Interventions to Increase Screening for Osteoporosis in Patients with Seizure Disorder on Antiepileptic Medications

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Dedication and Acknowledgement

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Abstract

Background: People with epilepsy (PWE) are at above-average risk for fracture due to the biochemical bone changes that result from the use of antiepileptic drugs (AEDs). Osteoporotic fractures can lead to considerable morbidity and mortality while simultaneously having negative effects on healthcare cost. There is no recommended routine screening for osteoporosis in people who are at high risk for osteoporotic fractures for other reasons except being female and post-menopausal. **Purpose:** The purpose of this quality improvement project was to increase provider understanding of the osteoporosis screening disparities that exist in PWE taking AEDs by presenting evidence-based information that highlights the relationship between AEDs and their negative effects on bone health, including fracture risk assessment tools and patient education handout materials. **Methods:** A provider education session was held at an outpatient neurological medical practice which included a review of the current USPSTF guidelines, a summary of the current evidence that supports the need for osteoporosis screening in PWE taking AEDs and proposed interventions to increase osteoporosis screening in PWE. Providers completed a post-education Likert-scale questionnaire which served to evaluate the session and their willingness to implement any of the proposed screening interventions demonstrated in the session. **Results:** There was a partial provider knowledge gap regarding the relationship between the relationship between AEDs and low BMD. The providers showed interest in future implementation of proposed interventions for screening. **Conclusion:** Ongoing provider education and workflow processes to allow time for screening are needed for successful intervention of osteoporosis screening in PWE taking AEDs in the outpatient setting. Providers were willing to implement interventions in the future.

Keywords: “antiepileptic drugs AND bone mineral density”, “antiepileptic drugs AND Vitamin D deficiency”, “antiepileptic drugs AND screening AND bone mineral density”, and “antiepileptic drugs AND osteoporosis AND screening”.

Background and Significance

Osteoporosis is a widespread and debilitating disease. In 2017-2018, the Centers for Disease Control and Prevention (CDC) estimated that 10.2 million people above the age of 50 have osteoporosis (Centers for Disease Control and Prevention [CDC], 2021). Osteoporotic fractures can lead to considerable morbidity and mortality while simultaneously having negative effects on healthcare cost. The current United States Preventative Services Task Force (USPSTF) guidelines recommend initiating screening for osteoporosis starting at the age of 65 for postmenopausal women. This screening process is completed using dual x-ray absorptiometry (DEXA) scans which measure bone mineral density. DEXA scans are used in populations that are at high risk for low bone mineral density fractures. The standard USPSTF guidelines recommend screening in post-menopausal women under the age of 65 who are at high risk for fracture based on a clinical risk assessment tool. The USPSTF guidelines do not currently recommend screening for men in any age group. (US Preventative Services Task Force [USPSTF], 2021). There is no recommended routine screening for osteoporosis in people who are at high risk for osteoporotic fractures for other reasons except being female and post-menopausal.

Therefore, individuals with epilepsy may be excluded from screening because they are not necessarily post-menopausal or female. This population numbers 3 million adults in the United States (CDC, 2020). Implications of high fracture risk are far-reaching and encompass many things such as decreased quality of life, depression, increased costs related to

hospitalizations, rehabilitation, and the need for additional medications (Willems et al., 2018). People with epilepsy (PWE) are at above-average risk for both falls because of the nature of the disease and osteoporosis due to the medications they may be taking. In a systematic review of bone fractures in seizure patients, Grzonka et al. (2019) noted the most reported locations for fractures in seizure patients were of the shoulders, thoracic and lumbar vertebrae, skull, jaw, and of the femur (Grzonka et al., 2019). Any one of these locations could be of great significance in terms of length of recovery and quality of life. Therefore, fracture prevention efforts should be considered for seizure patients.

Patients with epilepsy historically require management with chronic anti-epileptic drug (AED) therapy. AEDs have been associated with negative effects on bone health. There is a lack of strict protocols in guiding treatment to prevent future bone loss in patients on AED therapy. AEDs have been linked to a variety of abnormal biological chemical conditions, including low levels of calcium, phosphorus, and Vitamin D as well as increased levels of parathyroid hormone and alkaline phosphatase (Fahmy, et al., 2018). Any one of these biochemical abnormalities, even in isolation, can result in negative effects on bone health. They often co-occur with the chronic use of AEDs, amplifying these negative effects (Fernandez et al., 2018). There has been literature to support the association between PWE taking AEDs and increased fracture rates for over 60 years (Nordqvist et al., 2021). Despite the available literature to support chronic AEDs use and their negative effects on bone health, there are no current recommendations for risk assessment of bone mineral density in people with epilepsy taking AEDs.

Screening for osteoporosis could help to identify people at risk for osteoporotic fracture, thereby decreasing the potential for significant associated morbidity and mortality. The typical course of assessing risk for osteoporosis involves utilization of a screening tool followed by

measurement of bone mineral density using DEXA if the patient is deemed high risk per the screening tool. However, the screening tools are inadequate for identifying PWE at high risk for osteoporotic fracture. The most common tools available for assessing risk include variables such as age, body weight, the use of hormone therapy, and history of previous fractures. Very few include screening for secondary causes of osteoporosis and even fewer incorporate epilepsy and use of antiepileptic drugs in the screening tool.

There are disparities in osteoporosis screening in PWE who are taking AEDs despite years of research on the relationship between the drug class and poor bone health measures. Without standardized practices for osteoporosis screening, providers who treat PWE could benefit from utilization of fracture risk assessment tools or printed patient educational handouts as an aid to increase osteoporosis screening in this patient population.

Purpose

The purpose of this quality improvement project is to increase provider understanding of the osteoporosis screening disparities that exist in PWE taking AEDs by presenting evidence-based information that highlights the relationship between AEDs and their negative effects on bone health, including incorporation of fracture risk assessment tools and use of patient education handout materials.

Review of Current Evidence

In collecting evidence related to the topic of osteoporosis screening in this patient population, the databases used for the search included PubMed and the Cumulative Index to Nursing and Allied Health Literature (CINAHL) were utilized. The search terms included “antiepileptic drugs AND bone mineral density”, “antiepileptic drugs AND Vitamin D deficiency”, “antiepileptic drugs AND screening AND bone mineral density”, and “antiepileptic

drugs AND osteoporosis AND screening". The article search was limited to peer-reviewed articles and excluded articles written prior to 2017. The search yielded 481 articles, of which thirteen were chosen for the literature review. These included articles consisted of four case-control studies, two systematic reviews, two meta-analyses, three cross-sectional studies, and two retrospective cohort studies. The final articles were included as they provided full text, they were written in English language, and offered a variety of high levels of evidence. Multiple themes emerged from the literature review that lend credence to the need for screening for osteoporosis in PWE taking AEDs. The themes identified include the relationship between AED treatment and low bone mineral density (BMD), how the chronicity of use and cumulative drug load of AEDs affect BMD values, the effects of varying biokinetics of different types of AEDs, and a variety of trends in chemical biomarkers such as Vitamin D, calcium, alkaline phosphatase (ALP) and parathyroid hormone (PTH) in PWE on AED therapy. Finally, there was a recurring reference to the lack of interval screening frequency and a lack of screening tools for osteoporosis in this patient population.

Relationship of AED use and BMD values

The most noted theme in the literature was that AED use leads to a variety of negative effects on bone health, including effects on bone metabolism, bone mineral density, and fracture risk. Siniscalchi et al. (2020); Miziak et al. (2019); Dussault & Lazzari (2017); and Diemar et al. (2019) reviewed multiple studies that found significantly lower BMD values, accelerated rates of bone loss, and increased numbers of fractures in patient groups taking AEDs when compared to control groups not taking AEDs. A few studies discussed a relationship between epilepsy diagnosis and impaired bone health, independent of AED use. This was attributed to elevated ALP after recent seizure activity, comorbidities such as cerebral palsy, or variations in nutritional

status (Miziak et al., 2019; Rawat et al., 2020). While several theories were found that aimed to explain the pathogenesis of impaired bone health in PWE, the literature consistently agreed that there is a relationship between it and AED use.

Prolonged periods of time taking AEDs as well as higher cumulative drug load have been linked to lower BMD scores. Several studies found a statistically significant negative correlation between number of years of AED therapy and BMD scores (Singla et al., 2017; Fahmy et al., 2018; Miller et al., 2020; Mehicevic et al., 2020; Ahmad et al., 2017). According to Mehicevic et al. (2020) and Diemar et al. (2019), the duration of AED therapy can be considered an independent risk factor for BMD decline. Miziak et al. (2019) estimated that the risk of low bone mineral density-related fractures increases by up to 6% for every year of AED use. While there are some conflicting results throughout the literature search, which have been postulated to be due to study-related factors such as small sample size, high levels of heterogeneity, or short data collection periods to name a few, most of the literature supports the link between prolonged AED use with low BMD levels.

Cumulative drug load is a calculation based on the number of years of AED therapy and total number of AEDs prescribed to manage epilepsy (Singla et al., 2017). Many PWE use multiple AEDs to manage their disease. In two different case-control studies by Singla et al. (2017) and Fahmy et al. (2018), between 68-73% of their sample populations were on polytherapy for seizure control. Polypharmacy of AEDs leads to an increase in cumulative drug load, therefore increasing the risk for osteoporosis and osteoporotic fractures (Single et al., 2017; Fahmy et al., 2018).

Biokinetics of AED types

The mechanisms behind low BMD in people taking AEDs have been investigated in recent years. Multiple studies have identified that CYP450 enzyme-inducing AEDs (EIAEDs) have a more significant negative effect on BMD than the non-enzyme-inducing AEDs (NEIAEDs). This has been one of the most widely adopted explanations for the link between AED use and low BMD. This subtype of AEDs induces cytochrome P450 enzymes, activating osteoclast activity, which functions in bone degradation and remodeling (Chandrasekaran et al. 2021; Fahmy et al., 2018; Zhang et al., 2020). Studies reviewed by Fernandez et al. (2018), Diemar et al. (2019), and Miziak et al. (2019) identified lower BMD values in patient groups taking EIAEDs when compared to those taking NEIAEDs. Case controls by Fahmy et al. (2018) and Sheik et al. (2017) observed lower BMD values in cases receiving EIAEDs when compared to those who received NEIAEDs. In a retrospective cohort study, Nordqvist et al. (2021) observed a 63% fracture risk increase in participants taking EIAEDs compared to a 23% risk increase in participants taking NEIAEDs. High levels of evidence such as this could be useful in prescriber decision-making which could potentially thwart early bone loss in patients with epilepsy taking AEDs.

Biochemical measurements

There are several biochemical changes that occur with the use of AEDs. Vitamin D deficiency is a prevalent finding in AED users. Vitamin D deficiency is a well-known risk factor for osteoporosis. Without adequate Vitamin D, calcium reabsorption is inadequate, and reflexive hyperparathyroidism occurs, all of which results in a decrease in BMD. Zhang et al. (2020); Fahmy et al. (2018); Dussault & Lazzari (2017); Miziak et al. (2019); and Ustaoglu (2020) found significantly reduced Vitamin D and serum calcium levels, as well as increased PTH levels in cases taking AEDs compared to controls without AED use. Contrastingly, in an animal study by

Ustaoglu et al., (2020), experimental seizure groups without AED treatment also showed evidence of Vitamin deficiency, indicating that a diagnosis of epilepsy could be considered an independent a risk factor for osteoporosis.

Another biochemical change that was identified in the literature was an increase in ALP in PWE taking AEDs. ALP is also an important molecular marker for bone turnover, and increased levels can be indicative of bone diseases where there is higher than normal bone turnover rate such as osteoporosis. Zhang et al. (2020) and Fernandez et al. (2018) consistently found that people taking AEDs had elevated ALP levels. Fahmy et al. (2018) and Singla et al. (2017) reviewed several studies that identified significantly elevated ALP levels in patients with epilepsy when compared to healthy controls. However, Rawat et al., (2020) found elevated ALP levels in AED pretreatment groups with high seizure frequency, independent of AED use. This indicates that seizure activity in the absence of AED use may cause biochemical changes as well and that a diagnosis of epilepsy could be considered when screening for osteoporosis as well as AED use.

Lack of Routine Practice to Screen for low BMD in PWE taking AEDs

Despite the abundant literature that supports the correlation between AED use and BMD loss, there are no routine recommendations for interval screening for bone loss or biochemical changes such as Vitamin D deficiency, hypocalcemia, or elevated PTH or ALP. Screening for osteoporosis in seizure patients lacks consideration of epilepsy diagnosis or AED use (Anderson & Jorgensen, 2022). Almost unanimously, the literature consensus was that routine screening would be beneficial for PWE taking AEDs (Siniscalchi et al., 2020; Mehicic et al, 2020; Diemar et al., 2019; Miller et al., 2020; Zhang et al., 2020) to identify early bone loss.

Finally, there is no widely adopted screening tool for fracture risk screening in PWE on AEDs. Traditional screening tools for fracture risk such as the Fracture Assessment Tool

(FRAX), the Osteoporosis Risk Assessment Instrument (ORAI), the Osteoporosis Index of Risk (OSIRIS), and the Simple Calculated Osteoporosis Risk Estimation (SCORE) do not incorporate epilepsy or AED use and could therefore underestimate the likelihood of fractures related to low BMD in this patient population.

The Q fracture osteoporosis screening tool is one that does incorporate epilepsy and the use of AEDs as a risk factor, and it is used to help identify a person's 10-year probability of sustaining a fracture (Appendix G). This tool differs from other widely used osteoporosis screening tools in that it includes a history of falls and several other medical conditions that have had links to osteoporosis, one of which is a history of epilepsy and the use of AEDs. The number of items in the tool makes it more time intensive than others and could be a reason behind its uncommon use (Kanis et al., 2017). While this is a starting point for incorporating epilepsy and the use of AEDs in osteoporosis screening, it only identifies these components as a solitary risk factor, when the literature supports that epilepsy and AEDs have multiple effects on bone health.

Nordqvist et al. (2021) recognized that osteoporosis risk in PWE is multifaceted and that a tool to adequately represent this phenomenon did not exist in clinical practice. Therefore, in a retrospective cohort study, this team developed a novel screening tool for PWE taking AEDs called the Kalmar Epilepsy Fracture Risk Index (KEFRI) which along with age, gender, and BMI (the more commonly included fracture risk factors), it includes risk factors such as epilepsy diagnosis and AED type which have never been used in osteoporosis screening before (Appendix B). Nordqvist et al. (2021) concluded that including AED type and epilepsy diagnosis are important factors to consider when assessing a person's fracture risk. Furthermore, this tool could serve as a clinical practice guide for the preventative care of this patient population.

When considering the strong evidence that supports AED use and negative effects on bone health, paired with the lack of routine screening practices to identify those at highest risk for conditions related to it, increasing awareness, and encouraging screening for low BMD in PWE taking AEDs is needed. Chandrasekaran et al. (2021) discusses the insidious nature of osteoporosis onset, which then explains how it goes undetected until fractures occur. Providers who care for PWE on AED therapy as well as the patients themselves need more awareness of the potential negative effects that these medications can have on bone health. Increasing awareness can lead to more primary preventative efforts, and therefore better patient outcomes.

Conceptual Framework

The conceptual framework used for this DNP project was the ADKAR Change Management Model (see Appendix E). This five-step process is used as a guide for practice changes and includes the elements of awareness, desire, knowledge, ability, and reinforcement (Kachian et al., 2018). This model is an appropriate fit for this project because the current literature supports that there is a need for routine BMD screening in PWE taking AEDs but the guidelines and practices have not yet developed to support this proposed need.

Awareness

The awareness phase of the ADKAR model is a phase of pre-contemplation; one of recognition that change needs to occur (Kachian et al., 2018). The literature review serves to increase the awareness of the gap between evidence that supports osteoporosis screening in PWE taking AEDs and lack of practices that support it.

Desire

The neurological medical practice voiced their desire to decrease this gap during an informal needs assessment. They do not currently have a routine process for osteoporosis

screening in this patient population and are willing to engage in a project that will help to one day increase this type of screening in PWE. This is a contemplative step in the ADKAR process.

Knowledge

This phase of the ADKAR Model provides the knowledge to stakeholders of how to best facilitate the desired changes (Kachian et al., 2018). Distribution of the evidence collected in the literature review to the providers at the neurological medical practice will serve to increase the knowledge to help guide their practice in choosing and implementing a future process for screening for osteoporosis in PWE taking AEDs.

Ability

This phase of the ADKAR model is the action phase, when the interventions are put into place (Kachian et al., 2018). Instruction of various fracture risk screening tools and the use of patient educational handouts gave the medical practice the ability to attempt a new screening process. Analyzing the effectiveness of the educational session using a Likert-style questionnaire ascertained the medical practice's ability to put the interventions into practice.

Reinforcement

Finally, finding sustainability in a process that helps increase screening for osteoporosis in PWE taking AEDs served as the element of reinforcement. This dynamic step in the ADKAR process occurs after implementation and may require subsequent changes before maintenance can occur. The goal of this step is to ensure that the aims of the project were fulfilled.

Translational Framework

Summary of the Plan-Do-Study-Act Framework

The translational framework chosen for this quality improvement DNP project was the Plan Do Study Act (PDSA). The PDSA is a four-step method used for quality improvement

projects (see Appendix A). Ideas for improvement are organized, steps are taken to implement changes aimed at improvement, and they are then evaluated. Often, multiple repetitions of the PDSA process are required for successful quality improvement to occur (AHRQ, n.d.). This model is a good fit for this DNP project because the medical practice desires an increase in osteoporosis screening in PWE taking AEDs. Ideally, change at the organizational level can occur through the process of intervention implementation and subsequent testing, following the steps outlined by the PDSA. By supplying provider education about various ways of increasing osteoporosis screening in PWE taking AEDs, the goal of increased screening for osteoporosis is achievable.

Plan

The Plan portion of the PDSA model incorporates identification of the quality improvement goal and development of the proposed interventions used to achieve the goal (AHRQ, n.d.). Identification of the goal of increasing screening for osteoporosis in PWE taking AEDs serves the purpose of the "Plan" component of the PDSA framework. The project team leader created a Power point presentation for to the providers at the neurology medical practice, educating them about the current literature on the relationship between epilepsy, AED use, and negative bone health. This educational session also introduced multiple osteoporosis screening tools, one of which is a novel fracture risk screening tool which could be used in practice to help encourage patients to pursue BMD testing. Patient educational handouts were included in the educational session as an additional means to increasing patient awareness of osteoporosis risk which may serve to increase osteoporosis screening in the future for GNA.

Setting

This DNP project took place in an urban outpatient neurological medical practice in

the southeastern United States, serving people with neurological symptoms and illnesses such as epilepsy, Alzheimer's disease, dementia, stroke, transient ischemic attack, multiple sclerosis, Parkinson's disease, neuromuscular diseases, and sleep disorders. The practice consists of physicians, nurse practitioners, nursing staff, and neurodiagnostic technologists.

Population

The project population included healthcare providers who participate in the care of seizure patients at the neurological medical practice.

Do

The "Do" component of the PDSA model is the second step in which execution of the plan occurs. Supplying provider education about current literature including fracture risk tools as well as an example of printed patient educational resources served as the "Do" component of the framework.

Provider education session

A provider education session was held at the outpatient neurological medical practice and was completed by the project team leader. The education was provided to all staff members who care for and treat PWE taking AEDs. This includes physicians, nurse practitioners, and nurses. Participation in the educational session was voluntary. The educational session was administered using a PowerPoint presentation during a lunch session in August 2023. The Flesch-Kincaid Grade Level formula was applied to ensure readability of the PowerPoint presentation. It began with a review of the current USPSTF guidelines for osteoporosis screening and included a summary of the current evidence that supports the need for screening for osteoporosis in PWE taking AEDs. Specifically, the relationship between AED use and low BMD values, the biokinetics of AED types (specifically the difference between enzyme-inducing AEDs compared

to non-enzyme-inducing AEDs), the various biochemical changes that AEDs produce which effect bone health, and the lack of routine practices to screen for low BMD in PWE taking AEDs.

It also included education on two osteoporosis screening tools that incorporate the use of AEDs as a risk factor for osteoporosis. One of the tools is the Qfracture osteoporosis screening tool, and the other is a novel tool called The Kalmar Epilepsy Fracture Risk Index (KEFRI). Ola Nordqvist, an author of the original population-based retrospective cohort study, granted permission for the novel tool's use for this DNP project via email in January 2023 to the project team leader (see Appendix C).

The educational session also included a handout which helps to identify the relationship of AED use and negative effects on bone health (Appendix F). The Flesch-Kincaid Grade Level formula will be applied to ensure that the readability of the document will algin with the guidelines set forth by the United States Department of Health and Huan Services (USDHHS). According to Kher et al., (2017), the USDHHS recommends that public information should have a grade level readability level of 6th grade or lower to optimally reach the largest number of Americans. These project materials were provided in two ways for the GNA to easily obtain and use in practice. First, a physical folder with 50 copies of the educational handout was provided to the practice on the day of the educational session. A link to the URL where a digital copy of the handout was also provided in the educational PowerPoint that was presented.

Study

After implementation of the interventions has occurred, the next step in the PDSA is to analyze your results and determine if the goal of the project has been achieved (AHRQ, n.d.).

Instrument

In this DNP project, A 10-item, post-education Likert scale questionnaire was designed by the project team leader (see Appendix D). This questionnaire was completed by the providers who attended the provider education session and was used to evaluate the educational session, the patient educational handouts, and the providers' knowledge of the content and willingness to implement the fracture risk assessment tools demonstrated in the session. The surveys were voluntary, anonymous, and will not include any identifying information.

Data Collection

The Likert scale questionnaire were built into a web based Qualtrics survey tool and were disseminated to the providers who attend the educational session using a QR code. The answers to the surveys were stored on a password encrypted Qualtrics account during the data collection period and will be destroyed after the project is completed in May 2024. The surveys were voluntary, anonymous, and did not include any identifying information. Bar graphs were generated through Microsoft Excel for each Likert scale item. The Excel spreadsheet was stored in a password-secured personal computer and will also be destroyed after project completion.

Voluntary demographic data was also be requested from participants in the Qualtrics survey and were included in a Demographic Data table in Appendix H. Finally, an open-ended question about the participants' perceived barriers to implementation of any of the proposed interventions was included and discussed in the Discussion section. No patient data was used for this DNP project.

IRB Approval

All participants were safeguarded against privacy-related harm as no identifiable data will be obtained. No informed consent will be needed for this project. The project was deemed as being exempt from human subject research by the Internal Review Board (IRB) at

University of North Carolina at Greensboro in June of 2023. It was then approved by the Nursing Research Council and the IRB at Cone Health in August 2023.

Data Analysis

Data from the 10-item Likert questionnaire was collected by Qualtrics, version 2023 during a 4-week period following the educational session on 9/5/23. These descriptive statistics were analyzed using Qualtrics software and each dataset underwent frequency testing to quantify the percentages of the answers to each survey question. Additionally, the demographic data collected is included in Table 1.

Budget and Resources

Any expenses for this project were personally funded by the project team leader and will be limited to cost related to the lunch provided to the staff at GNA on 9/5/23 and printing the educational handout documents.

Act

The Act component in the PDSA model allows for the PDSA team to identify areas from the Study component that may need adjustments to achieve successful improvement (AHRQ, n.d.). It is this step where the decision to adopt or to adjust and repeat the PDSA cycle occurs.

Results

Seven healthcare providers were present for the educational session. Six participants completed the post-education questionnaire, leaving the final sample size of 6 individuals (*n*=6). Demographic data was collected as part of the post-education questionnaire and revealed one participant between the ages of 18-29 (n=1) and 5 participants between the ages of 30-49 (n=5). Professional data revealed that there was one medical doctor participant (n=1), four nurse practitioner participants (n=4), and one registered nurse participant (n=1). The number of years

of neurological practice was collected and revealed four participants with between 1-5 years of practice (n=4), one participant with between 10-15 years of practice (n=1), and one participant with between 15-20 years of practice (n=1). This demographic data is displayed in Table 1.

Table 1
Sociodemographic Data of Participants

Sample Characteristics	*n*	%
Age		
18-29 y/o	1	17%
30-49 y/o	5	83%
50-69 y/o	0	0%
> 69 y/o	0	0%
Licensure		
Registered Nurse	1	17%
Nurse Practitioner	4	67%
Medical Doctor	1	17%
Years of Neurological Practice		
1-5 years	4	67%
6-10 years	0	0%
10-15 years	1	17%
16-20 years	1	17%
> 20 years	0	0%

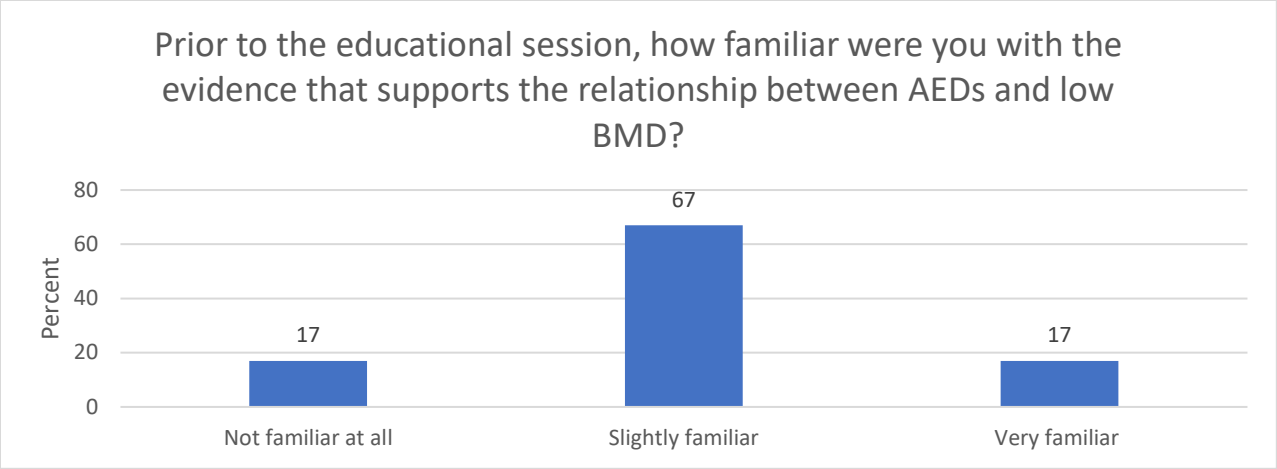
Table 2 displays the frequency testing from the questionnaire items (see Appendix H).

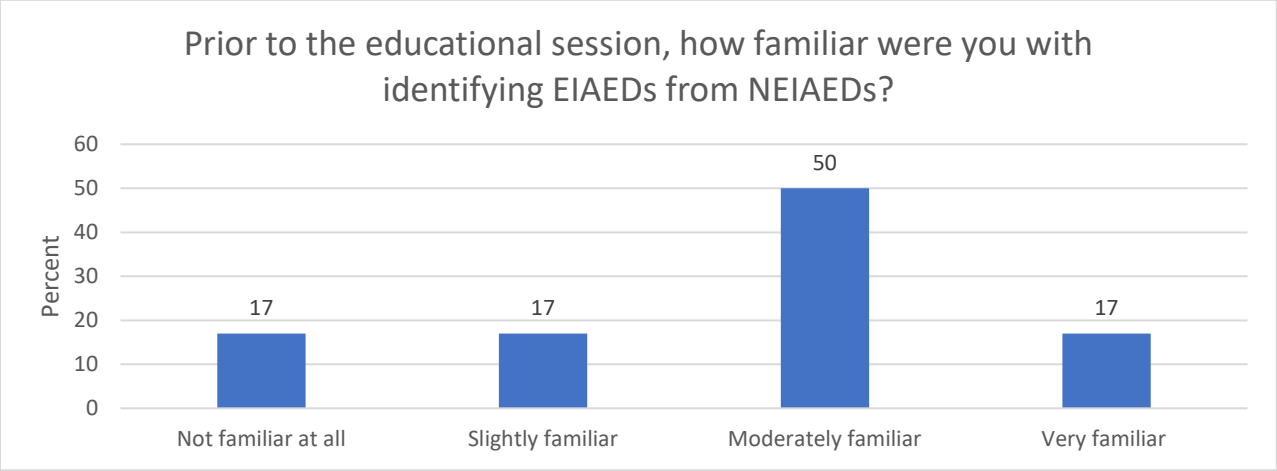
Table 3 displays this information in bar graph form. Prior to the educational session, 4 out of 6 participants (n=4) or 67% were only slightly familiar with the evidence that supports the relationship between AEDs and low BMD. One person (n=1) was not familiar at all, and one person (n=1) was very familiar with this evidence. Three individuals (n=3) or 50% of participants were moderately familiar with identifying EIAEDs from NEIAEDs. The remaining 3 participants were either not familiar at all (n=1), slightly familiar (n=1), or very familiar (n=1). Four out of the six participants (n=4), or 67% were familiar with CYP450 induction and its effect

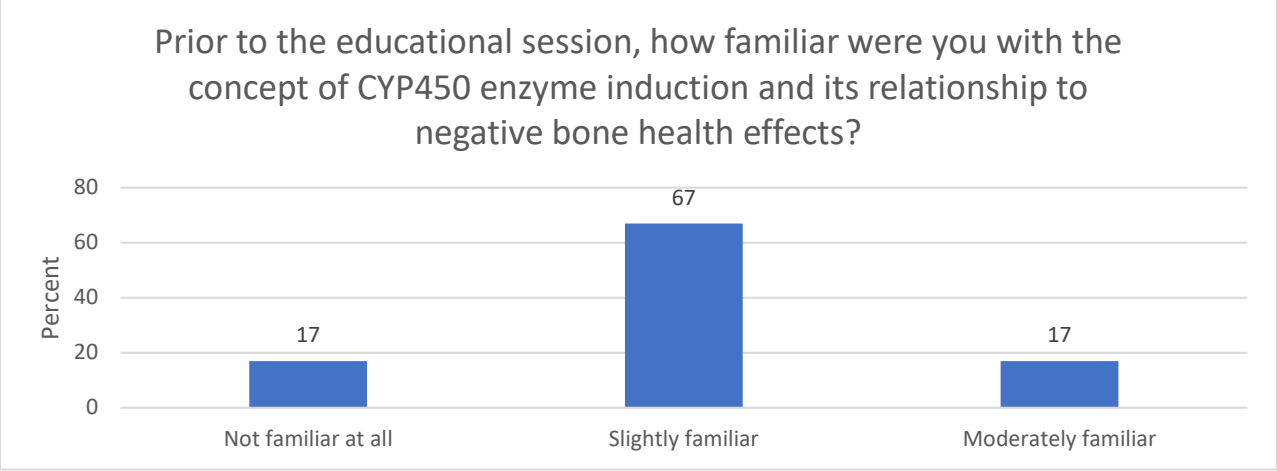
on BMD, and the remaining participants were not familiar at all (n=1) or moderately familiar (n=1). Five out of six participants (n=5), or 83% were somewhat aware that routine screening practices are lacking for osteoporosis in PWE taking AEDs. The remaining person (n=1) was not aware at all. Fifty percent of participants (n=3) routinely order BMD screening tests such as DEXA or serum labs. Two (n=2) report that they never order screening tests, and one (n=1) report ordering screening tests most of the time. Fifty percent (n=3) of participants reported that they would be somewhat likely to increase the number of screening tests after the educational session, and 2 participants (n=2) reported that they were extremely unlikely to increase the frequency of these types of tests. Five participants (n=5) or 83% reported that after the educational session, they would be somewhat likely to utilize a fracture risk assessment tool in practice, with the remaining participant (n=1) reporting that they are somewhat unlikely to do so. Two participants (n=2) rated the education provided as extremely useful to their practice, and 4 participants (n=4) rated it as very useful. Sixty-seven percent (n=4) of participants rated the educational handout materials as very useful, 17% (n=1) rated them as moderately useful, and 17% (n=1) rated them as extremely useful. Eighty-three percent (n=4) of participants were somewhat likely to incorporate the use of the handouts in practice, and 17% (n=1) were somewhat unlikely to use them.

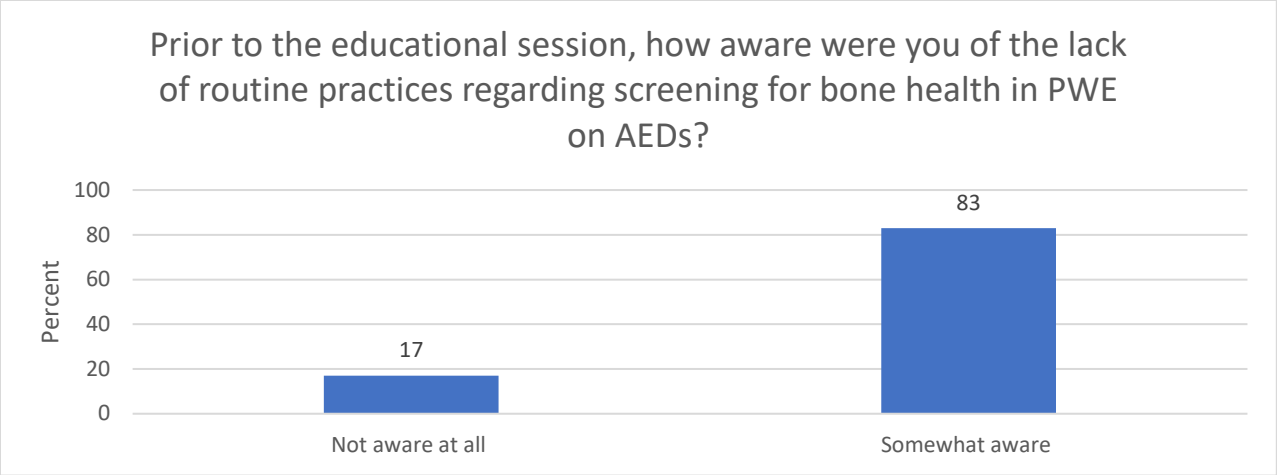
Table 3

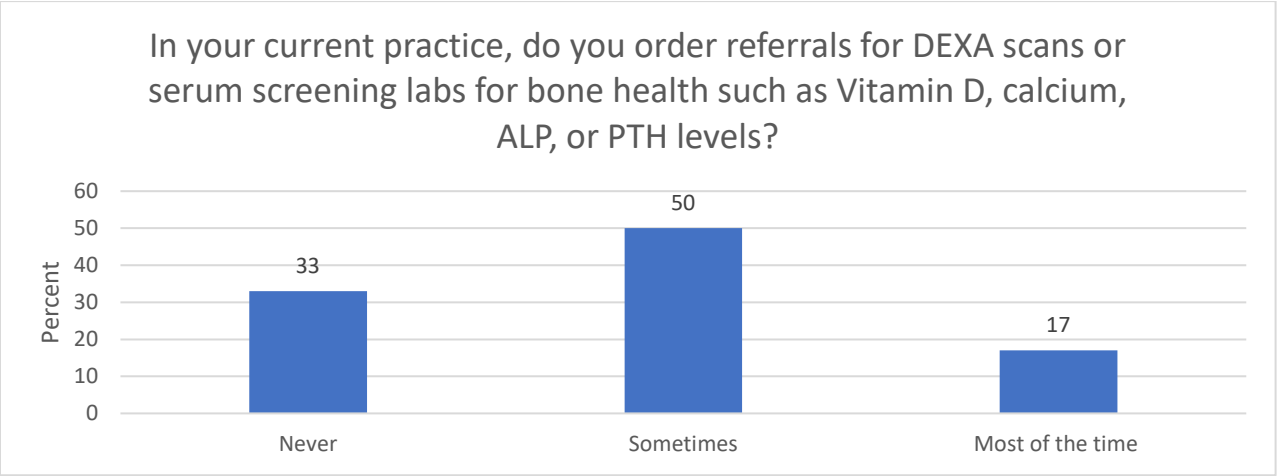
Bar Charts

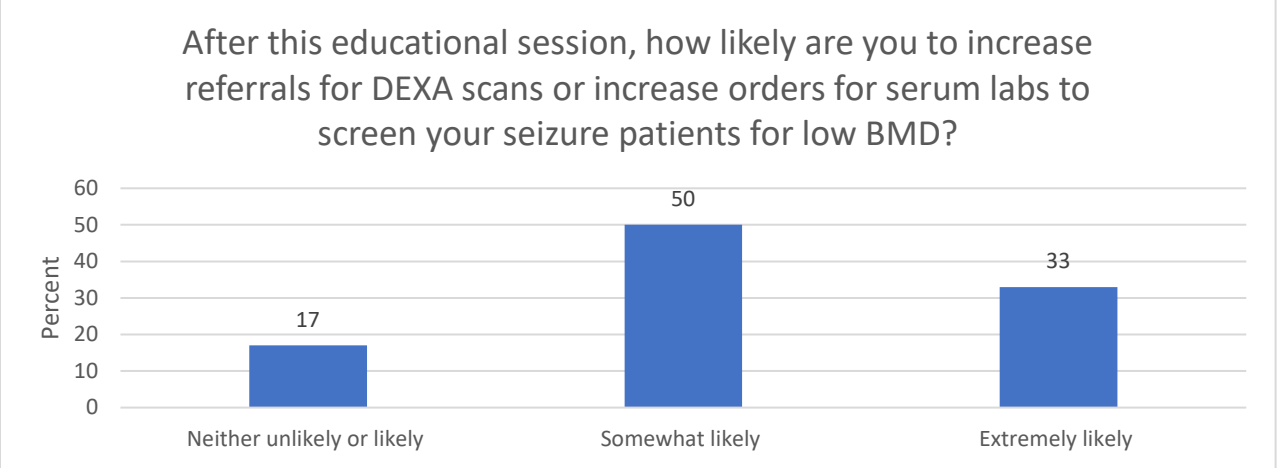

Prior to the educational session, how familiar were you with the evidence that supports the relationship between AEDs and low BMD?
Percent
80
60
40
20
0
17
67
17
Not familiar at all
Slightly familiar
Very familiar

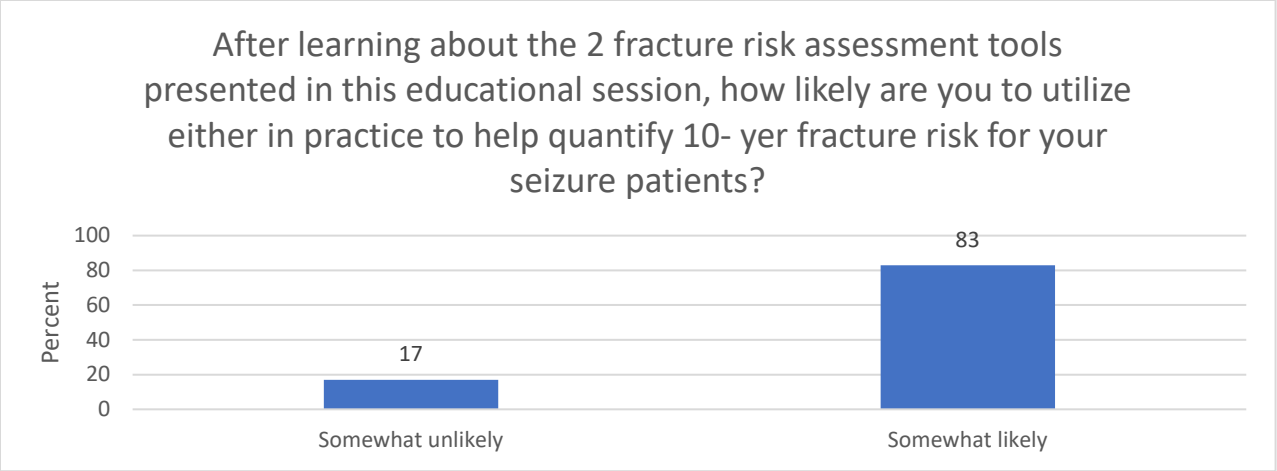

Prior to the educational session, how familiar were you with identifying EIAEDs from NEIAEDs?
Percent
60
50
40
30
20
10
0
17
17
50
17
Not familiar at all
Slightly familiar
Moderately familiar
Very familiar

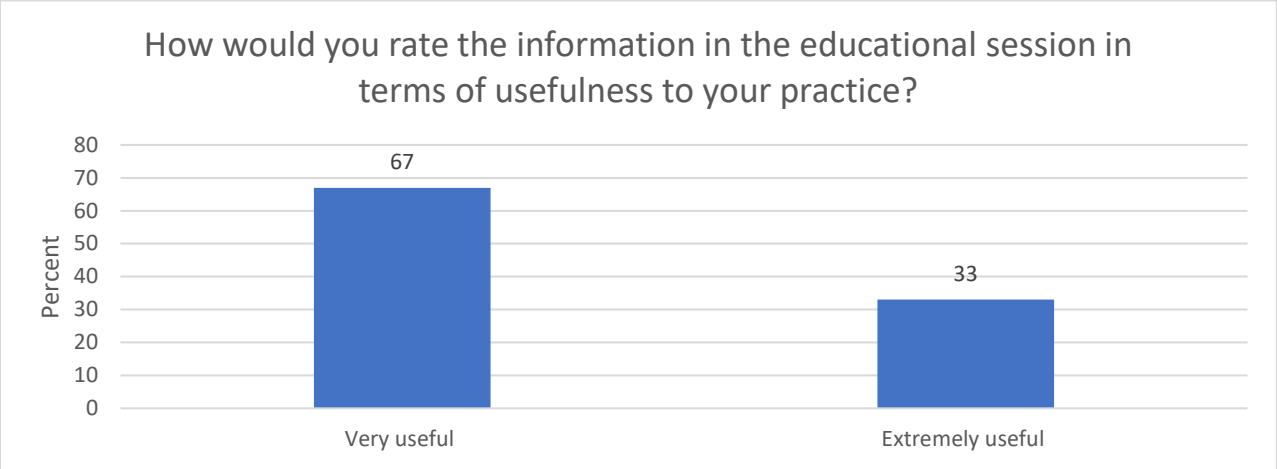

Prior to the educational session, how familiar were you with the concept of CYP450 enzyme induction and its relationship to negative bone health effects?
Percent
80
60
40
20
0
17
67
17
Not familiar at all
Slightly familiar
Moderately familiar

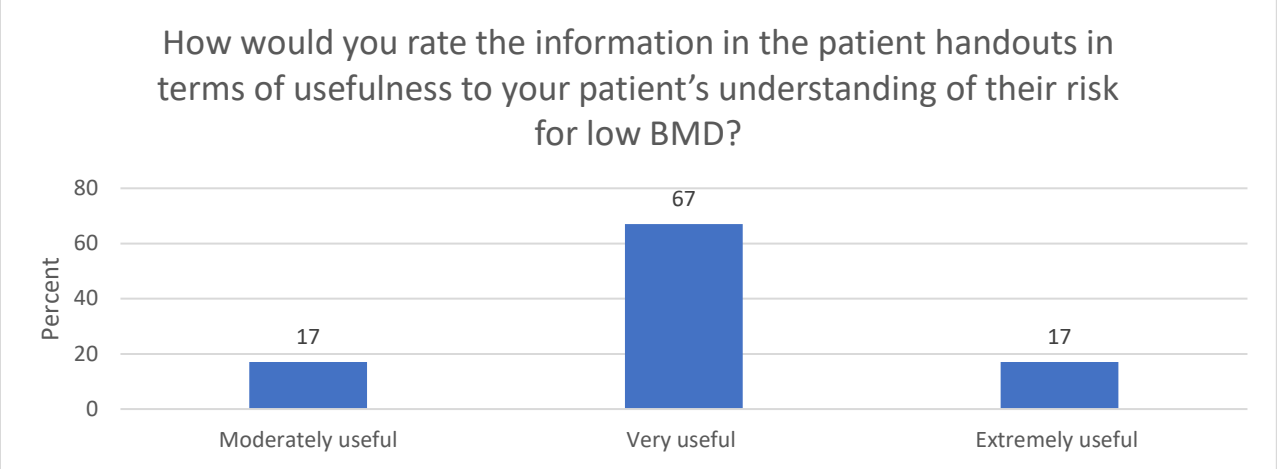

Prior to the educational session, how aware were you of the lack of routine practices regarding screening for bone health in PWE on AEDs?
Percent
100
80
60
40
20
0
17
83
Not aware at all
Somewhat aware


In your current practice, do you order referrals for DEXA scans or serum screening labs for bone health such as Vitamin D, calcium, ALP, or PTH levels?
Percent
60
50
40
30
20
10
0
33
50
17
Never
Sometimes
Most of the time


After this educational session, how likely are you to increase referrals for DEXA scans or increase orders for serum labs to screen your seizure patients for low BMD?
Percent
60
50
40
30
20
10
0
17
50
33
Neither unlikely or likely
Somewhat likely
Extremely likely


After learning about the 2 fracture risk assessment tools presented in this educational session, how likely are you to utilize either in practice to help quantify 10- yer fracture risk for your seizure patients?
Percent
100
80
60
40
20
0
17
83
Somewhat unlikely
Somewhat likely


How would you rate the information in the educational session in terms of usefulness to your practice?
Percent
80
70
60
50
40
30
20
10
0
67
33
Very useful
Extremely useful


How would you rate the information in the patient handouts in terms of usefulness to your patient's understanding of their risk for low BMD?
Percent
80
60
40
20
0
17
67
17
Moderately useful
Very useful
Extremely useful

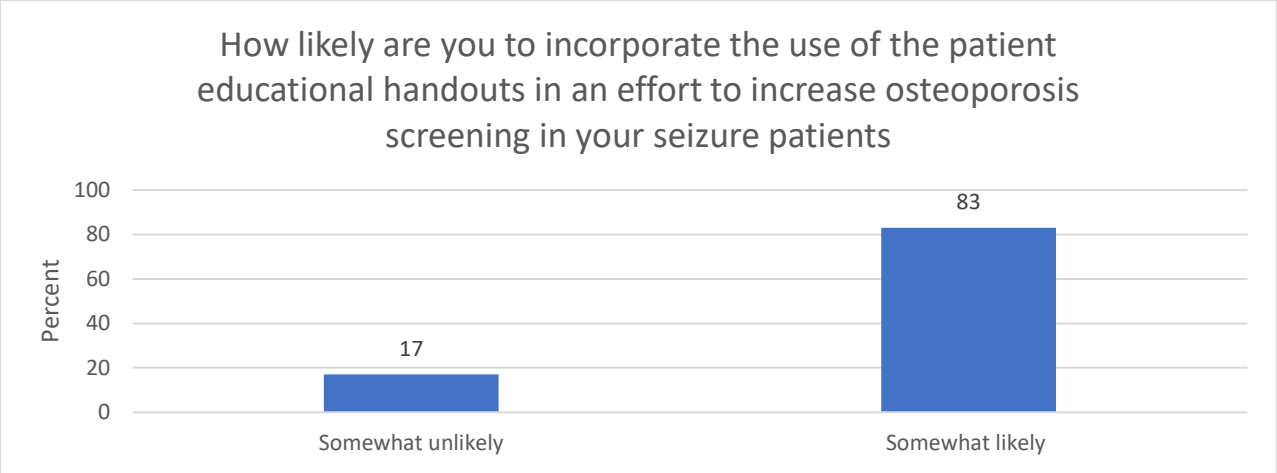


Table 3 displays the frequency testing from the questionnaire items (see Appendix H).

An open-ended question about the providers' perceived barriers to implementation of osteoporosis screening practices in PWE taking AEDs revealed that 50% (n=3) of respondents perceive time as a barrier to implementation. Other answers include lack of patient follow-up, lack of provider consideration during visits, and scarcity of resources.

Discussion

Despite over 60 years of research which associates the use of AEDs with poor bone health, there remains low utilization of screening measures to identify those at risk for osteoporosis in this patient population. According to the literature, there is no current standardized practice for osteoporosis screening in PWE taking AEDs. This remains one of the greatest barriers in implementation of screening practices, as there are no guidelines to follow. Without a standardized process to follow, it is difficult to ascertain how providers at GMA compare to other neurological providers in terms of how they screen for osteoporosis in PWE taking AEDs. The purpose of this project was to increase provider understanding of the osteoporosis screening disparities that exist in PWE taking AEDs. The data collected from this

project highlights the knowledge gap of the providers at GMA on the topic, simultaneously showcasing their willingness to implement future initiatives.

The results of the Likert-style questionnaire are suggestive of a partial knowledge gap on the providers' understanding of the current evidence that supports the relationship between AED use and their negative effects on bone health, which is consistent with the current literature. While there is some familiarity between providers on the topics, the data suggests that there is a need for further reinforcement on the current evidence and the various tools that can be used to successfully increase osteoporosis screening volume. A specific gap identified in this project was the level of provider knowledge regarding the higher risk of EIAEDs versus that of NEIAEDs. According to the literature, EIAEDs have higher rates of poor bone health markers than NEIAEDs (Fernandez et al., 2018; Diemar et al., 2019; Miziak et al., 2019; Fahmy et al., 2018; Sheik et al., 2017; Nordqvist et al., 2021). The project data indicated that there is provider unfamiliarity in identifying EIAEDs from NEIAEDs, as well as how CYP450 enzyme induction negatively affects bone health measures. This theme was a prominent one in the literature and increasing provider education about this could aid in GMA's future work to optimize the bone health profiles of their seizure patient population.

The project data illuminated a high level of provider awareness of the osteoporosis screening disparities in PWE taking AEDs. This aligns with the current literature consensus, in which almost unanimously, it is agreed that routine screening is underutilized and would be beneficial for PWE taking AEDs to identify early bone loss and decrease the poor outcomes associated with negatively altered bone profiles (Siniscalchi et al., 2020; Mehicic et al, 2020; Diemar et al., 2019; Miller et al., 2020; Zhang et al., 2020). Identification of osteoporosis

screening disparities in seizure patients is the first step in the PDSA model and is the starting point for future work in which implementation of screening practices may occur (AHRQ, n.d.).

The results also exemplify the providers' support and willingness to increase screening after the educational session. However, the data was not overwhelmingly suggestive that the interventions proposed in the educational session would very likely be used as the means to increase volume of osteoporosis screening in their practice. Responses to the questionnaire indicate that clinic time constraint is the largest perceived barrier to implementation of these interventions and could be a reason why the data shows that providers are only somewhat likely to utilize the proposed interventions. Perceived time constraint was not a concept identified in the literature. In fact, the literature lacked clear explanations behind osteoporosis screening disparities in PWE aside from the lack of standardization to guide clinical practice.

The data represents the providers' willingness to adopt change, albeit with an unsured approach to navigate change initiative. This aligns with the current literature, which overwhelmingly supports the idea of osteoporosis screening in PWE taking AEDs, but without a standardized process to follow, it is often not executed in practice. This parallels the idea that the PDSA often requires multiple cycles before sustainable improvement can be achieved. To successfully complete the Act component of the PDSA framework, the practice would need to adopt a process for osteoporosis screening in PWE taking AEDs or continue to adjust their workflow to be able to incorporate screening in the future (AHRQ, n.d.). The data do not definitively support that the practice is ready to commit to a specific screening process, so additional cycles of the PDSA will need to be performed. Similarly, the reinforcement stage of the ADKAR Conceptual Framework Model is operational after project implementation occurs. It is during this step of the model where sustainability takes place (Kachian et al., 2018). Sustained

practice changes that result in increased osteoporosis screening will be the hallmark of the reinforcement stage of the ADKAR model. This project did not elicit sustained change, and so more efforts are needed to implement changes to support sustainability. Reinforcement is vital to successful quality improvement.

Limitations

There were several limitations to this project. The sample size was small (n=6). While there was 86% participation in the original population, a sample size of 6 is not large enough to make statistically sound and generalizable conclusions. More extensive studies with larger sample sizes are needed to yield strong evidence to support negative effects of AEDs on bone health (Singla et al., 2017; Zhang et al., 2020). Additionally, there was minimal within-sample variability in the project participants' demographic characteristics. Most provider participants (83%) were between the ages of 30-49 years old. The sample primarily was comprised of nurse practitioners (67%), and providers with less than 6 years of neurological practice experience (67%). Having a more equally represented sample across demographic characteristics may have yielded different and more generalizable data.

Self-reported data can also be a project limitation, as its reliability, and therefore quality, is questionable. Likert-style questions can also lead to data deficiencies. For example, the data shows that 17% of respondents were unlikely to utilize the patient educational handouts. The data does not follow up on reasons for why this is unlikely for those providers. Further exploration via additional questions could have been used to help identify these barriers to implementation.

Overcoming limitations

Multiple attempts were made by the principal investigator to obtain data after the initial educational session. Reminder emails and text messages proved helpful in gathering data. Additionally, a folder with 20 printed copies the Qualtrics QR code that linked to the questionnaire was also hand delivered to serve as a request and reminder to complete the data items. Furthermore, providers were furnished with a copy of the presentation for future reference so that data collection could be done outside of the date of the provider education session.

Another strength to overcoming limitations was the high level of interest displayed by the participating providers. Overall, the respondents were interesting in learning about the screening disparities in their seizure patient population and most were somewhat willing to begin implementing one or more interventions to increase the volume of screening.

Finally, having an open-ended question about the providers' perceived barriers to implementation served as a strength in this project. This data highlighted a variety of things that could be considered in the future to help facilitate osteoporosis screening at the clinic, with specific focus on time constraints as a barrier.

Conclusion

People with epilepsy are at above-average risk for negative bone health profiles and fragility fracture as a result of AED use. Osteoporotic fractures can lead to considerable morbidity and mortality while simultaneously having negative effects on healthcare cost. There is no recommended routine screening for osteoporosis in people with epilepsy who do not fit traditional screening criteria despite years of research that supports the correlation between the AED use and poor bone health. As a result, osteoporosis screening in this patient population is vastly underutilized even in cases where providers recognize its importance. The goal of this

project was to increase provider awareness about this screening disparity and introduce interventions that could increase osteoporosis screening in their seizure population in the future.

Recommendations for Future Practice

Based on collective findings on this DNP project, the future recommendations for the designated practice include development of a standardized process for identifying seizure patients at risk for bone loss. This could be achieved by increasing the number of DEXA scan referrals or serum screening labs such as Vitamin D, calcium, alkaline phosphatase, and parathyroid hormone. The goal is feasible based on the data collected that supports the providers' willingness to promote change. The interventions proposed to the providers at the practice could also serve to increase screening thereby, increase the likelihood of achieving this goal. Additionally, attempts at overcoming barriers that were identified in the project should be considered when deciding which interventions to implement. Finally, staying up to date about current research regarding the relationship between AED use and bone health is important to substantiate the incorporation of osteoporosis screening in PWE, as is educating patients about their bone health risks so that they can be an active member in preventing early bone loss.

Dissemination

Dissemination is an integral part of quality improvement projects. It is essential to share the project findings to successfully integrate evidence into clinical practice, and therefor initiate and sustain change. Only then can outcomes and impact be evaluated. Web-based dissemination of project data in the form of tables and bar graphs were sent via email to the practice providers for review. Additionally, findings were disseminated at the 2024 UNCG DNP Poster Day using an electronic poster presentation during a 20-minute session allotment.

Summary

To summarize, there is a need for routine osteoporosis screening in patients with epilepsy due to the negative biochemical effects that antiepileptics have on the patients' bone profiles. Screening would ideally begin in the outpatient setting early in a patient's epilepsy diagnosis and course so that their bone health could be monitored for decline. Implementation of fracture risk assessment tools during clinic visits and patient education handouts are viable options for practitioners to implement to help increase the rates of osteoporosis screening in this patient population. For successful implementation to occur, workflow adjustments to allow for additional clinic time for screening will be needed. Steps to identify early bone loss in PWE can act as both primary and secondary preventative measures, increasing the potential for positive outcomes in the realms of mortality, morbidity, quality of life, and cost.

Osteoporosis screening in seizure patients taking antiepileptic drugs is insufficient. Additional efforts are needed to overcome this disparity to ensure bone health is routinely monitored in this fracture-vulnerable population. More work will need to be done with focus on implementation of screening strategies and how they can effectively and sustainably be utilized in the practice.

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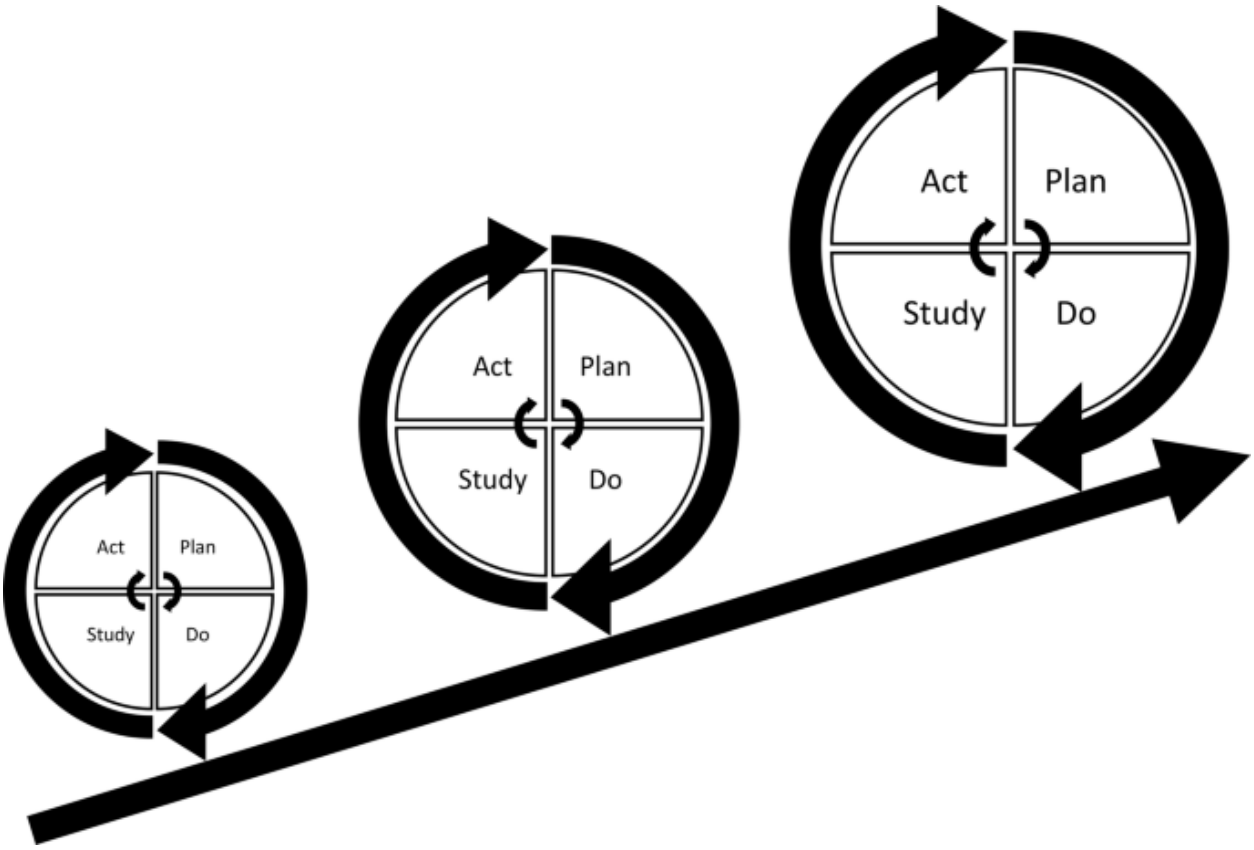
Appendix A

Figure 1. General Components of the PDSA Translational Framework. Source: Knudson et al., (2019)



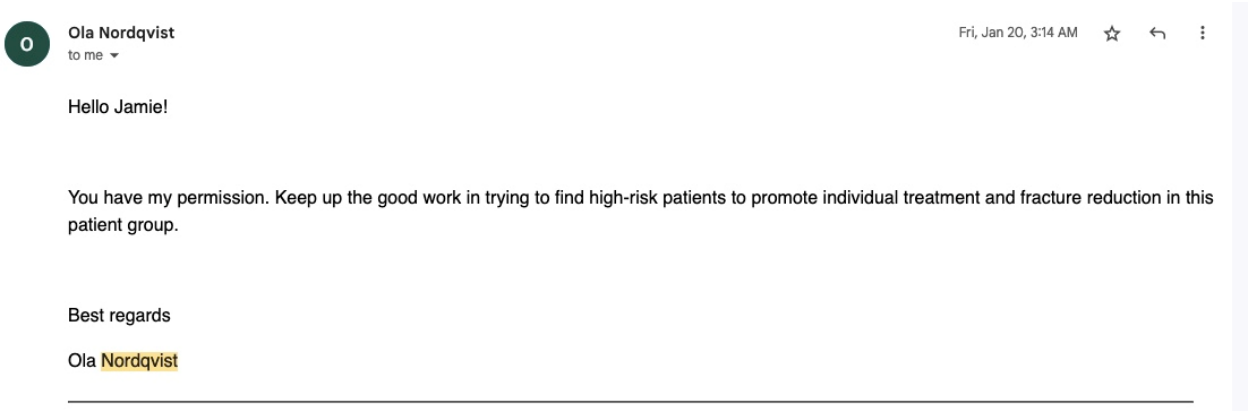
Appendix B

KEFRI Instrument. Source: Nordqvist et al. (2021)

KEFRI = Age-category x (1.18) + Gender x (-0.51) + AED-type x (0.29) + Epilepsy diagnosis-category x (0.31) + BMI-category x (-0.35)

Age categories (years):	≤ 50	=1
	51-74	=2
	≥ 75	=3
Gender:	Women	=1
	Men	=2
AED type:	Non-inducing	=1
	Inducing	=2
Epilepsy diagnosis:	No	=1
	Yes	=2
BMI-category (kg/m^2):	≤ 25	=1
	> 25	=2

Appendix C. Permission for Use of KEFRI Index



Ola Nordqvist
to me

Fri, Jan 20, 3:14 AM

Hello Jamie!

You have my permission. Keep up the good work in trying to find high-risk patients to promote individual treatment and fracture reduction in this patient group.

Best regards

Ola Nordqvist

Appendix D: Post-education survey instrument

1. Prior to the educational session, how familiar were you with the evidence that supports the relationship between AEDs and low BMD?

   Not familiar at all
   Slightly familiar
   Moderately familiar
   Very familiar
   Extremely familiar

2. Prior to the educational session, how familiar were you with identifying EIAEDs from NEIAEDs?

   Not familiar at all
   Slightly familiar
   Moderately familiar
   Very familiar
   Extremely familiar

3. Prior to the educational session, how familiar were you with the concept of CYP450 enzyme induction and its relationship to negative bone health effects?

   Not familiar at all
   Slightly familiar
   Moderately familiar
   Very familiar
   Extremely familiar

4. Prior to the educational session, how aware were you of the lack of routine practices regarding screening for bone health in PWE on AEDs?

   Not aware at all
   Somewhat aware
   Very aware

5. In your current practice, do you order referrals for DEXA scans or serum screenings labs for bone health such as Vitamin D, calcium, ALP, or PTH levels?

   Never
   Sometimes
   About half the time
   Most of the time
   Always

6. After this educational session, how likely are you to increase referrals for DEXA scans or increase orders for serum labs to screen your seizure patients for low BMD?

   Extremely Unlikely
   Somewhat unlikely
   Neither likely nor unlikely
   Somewhat likely
   Extremely likely

7. After learning about the novel screening tool presented in this educational session, how likely are you to utilize it in practice to help quantify 10-yer fracture risk for your seizure patients?

   Extremely Unlikely
   Somewhat unlikely
   Neither likely nor unlikely
   Somewhat likely
   Extremely likely

8. How would you rate the information in the educational session in terms of usefulness to your practice?

   Not at all useful
   Slightly useful
   Moderately useful
   Very useful
   Extremely useful

9. How would you rate the information in the patient handouts in terms of usefulness to your patient's understanding of their risk for low BMD?

   Not at all useful
   Slightly useful
   Moderately useful
   Very useful
   Extremely useful

10. How likely are you to incorporate the use of the patient educational handouts in an effort to increase osteoporosis screening in your seizure patients?

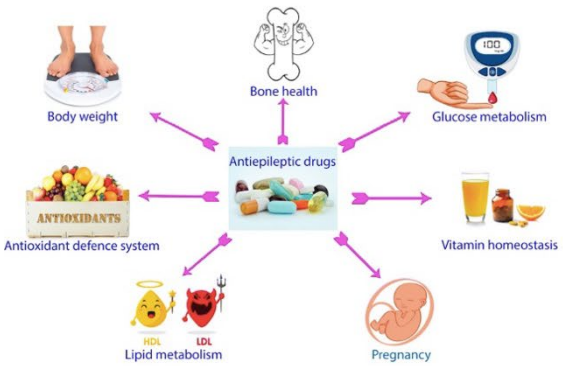
    Extremely Unlikely
    Somewhat unlikely
    Neither likely nor unlikely

Somewhat likely
Extremely likely

Appendix E: ADKAR Model for Change. Source: Warrilow, S. (2022)

Appendix F: Patient Handout

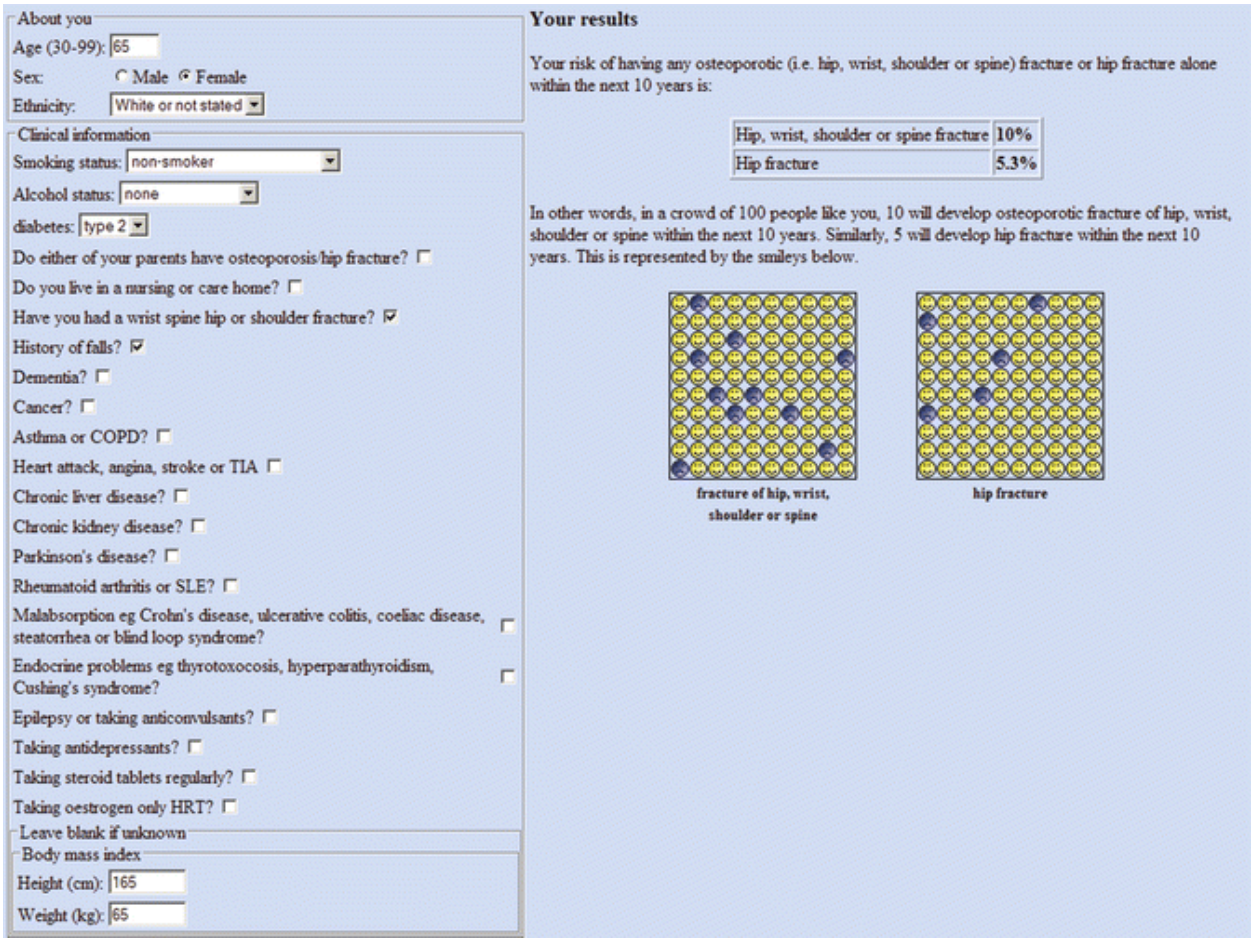
Source: Source: Safahani & Asadi-Pooya (2020)



Effects	Recommendations
Bone Health	Monitor bone mineral density Monitor Vitamin D, calcium, and parathyroid hormone Eat a balanced diet with adequate Vit D and Calcium Avoid tobacco, caffeine, and alcohol Exercise
Glucose Metabolism	Maintain healthy weight Eat diet low in saturated fats and carbohydrates Intake adequate protein and fiber Exercise
Vitamin homeostasis	Monitor vitamin status Eat balanced diet Supplement per your provider's recommendations
Pregnancy	Speak with your provider if you are pregnant or plan on becoming pregnant Folic acid supplementation
Lipid metabolism	Monitor cholesterol levels Eat diet low in saturated fats Maintain healthy weight Exercise Intake adequate dietary fiber
Antioxidants	Intake dietary sources of antioxidants
Body Weight	Maintain healthy weight Eat balanced diet Exercise

Appendix G: Q Fracture Assessment Tool

Source: Themes, U. (2017)



Appendix H: Table 3. Frequency Table for Survey Question Data

Table 3

Frequency Table for Survey Question Data

Questions	*n*	%
Prior to the educational session, how familiar were you with the evidence that supports the relationship between AEDs and low BMD?		
Not familiar at all	1	17%
Slightly familiar	4	67%
Moderately familiar	0	0%
Very familiar	1	17%
Prior to the educational session, how familiar were you with identifying EIAEDs from NEIAEDs?		
Not familiar at all	1	17%
Slightly familiar	1	17%
Moderately familiar	3	50%
Very familiar	1	17%
Prior to the educational session, how familiar were you with the concept of CYP450 enzyme induction and its relationship to negative bone health effects?		
Not familiar at all	1	17%
Slightly familiar	4	67%
Moderately familiar	1	17%
Very familiar	0	0%
Prior to the educational session, how aware were you of the lack of routine practices regarding screening for bone health in PWE on AEDs?		
Not aware at all	1	17%
Somewhat aware	5	83%
Very aware	0	0%
In your current practice, do you order referrals for DEXA scans or serum screening labs for bone health such as Vitamin D, calcium, ALP, or PTH levels?		
Never	2	33%
Sometimes	3	50%
About half the time	0	0%
Most of the time	1	17%
Always	0	0%
After this educational session, how likely are you to increase referrals for DEXA scans or increase orders for serum labs to screen your seizure patients for low BMD?		

Extremely unlikely	0	0%
Somewhat unlikely	0	0%
Neither unlikely or likely	1	17%
Somewhat likely	3	50%
Extremely likely	2	33%
After learning about the 2 fracture risk assessment tools presented in this educational session, how likely are you to utilize either in practice to help quantify 10- year fracture risk for your seizure patients?		
Extremely unlikely	0	0%
Somewhat unlikely	1	17%
Neither unlikely or likely	0	0%
Somewhat likely	5	83%
Extremely likely	0	0%
How would you rate the information in the educational session in terms of usefulness to your practice?		
Not at all useful	0	0%
Somewhat useful	0	0%
Moderately useful	0	0%
Very useful	4	67%
Extremely useful	2	33%
How would you rate the information in the patient handouts in terms of usefulness to your patient's understanding of their risk for low BMD?		
Not at all useful	0	0%
Somewhat useful	0	0%
Moderately useful	1	17%
Very useful	4	67%
Extremely useful	1	17%
How likely are you to incorporate the use of the patient educational handouts in an effort to increase osteoporosis screening in your seizure patients		
Extremely unlikely	0	0%
Somewhat unlikely	1	17%
Neither unlikely or likely	0	0%
Somewhat likely	5	83%
Extremely likely	0%	0%