2-27-2016

Duloxetine and Pregabalin: A Comparison and Contrast for the Treatment of Painful Diabetic Neuropathy

Maggie Hartmann

Duloxetine and Pregabalin: A Comparison and Contrast for the Treatment of Painful Diabetic Neuropathy

Maggie Hartmann

University of North Dakota

PERMISSION

Title Duloxetine and Pregabalin: A Comparison and Contrast for the Treatment of Painful Diabetic Neuropathy

Department Nursing

Degree Master of Science

In presenting this independent study in partial fulfillment of the requirements for a graduate degree from the University of North Dakota, I agree that the College of Nursing of this University shall make it freely available for inspection. I further agree that permission for extensive copying or electronic access for scholarly purposes may be granted by the professor who supervised my independent study work or, in her absence, by the chairperson of the department or the dean of the Graduate School. It is understood that any copying or publication or other use of this independent study or part thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to the University of North Dakota in any scholarly use which may be made of any material in my independent study.

Signature 

Date _5/3/2016_____

Abstract

Painful diabetic neuropathy (PDN) is a condition prevalent in diabetic patients. As the rate of diabetes mellitus (DM) continues to rise, so will the comorbid conditions associated with it, such as PDN. This review will examine a patient, D.J., seen during an OSCE exam, who was diagnosed with type two DM three years ago. He presents to his primary care provider for a follow up, with concerns of elevated fasting blood glucose levels. This review will further discuss the screening and periodic monitoring that diabetic patients need every three to six months, in order to assess for micro and macrovascular changes, including PDN. The prevalence of PDN is increasing with the rising rates of diabetes, and can have damaging effects on the patients who suffer from this condition. Furthermore, this review will discuss the consensus recommendations for the treatment of PDN, through a literature review. The literature review will specifically address treatment strategies for PDN with duloxetine, a serotonin-norepinephrine reuptake inhibitor, and pregabalin, an alpha-2-delta ligand agonist. Duloxetine and pregabalin have been shown to effectively treat PDN with fewer side effects and adverse drug reactions when compared to other treatment strategies. Duloxetine and pregabalin will be compared to each other for their efficacy and their cost effectiveness.

Background

This review will begin by discussing the case of D.J., a type two diabetic of three years, who presents to his primary care provider with elevated fasting glucose levels. Although this patient has no current overt micro or macrovascular changes associated with his diabetes, it is vital to routinely screen for these comorbidities at each patient encounter. D.J. is similar to many diabetic patients who have difficulty controlling either their fasting blood glucose levels or their postprandial blood glucose levels, or both. D.J. does not currently have peripheral neuropathy, as evidenced by subjective reports and physical assessment; but he, like each diabetic patient, is at risk for developing PDN. Elevated glucose levels are the main cause of PDN, and research has proven that tighter glycemic control prevents and delays the onset of PDN. Because of this, D.J.'s provider must continue to be diligent about lowering his blood glucose levels while continuing to screen for PDN.

The prevalence of DM is rising rapidly in the United States and worldwide. Currently, almost 30 million Americans are diagnosed with DM, with 95% of those patients being type two diabetics. This number will likely rise, and by 2050, one in three Americans will have a diagnosis of DM (American Diabetes Association [ADA], 2014). There are numerous micro and macrovascular changes that occur due to elevated glucose levels in diabetics, including PDN. Providers must be persistent in assessing for early signs of PDN during diabetic follow-up visits by completing various assessments, including a complete foot exam. This is of utmost importance because PDN is present in approximately 10-50% of diabetic patients (Peltier,

Goutman, & Callaghan, 2014), and is often the first presenting symptom of DM in type two diabetics. PDN can present insidiously and can be discovered by physical exam, while other times PDN presents with significant pain and distressing symptoms such as shooting pains, numbness, tingling, pins and needles sensations, and burning pain, prompting the patient to see a provider. Decreasing a patient's fasting plasma glucose levels and decreasing hemoglobin A1c levels to a goal set jointly by the patient and the provider are of utmost importance in the prevention of PDN. Although many patients may attempt to control their serum glucose levels, pharmacologic treatment for PDN will be necessary in many cases.

The treatment of PDN has evolved over the last decade, and likely will continue to evolve as more patients are diagnosed with DM, and will consequently suffer from PDN. There are multiple modalities providers can offer their patients for the relief of PDN. This review will focus on two of the first-line agents: duloxetine and pregabalin. Other agents exist for the treatment of PND, like tricyclic antidepressants (TCAs) and opioids. However, due to their side effect profile TCAs and opiates have fallen in superiority to serotonin and norepinephrine reuptake inhibitors and alpha-2-delta ligand agonists, which have proven to be at least as effective with fewer side effects.

Case Report

D.J. is a 65-year-old Caucasian male, who is assessed during an OSCE exam for a recheck of his type two DM. He was encouraged by his diabetic nurse educator to follow up with his primary care provider after reporting fasting blood glucose levels consistently over 150 mg/dL for one month. He checks his fasting glucose

approximately two to three mornings each week, and does not routinely check his postprandial blood glucose. D.J. was diagnosed with type two DM three years ago, at the age of 62, after months of fatigue, weight gain, and polydipsia. His initial A1c was 8.7%, and he initially underwent three months of medical nutrition therapy (MNT) and increased exercise. With MNT and exercise, he was able to drop his A1c to 8.2%, and at that time began on twice daily dosing of Metformin 500 mg. He has remained on this dose of Metformin and spent time with a dietician to learn how to incorporate carbohydrate counting into his diet. He has been following with his primary care provider every three to six months, and his hemoglobin A1c has been around 8% for the past year.

In addition to type two DM, D.J.'s past medical history includes hypertension, hyperlipidemia, and coronary artery disease with two coronary stents placed in 2014. His medications include Metformin 500 mg twice daily, Plavix 75 mg daily, Aspirin 81 mg daily, Lasix 20 mg daily, Lisinopril 20 mg daily, Atorvastatin 20 mg daily, and a Multivitamin daily. Like many type two diabetic patients, D.J. struggles with his weight and activity level. He works full time in an office setting and is sedentary most of the day. His BMI at the time of his most recent clinic visit is 29.1, which is elevated from 28 six months ago. Aside from his slight weight gain, and elevated fasting glucose levels, his review of systems is otherwise negative. A complete physical exam is also negative, including complete foot exam.

Although D.J. presents feeling well with a negative review of systems and physical exam, his provider understands the importance of routine screening in the diabetic population. At each clinic visit, D.J. has a comprehensive foot exam to assess

for peripheral neuropathy. It is imperative that his provider continues to assess for PDN, as it is known that between 10-50% of diabetic patients suffer from PDN (Peltier, Goutman, & Callaghan, 2014). This comprehensive foot exam will include a full inspection of his skin, pulse checks, capillary refill time, monofilament testing, pinprick testing, and vibration testing with a 10-g tuning fork. In addition to his foot exam, D.J. has not had fasting labs done for one year. Therefore, a fasting lipid panel, complete blood count, basic metabolic panel, liver function tests, Hemoglobin A1c, and Urinalysis were all completed in the clinic. His complete lab results are found in the Appendix.

Notably, D.J.'s A1c has risen to 9.5%. Because of this change, he will increase his Metformin dose to 1000 mg in the morning, and 500 mg at night for one week, then increase again to a goal of 1000 mg twice daily. He will be meeting with a Registered Dietician who specializes in DM to review carbohydrate counting and plan for weight loss. He has agreed to join an exercise facility with the intention of establishing with a physical trainer for an individualized exercise routine. Education was provided to D.J. that glucose control is of utmost importance to prevent PDN, and other end-organ damage. Although D.J. is not in need of treatment for PDN at this time, multiple pharmacotherapeutic options exist for PDN, including serotonin-norepinephrine reuptake inhibitors, and alpha-2-delta ligand agonists, among other options. The following sections of this review will discuss these options, with a focus on two of the most frequently used agents: duloxetine, a serotonin-norepinephrine reuptake inhibitor, and pregabalin, an alpha-2-delta ligand agonist. The efficacy,

benefits, risks, and cost-effectiveness of duloxetine and pregabalin will be discussed through a literature review.

Literature Review

As stated above, DM affects nearly 30 million Americans; if this trend continues, DM will affect one in three Americans by 2050 (ADA, 2014). Patients diagnosed with DM often have multiple comorbidities, including hypertension, hyperlipidemia, coronary artery disease, retinopathy, and PDN. The patient reviewed in the case study, D.J., has had relatively stable glucose control throughout his diagnosis, and although he has multiple comorbidities, he has not experienced PDN. While D.J. denies symptoms of PDN, it is imperative to continue screening him at each clinic visit. The importance of continued surveillance of PDN is emphasized by the prevalence of PDN in the diabetic population. Though reports vary, studies have shown PDN to be present in between 10-50% of diabetic patients (Peltier, Goutman, & Callaghan, 2014). Moreover, PDN is frequently detected at the time of DM diagnosis for type two diabetics, and close to five years after the initial diagnosis of type one diabetics.

Search Strategy

The author searched the CINAHL and PubMed databases for articles related to duloxetine, pregabalin, and diabetic nerve pain, between the years of 2005 and the present date. When searching for articles using the CINAHL database, the keywords “diabetes mellitus” and “duloxetine” and “pregabalin” retrieved nine articles. Search criteria included English language and peer-reviewed articles. The MeSH database through PubMed was utilized to search for additional articles. Using

the Boolean phrase “AND,” the MeSH terms “diabetic neuropathies” and “duloxetine hydrochloride” and “pregabalin” with search filters “human” and “10 years” were used and generated 32 additional articles.

Symptoms of Painful Diabetic Neuropathy

PDN causes many distressing and debilitating symptoms for the diabetic patient. PDN can cause pain often described as stabbing, electric, burning, cold, or sharp. These sensations may occur continuously or intermittently and often at night. The patient with PDN may also experience hyperalgesia or allodynia, which may be triggered by wind, clothing, heat, or cold (Attal, 2012). These symptoms are caused by microvascular changes that produce damage to small nerve fibers. The neuropathy causes a characteristic, symmetrical, stocking and glove sensory impairment, which begins in the bilateral toes and fingers, and progresses proximally in the extremities, not limited to a dermatome pattern (Peltier, Goutman, & Callaghan, 2014).

In addition to causing significant pain and decreased sensation, PDN impairs many other aspects of the patient’s life. Boyle et al. (2012) explain that PDN may reduce the patient’s sleep, mental health, and affect of the patient’s activities of daily living, consequently causing a decreased quality of life. Reduced quality of life, in addition to continuous pain, not only leads to financial costs of treatments, but also the financial cost from loss of productivity from these patients (Boyle et al., 2014).

Screening for Painful Diabetic Neuropathy

Due to the chronic nature and prevalence of PDN in diabetic patients, the American Diabetes Association recommends initiating screening for PDN at the

diagnosis of type two DM, and five years after the diagnosis of type one DM patients (Cefalu, 2016). There are multiple tools available for the screening of PDN, though the assessment of subjective reports of the patient's history of pain qualities must be completed first (Chong & Hester, 2007). Other objective screening methods, approved by the American Diabetic Association, include the use of monofilament testing and one or more of the following: Achilles tendon reflex, vibration perception using a 128 Hz tuning fork, or pinprick sensation (Peltier, Goutman, & Callaghan, 2014). Visual examination of the foot should occur at each clinician visit, and the above-mentioned assessment techniques should be assessed at least annually.

Another less-utilized method of screening for PDN frequently used in research studies, is the Leeds Assessment of Neuropathic Symptoms and Signs, which includes both subjective and objective assessments (Attal, 2012). For greater specificity, used in clinical practice and research studies, nerve conduction studies and biopsy of the hairy skin may be used. Though sensitivity and specificity are increased, nerve conduction studies and biopsies are used less often due to the need for an experienced technician as well as the cost (Peltier, Goutman, & Callaghan, 2014).

Treatment for Diabetic Neuropathy: Duloxetine

There have been many treatments and medications applied in the treatment of PDN; however, this literature review will focus on the efficacy and cost-effectiveness of two of the FDA approved medications: duloxetine and pregabalin.

Duloxetine is a serotonin and norepinephrine reuptake inhibitor that was first approved by the US Food and Drug Administration for the use in PDN in September 2004 (Wernicke et al., 2006). Tanenberg et al. (2011) explain that "by inhibiting the reuptake of norepinephrine and serotonin, duloxetine increases the levels of these neurotransmitters in the central nervous system" (p. 615), consequently reducing the perception of pain.

As for the efficacy in PDN pain reduction, duloxetine has shown good results. In a study by Boyle et al. (2012) the authors compared the effects of duloxetine, in the reduction of pain compared with placebo. Duloxetine was shown to have a greater reduction in pain levels when compared with placebo. In addition, the study assessed sleep continuity and quality. Although duloxetine showed benefits with pain levels, there was a significant effect on the patient's sleep continuity compared to placebo, and also compared to patients who were placed on pregabalin and amitriptyline. The study found a reduced total sleep time, as well as an increased wake time after sleep onset with duloxetine (Boyle et al., 2006).

In a review by Peltier, Goutman, and Callaghan (2014) the authors discovered a consistent improvement in PDN pain reduction with the use of SNRIs like duloxetine, especially when compared to older antidepressants used previously that have more side effects. They found that duloxetine has shown a reliable "NNT [number needed to treat] between 2.1 and 5.5 to maintain a 50% pain reduction" (Peltier, Goutman, & Callaghan, 2014, p. 5). Although duloxetine is not without side effects such as disturbed sleep, there are benefits to using an SNRI for PDN. Peltier, Goutman, and Callaghan (2014) point out that for patients who need

pharmacotherapeutics for anxiety and depression, duloxetine may offer the benefit of dual therapy for their pain relief and treatment for mental health conditions.

Similarly, a study by Wernicke et al. (2006) found efficacy in the treatment of PDN with duloxetine, both at 60 mg daily and 60 mg twice daily dosing through a 12-week trial, when compared to placebo. Although both dosing parameters were found to be effective in reducing PDN, the 60 mg twice daily dosing was continued for a 52-week extension trial versus placebo, due to slightly better efficacy when compared to the once daily dosing. Results of the 52-week study showed significant improvement in PDN, as well as quality of life as measured by the SF-36 (a short form health survey), for the patient randomized to the duloxetine 60 mg twice-daily group as compared to placebo. Adverse effects of duloxetine were found in the study, including a slightly increased fasting blood glucose level and a slightly increased LDL level; however, both of these findings were not statistically significant, and would need to be further studied to be conclusive (Wernicke et al., 2006).

A study by Chong and Hester (2007) compared various treatment options for PDN, including duloxetine, pregabalin, narcotic pain medications, and tricyclic antidepressants. The authors found promising results with duloxetine when comparing three large randomized control trials. The NNT for 60 mg daily of duloxetine was 4.3, while the NNT for 60 mg twice daily of duloxetine was 3.8, with the result of 50% pain relief, with a 95% confidence interval (Chong & Hester, 2007). Although narcotic pain medications revealed slightly better pain control when compared to duloxetine, the authors noted the fact that opiates bring a high

risk of addiction, adverse effects, and tolerance issues when compared to duloxetine.

In a study by Tanenberg et al. (2011) the authors completed a noninferiority study, assessing whether patients would receive as good of pain control when switching from gabapentin to duloxetine 60 mg daily, as they do while switching from gabapentin to pregabalin 300 mg daily. Patients' pain was measured using a Likert scale and assessed the reduction in weekly pain mean at baseline compared to the end of 12 weeks. The study concluded that duloxetine was noninferior to pregabalin for the reduction in PDN, with an estimated -2.6 change in daily pain score after 12 weeks with duloxetine, as opposed to a -2.1 change with pregabalin (Tanenberg et al., 2011). Interestingly, duloxetine was found to have better pain reduction versus pregabalin at week 2, 3, and 5 through 11, but at week 12 the results were not statistically significant, with both drugs showing good results.

Treatment for Diabetic Neuropathy: Pregabalin

Pregabalin is an alpha-2-delta ligand agonist, approved by the FDA in 2004 for the treatment of PDN. Attal (2012) explains that pregabalin works by "decreasing the central sensitization and nociceptive transmission through their action on the alpha-2-delta subunit of calcium channels" (p. 163). Pregabalin is a first line recommendation for PDN from the American Academy of Neurology, and multiple studies have shown its efficacy.

A randomized withdrawal trial by Raskin et al. (2014) looked at the efficacy of pregabalin versus placebo for the treatment of PDN after other therapeutic mechanisms had failed. At the end of this 19-week trial, the 125 people randomized

to the pregabalin group displayed a decrease in mean pain scores from 6.8 at the beginning of the trial to 2.9 at the end of the trial. In comparison, the placebo group decreased from a mean pain score of 6.7 to 3.2 at the end of the trial. Although results were similar and not statistically significant at the end of the 19-week trial compared to placebo, the mean pain scores at week 7 and 18 were in fact statistically significant in favor of pregabalin (Raskin et al., 2014). This is important to note, because pregabalin did show faster pain response, as compared to a gradual response to placebo. Lastly, it is important to point out two other factors found in the study which are significant to clinical practice: quality of life and sleep. In both categories, pregabalin showed statistically significant improvement in both quality of life and sleep when compared to placebo (Raskin et al., 2014). These two factors are often sought out from patients suffering from PDN.

Boyle et al. (2012) completed a double-blind, randomized control trial looking at the effects of amitriptyline, duloxetine, and pregabalin in patients with PDN. Each of the three drugs showed positive outcomes in pain reduction when compared to placebo; however, no one drug showed higher statistical significance in that respect. Although pain control was relatively similar across the board, pregabalin did show greater efficacy in other aspects of the trial including quality of life and sleep. Patients randomized to the pregabalin arm of the trial showed improved ability getting to sleep and improved quality of sleep. This may be a significant finding clinically, as pain control is often linked to fatigue and quality of sleep. Although sleep was improved, pregabalin was shown to be inferior to

duloxetine when it came to daytime sleepiness and concentration (Boyle et al., 2012).

In a review of PDN by McKeage (2007), pregabalin was shown to be efficacious in pain reduction with various doses. At the end of a 16-week trial, pregabalin 75 mg twice daily reduced mean pain scores from 6.5 to 4.9. While at the end of an eight week trial, pregabalin 150 mg twice daily reduced mean scores from a baseline of 6.5 to an end point of 4.0. These were compared to placebo, and found to be statistically significant. Although pregabalin was noted to be effective, the author did comment that tolerability was important to be aware of with pregabalin, with side effects including nausea, dizziness, somnolence, and fatigue. Yet, these same side effects were dually noted for duloxetine therapy (McKeage, 2007).

Chong and Hester (2007) reviewed various treatment options for PDN, including pregabalin. They examined a number of randomized placebo-controlled trials with at least 50 participants. Their review assessed the NNT for a minimum of 50% pain reduction valued with a confidence interval of 95%. Pregabalin dosed at 150 mg twice daily was shown to have a NNT of 3.9 in a study with 146 patients, while pregabalin dosed at 300 mg twice daily had even better results at NNT 3.3 in a study of 338 patients (Chong & Hester, 2007). The authors note that there are adverse effects associated with pregabalin, especially with rapid titration, including peripheral edema, euphoric mood, dizziness, and drowsiness. Cerebral edema and encephalopathy may occur when rapidly withdrawn, as well. Although these side effects can be severe, the authors note that this drug is extensively studied and efficacious, and best used when titrated slowly (Chong & Hester, 2007).

Tanenberg et al. (2011) undertook a study to determine whether switching from gabapentin to duloxetine 60 mg daily or pregabalin 150 mg twice daily provided superior pain control with suboptimal control on the gabapentin. Specifically, the study was looking at the noninferiority of duloxetine compared to pregabalin. The study concluded that duloxetine was, in fact, noninferior to pregabalin. Duloxetine showed even better pain control at weeks 2, 3, and 5 through 11, of this 12-week study. However, at week 12 pregabalin and duloxetine showed results that were not statistically different. This may suggest that although duloxetine may have a faster onset of action, pregabalin is just as effective as duloxetine after 12 weeks (Tanenberg et al., 2011).

A study by Razazian, Baziyar, Moradian, Afshari, Bostani, and Mahmoodi (2014) reviewed the effectiveness of pregabalin compared to carbamazepime, an anti-epileptic, and venlafaxine, a serotonin and norepinephrine reuptake inhibitor, similar to duloxetine. The study randomized 257 participants to the three groups and ultimately found pregabalin to be more effective than the other two drugs noted. Pregabalin's NNT was found to be 4.0, for a 50% or greater reduction in PDN.

In a meta-analysis by Zhang et al. (2015), the authors reviewed nine trials with a total of 2056 participants looking at the efficacy and safety of pregabalin. Similar to other trials reviewed, the authors found that pregabalin was indeed effective in reducing pain from PDN by at least 50%. Benefits and side effects of pregabalin were noted and were similar to other trials, including the benefit of improved sleep with pregabalin. Somnolence and dizziness were significantly worse

for the participants taking pregabalin, and were found to be worse with higher doses, including at 300 mg twice daily (Zhang et al., 2015).

Comparing Duloxetine and Pregabalin

After reviewing multiple studies, it would suffice to say that both duloxetine and pregabalin are beneficial for the treatment of PDN. Each drug has their benefits, risks, and side effects, making it crucial to look at each individual patient's circumstances prior to initiating a medication. For example, duloxetine is an antidepressant and anxiolytic medication, making it a potentially better option for a patient in need of therapy for PDN and depression and anxiety. Similarly, if a patient were already established on a serotonin-enhancing medication, the provider would not want to further reduce the reuptake of serotonin, for risk of serotonin syndrome, thus making pregabalin a better option.

Furthermore, each drug has potential side effects that must be reviewed with the patient in order to make an informed decision. Pregabalin has been shown to be associated with improved sleep when compared to duloxetine (Attal, 2012), and many patients greatly value improved sleep, accordingly improving their quality of life. Yet, pregabalin may cause daytime somnolence or dizziness, making this a less appealing choice for some patients in need of vigilance during the day. Other side effects associated with pregabalin include peripheral edema, weight gain, euphoria, headache, and dry mouth. Duloxetine is associated with side effects including nausea, dry mouth, constipation, low appetite, sedation, and dizziness (Attal, 2012). The presence of these side effects will depend on each individual patient, and also may be minimized by slow titration and avoiding rapid initiation or withdrawal.

Cost Effectiveness

Although the benefits and side effects of each medication are integral to patient care, the cost of the medication is a major factor as to whether the medication will work for each patient. According to UptoDate (2016) a 30-day supply of 60 mg duloxetine hcl tablets is $235.29. Instead, pregabalin will not be generic in the United States until 2018 and currently costs $621.05 for a 90-tablet supply of 150 mg tablets (UpToDate, 2016). Individual insurance coverage will vary among patients, but it is crucial to be aware of the high costs for patients, which may tempt patients to inconsistently take their medications due to high out of pocket costs, which may lead to suboptimal symptom control.

Conclusion

In conclusion, this review is meant to discuss the treatment options for the growing problem of PDN in diabetic patients. This growth will likely parallel the growth of DM, which is expected to be present in one in three Americans by 2050 (ADA, 2014). Although the patient in the case study, D.J., was not yet experiencing PDN, there is a high likelihood that he will encounter this comorbidity during his lifetime and treatment of DM. Because of this likelihood, it is imperative for providers to continue to follow the ADA recommendations for screening for PDN at each diabetic encounter using the methods suggested by the ADA.

The purpose of the literature review was to highlight and compare two of the FDA approved treatments for PDN, duloxetine and pregabalin. As seen in the literature review, there were few examples of trials comparing the efficacy of the two drugs exclusively, but many trials were examined comparing each drug to

placebo, and to multiple other drugs. Because of this, it is difficult to conclude superiority of one drug over the other. Instead, it was found that each drug was efficacious and safe compared to placebo for treatment of PDN in all trials reviewed. The choice between duloxetine and pregabalin for the treatment of PDN must be a joint decision between patient and provider, and include the discussion of comorbidities, polypharmacy, and benefits and risks of the medications. Furthermore, the cost of the medications for the patient must be considered before prescribing one of the two treatment options, as this may be a large burden on the patient.

Clinical Take Away

After reading this review, the reader should be able to communicate the following points, and relate these themes to clinical practice.

- PDN will be a growing problem seen in the clinical setting, with the increasing rates of DM. Ongoing screening and assessment for PDN is imperative for DM patients in order to reduce and avoid unnecessary physical and financial burden. Screening for PDN should take place no later than five years after the onset of type one DM, and at the initial diagnosis of type two DM. Screening shall continue at each clinical encounter and include subjective patient reports, as well as ADA-recommended screening methods.
- Duloxetine and pregabalin are FDA approved for the treatment of PDN, and have shown efficacy and safety in their reduction of PDN. Each drug has its benefits and risks; thus, the initiation of one of the medications needs to

include joint decision making between the patient and the provider and consider the patient's comorbidities and tolerance of the medication.

- Cost effectiveness is crucial for the patient in the treatment of PDN. Providers must keep in mind that the chosen drug will not be effective for PDN if the patient is not taking the medication due to cost constraints.

References

American Diabetes Association. (2014). Fast facts - data and statistics about diabetes. Retrieved from http://professional.diabetes.org/content/fast-facts-data-and-statistics-about-diabetes/?loc=dorg_statistics

Attal, N. (2012). Neuropathic pain: Mechanisms, therapeutic approach, and interpretation of clinical trials. *Continuum, 18*(1), February 11, 2016. doi:10.1212/01.CON.0000411564.41709.2d

Boyle, J., Eriksson, M., Gribble, L., Gouni, R., Johnsen, S., Coppini, D., & Kerr, D. (2012). Randomized, placebo-controlled comparison of amitriptyline, duloxetine, and pregabalin in patients with chronic diabetic peripheral neuropathic pain. *Diabetes Care, 35*, March 1, 2016. doi:10.2337/dc12-0656

Cefalu, W. T. (2016). Standards of medical care in diabetes—2016. *Diabetes Care, 39*(*Supplement 1*), February 26, 2016. doi:10.2337/dc16-S001

Chong, M. S., & Hester, J. (2007). Diabetic painful neuropathy, current and future treatment options. *Drugs, 67*(4), March 2, 2016-569-585.

McKeage, K. (2007). Treatment options for the management of diabetic painful neuropathy: Best current evidence. *Current Opinion in Neurology, 20*(5), February 14, 2016-553-557. doi:10.1097/WCO.0b013e32828da14e

Peltier, A., Goutman, S., & Callaghan, B. (2014). Painful diabetic neuropathy. *British Medical Journal, 348*(1799), February, 13, 2016. doi:10.1136/bmj.g1799

Raskin, P., Huffman, C., Toth, C., Asmus, M., Messig, M., Sanchez, R., & Pauer, L. (2014). Pregabalin in patients with inadequately treated painful diabetic peripheral neuropathy, a randomized withdrawal trial. *Clinical Journal of Pain, 30*(5), February 28, 2016-279-290. doi:10.1097/AJP.0b013e31829ea1a1

Razazian, N., Baziyar, M., Moradian, N., Afshari, D., Bostani, A., & Mahmoodi, M. (2014). Evaluation of the efficacy and safety of pregabalin, venlafaxine, and carbamazepine in patients with painful diabetic peripheral neuropathy: A randomized, double-blind trial *Neurosciences, 19*(3), March 15, 2016-192-198.

Tanenberg, R., Irving, G., Risser, R., Ahl, J., Robinson, M., Skijarevski, V., & Malcolm, S. (2011). Duloxetine, pregabalin, and duloxetine plus gabapentin for diabetic peripheral neuropathic pain management in patients with inadequate pain response to gabapentin: An open-label, randomized, noniferiority comparison. *Mayo Clinic Proceedings, 86*(7), February 8, 2016. doi:10.4065/mcp.2010.0681

UpToDate. (2016). Duloxetine: Drug information. Retrieved from http://www.uptodate.com/contents/duloxetine-drug-information?source=search_result&search=duloxetine+drug+information&selectedTitle=1~73#F163720

UpToDate. (2016). Pregabalin: Drug information. Retrieved from http://www.uptodate.com/contents/pregabalin-drug-information?source=search_result&search=Pregabalin%3A+Drug+information&selectedTitle=1~86

Wernicke, J., Raskin, J., Rosen, A., Pritchett, Y., D'Souza, D., Iyengar, S., . . . Le, T. (2006). Duloxetine in the long-term management of diabetic peripheral neuropathic pain: An open-label, 52-week extension of a randomized controlled clinical trial. *Current Therapeutic Research, 67* (5), February 9, 2016. doi:10.1016/j.curtheres.2006.10.001

Zhang S., Wu, Z., Zhang, L., Zhang, Z., Chen, R., Huang, Y., & Chen, H. (2015). Efficacy and safety of pregabalin for treating painful diabetic peripheral neuropathy: A meta-analysis. *Acta Anaesthesiologica Scandinavica, 59*, March 15, 2016-147-159. doi:10.1111/aas.12420

Appendix

Fasting Lab Results for D.J.

CBC	**Reference Range**	**Result**
WBC	3.6 - 11.0 K/uL	8.92
RBC	3.8-5.2 M/uL	5.04
Hgb	12.0-16.0 g/dL	12.5
Hct	35-47%	42.5
MCV	80-100 fL	85.4
MCH	26-34 pg	23.3 (L)
MCHC	32-36 g/dL	28.2 (L)
RDW	37-50 fL	52.8 (H)
Platelets	150-440 K/uL	351
MPV	8.0-13.0 fL	9.4
nRBC	0.0-0.2/100WBC	0.0

BMP	**Reference Range**	**Result**
Serum BUN	7-22 mg/dL	22
Sodium	136-145 mmol/L	139
Potassium	3.6-5.5 mmol/L	3.9
Chloride	98-109 mmol/L	102

CO2	23-33 mmol/L	27.3
Serum Glucose	70-99 mg/dL	151 (H)
Serum Creatinine	0.6-1.3 mg/dL	1.3
Calcium	8.8-10.5 mg/dL	9.8
Anion Gap	5-13 mmol/L	9.7
GFR Calculated	>60 ml/min	49 (L)
Serum Albumin	3.4-4.7 g/dL	4.00
Alkaline Phosphatase	50-136 U/L	88
Total Protein	5.9-7.6 g/dL	7.4

Urinalysis	**Reference Range**	**Results**
Urine Color	No range	Light Yellow
Urine Specific Gravity	1.003-1.03	1.012
Urine Glucose	Negative	Negative
Urine Ketones	Negative	Negative
Urine Hemoglobin	Negative	Negative
Urine Nitrite	Negative	Negative
Urine Leukocyte	Negative	Negative
Urine pH	5.0-8.0	7.0
Urine Total Protein	Negative	<300
Urine Bilirubin	Negative	Negative
Urine RBCs	#/HPF	2.6

Urine WBCs	#/HPF	1.2
Urine Bacteria	#/HPF	32.2
Urine Epithelial Cells	#/HPF	0.5
Hyaline Casts	0.00-5.00/LPf	0.41
Turbidity UA	Clear	Clear

LFTs	**Reference Range**	**Result**
Serum Albumin	3.4-4.7 g/dL	4.00
Alkaline Phosphatase	50-136 U/L	88
Total Bilirubin	0.2-1.2 mg/dL	0.4
AST	5-34 U/L	20
ALT	7-55 U/L	22
Total Protein	5.9-7.6 g/dL	7.4

Lipid Panel	**Reference Range**	**Result**
Cholesterol	<200 mg/dL	199
Triglycerides	<160 mg/dL	231 (H)
HDL	>40 mg/dL	38 (L)
LDL	<100 mg/dL	95