An academic review of the developed diagnostic and educational tools for bone diseases or disorders

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Abstract

Educational tools are exemplary means of disseminating comprehensive information on bone diseases or disorders which negatively influence a patient's quality of life. These resources require constant revision to provide the latest facts and figures to the global population at all times. Existing tools, whilst effective, may require updating and the adoption of novel approaches to meet the needs of specific target populations. Coupling educational resources with diagnostic tools such as Dual-energy X-ray absorptiometry (DEXA/DXA) is one such innovative way of providing optimum patient care and quality treatment. Furthermore, should new educational tools be devised, developers will need to reflect on the specific incongruity between the standards achieved using the current tools and the desired standards envisaged from the new tool. Reflecting on the former and latter tools will aid in identifying and addressing areas that require improvement in the current tool to optimise patient outcomes.

Keywords: role, educational tools, bone diseases, patient care

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Introduction

When the term bone disease or disorder is mentioned, though it refers to a group of conditions which affect bone sturdiness, the most common word a layperson might think of is, in most cases, osteoporosis.[1] Exploring the term meticulously through various patient educational tools would provide patients with clarity on information pertaining to other notably prevalent conditions of the human skeleton including Paget's disease, osteogenesis imperfecta, osteomalacia, osteoarthritis, rickets, and fibrous dysplasia, to name a few. Each of these disorders is characterised by a specific set of signs and symptoms which, for the most part, is unfavourably dismissed due to its imperceptibility and poor patient awareness. In fact, the term 'silent disease' is assigned to osteoporosis,[2] since patients are perceptive of the disease only after suffering from a fracture following an otherwise insignificant fall.

In this regard, educational tools serve as valuable resources to enlighten the general population about the numerous known bone diseases. On the one hand, the availability of webinars, leaflets, brochures, fact sheets, infographics, posters, slide kits, thematic reports, videos, risk calculators etc., provides patients with multiple educational tools that contain concise informational items[3] to choose from. Each available tool has a potential of addressing the diverse learning needs and capabilities of everyone. On the other hand, there are also certain unique tools which have been developed with the aim of aiding healthcare professionals in the identification, early diagnosis, and prevention of bone diseases, with the main focus being osteoporosis. Much importance is accorded to this specific condition which increases bone porosity and consequently induces bone fragility, because of the extent to which it can impact patients' lifestyles. An excerpt from a leaflet on osteoporosis published by the International Osteoporosis Foundation (IOF) for the occasion of World Osteoporosis Day, in describing the severity of osteoporosis, mentions that "When a sneeze can break your bones, that's Osteoporosis".[3]

Current diagnostic and educational tools being used for bone diseases

A tool which can foreshadow the risk of an osteoporotic fracture over a decade is what John Kanis and his team had in mind when they developed the Fracture Risk Assessment Tool (FRAX®).[4,5] The FRAX® tool not only incorporates data from elemental bone mineral density (BMD) tests, but it also encompasses the major factors contributing to a reduced bone quality in the hope of perfecting fracture-risk prediction. Being relatively straightforward to use, patients are simply required to complete a questionnaire[4] provided which comprises basic queries regarding the individual's femoral neck BMD, age (tailor made for those aged between 40 to 90 years old), gender, weight, height, past fractures, parental history of fractures, smoking habits, glucocorticoid therapy, presence of rheumatoid arthritis and secondary osteoporotic diseases, and finally, the daily alcohol consumption of the patient. Additionally, this readily available calculation tool facilitates decision-making concerning the treatment plan for those at elevated risk of a fracture.[4]

In a vastly similar manner, the QFracture® risk calculator was developed in the United Kingdom for health care professionals and researchers to achieve goals akin to those of FRAX®, however,

the QFracture® accommodated patients from the age of 30 years. Furthermore, contrary to FRAX®,[5] the QFracture®[6] tool considers a handful of other causative factors such as previous history of falls, presence of dementia, chronic obstructive pulmonary disease (COPD), endocrine disorders, chronic liver and kidney disease, cancer, cardiovascular diseases, malabsorption syndrome, diabetes, use of anticonvulsants and hormone replacement therapy particularly involving oestrogen, among others. The Garvan Institute of Medical Research contributing to the evolution, built their own Bone Fracture Risk Calculator[7] which is freely accessible to the public on the website "Know Your Bones" and it is reasonably analogous to the FRAX® calculator. To verify the claims made on the efficacy of the tools, the FRAX®, QFracture®, and Garvan's risk calculators have been subjected to certain validation studies, and the trio has proved to be meticulous in their prognostication.[8]

As for those individuals who have not exactly reached the age threshold beyond which a bone condition progresses enough to be diagnosed, calcium calculators[9,10] have evolved tremendously to help generations of any age maintain optimal bone health and thus mitigate the menace of a bone disease looming. These digital estimators take into consideration the age, gender, and weekly intake of foods which are loaded with calcium as well as those which are decent sources of this vital mineral serving as the elementary unit of the skeleton. The information obtained from the output is indispensable for monitoring an individual's daily calcium intake compared to the recommended amount to be consumed per day. These tools even go as far as providing a list of calcium-rich sources which can be incorporated into the diet for those who fail to make it to the required day-to-day mineral intake.[11]

Though the above-mentioned tools assist the general population in many ways, they are far better suited in the hands of healthcare professionals who are capable of providing a more in-depth explanation to patients with appropriate help from these algorithms. The public can derive benefit from countless educational resources which are regularly uploaded and distributed to shed light on basic pieces of information on bone diseases. These communicative tools employ visual illustrations, images, statistics, maps, catch phrases, facts versus misconceptions, and surveys, among others, to generate well compiled and easy-to-understand brochures, posters, videos, infographics, webinars, thematic reports, factsheets, leaflets, and myth debunking tools for new and intermediate audiences.[12] These tools provide patients with information on oral therapies for bone diseases, highlighting the reduced risks observed in those who undergo such treatment compared to those who do not.

In an endeavour to prevent the incidence of bone diseases, many of the existing educational tools focus on conveying, in a simple manner, factors leading to decreased bone quality – the primary reason frequently cited being an inadequate calcium and vitamin D intake. Secondary causes of bone diseases include the presence of other health conditions such as rheumatoid arthritis, anorexia, hypophosphataemia, coeliac disease, and diabetes. Other bone diseases such as drug-induced osteoporosis are caused by excessive or chronic use of glucocorticoid medicines and also include, but not limited to use of hormone therapy in menopausal men and women respectively.[13] To cater for those in search of a more in-depth explanation on bone diseases, specific websites such as the International Osteoporosis Foundation, among others, are available with information focused on all aspects of bone health. Countries across the globe have established organisations fighting bone conditions by means of developing and distributing the various educational tools mentioned, thus accommodating the global population.

Importance of developing educational tools used in bone disorders

While bone quality, referring to the measurement of bone geometry and structure, holds theoretical significance, its practical importance is limited due to the challenges of clinical measurement. Conversely, bone density provides a better understanding of bone health and offers reliable information on fracture risk, which is significant for patient education and prevention strategies. However, despite the insights provided by bone density regarding fracture risk, it is puzzling why the prevalence of osteoporosis is continuing to rise. Although multiple factors such as bone density contribute to fracture risk, a key challenge faced by healthcare professionals lies in patient communication – conveying the distinction between bone quality and fracture susceptibility. In addition to the myriads of challenges presented by the bone conditions themselves, the urgency for their diagnosis has intensified due to the rapidly growing at-risk population. To further elaborate, there is insufficient information available to improve the care of individuals of non-white ancestry, let alone support the treatment of those with rarer conditions like Paget's disease, hypophosphatasia and osteogenesis imperfecta. Hence, the development of such educational tools is of paramount importance in this population group.[4]

Developing educational tools not only aims to raise awareness of such diseases but also plays a critical role in preventing, facilitating early diagnosis and initiating timeous management of these bone disorders. With reference to the most common disorder of the bone, osteoporosis, early diagnosis is crucial, as a single fracture heightens the risk of subsequent fractures, potentially leading to long-term disability and loss of independence. Notably, as per the IOF, one in four women who experience a new spinal fracture will most likely suffer another one within a year. Furthermore, following a hip fracture, approximately one quarter of individuals either succumb to the injury or lose the ability to walk.[1] Building on this point, it is also important to consider the economic burden of osteoporosis owing to a lack of awareness. In 2005, the Journal of Bone Research reported that osteoporosis, a condition often overlooked, resulted in approximately two million fractures. Twenty five percent (25%) of these fractures, remarkably, occurred in men, leading to an economic burden exceeding 17 million US dollars.[14] Therefore, such tools not only help prevent additional fractures but also mitigate financial costs.

Criteria to consider while developing educational tools

During the pursuit of effective solutions, it is imperative that clear criteria be established for the development of these tools, for without guiding principles, innovation may falter and miss the mark. The first key point is that these tools must: a) be flexible to accommodate both one-on-one and group sessions, adaptable to diverse situations; b) include varying levels of difficulty and a vast range of themes; c) remain simple and user-friendly; and d) ensure that the primary purpose of educating people about the disease is fulfilled, especially given that the vast majority of those at risk belong to the elderly population. It is, therefore, crucial to outline the objectives of implementing a specific educational tool in developing an explicit treatment plan.

Catering for diverse patients' learning preferences makes the tool user-friendly as it incorporates the use of visual, tactile, kinesthetic, and auditory elements and aligns them with the daily routine of the targeted audience. At the same time, the tools should be developed in such a way that both the younger and the older audience could benefit from, regardless of their similarities and differences. Educational tools centred around important themes establish a clear and safe environment that encourages patients' participation and support. It also clarifies and aids in improving interpersonal relationships thereby enhancing patients' physical as well as mental well-being. Finally, educational tools designed to generate and disseminate valuable knowledge are likely to stimulate individuals to engage, improve patients' awareness, offer support and assist individuals in developing personal competency, ultimately motivating them to take proactive and responsible action regarding their health issues.[15]

Taking all these factors into account, paying attention to intricate details like those mentioned is crucial for the successful development of these tools. Such meticulous consideration ensures that the tools are not only effective but also significantly aid in advancing our understanding of various diseases and disorders. By addressing these specifics, the tools become more impactful, facilitating better education of, support to, and engagement with the patients, thus enhancing the overall effectiveness of efforts to address and manage these health conditions.

Use of educational tools as effective approaches to identify high-risk fracture patients

Educational tools serve as essential instruments in the timely and proactive detection of high risk fracture patients, emphasising their importance in improving patient care and guiding preventive strategies. Dual-energy X-ray Absorptiometry is a standard tool that measures bone mineral density and provides an accurate and reliable indication of bone strength, while the FRAX questionnaire is an excellent tool for the assessment of the risks associated with osteoporosis. Dual-energy X-ray Absorptiometry remains one of the most superior tools in the screening and diagnosis of bone disease.[16] According to the US Public Service Task Force, screening using the DXA, alongside with the FRAX questionnaire, helps with effective decision-making concerning therapy for osteoporosis. Screening and monitoring patients undergoing osteoporosis therapy, (such as bisphosphonate therapy) which carries rare but serious risks, such as atypical femoral fractures (AFFs) and osteonecrosis of the jaw (ONJ) are crucial and can ultimately be used in the prevention and early detection of such dangers. Additionally, optimising treatment duration aims to balance fracture risk reduction with minimising these adverse events throughout patient management.

The observation is that with the glucocorticoid related osteoporosis, the risk of developing osteoporosis is found to be directly proportional to the dose – high doses of glucocorticoids increase the risk to develop osteoporosis. It is also observed that, generally, older women have a higher risk of fractures compared to older men, initially due to post-menopausal osteoporosis. This occurs due to a decline in the level of oestrogen, that finally affects bone density. Also, greater loss of bone mass is observed in ageing women, increasing the risk of hip, spine, and wrist fractures.[6] Despite higher bone density in men and their retaining capacity, there is still an elevated risk of fracture in older men.[17] This paves the way to the secondary causes of osteoporosis, particularly hypogonadism. Androgen deprivation therapy (ADT), primarily used to treat older men with prostate cancer, often leads to hypogonadism and is linked to a rapid decline in Bone Mineral Density (BMD within 6–12 months of starting treatment. Men undergoing ADT face a significantly higher fracture risk in the five years following the start of therapy compared to those not receiving ADT.[18]

Aromatase inhibitors (AIs) in postmenopausal women lead to bone loss at an average rate of 1–3% per year, particularly in areas with high trabecular bone density and hence should get their fracture risk assessment done using FRAX®. The bone loss is even more pronounced in younger women undergoing treatment-induced ovarian suppression, with an average annual bone loss of 7–8%.[18] Additionally, whether in acute care or outpatient facilities, care coordinator-led programmes have demonstrated significant success in various aspects of patient management. These programmes have been highly effective in identifying patients at risk, providing them with the appropriate knowledge, conducting thorough evaluation, facilitating appropriate referrals, and ensuring timely therapy. The engagement of such coordinators has proven to be a key factor in improving patient outcomes and enhancing the overall quality of fracture care.

Recommendations to strengthen national policies implemented for bone diseases

Personal health is undeniably the responsibility of each individual, be it by following preventive measures to stay in sound health or by further educating themselves on specific diseases. At the same time, national policies implemented by the state or government play no less of a role in curbing the prevalence of health conditions. This fact, having been acknowledged by several nations like Saudi Arabia,[19] Canada,[20] and Europe,[21] among others,

has led to strategic plans being put together in an attempt to reduce mortality and economic harm. According to the Position Statement developed by the American Academy of Orthopaedic Surgeons (AAOS),[22] nations should allocate sufficient resources to cater for research grants and educational campaigns to reach the goal of eliminating, to a large extent, the number of osteoporotic fractures. Existing research has greatly helped to reach the current level of pharmacological therapy and education for healthcare professionals and patients alike. However, at no point does this mean that further research will not be beneficial in managing bone diseases. Instead, the focus of new research would be on evaluating the efficacy of current and newly discovered therapeutic agents to decrease bone fragility, along with developing educational tools for the ongoing learning process of healthcare professionals and patients. On the other side, Australia has formulated a national strategic plan elaborating on three priority areas for osteoporosis. Education and early prevention, improved diagnosis and patient care, and data gathering with research is the combination that the Australian government has deemed best to manage the prevalence of osteoporosis in the country.[23]

Conclusion

In conclusion, osteoporosis remains a major public health issue, characterised by the weakening of bones and an increased risk of fractures, particularly in the elderly. The silent nature of the disease emphasises the importance of early diagnosis and intervention to mitigate the long-term effects. Advanced tools like FRAX® and DXA scanning allow for a comprehensive evaluation of the disease and bone health, allowing clinicians to identify individuals with a heightened fracture risk and hence, personalise treatment strategies accordingly. The focus of these tools is not merely to help in the early diagnosis of the disease, but it also lies in educating individuals about the associated risks. Proactive steps can be taken towards managing osteoporosis and other bone disorders. Integrating these tools in routine clinical practice enhances both the prevention and treatment of highly prevalent bone diseases, as well as guiding the appropriate therapies and lifestyle changes to retard the bone loss process and reduce fracture incidence. Ultimately, these educational tools remain fundamental in improving patient outcomes, fostering disease management effectively, and reducing the burden of these diseases on individuals and the healthcare system.

Conflict of interest

The authors declare none.

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