, The Netherlands; Álvaro Casas Herrero, Pamplona, Spain; Marie-Eve Joël, Paris, France; Anna Björg Jónsdóttir, Reykjavík, Iceland; Gilles Kemoun, Paris, France; Istvan Kiss, Budapest, Hungary; Helgi Kolk, Tartu, Estonia; Marek L Kowalski, Lodz, Poland; Štefan Krajčík, Bratislava, Slovakia; Yesim Gökçe Kutsal, Ankara, Turkey; Fulvio Lauretani, Parma, Italy; Jūratė Macijauskienė, Kaunas, Lithuania; Marte Mellingsæter, Lørenskog, Norway; Jacques Morel, Montpellier, France; France Mourey, Dijon, France; Fati Nourashemi, Toulouse, France; Csaba Nyakas, Budapest, Hungary; François Puisieux, Lille, France; Patrick Rambourg, Montpellier, France; Alfonso González Ramírez, Salamanca, Spain; Kilian Rapp, Stuttgart, Germany; Yves Rolland, Toulouse, France; Jesper Ryg, Odense, Denmark; Opinder Sahota, Department of Orthogeriatric Medicine & Consultant Physician, QMC, Nottingham, UK; Sanne Snoeijs, Utrecht, The Netherlands; Yannick Stephan, Montpellier, France; Eric Thomas, Montpellier, France; Chris Todd, Manchester, UK; Jonathan Treml, Birmingham UK.

For the European Society for Clinical and Economic Aspects of Osteoporosis and Osteoarthritis (ESCEO), Osteoporosis Research and

Information Group (GRIO), and International osteoporosis Foundation (IOF): Rick Adachi, London, Ontario, Canada; Donato Agnusdei, Italy; Jean-Jacques Body, Brussels, Belgium; Véronique Breuil, Nice, France; Olivier Bruyère, Liège, Belgium; Peter Burckhardt, Lausanne, Switzerland; Jorge B. Cannata-Andia, Oviedo, Spain; John Carey, Galway, Republic of Ireland; Dinh-Chen Chan, Taipei, Taiwan; Laure Chapuis, Vitré, France; Thierry Chevalley, Geneva, Switzerland; Martine Cohen-Solal, Paris, France; Bess Dawson-Hughes, Boston, MA, USA; Elaine M Dennison, Southampton, UK; Jean-Pierre Devogelaer, Brussels, Belgium; Patrice Fardellone, Amiens, France; Jean-Marc Féron, Paris, France; Adolfo Diez Perez, Barcelona, Spain; Dieter Felsenberg, Berlin, Germany; Claus Glueer, Kiel, Germany; Nicholas Harvey, Southampton, UK; Mickael Hilgismann, Maastricht, The Netherlands; Muhammad Kassim Javaid, Oxford, UK; Niklas Rye Jørgensen, Glostrup, Denmark; David Kendler, Vancouver, Canada; Marius Kraenzlin, Basel, Switzerland; Michel Laroche, Toulouse, France; Erick Legrand, Angers, France; William D Leslie, Manitoba, Canada; Eric Lespessailles, Orléans, France; E. Michael Lewiecki, Albuquerque, NM, USA; Toshitaka Nakamura, Tokyo, Japan; Alexandra Papaioannou, Hamilton, ON, Canada; Christian Roux, Paris, France; Stuart Silverman, Los Angeles, CA, USA, IOF; Manuel Sosa Henriquez, Las Palmas de Gran Canaria, Spain; Thierry Thomas, Saint-Etienne, France; Samuel Vasikaran, Nedlands, Australia; Nelson B. Watts, Cincinnati, Ohio, USA; Georges Weryha, Vandœuvre-lès-Nancy, France.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflicts of interest concerning this article.

Statement of human and animal rights All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

References

- Johnell O, Kanis JA (2006) An estimate of the worldwide prevalence and disability associated with osteoporotic fractures. *Osteoporos Int* 17:1726–1733
- Fife D, Barancik JI (1985) Northeastern Ohio Trauma Study III: incidence of fractures. *Ann Emerg Med* 14:244–248
- Cummings SR, Nevitt MC (1994) Non-skeletal determinants of fractures: the potential importance of the mechanics of falls. Study of Osteoporotic Fractures Research Group. *Osteoporos Int* 4(Suppl 1):67–70
- Burge R, Dawson-Hughes B, Solomon DH et al (2007) Incidence and economic burden of osteoporosis-related fractures in the United States, 2005–2025. *J Bone Miner Res* 22:465–475
- Bliuc D, Nguyen ND, Milch VE et al (2009) Mortality risk associated with low-trauma osteoporotic fracture and subsequent fracture in men and women. *JAMA* 301:513–521
- Cooper C, Cole ZA, Holroyd CR et al (2011) Secular trends in the incidence of hip and other osteoporotic fractures. IOF CSA Working Group on Fracture Epidemiology. *Osteoporos Int* 22:1277–1288
- Roux C, Wyman A, Hooven FH et al (2012) Burden of nonhip, non-vertebral fractures on quality of life in postmenopausal women: the Global Longitudinal study of Osteoporosis in Women (GLOW). *Osteoporos Int* 23:2863–2871
- Bischoff-Ferrari H (2013) Fragility fractures: the future epidemic and its challenges. *Skeletal Radiol* 42:161–163
- Blain H, Abecassis F, Adnet PA et al (2014) Living Lab Falls-MACVIA-LR: the falls prevention initiative of the European Innovation Partnership on Active and Healthy Ageing (EIP on AHA) in Languedoc-Roussillon. *Eur Geriatr Med* 5:416–425
- European Innovation Partnership on Active and Healthy Ageing (2013) ACTION PLAN A2 on Specific Action on innovation in support of ‘Personalized health management, starting with a Falls Prevention Initiative’. https://ec.europa.eu/research/innovation-union/pdf/active-healthy-ageing/a2_action_plan.pdf
- Hung WW, Egol KA, Zuckerman JD et al (2012) Hip fracture management: tailoring care for the older patient. *JAMA* 307:2185–2194
- Bischoff-Ferrari HA, Meyer O (2014) Comparative effectiveness of pharmacologic treatments to prevent fractures: Is this all we need to know? *Ann Intern Med* 161:755–756
- Järvinen TL, Michaëlsson K, Jokihäärä J et al (2015) Overdiagnosis of bone fragility in the quest to prevent hip fracture. *BMJ* 350:h2088
- Compston J (2015) Overdiagnosis of osteoporosis: fact or fallacy? *Osteoporos Int* 26:2051–2054
- O’Loughlin JL, Robitaille Y, Boivin JF et al (1993) Incidence of and risk factors for falls and injurious falls among the community-dwelling elderly. *Am J Epidemiol* 137:342–354
- Tinetti ME (2003) Clinical practice. Preventing falls in elderly persons. *N Engl J Med* 348:42–49
- Tinetti ME, Speechley M, Ginter SF (1988) Risk factors for falls among elderly persons living in the community. *New Engl J Med* 319:1701–1707
- Campbell AJ, Borrie MJ, Spears GF et al (1990) Circumstances and consequences of falls experienced by a community population 70 years and over during a prospective study. *Age Ageing* 19:136–141
- Milat AJ, Watson WL, Monger C et al (2011) Prevalence, circumstances and consequences of falls among community-dwelling older people: results of the 2009 NSW Falls Prevention Baseline Survey. *N S W Public Health Bull* 22:43–48
- Cameron ID, Gillespie LD, Robertson MC et al (2012) Interventions for preventing falls in older people in care facilities and hospitals. *Cochrane Database Syst Rev* 12:CD005465
- Gillespie LD, Robertson MC, Gillespie WJ et al (2012) Interventions for preventing falls in older people living in the community. *Cochrane Database Syst Rev* 9:CD007146
- STEADI algorithm CDC’s Stopping Elderly Accidents, Deaths & Injuries (STEADI) Algorithm providing tools and educational material for health care providers. Centers for Disease Control and Prevention, National Center for Injury Prevention and Control, Division of Unintentional Injury Prevention. Available from: [stevens](http://www.cdc.gov/homeandrecreationsafety/Falls/steady/index.html.7). <http://www.cdc.gov/homeandrecreationsafety/Falls/steady/index.html.7>
- Stevens JA, Phelan EA (2013) Development of STEADI: a fall prevention resource for health care providers. *Health Promot Pract* 14:706–714
- El-Khoury F, Cassou B, Latouche A et al (2015) Effectiveness of two year balance training programme on prevention of fall induced injuries in at risk women aged 75–85 living in community: Ossébo randomised controlled trial. *BMJ* 351:h3830
- Wagner H, Melhus H, Gedeberg R et al (2009) Simply ask them about their balance—future fracture risk in a nationwide cohort study of twins. *Am J Epidemiol* 169:143–149
- Caillet P, Klemm S, Ducher M et al (2015) Hip fracture in the elderly: a re-analysis of the EPIDOS study with causal Bayesian networks. *PLoS ONE* 10:e0120125

27. Furrer R, van Schoor NM, de Haan A et al (2014) Gender-specific associations between physical functioning, bone quality, and fracture risk in older people. *Calcif Tissue Int* 94:522–530
28. Lundin H, Säaf M, Strender LE et al (2014) One-leg standing time and hip-fracture prediction. *Osteoporos Int* 25:1305–1311
29. Lord SR, March LM, Cameron ID et al (2003) Differing risk factors for falls in nursing home and intermediate-care residents who can and cannot stand unaided. *J Am Geriatr Soc* 51:1645–1650
30. El-Khoury F, Cassou B, Charles MA et al (2013) The effect of fall prevention exercise programmes on fall induced injuries in community dwelling older adults: systematic review and meta-analysis of randomised controlled trials. *BMJ* 347:f6234
31. Stubbs B, Brefka S, Denking MD (2015) What works to prevent falls in community-dwelling older adults? Umbrella review of meta-analyses of randomized controlled trials. *Phys Ther* 95:1095–1110
32. Keall MD, Piers N, Howden-Chapman P et al (2015) Home modifications to reduce injuries from falls in the home injury prevention intervention (HIPI) study: a cluster-randomised controlled trial. *Lancet* 385:231–238
33. Li W, Procter-Gray E, Lipsitz LA et al (2014) Utilitarian walking, neighborhood environment, and risk of outdoor falls among older adults. *Am J Public Health* 104:e30–e37
34. Campbell AJ, Robertson MC (2013) Fall prevention: single or multiple interventions? Single interventions for fall prevention. *J Am Geriatr Soc* 61:281–284
35. Vlaeyen E, Coussement J, Leysens G et al (2015) Center of Expertise for Fall and Fracture Prevention Flanders. Characteristics and effectiveness of fall prevention programs in nursing homes: a systematic review and meta-analysis of randomized controlled trials. *J Am Geriatr Soc* 63:211–221
36. Day LM (2013) Fall prevention programs for community-dwelling older people should primarily target a multifactorial intervention rather than exercise as a single intervention. *J Am Geriatr Soc* 61:284–285
37. Ambrose AF, Cruz L, Paul G (2015) Falls and Fractures: a systematic approach to screening and prevention. *Maturitas* 82:85–93
38. Zhang W, Zhu C, Sun M et al (2014) Efficacy of bisphosphonates against hip fracture in elderly patients with stroke and Parkinson diseases: meta-analysis of randomized controlled trials. *J Stroke Cerebrovasc Dis* 23:2714–2724
39. Taylor BC, Schreiner PJ, Stone KL et al (2004) Long-term prediction of incident hip fracture risk in elderly white women: study of osteoporotic fractures. *J Am Geriatr Soc* 52:1479–1486
40. Kojima G (2015) Frailty as a predictor of future falls among community-dwelling older people: a systematic review and meta-analysis. *J Am Med Dir Assoc* S1525–8610:00439–9
41. Beswick AD, Rees K, Dieppe P et al (2008) Complex interventions to improve physical function and maintain independent living in elderly people: a systematic review and meta-analysis. *Lancet* 371:725–735
42. American Geriatrics Society (2010) British geriatrics Society clinical practice guideline: prevention of falls in older persons. American Geriatrics Society, New York. <http://www.american-geriatrics.org/healthcareprofessionals/clinicalpractice/clinicalguidelinesrecommendations/2010>
43. Rizzoli R, Bianchi ML, Garabédian M et al (2010) Maximizing bone mineral mass gain during growth for the prevention of fractures in the adolescents and the elderly. *Bone* 46:294–305
44. Specker B, Minett M (2013) Can physical activity improve peak bone mass? *Curr Osteoporos Rep* 11:229–236
45. Golden NH, Abrams SA (2014) Committee on nutrition. Optimizing bone health in children and adolescents. *Pediatrics* 134:e1229–e1243
46. Harvey N, Dennison E, Cooper C (2014) Osteoporosis: a life-course approach. *J Bone Miner Res* 29:1917–1925
47. Milte R, Crotty M (2014) Musculoskeletal health, frailty and functional decline. *Best Pract Res Clin Rheumatol* 28:395–410
48. Kanis JA, McCloskey EV, Johansson H et al (2013) Scientific Advisory Board of the European Society for Clinical and Economic Aspects of Osteoporosis and Osteoarthritis (ESCEO) and the Committee of Scientific Advisors of the International Osteoporosis Foundation (IOF). European guidance for the diagnosis and management of osteoporosis in postmenopausal women. *Osteoporos Int* 24:23–57
49. Kanis JA, Rizzoli R, Cooper C et al (2014) Challenges for the development of bone-forming agents in Europe. *Calcif Tissue Int* 94:469–473
50. Kanis JA, McCloskey E, Branco J et al (2014) Goal-directed treatment of osteoporosis in Europe. *Osteoporos Int* 25:2533–2543
51. Rizzoli R, Branco J, Brandi ML et al (2014) Management of osteoporosis of the oldest old. *Osteoporos Int* 25:2507–2529
52. Kanis JA, Melton LJ 3rd, Christiansen C et al (1994) The diagnosis of osteoporosis. *J Bone Miner Res* 9:1137–1141
53. World Health Organization (1994) Assessment of fracture risk and its application to screening for postmenopausal osteoporosis. Report of a WHO Study Group. World Health Organization, Geneva. WHO Technical Report Series, No. 843
54. International Society for Clinical Densitometry (2013) Official positions—adult. <http://www.iscd.org/official-positions/2013-iscd-official-positions-adult/>
55. Masud T, Langley S, Wiltshire P et al (1993) Effect of spinal osteophytosis on bone mineral density measurements in vertebral osteoporosis. *BMJ* 307:172–173
56. Kanis JA, McCloskey EV, Johansson H et al (2008) A reference standard for the description of osteoporosis. *Bone* 42:467–475
57. Kanis JA, Hans D, Cooper C et al (2011) Interpretation and use of FRAX in clinical practice. *Osteoporos Int* 22:395–411
58. Blain H, Rolland Y, Beauchet O et al (2014) Groupe de recherche et d'information sur les ostéoporoses et la Société française de gérontologie et gériatrie. Usefulness of bone density measurement in fallers. *Joint Bone Spine* 81:403–408
59. Nevitt MC, Cummings SR (1993) Type of fall and risk of hip and wrist fractures: the study of osteoporotic fractures. *J Am Geriatr Soc* 41:1226–1234
60. Schuit SC, van der Klift M, Weel AE et al (2004) Fracture incidence and association with bone mineral density in elderly men and women: the Rotterdam Study. *Bone* 34:195–202
61. Crandall CJ, Newberry SJ, Diamant A et al (2014) Comparative effectiveness of pharmacologic treatments to prevent fractures: an updated systematic review. *Ann Intern Med* 161:711–723
62. Lyles KW, Colón-Emeric CS, Magaziner JS et al (2007) Zoledronic acid in reducing clinical fracture and mortality after hip fracture. *N Engl J Med* 357:nihpa40967
63. Eriksen EF, Díez-Pérez A, Boonen S (2014) Update on long-term treatment with bisphosphonates for postmenopausal osteoporosis: a systematic review. *Bone* 58:126–135
64. Hilgsmann M, Evers SM, Ben Sedrine W et al (2015) A systematic review of cost effectiveness analyses of drugs for postmenopausal osteoporosis. *Pharmacoeconomics* 33:205–224
65. Boonen S, Black DM, Colón-Emeric CS et al (2010) Efficacy and safety of a once-yearly intravenous zoledronic acid 5 mg for fracture prevention in elderly postmenopausal women with osteoporosis aged 75 and older. *J Am Geriatr Soc* 58:292–299
66. Boonen S, McClung MR, Eastell R et al (2004) Safety and efficacy of risedronate in reducing fracture risk in osteoporotic women aged 80 and older: implications for the use of antiresorptive agents in the old and oldest old. *J Am Geriatr Soc* 52:1832–1839

67. Boonen S, Marin F, Mellstrom D et al (2006) Safety and efficacy of teriparatide in elderly women with established osteoporosis: bone anabolic therapy from a geriatric perspective. *J Am Geriatr Soc* 54:782–789
68. Hochberg MC, Thompson DE, Black DM et al (2005) Effect of alendronate on the age-specific incidence of symptomatic osteoporotic fractures. *J Bone Miner Res* 20:971–976
69. Eastell R, Black DM, Boonen S et al (2009) Effect of once yearly zoledronic acid five milligrams on fracture risk and change in femoral neck bone mineral density. *J Clin Endocrinol Metab* 94:3215–3225
70. Reginster JY, Seeman E, De Vernejoul MC et al (2005) Strontium ranelate reduces the risk of nonvertebral fractures in postmenopausal women with osteoporosis: treatment of peripheral osteoporosis (TROPOS) study. *J Clin Endocrinol Metab* 90:2816–2822
71. Boonen S, Adachi JD, Man Z et al (2011) Treatment with denosumab reduces the incidence of new vertebral and hip fractures in postmenopausal women at high risk. *J Clin Endocrinol Metab* 96:1727–1736
72. Rolland Y, Abellan Van Kan G, Gillette-Guyonnet S et al (2011) Strontium ranelate and risk of vertebral fractures in frail osteoporotic women. *Bone* 48:332–338
73. Greenspan SL, Perera S, Ferchak MA et al (2015) Efficacy and safety of single-dose zoledronic acid for osteoporosis in frail elderly women: a randomized clinical trial. *JAMA Intern Med* 175:913–921
74. National Osteoporosis Foundation (2014) Clinician’s guide to prevention and treatment of osteoporosis. National Osteoporosis Foundation. <http://nof.org/files/nof/public/content/file/2791/upload/919.pdf>
75. Javaid MK, Kyer C, Mitchell PJ et al (2015) IOF Fracture Working Group; EXCO. Effective secondary fracture prevention: implementation of a global benchmarking of clinical quality using the IOF Capture the Fracture® Best Practice Framework tool. *Osteoporos Int* 26:2573–2578
76. Solomon DH, Patrick AR, Schousboe J et al (2014) The potential economic benefits of improved post-fracture care: a costeffectiveness analysis of a fracture liaison service in the US health-care system. *J Bone Miner Res* 29:1667–1747
77. Yong JH, Masucci L, Hoch JS, Sujic R, Beaton D (2016) Cost-effectiveness of a fracture liaison service—a real-world evaluation after 6 years of service provision. *Osteoporos Int* 27:231–240
78. Majumdar SR, Kim N, Colman I, Chahal AM, Raymond G, Jen H et al (2005) Incidental vertebral fractures discovered with chest radiography in the emergency department: prevalence, recognition, and osteoporosis management in a cohort of elderly patients. *Arch Intern Med* 165:905–909