Abstract: Demographic changes confront clinicians with an increasing number of orthogeriatric patients. These patients present with comorbidities, which force their surgeons to take into consideration their medical condition. A major risk factor for fractures in orthogeriatric patients is osteoporosis in combination with frailty. To prevent subsequent fractures in these patients, we need to pay attention to adequate osteoporosis treatment in orthogeriatric patients. There is a huge treatment gap. In Germany, 77% of patients with osteoporosis are not treated adequately. Even after fragility fractures, a low percentage of patients receive a specific osteoporosis therapy. Secondary prevention is of great importance in the treatment of these patients. Diagnostics and treatment should be already initiated with the admission to the hospital. Treatment decisions need to be made individually based on the risk profile of the patients. After discharge, it is important to involve the patients’ general practitioners and to follow up on patients regularly to improve their compliance and to ensure adequate therapy. Establishing a fracture liaison service helps coordinating osteoporosis treatment during hospitalization and after discharge. Subsequent fractures can be reduced; therefore, it is an effective service for secondary prevention. The present article provides an overview of how an efficient identification and subsequent treatment of osteoporosis can be achieved in aged trauma patients.

Keywords: fracture liaison service; hip fracture; orthogeriatric; osteoporosis; vitamin D.
of an underlying osteoporosis remains high. Osteoporosis was diagnosed in 56.2% of women older than 50 years with fragility fractures and men ages 60 years [4]. Patients with typical osteoporosis-related fractures should be screened for osteoporosis [8].

According to the guidelines for osteoporosis by the Dachverband Osteologie e.V. (DVO) 2014, patients without any fracture should generally be assessed at the age of 70 years in women and at the age of 80 years in men; in high-risk patients, a clarification in younger age might already be useful [9].

When orthogeriatric patients with fractures are admitted to hospital, risk factors for osteoporosis should be assessed by standardized questionnaires. Thus, standardized questionnaires and algorithms based on the osteoporosis guidelines of the DVO 2014 for prevention, diagnostics, and treatment of osteoporosis [9] can help to estimate the risk of a secondary fracture (downloads available at http://www.klinikum.uni-muenchen.de/Klinik-fuer-Allgemeine-Unfall-und-Wiederherstellungs chirurgie/de/fach/alterstraumatologie/downloads/index.html). Internationally acknowledged to identify the osteoporosis-associated fracture risk are the FRAX- or Q-factor score [10, 11]. A diagnostic assessment in postmenopausal women and men older than 60 years is recommended as soon as a fragility fracture or an increased risk of fractures is present [12].

**Osteoporosis diagnostics**

The new guidelines of the DVO 2014 recommend five diagnostic steps to confirm the diagnosis of osteoporosis.

Taking the medical history should already identify risk factors for osteoporosis as mentioned above. The following subjects are important to include in the medical history: tendency to fall, medication (especially glucocorticoids, aromatase inhibitors, and the long-term intake of proton pump inhibitors, which are a potential risk factor still under discussion), and preexisting conditions such as diabetes mellitus, ankylosing spondylitis, chronic obstructive pulmonary disease (COPD), and endocrine disorders (such as hypothyroidism).

Also, a detailed clinical examination helps finding indicators for osteoporosis. Especially, the Tannenbaum phenomenon is common. In addition, a loss of height over 2 cm may indicate further diagnostics [13].

A basic blood testing consists of calcium and phosphate in serum, alkaline phosphatase, γ-glutamyltransferase (γ-GT), creatinine, C-reactive protein (CRP), thyroid-stimulating hormone (TSH), 25-OH-vitamin D3, a serum electrophoresis, and a complete blood count.

Dual X-ray absorptiometry (DXA) is the gold standard to determine bone density. Radiation exposure and costs are relatively small [8]. The lower bone density is, the higher is the risk for osteoporotic fractures [14]. Density measurements of the lumbar spine, femur, and femoral neck are set in relation to bone density values of a normal population (T-value). Treatment is based on the t-value, age of patients, and the individual risk factors. Risk factors, such as glucocorticoid therapy or multiple fractures in the past 3 years, increase the treatment threshold.

According to the DVO 2014 [9], in some cases, bone density scans are not necessary to obtain the diagnosis of an underlying osteoporosis. Thus, in patients having suffered a fragility fracture that shows radiographic signs of an osteoporosis within the spine or proximal femur (i.e. Figures 1 or 2), an underlying osteoporosis can be diagnosed without bone density measurements. Also, multiple low-graded fractures of the vertebral spine, such as a singular grade II impression of the vertebrae according to the Genant classification, go in line with an underlying osteoporosis (Figure 1) [15].

Degenerative changes (i.e. of the spine) can increase the t-value. If, in these cases, bone density scans of the

**Figure 1**: Preoperative CT scan with an atraumatic lumbar vertebral fracture. In this case, the diagnosis of an underlying osteoporosis can be secured without further bone density scans.
Osteoporosis treatment

Vitamin D deficiency is widely spread among elderly patients. It is associated with muscle weakness and therefore with a tendency to fall. Aged trauma patients are at high risk to develop vitamin D deficiency because of malnutrition, reduced sunlight exposure, impaired intestinal absorption, and impaired hydroxylation in the liver and kidneys [18]. In elderly patients with hip fractures, only approximately 10% of the patients have an adequate vitamin D level [19].

Treatment algorithms can be helpful for the decision of the individual osteoporosis therapy (Figure 3).

Basic treatment aims on a compensation of vitamin D level and a sufficient calcium intake. A balanced calcium homeostasis is required for the initiation of a specific osteoporosis treatment and crucial to secure fracture healing [20].

According to the DVO guidelines, a dose of approximately 1000 IU/day vitamin D is needed to maintain a normal to high vitamin D level. Vitamin D application should be adjusted to the laboratory results (Table 1). A 25-OH-vitamin D level above 75 μg/L is not recommended, as it has been shown to be associated with an increased risk of falls [21].

The intake of calcium should be up to 1000 mg/day. Raising the calcium level can be achieved through diet, for example, with calcium-rich mineral water (about 400 mg/L) or dairy products such as milk, cheese, cottage cheese, or yogurt. During a therapy with glucocorticoids, calcium supplements with a dose of 1000 mg/day calcium are recommended.

As supplement, calcium carbonate is recommended. However, a high percentage of elderly patients have proton pump inhibitors among their daily medication. In these patients, calcium citrate or calcium gluconate is recommended for an adequate resorption of calcium [22].

Depending on laboratory findings, specific therapy can be initiated during hospitalization. Considering contraindications and comorbidities, a specialized physician should initiate specific therapy.

Oral bisphosphonates are the first-line medication in postmenopausal osteoporosis. In patients older than 75 years, alendronate and risedronate show a reduced risk for vertebral fractures [23]. Also, intravenously applied bisphosphonates such as ibandronate or zoledranate show a reduction of vertebral fractures and zoledronate also decreases the total fracture risk.

An intravenous therapy with bisphosphonates should not be started before 14 days after surgery to prevent accumulation around the internal fixation [24]. To avoid hypocalcemia, vitamin D levels should be normal before starting with a specific osteoporosis therapy. In some cases, an intravenous bisphosphonate therapy is recommended 6 weeks after fracture.

Studies show that intravenous therapy with bisphosphonates is not inferior to the therapy with oral bisphosphonates concerning fracture risk. The compliance of the patients might be even higher in monthly intravenous applications than in taking it orally [25, 26].

The osteoanabolic therapy with recombinant parathyroid hormone (teriparatide) is effective but costly. It can be an option when, despite adequate pretreatment, osteoporosis progresses or causes further vertebral fractures. Teriparatide received the recommendation level B of the DVO due to the superior effect compared to alendronate in treating glucocorticoid-induced osteoporosis and reducing peripheral postmenopausal osteoporotic fractures [27].

Depending on the risk profile of the patient, monoclonal antibodies, such as denosumab, are also considered as an option. Studies with denosumab show a reduction of vertebral fractures and peripheral fractures such as proximal femur fractures. Especially, in orthogeriatric patients with limited compliance associated with cognitive disorders such as dementia or patients who refuse taking more oral medication, denosumab offers advantages. Thus, a specific osteoporosis therapy with denosumab, which has to be applied only twice a year, can be secured easily, as it is injected subcutaneously, which could be handled, for example, by the
nursing staff and monitored by their general practitioners [28–30].

Due to the increased risk of thrombosis, strontium ranelate, selective estrogen receptor modulators (SERMs; raloxifene and bazedoxifene), and estrogens (optionally in combination with a progestin) are not suitable for orthogeriatric patients [10, 31].

Calcitonin plays no role in first-line therapy. Only in cases with severe renal insufficiency, it might be applied because other agents are contraindicated.
Prevention

An effective prevention of subsequent fractures includes also fall prevention with muscle training, physiotherapy, and critical adjustment of the preexisting medication.

Training should concentrate on an integration of general movement, improvement of coordination, balance, posture, and flexibility [32].

Medication, which causes vertigo or dizziness, should be reduced [33]. Also, medication that reduces bone quality (e.g. glucocorticoids) or bone healing [e.g. non-steroidal antirheumatics (NSAR)] should be avoided.

A big problem is also the compliance of these elderly patients. The literature shows that the percentage of compliant patients decreases to 50% over a period of 1 year after initiation of treatment and even to only 30% over time [34]. Women and patients with DXA were more likely to follow their doctors’ instructions, whereas older or multimorbid patients and those with a preexisting high amount of medications are more likely to not continue with their medication.

Secondary prevention via fracture liaison service (FLS) is another additional organization to comanagement to reduce subsequent fractures and postoperative complications. First mentioned in 1999, the “UK National Health Service” in Glasgow, Scotland, established one of the first FLS. Today, clinics can apply to certify through the International Osteoporosis Foundation (IOF) for FLS.

A specially trained fragility fracture nurse is taking care of the coordination of the patients’ treatment after admission to the hospital. Besides identifying patients of high risk and initiation of adequate diagnostics and osteoporosis therapy, the fragility fracture nurse is also monitoring the patients’ compliance after discharge.

This network also increases compliance by close supervision in rehabilitation and outpatient clinics [35, 36].

The rate of subsequent fractures in patients with untreated osteoporosis increases significantly within the first 2 years after the first fracture [37]. Patients with fragility fractures have an increased risk of 86% for subsequent fractures [38]. In patients with vertebral fractures, the risk of another fracture is doubled and after proximal femur fractures even trebled [39]. Recent studies show that establishing an FLS can reduce subsequent fractures by approximately 30%. Axelsson et al. stated that even a minimal resource FLS was effective in increasing investigation and treatment (Figure 4). Patients treated in an FLS setting had a re-fracture risk reduction of 51%. This indicates that an FLS can improve secondary prevention of fractures [40, 41].

To prevent one re-fracture in 3 years, the number needed to treat (NNT) with FLS is 20 [42]. For the widely spread angiotensin-converting enzyme (ACE) inhibitors and angiotensin receptor blockers (ARBs), the NNT is 80 and 338 over a period of 4.3 years to prevent one myocardial infarction.

Allowing an early initiation of appropriate treatment, the rate of subsequent fracture can be significantly reduced [41, 43]. Another positive effect lays in the reduction of subsequent fractures [38].

Table 1: Vitamin D3 levels and treatment recommendations adapted from Amling [20].

| 25-OH-vitamin D3 level, mg/L | Cholecalciferol | Comments |
|-----------------------------|----------------|----------|
| Severe deficiency           | < 10           | 20,000 IU/day for 10 days then 20,000 IE/week | Additional tests for calcium metabolism |
| Distinct deficiency         | 10–20          | 20,000 IU/day for 5 days then 20,000 IE/week | Follow up after 2–3 months |
| Deficiency                  | 21–30          | 20,000 IU/week | Follow up after 2–3 months |
| Optimal level               | 31–60          | 1000–2000 IU/day | Maintain level |
| Oversupply                  | > 100          | Pause therapy | Addressing causes |

Figure 4: Re-fracture rate with and without treatment of osteoporosis in an FLS setting from 2011 to 2014 [40].
Concentration is an effective service to secure secondary fracture prevention.

FLS is a new approach that can significantly increase the efficiency of osteoporosis treatment by coordinating osteoporosis treatment during hospitalization and after discharge. It helps avoiding subsequent fractures and therefore is an effective service to secure secondary fracture prevention.

Author Statement
Research funding: Authors state no funding involved.
Conflict of interest: Authors state no conflict of interest.
Informed consent: Informed consent is not applicable.
Ethical approval: The conducted research is not related to either human or animal use.

Author Contributions
Deborah Schray: writing of the manuscript. Ulla Stumpf: approval of the manuscript. Christian Kammerlander: approval of the manuscript. Wolfgang Böcker: approval of the manuscript. Carl Neuerburg: revision of the manuscript.

References
[1] Johnell O, Kanis J. Epidemiology of osteoporotic fractures. Osteoporosis Int 2005;16(Suppl 2):S3–S7.
[2] Johnell O, Kanis JA. An estimate of the worldwide prevalence and disability associated with osteoporotic fractures. Osteoporosis Int 2006;17:1726–1733.
[3] Gibson-Smith D, Klop C, Elders PJ, et al. The risk of major and any (non-hip) fragility fracture after hip fracture in the United Kingdom: 2000–2010. Osteoporosis Int 2014;25:2555–2563.
[4] Haasters F, Prall WC, Himmler M, Polzer H, Schieker M, Mutschler W. Prevalence and management of osteoporosis in trauma surgery. Implementation of national guidelines during inpatient fracture treatment. Unfallchirurg 2015;118:138–145.
[5] Haussler B, Gothe H, Gol D, Glaeske G, Pientka L, Felsenberg D. Epidemiology, treatment and costs of osteoporosis in Germany – the BoneEVA study. Osteoporosis Int 2007;18:77–84.
[6] Kanis JA, McCloskey E, Branco J, et al. Goal-directed treatment of osteoporosis in Europe. Osteoporosis Int 2014;25:2533–2543.
[7] Johnell K, Fastbom J. Undertreatment of osteoporosis in the oldest old? A nationwide study of over 700,000 older people. Arch Osteoporosis 2009;4:17–23.
[8] Neuerburg C, Schmidmaier R, Schilling S, et al. Identifikation, Diagnostik und leitliniengerechte Osteoporosetherapie (DVO) unfallchirurgischer Patienten. Unfallchirurg 2015;118:913–924.
[9] (DVO) DOeV. Osteoporose-Leitlinien 2014. http://www.dvo-osteologie.org/DVO_leitlinien/osteoporose-leitlinie-2014.
[10] Kanis JA, McCloskey EV, Johansson H, et al. European guidance for the diagnosis and management of osteoporosis in postmenopausal women. Osteoporosis Int 2013;24:23–57.
[11] McGowan B, Kanis JA, Johansson H, Silke C, Whelan B. Development and application of FRAX in the management of osteoporosis in Ireland. Arch Osteoporosis 2013;8:146.
[12] Koliou L, Takur C, Moghaddam A, et al. Anamnestic risk factor questionnaire as reliable diagnostic instrument for osteoporosis (reduced bone morphogenic density). BMC Musculoskel Disord 2011;12:187.
[13] Baum E, Peters KM. The diagnosis and treatment of primary osteoporosis according to current guidelines. Deutsches Ärzteblatt Int 2008;105:573–582.
[14] Ahmed LA, Emaus N, Berntsen GK, et al. Bone loss and the risk of non-vertebral fractures in women and men: the Tromso study. Osteoporosis Int 2010;21:1503–1511.
[15] Genant HK, Wu CY, van Kuijk C, Nevitt MC. Vertebral fracture assessment using a semiquantitative technique. J Bone Miner Res 1993;8:1137–1148.
[16] Moyad MA. Osteoporosis: a rapid review of risk factors and screening methods. Urol Oncol Semin Orig Invest 2003;21:375–379.
[17] Guglielmi G, Ferrari F, Bazzocchi A. Bone mineral density and quantitative imaging. In: Peh WCG, editor. Pitfalls in diagnostic radiology. Berlin/Heidelberg: Springer, 2015:109–132.
[18] Janssen HC, Samson MM, Verhaar HJ. Vitamin D deficiency, muscle function, and falls in elderly people. Am J Clin Nutr 2002;75:611–615.
[19] de Jong A, Woods K, Van Gestel L, Suresh M, Porteous M. Vitamin D insufficiency in osteoporotic hip fracture patients: rapid substitution therapy with high dose oral cholecalciferol (vitamin D3). Acta Orthopæd Belg 2013;79:578–586.
[20] Amling M. Calcium and vitamin D in bone metabolism: clinical importance for fracture treatment. Unfallchirurg 2015;118:995–999.
[21] Scharla. Therapie mit Vitamin D: gibt es Grenzen? J Miner Stoffwechsel 2014;21:51–55.

[22] Bo-Linn GW, Davis GR, Buddrus DJ, Morawski SG, Santa Ana C, Fordtran JS. An evaluation of the importance of gastric acid secretion in the absorption of dietary calcium. J Clin Invest 1984;73:640–647.

[23] Wells GA, Cranney A, Peterson J, et al. Alendronate for the primary and secondary prevention of osteoporotic fractures in postmenopausal women. Cochrane Database Syst Rev 2008;Cd001155.

[24] Eriksen EF, Lyles KW, Colon-Emeric CS, et al. Antifracture efficacy and reduction of mortality in relation to timing of the first dose of zoledronic acid after hip fracture. J Bone Miner Res 2009;24:1308–1313.

[25] Horikawa A, Miyakoshi N, Shimada Y, Sugimura Y, Kodama H. A comparative study between intravenous and oral alendronate administration for the treatment of osteoporosis. SpringerPlus 2015;4:675.

[26] Epstein S. Ibandronate treatment for osteoporosis: rationale, preclinical, and clinical development of extended dosing regimens. Curr Osteoporosis Rep 2006;4:14–20.

[27] Nickolaus B. Osteoporose: Teriparatid bei hohem Frakturrisiko. Dtsch Arztebl Int 2010;107:A-1224.

[28] Hanley DA, Adachi JD, Bell A, Brown V. Denosumab: mechanism of action and clinical outcomes. Int J Clin Pract 2012;66:1139–1146.

[29] Lewiecki EM, Miller PD, McClung MR, et al. Two-year treatment with denosumab (AMG 162) in a randomized phase 2 study of postmenopausal women with low BMD. J Bone Miner Res 2007;22:1832–1841.

[30] Cummings SR, San Martin J, McClung MR, et al. Denosumab for prevention of fractures in postmenopausal women with osteoporosis. N Engl J Med 2009;361:756–765.

[31] Ishtiaq S, Fogelman I, Hampson G. Treatment of post-menopausal osteoporosis: beyond bisphosphonates. J Endocrinol Invest 2015;38:13–29.

[32] Woolf AD, Akesson K. Preventing fractures in elderly people. BMJ (Clin Res Ed) 2003;327:89–95.

[33] Kannus P. Preventing osteoporosis, falls, and fractures among elderly people: promotion of lifelong physical activity is essential. Br Med J 1999;318:205–206.

[34] Gosch M, Kammerlander C, Nicholas JA. Treatment of osteoporosis in older adults. Panminerva Med 2014;56:133–143.

[35] Eisman JA, Bogoch ER, Dell R, et al. Making the first fracture the last fracture: ASBMR task force report on secondary fracture prevention. J Bone Miner Res 2012;27:2039–2046.

[36] Ganda K, Puech M, Chen JS, et al. Models of care for the secondary prevention of osteoporotic fractures: a systematic review and meta-analysis. Osteoporosis Int 2013;24:393–406.

[37] Center JR, Bl unc D, Nguyen TV, Eisman JA. Risk of subsequent fracture after low-trauma fracture in men and women. J Am Med Assoc 2007;297:387–394.

[38] Kanis JA, Johnell O, De Laet C, et al. A meta-analysis of previous fracture and subsequent fracture risk. Bone 2004;35:375–382.

[39] Black DM, Arden NK, Palermo L, Pearson J, Cummings SR. Prevalent vertebral deformities predict hip fractures and new vertebral deformities but not wrist fractures. Study of Osteoporotic Fractures Research Group. J Bone Miner Res 1999;14:821–828.

[40] Axelsson KF, Jacobsson R, Lund D, Lorentzon M. Effectiveness of a minimal resource fracture liaison service. Osteoporosis Int 2016;27:3165–3175.

[41] Nakayama A, Major G, Holliday E, Attia J, Bogduk N. Evidence of effectiveness of a fracture liaison service to reduce the re-fracture rate. Osteoporosis Int 2016;27:873–879.

[42] Brugs Jj, van Vark L, Akkerhuis M, et al. Impact of renin-angiotensin system inhibitors on mortality and major cardiovascular endpoints in hypertension: a number-needed-to-treat analysis. Int J Cardiol 2015;181:425–429.

[43] Huntjens KM, van Geel TA, van den Bergh JP, et al. Fracture liaison service: impact on subsequent nonvertebral fracture incidence and mortality. J Bone Joint Surg Am Vol 2014;96:e29.

[44] Yates CJ, Chauchard MA, Liew D, Bucknill A, Wark JD. Bridging the osteoporosis treatment gap: performance and cost-effectiveness of a fracture liaison service. J Clin Denistomet 2015;18:150–156.

[45] Solomon DH, Patrick AR, Schousboe J, Losina E. The potential economic benefits of improved postfracture care: a cost-effectiveness analysis of a fracture liaison service in the US health-care system. J Bone Miner Res 2014;29:1667–1674.

Supplemental Material: The article (DOI: 10.1515/iss-2016-0028) offers reviewer assessments as supplementary material.
Diagnosis and therapy of osteoporosis in geriatric trauma patients: an update

DOI 10.1515/iss-2016-0028
Received October 15, 2016; accepted December 8, 2016

*Corresponding author: Carl Neuerburg,
Department of General, Trauma and Reconstructive Surgery, University Hospital LMU, University of Munich, Marchioninistraße 15, 81375 Munich, Germany, E-mail: carl.neuerburg@med.uni-muenchen.de

Reviewers’ Comments to Original Submission

Reviewer 1: Carsten Schöneberg
Nov 09, 2016

Reviewer Recommendation Term: Accept with Minor Revision
Overall Reviewer Manuscript Rating: 64

Custom Review Questions
Response
Is the subject area appropriate for you? 4
Does the title clearly reflect the paper’s content? 5 - High/Yes
Does the abstract clearly reflect the paper’s content? 5 - High/Yes
Do the keywords clearly reflect the paper’s content? 3
Does the introduction present the problem clearly? 4
Are the results/conclusions justified? 4
How comprehensive and up-to-date is the subject matter presented? 4
How adequate is the data presentation? 4
Are units and terminology used correctly? 3
Is the number of cases adequate? N/A
Are the experimental methods/clinical studies adequate? N/A
Is the length appropriate in relation to the content? 4
Does the reader get new insights from the article? 4
Please rate the practical significance. 5 - High/Yes
Please rate the accuracy of methods. N/A
Please rate the statistical evaluation and quality control. N/A
Please rate the appropriateness of the figures and tables. 3
Please rate the appropriateness of the references. 4
Please evaluate the writing style and use of language. 3
Please judge the overall scientific quality of the manuscript. 4
Are you willing to review the revision of this manuscript? Yes

Comments to Authors:

©2016 Neuerburg C. et al., published by De Gruyter.
This work is licensed under the Creative Commons Attribution-NonCommercial-NoDerivs 4.0 License.
Dear Authors,

your Article „Diagnostic and therapy of osteoporosis in geriatric Trauma patients“ presents a really good overview in a Topic, which is very important already and will me even more important in the future. I believe, your article will help Trauma surgeons, who are involved in the Treatment of geriatric Trauma patients. Osteoporosis is one of the Major Problems in patients healthcare, especially in Trauma surgery.

Nevertheless, I have some minor Points for Revision:
- Abstract: FLS appears for the first time. Therefore it has to be written in full length
- Osteoporosis diagnostics; Line 56: Some in vitro studies reported, that there was no adverse effect of PPI on human osteoblasts (Prause, M et al. Injury 2014; Prause, M et al. Mediators inflamm 2015). Therefore it remains unclear, if PPI are associated with a higher fracture risk.
- Figure 3: There are two speech bubbles. I can’t find any Information in them.
- Figure 3: One box is written in German
- Site 10 Line 192: …Treatment an even; does it mean:… Treatment and even
- Site 10 Line 197,198: The Fracture Liaison Service…. This is a final Statement. You should not start your paragraph about FLS with a final Statement. This should be at the end.

In General:
- Was the manuscript reviewed by a native Speaker? It might benefit from language Support.
- All figures and tables are not cited in the text. It is important to cite them in the text.
- Our patients might benefit from a FLS. In Germany, such a Service is not payed by the public health insurance, currently. I think, this is another great Problem. Who has to pay the costs of secondary prevention?
- Your presented algorithm for Treatment of osteoporosis is really impressive. I think in a Center for geriatric Trauma with geriatricians, such a algorithm is very good. But in a Standard Trauma department without geriatric Support, I think there are some risks like contraindications, medical interactions ect. Basic Treatment with Vitamin D and Calcium is no Problem and should be started, when osteoporosis is diagnosed. But Specific medical treatment should be given by specialized physicians. In our „Alterstraumazentrum“ we have defined that in this way.
- Patients with distal radius fractures are usually hospitalized for only one or two days. Therefore we have to built Networks, to treat their osteoporosis. In These cases the time is to short for your algorithm

Reviewer 2: Peter Giannoudis

Nov 28, 2016

| Reviewer Recommendation Term: | Revise with Major Modifications |
|-------------------------------|--------------------------------|
| Overall Reviewer Manuscript Rating: | 70 |
| Custom Review Questions | Response |
| Is the subject area appropriate for you? | 5 - High/Yes |
| Does the title clearly reflect the paper’s content? | 3 |
| Does the abstract clearly reflect the paper’s content? | 3 |
| Do the keywords clearly reflect the paper’s content? | 4 |
| Does the introduction present the problem clearly? | 3 |
| Are the results/conclusions justified? | 3 |
| How comprehensive and up-to-date is the subject matter presented? | 4 |
| How adequate is the data presentation? | 3 |
| Are units and terminology used correctly? | 5 - High/Yes |
| Is the number of cases adequate? | N/A |
| Are the experimental methods/clinical studies adequate? | N/A |
| Is the length appropriate in relation to the content? | 3 |
| Does the reader get new insights from the article? | 3 |
| Please rate the practical significance. | 4 |
| Please rate the accuracy of methods. | 3 |
| Please rate the statistical evaluation and quality control. | N/A |
| Please rate the appropriateness of the figures and tables. | 3 |
| Please rate the appropriateness of the references. | 4 |
| Please evaluate the writing style and use of language. | 2 |
| Please judge the overall scientific quality of the manuscript. | 3 |
| Are you willing to review the revision of this manuscript? | Yes |

Comments to Authors:
This is an interesting article. The topic is relevant. However, the manuscript can be improved further by:

1. The language being checked by a native English speaker.
2. Title should be revised
3. Back ground: further information is required i.e.: (that usually the underlying osteoporosis condition is overlooked. There are issues not only how to fix the fractures because of the compromised bone but also to ensure that we can influence prevention of further fractures.. Appropriate references must be used). 
4. A special paragraph should be inserted to address the fact that 30-40% of elderly patients admitted are with dementia. Specific instructions as to how these patients should be assessed and managed should be included.
5. Please see below some comments:

Title: Diagnostic and therapy of osteoporosis in geriatric trauma patients

Revise to: Diagnosis and treatment of osteoporosis in geriatric trauma patients: An update

Sentence 5:.... These patients present with comorbidities, which forces their surgeons to take into consideration their medical condition.

Sentence 14: However, there is a huge treatment gap as 77% of these patients are not treated adequately (3).

Sentence 23: At a first glance, the identification of patients at risk of osteoporosis appears complicated.

Sentence 41:...... (7) help estimating the fracture risk. These algorithms can be accessed on our 42 homepage (8).

Please move reference 8 next to 7 to read as follows:...... (7, 8) help estimating the fracture risk.

Sentence 60: Especially the Tannenbaum phenomenon is an indicator of bone loss and also a loss of height more than 2cm may indicate further diagnostics. Please insert reference.

Sentence 68:... The lower bone density the higher is the risk for osteoporotic fractures (13).
Should be: The lower the bone density is the higher would be the risk for osteoporotic fractures (13).

Sentence 74-75: .... According to the DVO guideline 2014 (7) patients having suffered a trochanteric fracture which is suspicious for an osteoporosis given the radiographic...
Should be: According to the DVO guideline 2014 (7) patients having suffered a trochanteric fracture which is suspicious for osteoporosis given the radiographic...

Sentence 76: ....which is associated with a low energy trauma no further bone density Should be: ....which is associated with a low energy trauma no bone density...

Sentence 79:..... Genant classification go inline Please insert reference.

Sentence 105: Title: Treatment of osteoporosis in stationary trauma
Comment: Stationary trauma not appropriate word!! You mean following low velocity trauma?

Sentence 170: ..Their general practitioners can monitor patients with dementia or patients who refuse taking more oral medication, application is only necessary twice a year (25-27).

Revise to: Patient with dementia or patients who refuse taking more oral medication can be monitored by their general practitioners, application is only necessary twice a year.

Sentence 192:....... an even to only 30% over time (29).
Revise ...and even to only 30% over time (29).

Sentence 243: Orthogeriatric patients challenge their physicians to include their special needs in the treatment. It is important not only concentrate on the surgical treatment but to address osteoporosis its diagnostic and its treatment especially to avoid subsequent fractures.
Revise: Management of Orthogeriatric patients not only should be focused on the surgical aspects of treatment but also should include diagnosis and treatment of the underlying osteoporosis

Please revise and resubmit.
Authors’ Response to Reviewer Comments

Dec 05, 2016

Dear Reviewers,

The authors would like to thank you for having reviewed our manuscript “Diagnosis and therapy of osteoporosis in geriatric trauma patients: An update”.

We appreciate the additional perspective that you provided.

We appreciate the comments of all Reviewers and we tried to integrate your suggestions in our article.

Please find below our responses to the Reviewers’ comments. Changes to the manuscript have been made according to the Reviewers’ suggestions and are highlighted using “Track Changes”.

The manuscript was checked by a native speaker with regards to language editing.

Ad Reviewer #1:
Osteoporosis diagnsotics; Line 56: Some in vitro studies reported, that there was no adversed effect of PPI on human osteoblasts (Prause, M et al. Injury 2014; Prause, M et al. Mediators inflamm 2015). Therefore it remains unclear, if PPI are associated with a higher fracture risk.
Response: Literature shows differing conclusions, but a number of studies are showing consistent results that support the conclusion that there might be long-term adverse effects. You are right it remains unclear, but PPI prescriptions are high in this age group and should at least be reconsidered.

Our patients might benefit from a FLS. In Germany, such a Service is not payed by the public health insurance, currently. I think, this is another great Problem. Who has to pay the costs of secondary prevention?
Response: This is an interesting aspect. The focus of public health insurance is slowly shifting towards prevention. Small hospitals might have problems organizing and financing an FLS. Future models of an integrated care or Best practice tariffs might serve as an incentive for improved secondary fracture prevention. Yet, we refrained from stressing the financial burden of the FLS within the manuscript to avoid confusion. However, monitoring of these patients should be integrated in general checkups and surgical follow-ups.

Your presented algorithm for Treatment of osteoporosis is really impressive. I think in a Center for geriatric Trauma with geriatricians, such a algorithm is very good. But in a Standard Trauma department without geriatric Support, i think there are some risks like contraindications, medical interactions ect. Basic Treatment with Vitamin D and Calcium is no Problem and should be started, when osteoporosis is diagnosed. But Specific medical treatment should be given by specialized physicians. In our “Alterstraumazentrum” we have defined that in this way.

Patients with distal radius fractures are usually hospitalized for only one or two days. Therefore we have to build Networks, to treat their osteoporosis. In These cases the time is too short for your algorithm.
Response: This is an important aspect that you are mentioning. In our center, the fragility fracture nurse and a geriatrician monitor the treatment of our patients. Therapy is initiated during the hospital stay or during close follow-ups at our outpatient clinic. A recommendation for adequate medication is mentioned in our discharge letter. It is important to raise patients’ awareness for osteoporosis, to start with basic medication and to follow up in order to adjust the current medication and add specific medication.

We start our algorithm with the patient’s admission to our hospital and depending on their stay we add recommendations for diagnostics
or adequate medication to our discharge letter. We also suggest appointments to follow up. In order to monitor these patients closely we need to establish networks that improve the compliance of these patients.

Ad Reviewer #2:

A special paragraph should be inserted to address the fact that 30-40% of elderly patients admitted are with dementia. Specific instructions as to how these patients should be assessed and managed should be included.

Response:

You are absolutely right. We tried to integrate treatment advices in our article, especially concerning the intake of medication. Patients with dementia are more likely to fall and suffer subsequent fractures, therefore it is important to treat osteoporosis adequately. Daily intake of medication is difficult; we therefore recommend medication that is only applied monthly or twice a year. In order to monitor these patients a close network with their family doctors is very important. As an attempt to indicate the problem of cognitive disorders alternative osteoporosis treatment was mentioned within the manuscript.

Thank you for your review and your consideration to publish our article in Innovative Surgical Sciences.

Sincerely,
The authors

---

**Reviewers’ Comments to Revision**

**Reviewer 1: Carsten Schöneberg**

Dec 07, 2016

| Reviewer Recommendation Term: | Accept |
|------------------------------|--------|
| Overall Reviewer Manuscript Rating: | 65 |

**Custom Review Questions**

| Question | Response |
|----------|----------|
| Is the subject area appropriate for you? | 4 |
| Does the title clearly reflect the paper’s content? | 5 - High/Yes |
| Does the abstract clearly reflect the paper’s content? | 5 - High/Yes |
| Do the keywords clearly reflect the paper’s content? | 3 |
| Does the introduction present the problem clearly? | 4 |
| Are the results/conclusions justified? | 4 |
| How comprehensive and up-to-date is the subject matter presented? | 4 |
| How adequate is the data presentation? | 4 |
| Are units and terminology used correctly? | 3 |
| Is the number of cases adequate? | N/A |
| Are the experimental methods/clinical studies adequate? | N/A |
| Is the length appropriate in relation to the content? | 4 |
| Does the reader get new insights from the article? | 4 |
| Please rate the practical significance. | 5 - High/Yes |
| Please rate the accuracy of methods. | N/A |
| Please rate the statistical evaluation and quality control. | N/A |
| Please rate the appropriateness of the figures and tables. | 4 |
| Please rate the appropriateness of the references. | 4 |
| Please evaluate the writing style and use of language. | 4 |
| Please judge the overall scientific quality of the manuscript. | 4 |
| Are you willing to review the revision of this manuscript? | Yes |

**Comments to Authors:**

Dear Authors,

the manuscript benefits from the changes you made. Now, I can accept the manuscript for publication.
Reviewer 2: Peter Giannoudis

Dec 06, 2016

| Reviewer Recommendation Term:          | Accept          |
|----------------------------------------|-----------------|
| Overall Reviewer Manuscript Rating:    | 80              |
| Custom Review Questions                | Response        |
| Is the subject area appropriate for you?| 5 - High/Yes    |
| Does the title clearly reflect the paper’s content? | 5 - High/Yes |
| Does the abstract clearly reflect the paper’s content? | 4               |
| Do the keywords clearly reflect the paper’s content? | 5 - High/Yes |
| Does the introduction present the problem clearly? | 4               |
| Are the results/conclusions justified? | 4               |
| How comprehensive and up-to-date is the subject matter presented? | 4               |
| How adequate is the data presentation? | 4               |
| Are units and terminology used correctly? | 5 - High/Yes |
| Are the number of cases adequate?      | N/A             |
| Are the experimental methods/clinical studies adequate? | N/A |
| Is the length appropriate in relation to the content? | 4               |
| Does the reader get new insights from the article? | 4               |
| Please rate the practical significance. | 5 - High/Yes    |
| Please rate the accuracy of methods.   | 4               |
| Please rate the statistical evaluation and quality control. | N/A |
| Please rate the appropriateness of the figures and tables. | 4               |
| Please rate the appropriateness of the references. | 5 - High/Yes |
| Please evaluate the writing style and use of language. | 4               |
| Please judge the overall scientific quality of the manuscript. | 4               |
| Are you willing to review the revision of this manuscript? | Yes             |

Comments to Authors:
The revised paper has been improved. It reads better. It can be accepted now.