UNIVERSITY of DERBY

National Osteoporosis Society

A structure for reporting dual energy X-ray absorptiometry scans at the hip and spine in adults

National Osteoporosis Society Practical Guides

Building stronger bones

A structure for reporting dual energy X-ray absorptiometry scans at the hip and spine in adults

Many dual energy X-ray absorptiometry (DXA) scans are returned to referrers unreported. Not all registered healthcare professionals have the knowledge, skills and experience to interpret DXA results correctly or to translate scan print-outs into effective management plans for their patients. IR(ME)R regulations and best practice recommendations from professional bodies are for DXA scans to be reported. This practical guide describes a consensus view of a standard for the content and structure for the DXA report that will assist referring clinicians to achieve optimal care for their patients.

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Contents

Key recommendations

- There is a need for optimal communication between the diagnostic centre and the clinician managing the patient regarding fracture risk and management advice.
- DXA reporting should provide the responsible clinician with sufficient information and guidance so that the most informed management decision can be made.
- The level of detail should be customised for the service for which the report is being prepared.
- The final report is best based on a template that is designed to fit on one side of A4 paper; it should serve as a "stand-alone" report, such that the clinician should not need to view a risk factor-based questionnaire or the DXA images.
- When making recommendations for the management of the patient, the reporter should acknowledge that their advice is given in the context of the information they have received from the patient questionnaire.
- The reporting clinician will need to be aware of and work to local policies and procedures within their competency and training and in line with usual clinical governance standards, which will be in place within a bone densitometry service.
- Non-prescribing clinicians should not be making prescribing recommendations when reporting DXA, though they may refer to locally agreed management prescribing algorithms.
- Physicians and other healthcare professionals involved in reporting should have in place a process of supervision, accountability and continuing professional development and a consultative pathway when greater experience or expertise is needed.
- The role of the reporting clinician is characterised by the need for a wide range of competencies that include knowledge of basic physical science and the clinical, diagnostic and therapeutic aspects of osteoporosis.
- The general principles of high-quality reporting and governance are generic and can be applied to any healthcare setting with reference to appropriate national standards.
- While this guide describes a set of agreed standards that may be useful in the UK, these may not necessarily be applicable in other settings in other countries.

Background

Although dual energy X-ray absorptiometry (DXA) has been available for over 20 years, it is still perceived in the UK to be a relatively new technology, since access has been severely restricted due to a lack of availability and funding. Therefore, the interpretation and reporting of DXA scans has largely evolved *ad hoc*. As such, the content, standard and usability of reports vary widely. The International Society for Clinical Densitometry (ISCD) has led the way in providing guidance for those evaluating DXA scans in the form of position statements that have been placed in the public domain[1] as well as in a peer-reviewed journal[2–4]. While patients are usually referred to secondary care for DXA scans, greater than 90% of osteoporosis prescribing in the UK occurs in primary care[5]. Therefore, there is a need for optimal communication between the diagnostic centre and the clinician managing the patient regarding the fracture risk, along with management advice. In the UK this clinician is usually a general practitioner (GP). A template report has been provided by the Scottish Intercollegiate Guideline Group[6] and a practical guide on the reporting of DXA scans has recently been reviewed and updated by the National Osteoporosis Society (NOS)[7]. A need has been identified for a detailed "gold standard" statement defining, justifying and illustrating the components of a high-quality DXA report. The report should inform the referring clinician regarding the interpretation of the scan and provide guidance on management options for the patient that align to UK practice and clinical guidelines. The recommendations in this guide have been developed in parallel with the NOS practical guide and are summarised in that document.

It is known that the manner in which DXA results are communicated to patients affects how therapeutic interventions are accepted and whether treatments are adhered to[8,9]. There has been no research directed at understanding the needs of referring clinicians in the UK, but in a USA survey it was found that 60% of responders from university settings preferred the level of detail recommended by the ISCD, although a substantial minority (20%) did not[10]. This indicates that not all recommendations may be appropriate for all clinicians and that there may be a need to customise outputs for some clinical groups, even if a consideration of all the points discussed below may still be appropriate.

Expert opinion recommends providing referring clinicians with precise interpretation of all DXA scan results and subsequent guidance for patient management. Current practice is inconsistent and guidance may be vague, so that the many specialists (including nurses, GPs, gerontologists, gynaecologists, orthopaedic surgeons etc.) who are involved in referring patients for bone densitometry may be unclear as to how best to act on the results. Skills, knowledge about and interest in the significance of DXA findings and which investigations and interventions are appropriate vary across these different disciplines. This challenge is likely to continue as national guidance[11–13], policy frameworks[14] and the inclusion of secondary prevention in the Quality Outcomes Framework may result in the increasing use of bone densitometry to predict fracture risk in the UK.

Many scans are reported by registered healthcare professionals (e.g. radiologists, radiographers, physicians, nurses etc.), whether medically qualified or not, who may not have direct experience in the management of osteoporosis and metabolic bone disease. Furthermore, many reporting healthcare professionals have not had formal training in DXA methodology or image interpretation,

and do not themselves operate a scanner. They therefore need to be made aware of the subtleties of interpretation; the significance of artefacts and abnormalities; and the importance of correct positioning when comparing scans[15]. In addition, there may be a need to make the referrer aware of other factors in the patient's clinical history that may modulate the patient's fracture risk or that may influence the application of clinical guidance or the necessity for further investigations or follow-up scans. Hence, there is a need to identify and address the educational and training needs of healthcare professionals in this area and for a standard to be established to set the learning outcomes.

The recommendations in this practical guide refer to DXA imaging at the hip and spine in adults only. They do not apply to imaging at other sites or with other technologies, such as ultrasound or peripheral DXA examinations of the wrist or heel. The recommendations have been derived from evidence-based medicine and current practice and the content has been developed and consensus gained from a number of experienced clinicians in the area of bone health.

General principles of reporting

The elements to be considered when reporting DXA scans are detailed in Table 1. The objective is to provide the responsible clinician with sufficient information and guidance so that the most informed management decision can be made. In this respect the level of detail may be customised for the service for which the report is being prepared. The suggested content may not all be necessary or required, but it should all be considered and taken into account. The final report may be best based on a template that is designed to fit on one side of A4 paper. Documenting the patient characteristics may modify the management options determined by bone mineral density (BMD) in combination with clinical risk factors or by guideline-dependent algorithms, and will assist the clinician in giving their patient the best possible advice.

It is assumed as a general principle that it should be possible to provide sufficient information for the clinician managing the patient in a single document. In other words, the document should be "stand-alone", without the clinician needing to view a risk factor-based questionnaire or the DXA images (unless they wish to) or to have the skills and training to interpret them. This is particularly important for UK GPs, who may physically archive the DXA image print-out and scan the report into the electronic patient record (EPR).

Frequently, information on referral forms is incomplete. Patient questionnaires may also omit important clinical information or be inaccurate. The reporter should be aware of this and should acknowledge that their advice is expressed in this context when making recommendations for the management of the patient.

Clinical governance in relation to DXA reporting

In the application of any consensus statement, the reporting clinician will need to be aware of and work to local policies and procedures within their competency and training and in line with usual clinical governance standards, which will be in place within a bone densitometry service. Generic guidance has been issued for reporting radiologists[16] and it is important that these principles are maintained when agreeing protocols for reporters. While radiologists are medically qualified, they may not be directly involved in the management of patients with osteoporosis and should therefore recommend treatment in line with local or national guidance.

Traditionally, it has been the norm for doctors to undertake the interpretation of imaging, especially where clinical risk factors are taken into account in making specific therapeutic recommendations. However, it is now recognised that many specialist non-medical healthcare professionals are working safely under supervision or as part of a team and provide a high-quality reporting service. Non-prescribing clinicians should not be making prescribing recommendations when reporting DXA, though they may refer to locally agreed management prescribing algorithms.

It is important, therefore, that physicians and other healthcare professionals involved in reporting have in place a process of supervision, accountability and continuing professional development and a consultative pathway for when greater experience or expertise is needed. It is for each healthcare organisation to ensure that they have formally agreed the parameters within which all reporters may operate as part of their clinical governance arrangements. The areas of interpretation and recommendations that should properly be considered the responsibility of a medically qualified clinician have been highlighted in the NOS practical guide; these include clinical evaluation, fracture risk assessment and advice on clinical management. While this paper goes into greater detail on the content of the report, it is recommended that those working in this clinical area are aware of the advice in the remainder of the NOS practical guide[7].

The role of the reporting clinician is characterised by the need for a wide range of competencies that include knowledge of basic physical science as well as the clinical, diagnostic and therapeutic aspects of osteoporosis. In general, the following considerations concerning knowledge base and skills should be taken into account:

- Familiarity with DXA technology and with the Ionising Radiation (Medical Exposure) Regulations (IR(ME)R) 2000[17].
- Understanding of normative databases and their limitations.
- Familiarity with the acquisition of images, their analysis, the identification of artefacts and the principles of the measurement techniques in densitometry.
- Understanding of basic statistics.
- Understanding of the link between BMD, clinical risk factors and fracture risk, and secondary causes of osteoporosis.
- Up-to-date understanding of therapeutics relating to osteoporosis.
- Familiarity with current guidance, cost effectiveness and local and national strategies.
- Evidence of having met the learning outcomes of relevant formal post-graduate training at

Masters' level or equivalent.
- Commitment to continuing professional development and clinical audit.
- Working within a bone densitometry service that has a defined relationship with a local specialist bone metabolism clinical service (in secondary care).

This practical guide is a consensus on the standards for the reporting of DXA scans. It has been developed with the involvement of a group of clinical professionals on behalf of the University of Derby and the National Osteoporosis Society.

While this statement is most applicable to the UK, the general principles of high-quality reporting and governance are generic and can be applied to any healthcare setting with reference to appropriate national standards. The principles will inform referral guidelines and can be applied to the development of online tools to structure the referral process so that the referring physician provides the right information to DXA services to ensure there is adequate justification for exposure to ionising radiation and to enable informed reports to be written. Equally, the principles can be used to inform the development of patient pathways to specialist clinics in secondary care. Advice on treatment will need to be re-evaluated in the light of future developments in the management and treatment of osteoporosis.

In the 20 years that DXA has been routinely available in the UK, the understanding of the diagnosis of osteoporosis has moved on well beyond the basic reporting of T-score against the World Health Organization (WHO) criteria. While this guide describes a set of agreed standards that may be useful in the UK, these may not necessarily be applicable in other settings in other countries.

Detail: to be considered for inclusion	Commentary and rationale
1. Identifier details Name/address Medical record number (institution/NHS) Date of birth Gender Ethnicity.	It is important to confirm the accuracy of these details, particularly with respect to date of birth and gender, which will influence interpretation and management. In training and educational settings, both the scan and the report should be anonymous except for age, sex and ethnicity.
2. Height/weight and body mass index (BMI).	Low BMI is associated with low BMD[18], although some research suggests weight alone is a better predictor of osteoporosis[19]. BMI is well evidenced as a risk factor for fracture but it is not independent of BMD[20]. Thresholds are set at 22 kg/m^2 in National Institute for Health and Clinical Excellence (NICE) guidance[12] and 19 kg/m^2 in National Osteoporosis Guideline Group (NOGG) recommendations[21]. Height and weight are required for clinicians calculating absolute risk with FRAX®. DXA results will underestimate volumetric BMD in individuals of small skeletal size and hence overestimate fracture risk and vice versa.
3. Date of scan and any previous scans.	This information is useful when monitoring BMD gain or loss over time. Note whether any previous scan is from another densitometer, as it will not be possible to make statements about gain or loss of BMD without cross-calibration.
4. Manufacturer and model of instrument used .	This is needed for FRAX calculations.
5. Requesting clinician or service.	This may define the style of the report; it may also be useful information for service evaluation and clinical audit. If the request is from a community-based or hospital service, consider whether a report should be copied to the GP or other relevant clinicians.
6. Indications for scan and other risk factors.	The main indication for referral may be stated separately. Listing known risk factors for osteoporosis and fracture over and above the IR(ME)R justification will help the responsible clinician to assess fracture risk.

Detail: to be considered for inclusion	Commentary and rationale
7. Other relevant medical history.	Many services find it helpful to have a patient questionnaire supervised but self-completed at the time of the scan. This may help to identify medication and diseases affecting fracture risk. Significant gastro-oesophageal or renal disease may indicate a need for caution when recommending treatment with oral bisphosphonates.
8. Falls history.	Good practice would be for services to routinely record the number of falls in patients aged over 65 in the previous 12 months, as recommended by NICE Clinical Guideline 21[22]. The National Service Framework (NSF)[23], the Blue Book[24] and the Prevention Package for Older People[14] all recommend the integration of falls management with bone health care. The combination of a recent fall and osteoporosis greatly increases fracture risk in those over 65[25] and therefore identifies a very high-risk population. (While fracture risk deriving from poor bone health may be modified by pharmacological and lifestyle interventions, fracture risk deriving from a propensity to fall would lead to recommendations about falls assessments and appropriate interventions).
9. Current drug therapy, where relevant.	Medications known to predispose patients to osteoporosis or increase fracture risk are numerous[26]. Glucocorticoid dosage should be stated here if known, as this will influence management decisions[27]. Only the risk generated by the mean glucocorticoid dose in the contributory cohort studies is incorporated into FRAX as a risk determined by any prior exposure. High or low doses and current or past usage modulate this risk[28]. Excess risk deriving from aromatase inhibitors is well documented and subject to new consensus guidelines[29]. Similar considerations should apply to males receiving androgen deprivation therapy. Another example is proton pump inhibitors (PPIs), which have been associated with excess fracture risk[30,31], though a causal link has not been established. Regular use also points to a risk of a potential intolerance to bisphosphonates.
10. Technical quality and limitations of the study, stating why a specific site or region of interest (RoI) is invalid or not included if relevant.	Most healthcare organisations that provide bone densitometry should have standard operating procedures for the acquisition, analysis and assessment of DXA images. A recently updated practical guide on assessment is available from the NOS[7]. The skills necessary to evaluate diagnostic images are part of the core competencies of radiographers and radiologists. Additional skills are necessary for the interpretation of DXA scans and healthcare organisations should ensure this issue is addressed. It is normally only necessary to report abnormalities that influence the interpretation, in order to avoid overloading the scan report with information. Care should be taken not to over-interpret any abnormalities observed for which DXA has not been validated (e.g. aortic calcification, osteoarthritis).

Detail: to be considered for inclusion	Commentary and rationale
11. The skeletal sites, RoI and the side that were scanned (BMD in g/cm^2 to two decimal places for each RoI).	Hip and spine sites should be used. The forearm (33% radius) should be used when the hip or spine are not evaluable. Other indications for a forearm scan include a suspicion of hyperparathyroidism, or if the patient's weight exceeds DXA specifications. All evaluable vertebrae of the PA lumbar spine (L1–4) should be used. It is usual to report either total hip or neck of femur BMD. However, the latter is used for FRAX. The emergence of the total hip RoI is relatively recent and nearly all research is based on neck of femur BMD and lumbar spine BMD. The majority of the epidemiological evidence relating fracture risk to hip BMD is based on evidence at the femoral neck.
12. The T-score and/or Z-score to one decimal point where appropriate for each RoI.	Avoid applying WHO diagnostic categories to single sites or RoIs. The diagnostic category characterises the patient. It may be appropriate to state that the BMD at a particular site or RoI is in the osteopenic range or exceeds the osteoporotic diagnostic threshold (but see comments in point 19 on Read codes). Note that the WHO diagnostic criteria were developed for diagnostic classification in post-menopausal women using DXA of the spine, hip and forearm. There is reasonable evidence for using T-score cut-offs in older men; however, WHO criteria should be used with caution in younger men (such as those under 50 years of age[32]) and pre-menopausal women, and are inappropriate for use in children and young adults prior to skeletal maturity[33].
13. Opinion including a specific statement about which diagnostic category the patient falls into.	Basing the WHO category on the lowest BMD (total hip, femoral neck or lumbar spine) is recommended by the ISCD though this will identify a higher proportion of the population as osteoporotic than using only one RoI at the hip. It is recommended that local policies should stipulate which of total hip or femoral neck BMD is preferred. It should be noted, though, that the clinical efficacy studies for treatments are based on BMD measurements at the neck of the femur. Guidance from NICE accepts a clinical diagnosis of osteoporosis on the basis of an unspecified RoI at the hip or spine. Neither Ward's area nor the greater trochanter should be used. Caution should be used in making management decisions when the forearm is the only evaluable site[34]. It is better to avoid subjective qualifications such as "significantly osteoporotic" or "moderate osteopenia". Phrases such as "This is an important finding in a patient of this age" are acceptable, however, since they imply a practical relevance that influences management advice. You may consider reporting the patient to be of high, low or intermediate fracture risk, although this is not objective.

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14. Interpretation of vertebral fracture assessment (VFA) scans, where performed.	Vertebral fractures are important and powerful predictors of future fracture risk but infrequently come to clinical attention. VFA scans acquired using DXA are a potential way of identifying such fractures but their exact role and for whom the procedure is indicated are still emerging. Newer, higher-resolution fan-beam densitometers may improve the precision, sensitivity and specificity of this approach. Though DXA software can attempt to identify vertebral fractures using morphometric approaches, there are well-recognised limitations. Local protocols will normally be used to determine when VFA is indicated. It is recommended that the interpretation of these images is performed by physicians with extensive experience of the anatomy of vertebral bodies and normal and abnormal variations. It is advisable to consider radiological confirmation of the aetiology of apparent vertebral fractures identified on VFA, so as not to overlook pathologies other than osteoporosis.
15. A statement about absolute fracture risk (if this is part of local standard operating procedures) and issues that might modify that risk.	Absolute fracture risk is a useful way to encapsulate all information gathered from the assessment so far. FRAX is a widely available tool (www.shef.ac.uk/FRAX). It can be incorporated into DXA print-outs but may need to be repeated in the report for reasons mentioned above. Both major osteoporotic and hip fracture estimates should be reported. The significance of "major osteoporotic fracture" may need to be interpreted, since in the younger patient this is more likely to be a forearm fracture but in the older patient it will probably be a vertebral, humeral or hip fracture. This has significant implications on treatment recommendations in view of the lack of efficacy of alendronate in preventing forearm fracture in women without a vertebral fracture[35]. The following limitations need to be taken into account for FRAX (although this list is by no means exhaustive): • It does not include any incremental fracture risk due to falls if the falls risk is higher than that in the cohorts used to derive fracture risk[36]. • It may underestimate fracture risk for dose-dependent variables such as smoking, alcohol, multiple fractures or glucocorticoid usage[28]. • It underestimates risk if there is a previous clinical vertebral fracture rather than a morphometrically defined fracture. • It underestimates vertebral fracture risk if lumbar BMD is particularly low[37]. • It is not validated for patients on treatment. • The use of FRAX outputs for patients on current glucocorticoid therapy should be undertaken with caution as the risk contribution does not distinguish between current high-dose

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	users and past users. The risk contribution may differ significantly, or even disappear completely with an offset of effect over 12 months[38]. Aromatase inhibitors or other therapies associated with a significant impact on fracture risk have not been validated through FRAX. • FRAX is a risk prediction tool only and does not in itself define thresholds for intervention. In the UK the National Osteoporosis Guideline Group (NOGG) has based its recommendations on both FRAX and legacy guidance from the Royal College of Physicians. Absolute fracture risk derived from FRAX can also aid clinical decisions in the context of other guidance such as that from NICE. Because the intervention thresholds differ noticeably from those in NICE technology appraisal guidance, particularly in younger and older patients, the NOGG recommendations will select different patients as eligible for treatment than NICE. Reporting clinicians will need to be aware of local treatment protocols when making their recommendations in this respect.
16. Recommendations: General comments.	This section of the report will be informed by local and/or national guidance. The extent to which specific recommendations are made will be in line with departmental policy, delegated authority and ultimately the clinical expertise and experience of the reporter. This will be validated by appropriate training, accreditation and continuing professional development in line with local clinical governance processes. As well as reflecting contemporary evidence-based medicine and the research literature, the reporting clinician will take into account guidance such as that from the Scottish Intercollegiate Guidelines Network[6], the National Institute for Health and Clinical Excellence[11–13] and the NOGG21. More specific consensus statements relating to individual clinical situations are available for glucocorticoid-induced osteoporosis[27], breast cancer treatment-induced bone loss[29], gastroenterological conditions[39], etc. NICE technology appraisal guidance is likely to heavily influence advice given in the UK because healthcare organisations are required to report on their progress in delivering their determinations. Ultimately the decision rests with the clinician responsible for care decisions and/or ongoing management where there is guideline conflict or a lack of a specific statement. In this respect he or she will be aware of the core principles of NICE as described overleaf.

Detail: to be considered for inclusion	Commentary and rationale
a) Pharmacological interventions • Bone-sparing agent • Calcium and vitamin D3.	"This guidance is written in the following context: This guidance represents the view of the Institute, which was arrived at after careful consideration of the evidence available. Healthcare professionals are expected to take it fully into account when exercising their clinical judgement. The guidance does not, however, override the individual responsibility of healthcare professionals to make decisions appropriate to the circumstances of the individual patient, in consultation with the patient and/or guardian or carer. Implementation of this guidance is the responsibility of local commissioners and/or providers.Commissioners and providers are reminded that it is their responsibility to implement the guidance, in their local context, in light of their duties to avoid unlawful discrimination and to have regard to promoting equality of opportunity. Nothing in this guidance should be interpreted in a way which would be inconsistent with compliance with those duties." NICE currently has not produced guidance on the management of osteopenic patients. The evidence for efficacy of treatment in the absence of a T-score <–2.5 is weaker and the numbers needed to treat higher because of the low absolute risk unless vertebral fracture is present. In the absence of local protocols, clinical judgement is especially needed and the reporter will need to be confident in their knowledge base and experience in the management of metabolic bone disease to venture an opinion here. An appropriate form of words may include a statement that, although the patient does not have osteoporosis, the combination of BMD and clinical risk factors may confer a future fracture risk that is greater than that predicted by BMD alone, or is greater than that which would be faced by a patient with osteoporosis. FRAX and NOGG guidance may be helpful here. This section will include, where appropriate, advice on pharmacological interventions, lifestyle advice, falls risk assessment, investigations, referral to a specialist clinic (see below) and advice about re-scan. Phrases such as "Specific bone therapy is not indicated at present" are preferred to "Treatment: none". Comments on therapeutic interventions may be restricted to a simple statement that treatment should be considered. Any advice beyond this will reflect local or national guidance that has been

Detail: to be considered for inclusion	Commentary and rationale
	agreed as part of a patient management pathway and the experience and prescribing status of the reporter. Generally a weekly bisphosphonate at the lowest acquisition cost, if not contraindicated (see relevant Summary of Product Characteristics), will be the first recommended therapy. Reporters will normally leave the choice of second-line therapies to the clinician responsible, although they may make recommendations if their experience and qualifications permit this. Medical and accredited non-medical prescribers may have greater latitude. Any specific drug treatments recommended must align to permitted licensed use (this applies especially to men). The decision on whether and what to prescribe will ultimately be made by the physician who is acting on the report after discussion with the patient. The prescribing clinician assumes responsibility for what is prescribed. The report informs that decision based on the BMD and clinical risk factor profile. However, the prescribing will be made in the context of the patient's clinical history in the knowledge of any co-morbidities, current medications and contraindications. Vitamin D insufficiency and deficiency is extremely common in older people, especially in those with osteoporosis and a history of fragility fractures[40]. Optimal gains in BMD are seen when this situation is corrected[40,41]. Adequate calcium intake may also be necessary for fracture reduction[42]. Co-prescription of calcium and vitamin D3, however, is sub-optimal in UK general practice, with approximately 50% of patients prescribed a bisphosphonate not documented as receiving supplements[43]. It is recommended that a comment is made about ensuring the patient is replete in calcium and vitamin D3 and that co-prescription may be necessary (1000–1200 mg calcium and 800 IU colecalciferol daily) in line with NICE guidance and all national and international recommendations. Many patients are unable to persevere with treatment or misunderstand the need for long-term treatment. A reminder to the referring clinician to ensure the patient is concordant with dosing instructions and is adherent to treatment may be helpful.
b) Lifestyle advice.	A simple statement such as "The patient should be provided with the necessary advice to preserve bone health" may be appropriate. Alternatively, a more detailed description could be included, such as: "General bone health measures are advised. This includes maintaining optimum weight (BMI>19), stopping smoking (if relevant), avoiding excess alcohol (FRAX uses a threshold of three units/day but other thresholds between two and

Detail: to be considered for inclusion	Commentary and rationale
	four units per day, depending on sex, have appeared in other guidelines) and optimising weight-bearing exercise and resistive activities. It is also recommended that, as well as a balanced diet, calcium intake should be optimised and the patient advised about ensuring he or she is replete in vitamin D3 through a combination of a balanced diet containing adequate protein and calcium and safe sun exposure."
c) Falls risk assessment.	This is indicated according to NICE CG21[22] if there have been two or more falls in the previous 12 months or an injurious fall, or one fall plus a disorder of gait or balance (e.g. failed "get up and go" test, prior stroke, Parkinson's disease, use of a walking aid etc.). It is unlikely that the reporter will have access to this information unless a pro-forma includes these questions, a relevant medical history is declared or there is the opportunity to take a medical history at scan capture. A simple statement could be included, especially for older patients (of 75 years or over) with osteoporosis, about the need to consider an appropriate falls service referral if the patient is at a high risk of falls.
d) Investigations.	A statement should be included regarding consideration of further investigations in all patients with a new diagnosis of osteoporosis or deteriorating BMD despite treatment. It is usually enough to recommend investigations to exclude secondary causes of osteoporosis in line with local protocols or guidelines. The range of investigations that may be considered is summarised below (although this list is not exhaustive). It is important to consider investigations in: • Younger women, particularly those who are pre-menopausal • Men, particularly those under 75 years of age • Patients with unexplained bone loss on serial scans that is greater than the least significant change and inappropriate to the clinical circumstances • Patients found to have a vertebral fracture • Patients with an increasingly low Z-score, since this is often regarded as being associated with an increasing likelihood of secondary causes. However, a threshold set at –2.0 SD has recently been identified as a poor discriminator of this likelihood[44]. Identifying a sub-population via a Z-score cut-off would miss cases that should have been investigated, but this may be an appropriate approach (if

Detail: to be considered for inclusion	Commentary and rationale
	defined in local policies) in terms of reflecting a reasonable balancebetween sensitivity and specificity. Further imaging should also be considered if important pathology that cannot be evaluated with DXA is suspected. **Routine:** • Full blood count, sedimentation rate or C-reactive protein • Blood chemistry: serum calcium, albumin, creatinine, phosphate, alkaline phosphatase and liver transaminases • Thyroid function tests • 25(OH) vitamin D and parathyroid hormone (PTH) may be appropriate and is routine in some centres. **Other procedures might include:** • Lateral radiographs of lumbar and thoracic spine/DXA-based vertebral imaging (if available); generally, VFA scans by DXA should be performed at the time, according to local protocols • Protein immunoelectrophoresis and urinary Bence-Jones protein • In men: serum testosterone, sex-hormone binding globulin (SHBG), follicle stimulating hormone (FSH); in women: luteinising hormone (LH) • Serum prolactin • 24-hour urinary cortisol/dexamethasone suppression test • Endomysial and/or tissue transglutaminase antibodies (coeliac disease) • Isotope bone scan • Markers of bone turnover • Urinary calcium excretion. The above suggestions are not exhaustive and other investigations, for example bone biopsy and genetic testing, are restricted to specialist centres.
e) Referral to specialist clinic.	Local protocols and recommendations should be adhered to. In their absence, it may be appropriate to consider referral: • When there is continued bone loss or fragility fractures despite adherence to treatment • In all pre-menopausal women, especially in those with deteriorating BMD

Detail: to be considered for inclusion	Commentary and rationale
	• In men, particularly those under 75 years of age • In those with unexplained or unexpectedly low BMD. Referrals to the following specialist clinics may be appropriate for further investigations of identified risk factors (depending on local protocols): • Endocrinology • Elderly care • Rheumatology • Smoking cessation clinic • Early menopause clinic Vertebroplasty and balloon kyphoplasty may be an effective way of managing acute painful recent vertebral fractures that do not respond in a timely fashion to conservative management, but recommendations by reporters are only likely to be a consideration in units with clearly defined protocols and patient pathways. NICE has reviewed these technologies[45,46] though newer evidence is constantly emerging.
f) Re-scan if appropriate.	Reports should make some recommendation regarding a re-scan. This may be determined by departmental policy. A re-scan may not be necessary, providing advice as to who to contact if there are particular concerns is provided. Re-scan may be appropriate when a decision not to treat at the current level of risk has been made. The advice may involve standard review intervals determined by local policy. These are unlikely to be less than two years unless there is an underlying risk associated with high bone turnover such as glucocorticoid therapy. A phrase such as “Re-scan not indicated unless a new risk factor arises” may be all that is required. National guidance, such as that on aromatase inhibitors, may usefully be commented upon here.

Detail: to be considered for inclusion	Commentary and rationale
17. Comments on follow-up DXA reporting	After age 65 in women, lumbar spine BMD may rise due to degenerative changes even though bone strength is decreasing. A statement indicating that any observed increase may be spurious should be made when it is obvious from the scans that a significant increase in osteophytes, degenerative disease or sclerosis has occurred. It is important to recognise when reporting increases in BMD that only a small proportion of fracture risk reduction can be attributed to changes measured by DXA[47]. Hip BMD can be used for monitoring but awareness is needed of the anticipated change in response to treatment at this site, which will influence the timing of the repeat assessment. A statement may be useful to define which previous study and RoI is being used for comparison. Report any significant change between the current and previous study or studies in g/cm^2 and as an annualised percentage or a percentage change over a stated time interval. The same vertebrae and the same projection should be checked at the lumbar spine and the same rotation and abduction angle at the hip, if that is used. Do not compare T-scores. The least significant change is the minimum change in BMD between two scans on the same individual that indicate a real increase or decrease in BMD. It is calculated as 2.77 times the long-term precision error (co-efficient of variation) of the equipment[48]. There is also a generalised method for estimating this when the individual has been measured on two different DXA systems[49]. It is important to state clearly firstly whether a change is statistically significant and secondly whether it is clinically significant taking into account the time between scans, treatment, menopausal status etc. It may be necessary to draw attention to the inappropriateness of comparison with any outside study on different manufacturers' platforms and different models. As always, recommendations for the necessity and timing of the next BMD study should be stated, according to local policies and guidance. Many UK centres do not have the capacity to offer follow-up scans. Therefore, decisions have to be driven by local policy as well as clinical judgement. However, it is important that a long enough interval is recommended to increase the likelihood that a clinically significant result will be obtained.

Detail: to be considered for inclusion	Commentary and rationale
18.Effect of strontium therapy on BMD.	Interpret DXA results in patients who have had treatment with strontium ranelate with caution because of partly artefactual change in measured BMD (increase in LS-BMD of 14.4% and 14.7% over three years for SOTI and TROPOS respectively[50,51]). Much of this is due to the substitution of calcium (atomic number 20) with strontium (atomic number 38). The following considerations may be helpful: • After three years of treatment with strontium ranelate, the molar ratio of strontium in bone is approximately 1%[52]. Concordance and adherence may reasonably be expected to influence this figure. • A 1% molar ratio may overestimate BMD by 10%[53]. • The SPC[54] states that 50% of the measured lumbar spine BMD changes at three years are due to the bone strontium content and a gut absorption of 25% is assumed. • Blake *et al*. calculate that 75% of the measured changes over three years are due to the change in molar ratio[55]. Strontium retention may persist for many years[52]. • After discontinuing strontium therapy, bone content may drop rapidly in the first few months but with unpredictable variation[56], making the interpretation of BMD changes unhelpful.
19. Read coding issues.	Consider using Read codes if communicating with primary care. Read codes are the standard nomenclature used by GPs to record major clinical events, interventions, investigations etc. in their EPRs. They are used extensively and form the basis of remuneration in "pay for performance" programmes such as the Quality Outcomes Framework. They support the only widely used patient-level health informatics records used within the NHS and held in general practice. Good coding practice forms the basis of research and electronic clinical audit. The overwhelming majority of practices now claim to be paper-free or "paper-light". Paper-based or electronically transmitted cross-boundary information flows between providers and GPs have to be visually scanned for important clinical information. Such information is more likely to be translated into a machine-readable form if Read codes become a standard part of the communication. Read codes contain patient-related WHO diagnostic codes and site-specific diagnostic codes but no RoI-specific diagnostic codes. Anatomical site-specific diagnostic codes (lumbar spine and hip)

Detail: to be considered for inclusion	Commentary and rationale
	were included as it was and still is impossible to attach a value for a biological variable that can be both positive and negative to a DXA site code. “Qualitative” diagnostic codes were therefore introduced. If Read codes are incorporated into reports it is preferable to use the patient diagnostic codes.

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