Spring 5-10-2024

LOW VITAMIN B12: THE NEED FOR UPDATED PROVIDER EDUCATION

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A Scholarly Project Submitted to the Graduate School
In Partial Fulfillment of the Requirements
for the Degree of
Doctor of Nursing Practice

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Pittsburg, Kansas

April 2024

Acknowledgements

I want to express my gratitude to my committee members: Dr. Karen Johnson, Dr. Jennifer Harris, and Dr. Cole Shewmake. I appreciate their time, expertise and recommendations to aid in completion of this project.

I would like to extend an additional profound thank you to my faculty advisor, Dr. Karen Johnson. Without Dr. Johnson's understanding, compassion, and encouragement, I would not have completed this program.

I would like to thank husband, my children and my dear friends for your love and support during the years it has taken me to complete this venture.

Separately to my children, you have blessed me more than I could have ever imagined. I love you each to the moon and back.

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An Abstract of the Scholarly Project by
Tracy Coltharp

Vitamin B12 deficiency is a notable clinical problem with multi-factorial risk factors and a multitude of clinical manifestations. It is associated with polyglandular autoimmune syndromes, some familiar and some lesser well known. The specific aim of this scholarly project was to evaluate whether education aimed at providers such as nurse practitioners, nurse practitioner students, physician assistants, and physicians regarding updated diagnostic criteria for vitamin B12 deficiencies as well as associated diseases, specifically autoimmune gastritis, and pernicious anemia, increased their knowledge and ultimately improved clinical practice. The project utilized a pre-test/post-test design with education provided in between. There was an improvement in all five of the post-scores when compared to the pre-test scores. In addition, 94.1% of respondents thought the education provided would lead to an improvement in their clinical practice.

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Chapter I

Introduction and Purpose

Cobalamin, more commonly known as vitamin B12, is a water-soluble vitamin essential to red blood cell formation, the preservation of the neuronal myelin sheath and for the synthesis of neurotransmitters. Dietary sources of vitamin B12 include meat, fish, dairy products, fortified foods, as well as over-the-counter supplements. A deficiency of cobalamin can lead to a multitude of manifestations including anemia, specifically megaloblastic anemia, neurologic symptoms, psychiatric symptoms, or non-specific symptoms such as fatigue. If misdiagnosed or left untreated, this deficiency can lead to irreversible neurocognitive decline (Solomon, 2019).

Clinical Issues and Significance

Vitamin B12 deficiency varies in incidence both across the world and across the age spectrum. Review of data suggests an incidence of anywhere from 3% in younger age groups, such as 20-39-year-olds, to greater than 20% in those over 60 (Shipton & Thachil, 2015). Increased incidence in recent years is also associated to the rise in gastric surgeries for obesity such as gastric bypass surgery. In the United States, there is no routine screening for low serum vitamin B12 levels. Screening is generally done for patients with one or more risk factors such as a history of gastric or small bowel surgery, inflammatory bowel conditions, use of certain medications, those who follow a

vegetarian or vegan diet, or those of advanced age (Langan & Goodbred, 2017). Standard medical practice is to check a serum vitamin B12 level and a complete blood count in those patients with one or more risk factors. Diagnostic criteria are typically a low serum B12 level along with anemia, specifically megaloblastic. The low, normal and high range levels are dependent upon the assay utilized. Examples of assays noted in various research and clinical trials: an enzyme-linked immunosorbent assay (ELISA), radio immunoassays, chemiluminescence immunoassays, IMx assay, and others. Regardless, generations of providers "have been educated with the view that vitamin B12 deficiency presents itself with this type of anemia" (Wolffenbuttel et al., 2019, p.200). However, newer research as well as case studies have shown that patients have later been diagnosed with conditions caused by vitamin B12 deficiency yet had subclinical low vitamin B12 or had no associated anemia or macrocytosis.

Once vitamin B12 deficiency is diagnosed, it is often treated without fully exploring the underlying cause. However, polyglandular autoimmune syndromes is a newer term which is "easily recognizable as a cause of deficiency" of vitamin B12 in certain patients (Wolffenbuttel et al., 2019, p.206). These syndromes are characterized by endocrine diseases in which antibodies are directed against the endocrine organ. More commonly known such autoimmune conditions that fall into this category include: Hashimoto's thyroiditis, Graves disease, hypoparathyroidism, Addison's disease, and vitiligo. Less well-known of these is autoimmune gastritis.

Autoimmune gastritis (AIG) is a chronic inflammatory condition which leads to destruction of parietal cells of the stomach. It is more common in whites, in females, and "especially those of Scandinavian decent" (Hall & Appelman, 2019, p.1328). Incidence

of autoimmune gastritis in the data seems to vary, with the highest noted at 2%, the lowest at 0.8%. AIG does not have a typical list of presenting symptoms, therefore the presenting symptoms for patients are typically those related to the resulting B12 deficiency rather than the gastritis itself leading to an incidental diagnosis. Pathologically, AIG involves destruction of the oxyntic mucosa of the stomach by antibodies also targeting parietal cells, intrinsic factor, or both (Neumann et al., 2013). This leads to a decrease in hydrochloric acid of the stomach, impaired absorption of iron and vitamin B12, and is a pre-neoplastic condition that places patients at increased risk for gastric adenocarcinoma and neuroendocrine tumors (Nehme et al., 2020). Diagnosis involves confirmation histologically from biopsies taken of the stomach, findings of which are correlated with laboratory findings.

Pernicious anemia (PA) is the most common cause of vitamin B12 deficiency worldwide (Tun et al., 2017). It can take months to years before being correctly diagnosed despite its more well-known features, yet it is still considered both neglected and under diagnosed (Esposito et al, 2022). According to Rodriguez & Shackelford (2020), it affects 0.1% of the population worldwide, but increased to 1.9% in those over 60 years of age. Multiple sources indicate a higher prevalence in women, however “no firm data exists as to the exact proportion” (Pernicious Anaemia Society, n.d.). PA is an autoimmune disease, more specifically caused by antibodies targeting gastric parietal cells, intrinsic factor, or both, and results in the need for lifelong treatment of vitamin B12 replacement via intramuscular injection. A diagnosis of pernicious anemia can take months to years before being accurately diagnosed due to the variety of presenting symptoms that result from vitamin B12 deficiency.

Specific Aims/Purpose

Clearly vitamin B12 deficiency is a notable clinical problem with multi-factorial risk factors and a multitude of clinical manifestations. It is associated with polyglandular autoimmune syndromes, some familiar and some lesser well known. The purpose of this scholarly project was to provide education to clinical staff such as nurse practitioners, physician assistants, and physicians regarding updated diagnostic criteria for vitamin B12 deficiencies as well as associated diseases, specifically autoimmune gastritis and pernicious anemia. Information regarding pathologies for vitamin B12 deficiency, PA and AIG. In addition, emphasizing that evidence shows that both diseases disproportionately impact females. Finally, discussion regarding when it is necessary to refer a patient to a gastroenterologist (GI) for the purposes of health promotion and early prevention. This was the intended goal under preliminary investigation for the purposes of the Doctor of Nursing Practice (DNP) Scholarly Project.

There was a pre-test to evaluate provider's level of knowledge regarding the symptoms associated with low B12, B12 supplementation, polyglandular autoimmune syndromes, autoimmune gastritis, as well as when patients should be referred to a gastroenterologist. After the educational presentation, a post-test questionnaire was given which included the pre-test questions as well as a question to assess if there was knowledge gained which would be applicable to their clinical practice.

Theoretical Framework

Two theoretical frameworks were used for this project. The first was the that of Kurt Lewin's "Change Theory of Nursing" which focuses on change in a sequential manner: unfreezing, change and refreeze (Hussain et al., 2018). The theory allowed this

researcher to assess prior knowledge and then replace it with new information. In addition, the Levels of Prevention Model Framework was utilized, which was advocated by Leavell and Clark back in 1975, and suggests that disease exists on a continuum from health at one end to advanced disease at the other. The goal is to stay as close to the health end as possible. There are four areas that are further categorized: primordial, primary, secondary, and tertiary prevention. Primordial is prevention of risk factors. Primary aims to prevent disease before it occurs. Secondary is detecting a disease early. Tertiary prevention is minimizing the impact of the disease. (Edelman & Mandle, 2018)

This DNP Scholarly Project targeted the secondary prevention level. Therefore, the target population is, ultimately, the patient by providing education to the provider in order to increase early detection, diagnosis and early treatment of AIG. The goal of this project was to encourage healthcare providers to recognize AIG early and treat it promptly in order to allow for the early detection of more advanced disease such as cancer. Patients with AIG have an increased risk of developing adenocarcinoma of the stomach as well as neuroendocrine tumors.

Project Questions

- Did the providers become more comfortable in recognizing the symptoms of low B12 after the educational presentation?
- Did providers choose to prescribe the more effective form of vitamin B12 supplementation, intramuscular injection, after the educational presentation?
- Did the providers become more familiar with polyglandular autoimmune syndromes and autoimmune gastritis after the educational presentation?

- Due to the relationship that exists between females diagnosed with pernicious anemia and autoimmune gastritis, after an educational presentation was there an increase in the percentage of providers who will refer a patient to a Gastroenterologist?
- Did the educational presentation provide knowledge that will lead to an improvement in practice?

Definition of Key Terms

The following definitions are provided to for clarification throughout the project.

- Autoimmune gastritis (AIG): an autoimmune disease causing destruction of the oxyntic mucosa of the stomach leading to a characteristic pattern of atrophy with antral sparing (Shah et al., 2021)
- Gastroenterologist (GI): a physician who specializes in management of disease of the gastrointestinal tract and liver (American College of Gastroenterology, n.d.)
- Intrinsic factor: a glycoprotein that binds vitamin B12 and allows it to transport through the terminal ileum to the body for use (Vannella et al, 2012)
- Parietal (or oxyntic) cells: epithelial cells of the stomach that secrete hydrochloric acid and intrinsic factor (Rustgi et al., 2021)
- Pernicious anemia (PA): autoimmune disease resulting in a macrocytic anemia due to vitamin b12 malabsorption (Esposito et al., 2022)
- Primary care providers (PCPs): nurse practitioners, physician assistants, and physicians (HealthCare.gov, n.d.)
- Secondary prevention: screening to identify diseases in the earliest stages, before the onset of signs and symptoms (Centers for Disease Control, n.d.)

- Vitamin B12, or cobalamin: a water-soluble molecule crucial for several metabolic functions (Marchi et al., 2020)

Logic Model

A logic model is a graphical representation showing the relationships between the resources, activities, outputs, outcomes, and impact for a project. In this case, it demonstrates the relationship between this scholarly project and the intended outcomes. The outcomes for this project were divided into short, intermediate, and long-term. In the short-term, the main outcome would be a change in personal clinical practice. Intermediate outcomes could include changes in practice by all providers in clinic. Long-term goals would be a change in practice by all primary care providers.

The primary inputs were time needed for research, a computer, internet access, a printer, paper, writing utensils, and then inputs from faculty at the Irene Ransom Bradley School of Nursing. There are no constraints on this project other than time.

The primary outputs will be seeking improvement in the practice of primary care providers, decreasing the delay in achieving an accurate diagnosis and improving patient outcomes.

Table 1

Logic Model

Project: Coltharp DNP Scholarly Project **Goal: Educate providers regarding diagnostic criteria for vitamin B12 deficiencies**					
INPUTS	**ACTIVITIES**		**OUTCOMES**		
What is invested	**What is done**	**Who is reached**	**Why this project: short-term results**	**Why this project: intermediate results**	**Why this project: long-term results**
Time Computer Internet access Supplies Time from faculty	Data collection Data review Data analysis Statistics	Clinicians in clinical practice with at least 10% of the practice being adult patients	Improve the practice of primary care providers	Decrease the delay in achieving an accurate diagnosis	Improve the outcomes of patients

Assumptions	**External Factors**
Primary care providers have a basic knowledge of PA	Lack of acceptance by PCPs

Summary

Vitamin B12 deficiency is a global problem with increased incidence in older age groups and in those having had gastric surgery. Pernicious anemia is the leading cause of B12 deficiency worldwide. Diagnosis can be delayed, and without proper vitamin B12

supplementation, lifelong effects can occur. Autoimmune gastritis is an autoimmune disease that also ultimately causes B12 deficiency. In addition, it is correlated with higher incidence of certain cancer types. The pathophysiology of both diseases has striking similarities with both disproportionately affecting females. Taking this information into consideration, updated educational information to providers is warranted. If the project leads to an increase in knowledge for providers, there is the potential to modify current diagnostic algorithms to guide primary care providers toward best practice in how to evaluate and treat patients with vitamin B12 deficiency in order to properly diagnose pernicious anemia and possibly autoimmune metaplastic atrophic gastritis.

Chapter II

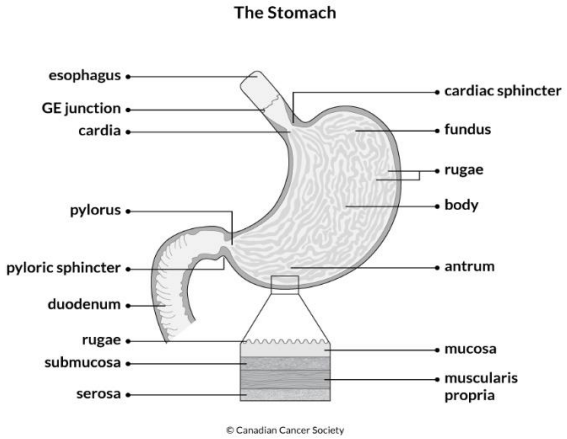
Review of Relevant Literature and Evidence

Review of Anatomy and Pathophysiology of PA and AIG

Understanding the complex anatomy of the stomach will lead to better comprehension of the pathology and subsequent sequela of both autoimmune gastritis (AIG) and pernicious anemia (PA), two of the polyglandular autoimmune syndromes. The stomach has five sections: cardia, fundus, body/corpus, antrum, and pylorus. The Canadian Cancer Society (n.d.) explains that the stomach tissue has four layers, shown in the diagram below. The mucosa, or mucous membrane, is the inner lining of the stomach that has specialized cells which have a multitude of functions. The functions of the cells of this layer will be the focus of this review.

Figure 1

The Stomach



Canadian Cancer Society (n.d.)

The mucosa contains six different types of cells: tall columnar surface epithelial cells, mucoid cells, zymogenic cells, gastric cells, parietal (oxyntic) cells, and enterochromaffin-like (ECL) cells. The parietal cells are found in the body and fundus portions of the stomach. These cells function to secrete hydrogen ion, produce "most of the water in gastric juice" and intrinsic factor (Britannica, n.d.). The hydrogen ion subsequently combines with chloride ions to make hydrochloric acid (HCl). The parietal cells are regulated by several mechanisms, including: "the vagus nerve, gastrin, histamine, ghrelin, somatostatin, glucagon-like peptide 1, and other agonists and antagonists." (Engevik et al., 2020, p. 572). These multiple pathways allow for a tight coordinated secretion of HCl. Gastrin, a hormone made by the gastric cells, is regulated by the acid level in the stomach, particularly in the antrum, thereby low HCl leads to increased gastrin and, conversely, high HCl leads to low gastrin (Hall & Appelman, 2019).

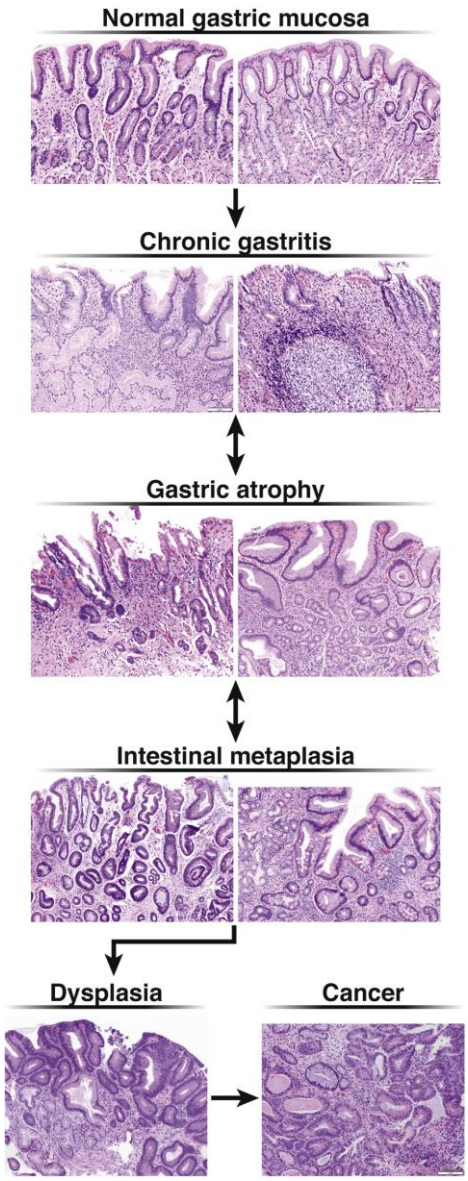
Gastritis, or inflammation of the stomach, is largely believed to have two different pathways: autoimmune or infectious, more specifically infection from *Helicobacter pylori (H. pylori)*. The distinction of two pathways of gastritis came from a study by Strickland and Mackay in 1973 that has been deemed landmark status by a multitude of authors since its publication. Strickland and Mackay proposed that "the essential distinctive criteria of which were supposed to be the presence of lacking of anti-parietal cell antibodies (APCA) together with the presence or absence of antral damage" (Lahner et al., 2019, p. 1622). Strickland and Mackay go on to detail the differences seen in the two types, Type A, which is considered to be autoimmune in origin, and Type B, which is considered to be environmental, primarily the presence of H. pylori infection.

Autoimmune gastritis has been discussed by a multitude of authors since the Strickland and Mackay study, however as Massironi et al. (2019) points out, "the real pathophysiological mechanisms, the natural history and the possible neoplastic complications are not completely known" (p. 215). Research indicates that at least one, if not both, antibodies to parietal cells and antibodies to intrinsic factor are involved. Tissue damage at the level of the mucosa in the corpus and fundus occurs as a result of the "antibody-mediated destruction of the parietal cells due to a selective targeting of the H+/K+ ATPase proton pump" (Lahner et al., 2019, p. 1622). With loss of parietal cells, a low acid state occurs thereby triggering the gastric cells to increase production of gastrin. This feedback loop continues as parietal cells are lost ultimately leading to a constant state of hypergastrinemia. Loss of parietal cells also leads to ECL hypertrophy and overall atrophy of the mucosa.

The mucosal atrophy associated with autoimmune gastritis has a “characteristic pattern of corpus predominant atrophy with antral sparing” that distinguishes it from the destruction seen in the setting of H. pylori infection (Shah et al., 2021, p. 1327). The disappearing parietal cells are replaced by other cell types such as mucous cells, metaplastic glands of different types, such as intestinal or pseudo-pyloric, or connective tissue. Researchers believe this process is slow, however the cellular remodeling will eventually result in complete loss of parietal cells. These destructive cellular changes lead to an increased risk of different cancers, which will be further discussed in chapter III. This transformation of cells was first described in 1975 by pathologist, Dr. Paleyo Correa, and are now termed the Correa Cascade by researchers. The cascade shows the changes from normal tissue to chronic gastritis, subsequent atrophy leading to more concerning morphologic changes. Below are some images of this cascade as seen in Gawron et al. (2020, p. 706).

Figure 2

Correa Cascade



Gawron et al. (2020, p. 706).

Loss of gastric acidity due to AIG also contributes to an iron malabsorption and thereby iron deficiency. Dietary iron intake is composed of 20% heme iron, which comes from meat, and 80% non-heme sources. (Kulnigg- Dabsch, 2016). The non-heme iron

must be broken down into a reduced form before it can be utilized by the body. This is managed by several processes, but most importantly by gastric acid. In addition, vitamin C, or ascorbic acid, which is needed for iron uptake is found to be reduced in patients with AIG. The low vitamin C levels of AIG patients is hypothesized to be as a result of its destruction in the higher pH state of the stomach (Kulnigg-Dabsch, 2016, p. 425). Ultimately, AIG leads to iron deficiency anemia as well due to impaired absorption.

Pernicious anemia (PA) is linked to autoimmune gastritis (AIG), although the literature is inconsistent in the consensus regarding its relationship. Murphy et al. (2015) refers to PA as the final stage of AIG, whereas Esposito et al. (2022) state that PA is "linked to autoimmune gastritis, but PA and autoimmune gastritis are not synonyms" (p. 1671). These authors go on to provide the explanation that this is because the pathogenesis of PA cannot be explained completely, however add that it is likely autoimmune in nature. Weiss et al. (2020) states that PA "may eventually develop in patients with atrophy of the oxyntic gastric mucosa due to either H. pylori or AIG" (p. 176). Tozzoli et al. (2020) describe the autoimmune destruction of cells associated with AIG and state that this "may result in decreased acid secretion, hypergastrinemia, iron-deficient anemia, pernicious anemia due to vitamin B12 deficiency, and gastric malignant tumors" (p. 80). Neumann et al. (2013) explains why there is perhaps confusion regarding PA and AIG by explaining that since PA's discovery "preceded the discovery of its cause [AIG] by several decades and the two terms are often, if incorrectly, used synonymously" (p. 529). These authors state that AIG is a "condition that progresses at an unknown pace from a mild chronic inflammation of the gastric corpus to an advanced stage associated

with a severe form of vitamin B12 deficiency anemia known as PA" (Neumann et al., 2013, p. 529).

Though the exact relationship may not be completely clear, PA is a result of lack of intrinsic factor needed for absorption of vitamin B12, also known as cobalamin. The malabsorption of vitamin B12 leads to the development of macrocytic anemia. Literature suggests that this may take anywhere from 5-15 years to develop. In addition to the hematologic manifestations associated with the anemia caused by the vitamin B12 deficiency, neuronal cells need vitamin B12 for their myelin sheaths. Low B12 can result in demyelination that can progress quickly to cell death if left untreated.

Clinical Presentations

PA presents as symptoms most notably associated with anemia such as fatigue, paleness, lightheadedness, near syncope, and tachycardia. Additional symptoms include signs of malabsorption such as weight loss and diarrhea. Neurologic symptoms such as numbness, memory loss, paresthesia and weakness are a direct result of the vitamin B12 deficiency. Kulnigg-Dabsch (2016, p. 426) provides a table summarizing the symptoms associated with anemia as a broad category, vitamin B12 deficiency, and iron deficiency which is included below.

Table 2

Table 2 Symptoms of iron deficiency, vitamin B12 deficiency, and anemia

Symptoms		
Iron deficiency	Vitamin B12 deficiency	Anemia
Fatigue	*Neurological*	Shortness of breath
Restless legs syndrome	Peripheral neuropathy	Dizziness
Attentiveness disorder	Myelopathy	Tachycardia
Brittle nails	Spinal ataxia	Decreased physical function
Hair loss	Weakness	Decreased cognitive function
Sleeping disorder	Depression	–
–	*Gastrointestinal*	–
–	Glossitis	–
–	Malabsoprtion	–
–	Diarrhea	–

ID iron deficiency, *IDA* iron deficiency anemia

Kulnigg-Dabsch (2016, p. 426)

AIG is often deemed as silent due to lack of symptoms; it only becomes symptomatic years after the disease has progressed and other manifestations as a result of vitamin deficiencies have been manifested such as PA or iron deficiency anemia. AIG is noted by multiple authors to often be discovered incidentally through routine endoscopy rather than related to patient symptomatology. If symptoms occur, they are primarily noted to be dyspepsia, bloating or heartburn symptoms. Other less common symptoms mentioned are delayed gastric emptying, small intestinal bacterial overgrowth, and increased gastrointestinal infections such as *Clostridium difficile* colitis.

Diagnosis

The diagnosis of AIG is made through biopsies done of the stomach via upper endoscopy. The biopsies may be followed by serum testing for the antibodies to parietal cells and intrinsic factor. Biopsies need to be performed specifically of the antrum and corpus. The characteristics of the tissue found on biopsy will depend on the phase of the

disease. Hall and Appelman (2019) condensed the tissue characteristics to the following findings:

- Early phase: diffuse, basal-predominant inflammation of the oxyntic mucosa, lymphocyte infiltration of glands, a variety of epithelial metaplasia
- Florid phase: atrophy of the oxyntic mucosa, diffuse lymphoplasmacytic inflammation, persistent epithelial metaplasia, proliferation of ECL cells; if antral mucosa is biopsies, gastrin cell hyperplasia present
- End stage: near complete oxyntic cell loss, marked epithelial metaplasia, ECl hyperplasia, overall reduced inflammation

In order to more accurately classify the severity of AIG and its associated cancer risk, there are two known staging systems: Operative Link for Gastritis Assessment (OLGA) and Operative Link for Gastric Intestinal Metaplasia (OLGIM). The OLGA staging system is a four-tiered scale developed in 2005 by an international group of gastroenterologists and pathologists as an updated version of the previously established Sydney System guidelines for chronic gastritis. The OLGA system uses severity of atrophy in the corpus on the x-axis and the atrophy in the antrum on the y-axis in a cross-tabulation format as shown below in order to provide staging to gastritis (Rugge et al., 2005, p.1807).

Table 3

OLGA Staging System

		CORPUS			
		No Atrophy (score 0)	Mild Atrophy (score 1)	Moderate Atrophy (score 2)	Severe Atrophy (score 3)
ANTRUM	No Atrophy (score 0) (including *incisura angularis*)	STAGE 0	STAGE I	STAGE II	STAGE II
	Mild Atrophy (score 1) (including *incisura angularis*)	STAGE I	STAGE I	STAGE II	STAGE III
	Moderate Atrophy (score 2) (including *incisura angularis*)	STAGE II	STAGE II	STAGE III	STAGE IV
	Severe Atrophy (score 3) (including *incisura angularis*)	STAGE III	STAGE III	STAGE IV	STAGE IV

Rugge et al. (2005, p.1807)

The OLGIM staging system was developed shortly after the OLGA staging system as a modification of the OLGA. OLGIM uses the same cross-tabulation format as the OLGA with the same corpus atrophy on the x-axis, however instead of atrophy of the antrum on the y-axis, it uses the severity of intestinal metaplasia. It was hypothesized that including intestinal metaplasia would be more predictive of gastric cancer risk compared to atrophy of the antrum. Interestingly, Isajevs et al. (2014) conducted a study with 835 patients comparing the two systems and concluded:

> OLGIM staging goes along with better interobserver reproducibility, but it stages some patients lower than OLGA. For accurate prediction of gastric cancer risk, both OLGA and OLGIM systems might have to be used in pathology practice. (p. 407)

Table 4

OLGIM Staging System

IM score \ Atrophy score		Corpus			
		No Atrophy (score 0)	Mild Atrophy (score 1)	Moderate Atrophy (score 2)	Severe Atrophy (score 3)
Antrum	No IM (score 0)	STAGE 0	STAGE I	STAGE II	STAGE II
	Mild IM (score 1)	STAGE I	STAGE I	STAGE II	STAGE III
	Moderate IM (score 2)	STAGE II	STAGE II	STAGE III	STAGE IV
	Severe IM (score 3)	STAGE III	STAGE III	STAGE IV	STAGE IV

Saka et al. (2015, p. 407)

Kulnigg-Dabsch (2016) discuss that in addition to the gold standard of upper endoscopy with biopsies, that taking gastric secretion samples "after stimulation with gastrin and further determination of hydrogen ion concentration by titrate is accurate" for diagnosis of AIG but add that it is time consuming (p. 427). This author goes on to discuss simple intragastric pH measurement during endoscopy as an additional option for testing, but there are concerns regarding its efficacy in regards to AIG.

Serum testing for the presence of parietal cell antibodies (PCA) and intrinsic factor antibodies (IFA) can be used as supportive information to the diagnosis of AIG, however the data is mixed on the exact clinical significance. Kulnigg-Dabsch (2016) calls PCA the "most sensitive serum biomarker for AIG" but goes to point out that the presence of IFA is proven to be more specific but less sensitive than the presence of PCA (p. 427). The author goes on to review outside studies to conclude that PCA and IFA "can precede clinical symptoms by years" (Kulnigg-Dabsch, 2016, p. 428). Antico et al. (2012) specifically studied the relationship of these antibodies along with serum gastrin

levels and anti-helicobacter pylori antibodies. These authors concluded that these four serum tests “proved particularly effective in the diagnostic classification of gastritis and highly correlated with the histological profile” however did note that PCA by itself did not correlate with statistical significance with the severity of the disease (Antico et al., 2012, p. 1).

PA is diagnosed primarily through lab work. It is recommended to check a complete blood count, vitamin B12 level, folate level, iron level, and antibodies to parietal cells and to intrinsic factor to screen for PA. PA is diagnosed with presence of the following: megaloblastic anemia, low serum vitamin B12 levels, presence of one or both antibodies to gastric parietal cells or intrinsic factor, and a gastric body mucosal atrophy by biopsy can also be included. The anemia is typically defined as a hemoglobin less than 13 g/dL for men and less than 12 g/dL for women and classified as macrocytic with an elevated mean corpuscular volume, although sources vary from greater than 100 fL (Means & Fairfield, 2022) to greater than 120 fL (Bizarro & Antico, 2014). Chan (2016) states that there is no “gold standard” for serum vitamin B12 levels; Means and Fairfield (2022) use less than 200 pg/mL as deficient and 200-330 pg/mL as borderline. Antibodies are either positive or negative for both parietal cells and intrinsic factor. Bizzaro and Antico (2014) discuss that PCA are found more commonly in patients with PA, up to 90%, however add that PCA are less specific than IFA when diagnosing PA. McPherson and Pincus (2022) cite a 40-60% occurrence of IFA in patients with PA thereby also supporting the additional suggested lab work noted above.

Epidemiology for Pernicious Anemia

Esposito et al. (2022) discuss that epidemiological studies indicate that PA impacts 0.1% of the general population, but that increases to 2-3% of the in those greater than 65 years of age. Esposito et al. (2022) go on to cite the female:male of 2:1. Neumann et al. (2013) mention the increased female incidence as well without assigning a numerical significance. However, Bizzaro and Antico (2014) state that PA "strikes both sexes equally," adding that it typically manifests in those over 30 years of age and is more prevalent in northern Europeans, particularly Scandinavians (p. 566). Means and Fairfield (2022) also mention the increased frequency in those from northern European decent, adding that the incidence is lower in those with African and non-northern European ancestry. Della Bella et al. (2022) state that the incidence of PA is only 0.1% in the general population, however also note an increase in the greater than 60 population to 1.9%. Interestingly, Della Bella et al. (20200) is the only study reviewed that mentions African ancestry in addition to European ancestry as having an increased incidence (4.3% and 4.0%, respectively).

Epidemiology for Autoimmune Gastritis

Lenti et al. (2019) states that AIG is estimated to impact 2-5% of the population, dependent upon inclusion criteria, adding that prevalence is higher in women greater than 60 years of age. Coati et al. (2015) quote similar incidence rates from 2-5%, also adding an increase occurrence in women and older people, although that age is undefined. Esposito et al. (2022) cite studies with prevalence with slightly lower incidence, ranging from 0.5-4.5%. Rustgi et al. (2021) also state a lower incidence 1-2% of the population based on their literature review while also mentioning a higher prevalence in women.

Conversely, Carabotti et al. (2017) states a higher incidence of AIG in the general population at 8%. Lahner et al. (2019) cite a systematic review done from 1988-2008 which showed a range of 0 – 10.9% incidence of chronic gastritis, all inclusive of autoimmune and *H. pylori* causes. Massironi et al. (2019) quote a prevalence of 2% with an age-dependent increase and note a higher frequency in those with other autoimmune diseases. In addition, Massironi et al. (2019) state a ratio of 3:1 of incidence in females:males.

Iron deficiency anemia (IDA) is the most common form of anemia and has a multitude of causative factors. IDA has an incidence of 2.9% in North America as of 2010 according to Ko et al. (2020). IDA is also a known sequela of AIG as a result of cellular and metabolic changes discussed in the previous physiology section. In a study by Hershko et al. (2006), the authors found up to 30% of patients with IDA were found to have AIG as well. Similar statistics were found in patients already known to have AIG to assess for IDA, as Carabotti et al. (2017) discovered that 34.8% of the 379 AIG patients studied had IDA. Kulnigg-Dabsch (2016) provide supportive data of the increased incidence of AIG in patients with iron deficiency anemia summarized in the table below (p. 425).

Table 5

Table 1 Prevalence of autoimmune gastritis in patients with iron deficiency

Study	Number	Prevalence of autoimmune gastritis in iron deficiency		
		Patients	Test	Prevalence (%)
Dickey et al. [3]	41	Iron deficiency anemia	Histology and pos PCA/IFA	15
Hershko et al. [4]	150	Iron deficiency anemia	↑ Gastrin and pos PCA	27
Annibale et al. [5]	71	Iron deficiency anemia	Histology (body atrophy)	27
Kaye et al. [26]	156 44	Iron deficiency anemia	Histology (body atrophy) Pos PCA	26 27
Kulnigg-Dabsch et al. [27]	409	Iron deficiency	Pos PCA	19

PCA parietal cell antibodies, IFA intrinsic factor antibodies, *pos* positive

Kulnigg-Dabsch (2016) p. 425

Autoimmune Association

Patients with AIG have been shown in studies to have an increased risk when compared to the general population of developing additional autoimmune diseases such as: autoimmune thyroiditis, type I diabetes mellitus, rheumatoid arthritis, celiac disease, Addison's disease, vitiligo, and alopecia, to name a few. Kalkan et al. (2016) studied 320 patients with AIG and 53% of these patients had one additional autoimmune disorder, while 11% had more than one additional autoimmune disorder. Kulnigg-Dabsch (2016) cite the incidence specifically of autoimmune thyroid disorders and AIG at approximately 35%. Lahner et al. (2019) mention the link between AIG and autoimmune thyroid disorders as well and further state that the correlation is such "that the term 'thyrogastric syndrome' has been used for years to indicate the presence of both conditions in the same individual (p. 1625).

Massironi et al. (2019) express that those with AIG have anywhere from 3-5 times higher risk than the general population of developing additional autoimmune diseases. These same authors go on to review studies and case reports of AIG and additional autoimmune diseases to provide the following summary below in the table format (Massironi et al., 2019, p. 216).

Table 6

Autoimmune diseases associated with AIG

Table 1
Autoimmune diseases associated with CAAG. The strongest association is found with autoimmune thyroiditis and type-1 diabetes mellitus. (CAAG: chronic atrophic autoimmune gastritis; PSC: primary sclerosing cholangitis; PBC:primary biliary cholangitis).

Autoimmune diseases associated with CAAG	Stenght of association
Chronic autoimmune thyroiditis (Hashimoto's thyroiditis) and Graves' disease	+ + + + (some cohort studies, two cross-sectional studies and two case-control studies)
Type-1 diabetes mellitus	+ + + (one case-control study and some cohort studies)
Vitiligo	+ + (one cohort study and some case reports)
Alopecia	+ + (some cohort studies)
Celiac disease	+ + (some cohort studies)
Myasthenia gravis	+ (only case reports)
Connective tissue disease	+ + (one cohort study and case reports)
Primary biliary cholangitis	+ + (case reports and one cohort study)
Primary sclerosing cholangitis	+ (only case reports)
Autoimmune hepatitis	+ (only case reports)
Addison's disease	+ (only case reports)
Primary ovarian failure,	+ (only case reports)
Primary hypoparathyroidism,	+ (only case reports)
Lambert–Eaton syndrome	+ (only case reports)
Oral erosive lichen planus	+ (only case reports)

Massironi et al. (2019, p. 216)

Cancer Risk

AIG is not unlike any other chronic inflammatory disease in that those affected are at higher risk of developing cancer. The Correa pathway previously discussed showed the cascade of cellular changes as a result of the AIG process leading to precursor cancerous lesions. Shah et al. (2021) describes AIG as a preneoplastic condition, going on to describe it as “the first of a multistep precancerous cascade, with more advanced stages including gastric intestinal metaplasia, dysplasia, and ultimately gastric adenocarcinoma” (p. 1327). These authors go on to state that the risk of progression from AIG to adenocarcinoma of the stomach is 0.1-0.3% per year, but add that this may increase depending on other factors. The significance of the latter is highlighted by

Gawron et al. (2020) who specify that gastric cancer is “the third leading cause of cancer-related mortality and the fifth most common cancer globally” (p. 705).

Vannella et al. (2013) did a meta-analysis of 26 studies demonstrating that those with PA showed an overall gastric cancer relative risk at 6.8 (with a 95% confidence interval of 2.6-18.1). Murphy et al. (2015) performed a large, population-based, case-controlled study using a Medicare database comparing greater than 1.13 million cancer cases (66-99 years old) to 100,00 matched controls, or individuals without cancer. Those with PA based on their medical claims were identified. The results showed that, compared with controls, those with PA were at an increased risk for: non-cardia gastric adenocarcinoma, gastric carcinoid (or neuroendocrine tumors), tonsillar cancer, hypopharyngeal cancer, esophageal squamous cell carcinoma, small intestinal cancer, myeloma, and myelodysplastic syndrome. (Murphy et al, 2015)

Patients with AIG are at an increased risk specifically for development of neuroendocrine tumors (NETs), specifically Type I which arise in the corpus, as a result of parietal cell loss that the cascade of events that follows. Shah et al. (2021) state that based on longitudinal cohort studies that the risk of developing NETs in AIG patients is 0.4-0.7%. Coati et al. (2015) goes on to cite a study of 4000 Swedish patients which showed a 13-fold higher increase of AIG-related Type I NETs in those with PA. Fortunately, NETs are slow-growing with low incidence of nodal metastasis. Coati et al. (2015) report the overall survival rate for patients with gastric NETs is 95% at 5 years and 74% at 10 years.

Diagnostic Delay

Diagnostic delay is common for patients with AIG particularly due to the condition often being asymptomatic, especially in the early stages of the disease. Anemia found in later stages of the disease, either PA or IDA, may lead to additional work-up that uncovers the AIG diagnosis. Miceli et al. (2012) demonstrate this in their study which followed 99 patients with AIG. In this study, factors that lead to diagnosis were not gastrointestinal specific, but instead were: vitamin B12 deficiency at 37.4%, incidental at 34%, immune disorders at 18%, neurologic symptoms at 6%, and family history of AIG at 4%. Thereby these authors conclude that factors that should lend toward suspecting AIG are the presence of vitamin B12 deficiency, histologic factors and other autoimmune disorders. Lenti et al. (2019) also specifically aimed to quantify the delay in diagnosis by following 291 patients with AIG evaluated in a GI outpatient clinic between 2009-2018. These authors found the median overall diagnostic delay was 14 months, however being of female sex, having a previous misdiagnosis, or having a history of infertility or miscarriage lengthened the delay even further. Lenti et al. (2019) explain further in regards to misdiagnosis that:

> Disappointingly, despite the broad availability of non-invasive tests, serum autoantibodies and ad hoc laboratory scores, that could be useful as the first-line screening to identify individuals who should undergo an esophagogastroduodenoscopy, there is still evidence that AAG is misdiagnosed and possibly underdiagnosed. (p. 168)

PA is also acknowledged as a disease process that has a delay in diagnosis as well. Oo (2019) cites a survey by the United Kingdom's Pernicious Anaemia Society that

reported 44% of patients being wrongly diagnosed initially and an additional 14-22% of survey participants had delays of 5-10 years until an accurate diagnosis was made. Oo (2019) places blame on vague symptoms, unusual clinical presentations, as well as unreliable vitamin B12 testing.

Chapter III

Methods

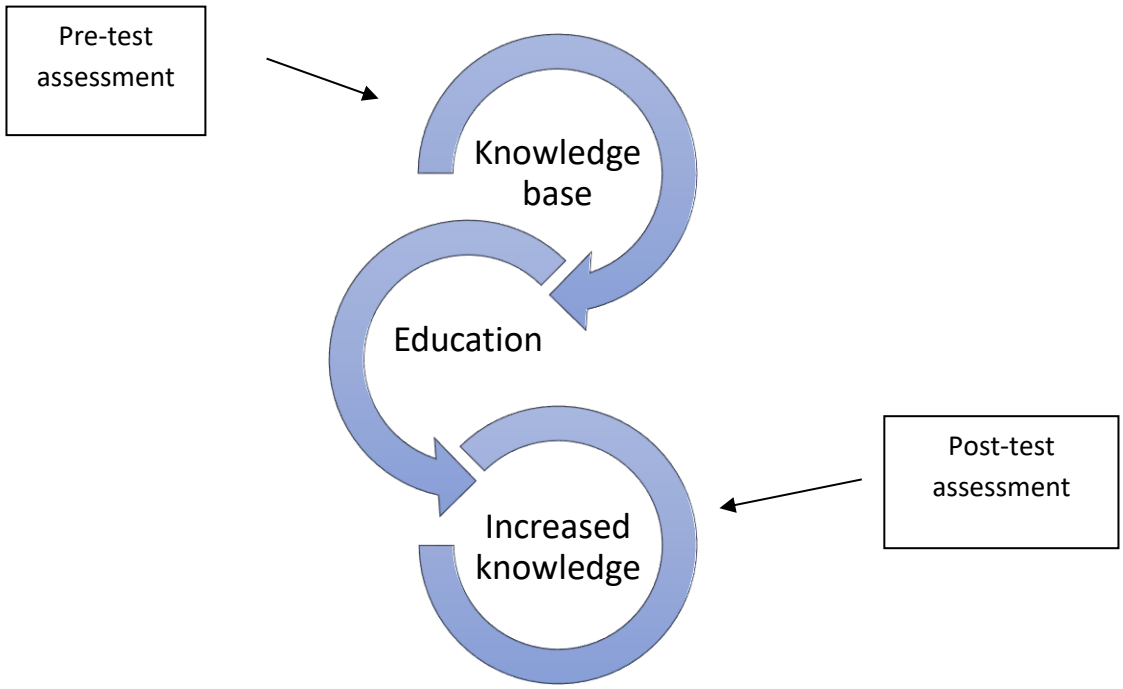
This chapter aims to outline the specific methodology for the Doctor of Nursing Practice (DNP) scholarly project regarding the project design, collection of data, analysis of data, and dissemination of data. The focus of this DNP scholarly project was on providing education to providers caring for adult patients in order to increase their knowledge base and ultimately aid them in providing up to date evidence-based practice. While primary care providers such as those in family practice or those in internal medicine are the primary focus, this is applicable to any provider treating adult patients no matter the setting.

Project Design

This study was designed with the purpose of first assessing the provider's knowledge of vitamin B12 deficiencies and associated disorders, in this case specifically pernicious anemia and autoimmune gastritis. This assessment was done by first giving providers a pre-test. Immediately following the pre-test, an educational presentation was given with the goal of increasing knowledge. A post-test was administered assessing new knowledge gained. The data has been compared between the pre-test to post-test in order to determine if the goal was met and to what degree.

Figure 3

Project Design



A link was provided to all participants which contained all of the above noted components: pre-test, PowerPoint presentation, and post-test. There were instructions given prior to participants engaging in the pre-test (Appendix A). The pre-test consisted of eight questions. Three of the pre-test questions, which are not repeated in the post-test, were to gather data about the participant: type of degree the provider has, clinical practice setting and years in clinical practice. The remaining five were repeated in the post-test (Appendix C) after the educational intervention (Appendix B). Repeating five of the pre-test questions in the post-test was done intentionally in order to evaluate the effectiveness of the teaching. The post-test also included two new questions of the responder to allow for assessment of an improvement in practice as well as an open-ended question for any additional comments.

Target Population

The sample population for this research study included: nurse practitioners, physician assistants, physicians, and MSN or DNP students. The initial focus was on those healthcare providers in the Kansas and Missouri locations. However, this was extended beyond this range to attract more participants. Inclusion criteria included all those in active practice within their state of licensure as well as those who have been in practice within the past 12 months or those planning to return to or begin practice in the next 12 months. Those in active practice must have an active state license or must be in an accredited Masters of Science in Nursing or Doctor of Nursing Practice program. In addition, participants needed to have access to the internet, a computer and be able to read and write in English.

Exclusion Criteria

This project did not contain exclusion criteria in regards to gender, race, ethnicity, or socioeconomic factors. The only exclusion criteria are those healthcare providers who only treat pediatric patients, as there is no data to suggest this is prevalent in pediatric patients.

Recruitment

Participants were invited to engage in this project via social media and email. Participation was voluntary and no compensation was given to those providers who chose to participate. This researcher was hoping to gain a snowball effect by asking those colleagues who are also healthcare providers to participate in the project.

Protection of Human Subjects

The Pittsburg State University's Policy Assurance Handbook was reviewed in order to fully understand the policies and procedures related to the Protection of Human Subjects Code (PHS) of Federal Regulations as well as the Belmont Report and the U.S. Department of Health and Human Services policy 45CFR46. Permission to conduct this study was obtained from Pittsburg State University's Institutional Review Board (IRB) before participants were recruited. The privacy of the participants was protected by not collecting any identifying information during data collection. The participants were able to answer the pre- and post-tests anonymously.

Institutional Review Board Approval

The DNP scholarly project was presented to this researcher's scholarly project committee members through the PHC Committee of Pittsburg State University Irene Ransom Bradley School of Nursing (IRBSON) after approval of the project proposal. After the IRBSON approval, it was sent to the university's IRB Committee. This researcher completed the required ethical research education prior to submission of the proposal to the University's IRB committee and their subsequent approval.

Instruments

The tools used for this project included a pretest, post-test and an educational presentation. The pretest contained questions to assess the provider's knowledge prior to the material presented. This pretest is included as Appendix A. The post-test included questions from the pretest as well as demographic questions about the test-takers. This is included as Appendix B. The slides from the educational material are included as Appendix C.

Timeline of Project Phases

The completion of both the IRBSON and University IRB approval occurred in the fall semester of 2023. After approval, the researcher met with her committee before the process of dissemination of the project to potential test subjects occurred. The researcher planned for 30 days for dissemination of the information. Collection and evaluation of the data took an additional 30 days. Then compilation of the data into the final product for presentation to the Scholarly committee took approximately 30 days as well. The completed project included a presentation to committee in April 2024 in anticipation of graduation from the DNP program.

Resources Needed

The resources required for this scholarly project included a computer with online Wi-Fi access equipped with Word, PowerPoint, Excel for data evaluation, and a web browser. Participants needed a computer with Wi-Fi access as well as a web browser.

Project Sustainability

The sustainability of this required participants willingness to give up approximately 20 minutes in order to complete the pretest, review the educational content, and take the post-test. After the data was collected and reviewed, further sustainability required proof that the education provided benefit to the participants by improving their knowledge and thus improving their practice. Since improvement was found based on improvements in scores from pre-test to post-test, then consideration could be given to finding the most impactful ways to disseminate the information such as via online organizations geared toward providers.

Summary

This DNP scholarly project is an education-focused project with the goal of improving providers' knowledge underlying causes of vitamin B12 deficiencies, the lesser known autoimmune gastritis as well as the more well-known pernicious anemia. The ultimate goal beyond improving providers' knowledge is to then improve their practice leading to increased referral to the appropriate specialist and a subsequent decrease in length of time to a correct diagnosis and treatment plan.

Chapter IV

Evaluation of Results

The overall purpose of this project was to improve providers' knowledge in regards to underlying causes of vitamin B12 deficiencies. A pre-test and post-test design was utilized in order to assess knowledge prior to and then again after the educational presentation created by the project author. In addition, the pre-test was used to gather information about the participants in relation to their degree, their practice affiliation and their years in practice.

Description of Sample/Population

The target audience for this project was health care providers, specifically aimed at: nurse practitioners, physician assistants, physicians and fellow DNP students. Potential participants were invited to partake through social media primarily along with direct emails. A link to the project was first shared via Pittsburg State University's Irene Ransom Bradley School of Nursing's Facebook page. Once this was shared by the IRBSON, it was shared by the DNP student's Facebook page and in several nursing Facebook pages I belong to including: Nurses KC, Physician Assistant, Nurse Practitioner & Recruiting Network, Doctor of Nursing Practice Group, Nurse Practitioners' Resource Group, Family Nurse Practitioner – Networking Group, 4 State APN, Nurse Practitioner New Grads and Students, MO APRN FPA Missouri APRN Full

Practice Authority, United States Pernicious Anemia/B12 Deficiency and Anemia Support Group, Autoimmune Atrophic Gastritis & Pernicious Anemia, Kansas Nurse Practitioner Network. It was also shared to current colleagues with Curana Health via direct email as well as direct emails to former colleagues.

The study was open for a total of six weeks. A total of 18 participants took part in the study. The pre-test asked participants three questions to assess their demographic information; these were not repeated on the post-test. Participants were first asked to select their degree from the following list: Master of Science in Nursing (MSN), Doctor of Nursing Practice (DNP), Master of Physician Assistant Studies (MPAS), Doctor of Osteopathic Medicine (DO), Medical Doctor (MD), or MSN or DNP student. All 18 participants answered this question.

Table 7

Demographics of Participants: Degree Status (N=18)

Degree	**Percentage of Participants**
MSN	50%
DNP	11.1%
MPAS	5.6%
MD	5.6%
MSN or DNP student	27.8%

The next question in the post-test was an open-ended statement question asking the participants to state their area of practice. Only 14 of 18 participants completed this section.

Table 8

Demographics of Participants: Area of Practice (N=14)

Area of Practice	**Percentage of Participants**
Family practice	28.6%
Palliative care and hospice	21.4%
Rheumatology	14.3%
Education	14.3%
Pediatrics	7.1%
Neonatology	7.1%
Acute care	7.1%

Finally, for demographic purposes, participants were asked to select their years of practice from the following options: 1-5 years, 6-10 years, 11-15 years, 16-20 years, and >20 years.

Table 9

Demographics of Participants: Years in Practice (N=18)

Years in Practice	**Percentage of Participants**
1-5 years	27.8%
6-10 years	22.2%
11-15 years	16.7%
16-20 years	16.7%
>20 years	16.7%

Project Variables

The independent variable for this study was the education provided after the pre-test. The pre-test was utilized to assess knowledge prior to the educational presentation. The presentation was then done via a voice-over PowerPoint that was created after an extensive literature review. The educational portion of the presentation included 16 slides total and can be found in Appendix B.

The dependent variable was provider knowledge, specifically on recognizing the symptoms of low B12, understanding the best form of B12 to prescribe, knowledge of polyglandular autoimmune syndromes including autoimmune gastritis, and understanding when to refer patients with pernicious anemia to a gastroenterologist for evaluation. Provider knowledge was evaluated directly after the presentation via a link to a post-test. In addition to assessing the aforementioned knowledge bases, providers were asked if the presentation would lead to an improvement in their practice. They were also provided the opportunity to offer comments at the end of the post-test.

Analysis of Project Questions

The design of this project utilized a pre-test followed by education then a post-test in order to immediately analyze if knowledge was gained, specifically regarding underlying causes of vitamin B12 deficiencies. There were three questions on the pre-test which assessed the demographics of the participants; see description of population earlier in this chapter. There were five questions on the pre-test repeated on the post-test. There is an additional question on the post-test asking the participant about if the education will lead to an improvement in their practice. The results of these six questions will be analyzed below in comparative table format.

Question 1: On a scale of 1-5, how comfortable do you feel recognizing the symptoms of low B12? 1 = not comfortable, 5 = completely comfortable

Table 10

Pre-test and Post-test Results for Question 1 (N=18; N=17)

Score	**Pre-test**	**Post-test**
1	3 (16.7%)	0
2	4 (22.2%)	0
3	8 (44.4%)	4 (23.5%)
4	3 (16.7%)	11 (64.7%)
5	0	2 (11.8%)

Question 2: If you diagnose a patient with pernicious anemia, what type of vitamin B12 supplementation do you prescribe?

Table 11

Pre-test and Post-test Results for Question 2 (N=18; N=17)

Form of B12	**Pre-test**	**Post-test**
Oral	2 (11.1%)	0
Sublingual	2 (11.1%)	0
Intramuscular injection	14 (77.8%)	17 (100%)
Intranasal	0	0

Question 3: On a scale of 1-5, how likely are you to refer a patient with pernicious anemia to a Gastroenterologist? 1 = not likely. 5 = very likely

Table 12

Pre-test and Post-test Results for Question 3 (N=18; N=17)

Score	**Pre-test**	**Post-test**
1	3 (16.7%)	1 (5.9%)
2	2 (11.1%)	0
3	6 (33.3%)	1 (5.9%)
4	6 (33.3%)	3 (17.6%)
5	1 (5.6%)	12 (70.6%)

Question 4: On a scale of 1-5, how familiar are you with the newer terminology of polyglandular autoimmune syndromes? 1 = not familiar. 5 = very familiar

Table 13

Pre-test and Post-test Results for Question 4 (N=18; N=17)

Score	**Pre-test**	**Post-test**
1	14 (77.8%)	0
2	3 (16.7%)	0
3	1 (5.6%)	6 (35.3%)
4	0	8 (47.1%)
5	0	3 (17.6%)

Question 5: On a scale of 1-5, how familiar are you with autoimmune gastritis? 1 = not familiar. 5 = very familiar

Table 14

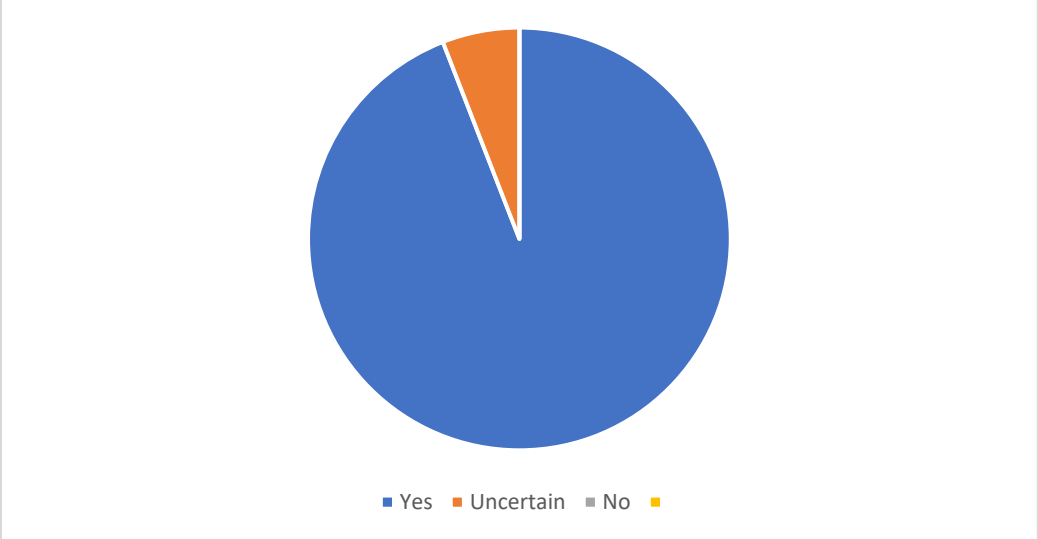
Pre-test and Post-test Results for Question 5 (N=18; N=17)

Score	**Pre-test**	**Post-test**
1	9 (50%)	1 (5.9%)
2	6 (33.3%)	0
3	1 (5.6%)	5 (29.4%)
4	2 (11.1%)	7 (41.2%)
5	0	4 (23.5%)

Additional question only on the post-test, question 6: Did this presentation provide information that will improve your practice? Options were: yes, uncertain or no.

Figure 4

Post-test improvement in practice question (N=17)



Summary

The purpose of this scholarly project was to provide education to providers on vitamin B12 deficiencies and the associated symptoms, causes and diagnosis. The findings from this education-based project show that healthcare providers gained knowledge about how to recognize the symptoms of low B12, the appropriate B12 supplementation to prescribe to those diagnosed with pernicious anemia, polyglandular autoimmune syndromes, autoimmune gastritis, and what patients are appropriate to refer to a gastroenterologist. There were improvements in post-test results in all five assessment questions of the pre-test. This suggests the use of an educational presentation is an effective method of increasing healthcare providers knowledge levels. Future research needs a larger sample size to get a more accurate assessment of knowledge gained. See Chapter V for further discussion about this study.

Chapter V

Discussion

Relationship of Outcomes to Research

The purpose of this scholarly project was to provide education to providers on vitamin B12 deficiencies and the associated symptoms, causes and diagnosis. The project obtained data from various healthcare providers using a pre-test/post-test format with an educational presentation in between. The pretest was used to gather demographic information about the participants and then to assess their knowledge regarding the topic prior to teaching. The post-test was used to measure potential knowledge gain after the educational presentation. The research questions addressed in this study are as follows:

- Did the providers become more comfortable in recognizing the symptoms of low B12 after the educational presentation?
- Did providers choose to prescribe the more effective form of vitamin B12 supplementation, intramuscular injection, after the educational presentation?
- Did the providers become more familiar with polyglandular autoimmune syndromes and autoimmune gastritis after the educational presentation?
- Due to the relationship that exists between females diagnosed with pernicious anemia and autoimmune gastritis, after an educational presentation was there an

increase in the percentage of providers who will refer a patient to a Gastroenterologist?

- Did the educational presentation provide knowledge that will lead to an improvement in practice?

For question one, there was an increase in the overall level of comfort in recognizing symptoms of low B12 after the educational presentation. The same can be said for questions two-four, with question four being a two-part question. In addition, the last quantifiable question of the post-test recorded that 94.1% of participants felt that the information provided would improve their practice. However, the encouraging results of this project may be skewed due to the small sample size and could potentially change in a larger participant population.

Observations

Starting with the positive, the data showed improvement in the providers' knowledge in comparing pre-test to post-test values. In addition, the open-ended feedback from participants was encouraging and included are the following remarks: "great job"; "excellent – I was not aware of the links between autoimmune disease and B12/pernicious anemia"; "very informational on a topic I did not know much about – thank you!"; "great presentation and much needed information; outstanding presentation – well done"; "great presentation and visual aids – the voiceover sounded great and together maximized the intended learning – great job!"

Feedback was also received on social media sites where the study invitation was shared. A dietitian who did not participate in the pre- and post-tests, however listed to the information presented and commented that she enjoyed learning more about B12

deficiencies. Two other participants who have autoimmune gastritis (AIG) also not participate in the pre- and post-tests, but did listen to the educational presentation. One commented that there was not enough information in the presentation about AIG; the other simply commented “good information.”

There were several obstacles in the educational presentation itself. First and foremost was the challenge of making the presentation compact enough that it would not take too much time away from busy providers nor cause providers to lose interest, yet at the same time provide valuable information without overwhelming providers. After multiple recordings, the final product provided information in under 15 minutes. Second was the dissemination of the PowerPoint recording, which included links to the pre- and post-tests imbedded within it. However, it was created on PowerPoint which was linked to PSU and made it not shareable outside of those with a PSU email. Many unsuccessful hours were spent with campus information technology (IT) professionals as well as those outside the university in order to convert the PowerPoint to a format readable outside of those associated with PSU. The link initially seemed to work without problem, however shortly after sharing it there was clearly a problem with participants’ ability to edit it. In other words, it was not locked and was being intentionally or unintentionally edited. This was later corrected, but again added unexpected time spent. There were also challenges with participants being able to access the site despite being on a computer. If this study were to be replicated, it is suggested to use a format that is accessible by mobile devices as well as a laptop computer. an IT professional was located who made it into a website whose link was shareable.

Another observation was the low number of participants despite it first being shared on the School of Nursing Facebook page and it being shared in several private medically-focused groups, some of which have hundreds of members and others thousands of members. Speculation could be made that should CEU credit been offered for participating, or better yet, monetary incentive then participation would have been higher.

Evaluation of the Theoretical Framework

The first theoretical framework used for this project was the Kurt Lewin's "Change Theory of Nursing," which focuses on change in a sequential manner: unfreezing, change and refreeze (Hussain et al., 2018). The theory along with the pre-test allowed this researcher to assess prior knowledge of the key topics prior to the presentation and then replace it with new information. The post-test allowed for evaluation of the value of the information provided, which showed positive results.

In addition, the Levels of Prevention Model Framework was utilized. This model suggests that disease exists on a continuum from health at one end to advanced disease at the other with the goal being to stay as close to the health end as possible. There are four areas that are further categorized: primordial, primary, secondary, and tertiary prevention. Secondary prevention is detecting a disease early and is the target of this DNP Scholarly Project. Again, the post-test suggested improvement in provider knowledge which, in turn, should lead an increase early detection, diagnosis and early treatment of conditions causing low B12 in the target patient population.

Evaluation of the Logic Model

The logic model included in Chapter I showed the relationship between this scholarly project and its intended outcomes. The primary inputs were time needed for research, a computer, internet access, a printer, paper, writing utensils, and then Pittsburg State University faculty and committee members' input, the only constraint on this project other than time.

The outcomes for this project were divided into short, intermediate, and long-term. In the short-term, the main outcome was a change in personal clinical practice. The post-test results indicated this outcome was met with 94% of respondents stating their practice would be impacted. Intermediate outcomes included changes in practice by all providers in a clinic; however, this was not met, nor expected to be met, with this project. This could be a future goal of similar projects if aimed at practice groups. Long-term goals would be a change in practice by all primary care providers, which again would extend beyond the scope of this project.

The primary outputs were seeking improvement in the practice of primary care providers, decreasing the delay in achieving an accurate diagnosis and improving patient outcomes. These outputs are not measurable within the constraints of this project, however could potentially be implemented, for example, within a large healthcare system were primary care clinics were targeted and patient data could be obtained and monitored.

Limitations

There were several limitations to this scholarly project. First is the duration of the study, which was limited to approximately four weeks. Second, was the small number of

participants limiting the validity of the data. Thirdly, were the time constraints of the project for participants. The pre-test, educational presentation and post-test took participants approximately 20 minutes and, likely, most participants were not willing to invest that much time in a project where the only reward is patient-centered. Finally, there were technical difficulties in the creation and dissemination of the scholarly project to participants.

Implications for Future Research

The results of this project demonstrate a lack of knowledge regarding the symptoms of low B12, diagnosis of underlying causes, and overall management. The education provided showed an improvement in providers' level of knowledge about the topics presented and has the potential to change clinical practice and positively impact patient outcomes. This shows that more educational offerings about this topic are needed, especially to those in primary care settings where initial diagnosis and treatment often occurs.

Conclusion

The purpose of this scholarly project was to assess if an educational presentation could improve the level of knowledge providers have in regards to the symptoms, diagnosis of underlying causes, and management of low B12. This study found that there was a lack of knowledge especially in regards to underlying causes such as polyglandular autoimmune syndromes including autoimmune gastritis. The study found that by providing appropriate education, a change in practice could occur which has the potential to impact the lives of patients.

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APPENDIX

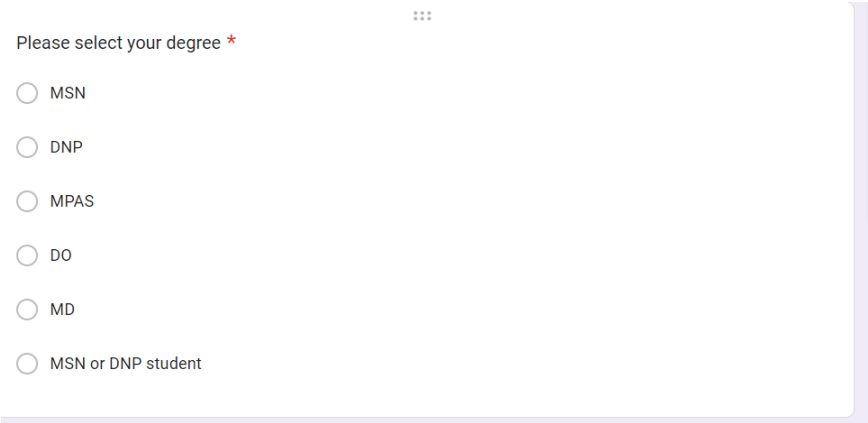
Appendix A

Instructions/Preface

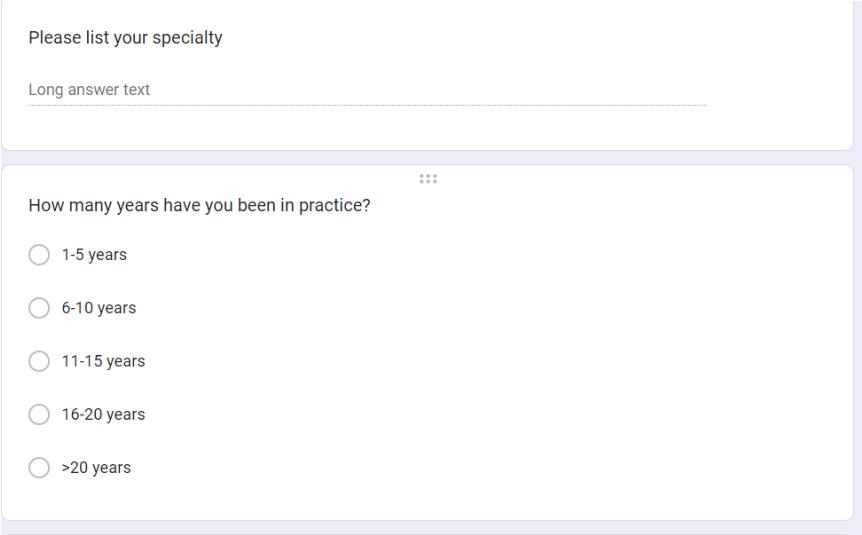
Thank you for your participation in this research study. The purpose of this study is to evaluate provider's level of knowledge regarding the symptoms associated with low B12, B12 supplementation, polyglandular autoimmune syndromes, autoimmune gastritis, and when patients with low B12 should be referred to a gastroenterologist. After the educational presentation, a post-test questionnaire will be given which will include the pre-test questions as well as a question to assess if there was knowledge gained which could be applicable to their clinical practice. The questionnaire is not timed and can be completed at your own pace. The questionnaire contains multiple choice questions, open-ended questions and questions with responses given on a scale from 1-5. Participation in this study is completely voluntary and refusal to participate will not result in personal or professional consequences. Participants can submit or abort the questionnaire at any time without penalty. Submission of the answers will be considered as giving consent to utilize the responses for the research purposes of this study. Following submission, specific questionnaires cannot be deleted. Individual results cannot be provided as no identifying information will be collected. Following completion of the data collection and analysis, overall study results can be provided per individual request. For questions regarding this study, you may contact the principal investigator, Tracy Coltharp, by email at tacoltharp@gus.pittstate.edu.

Pre-test

Question 1:



Questions 2 & 3:



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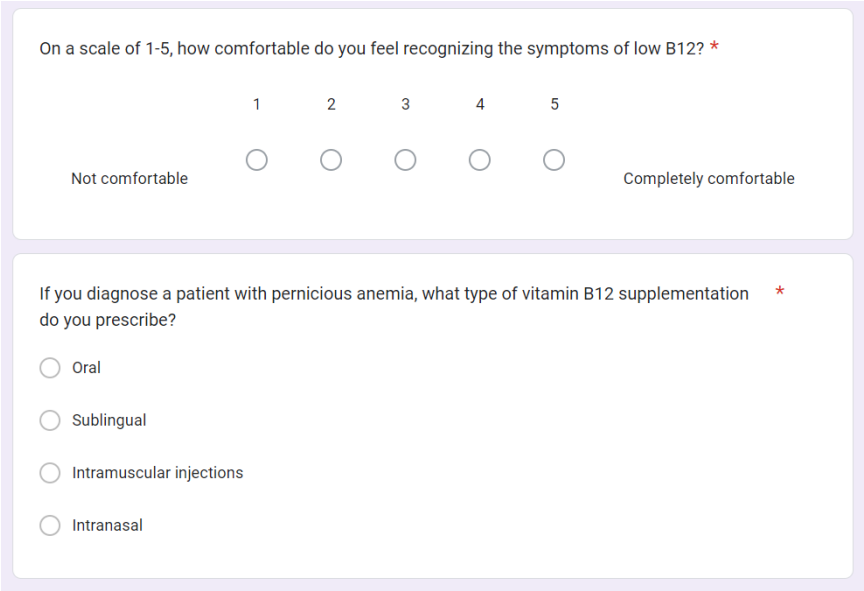
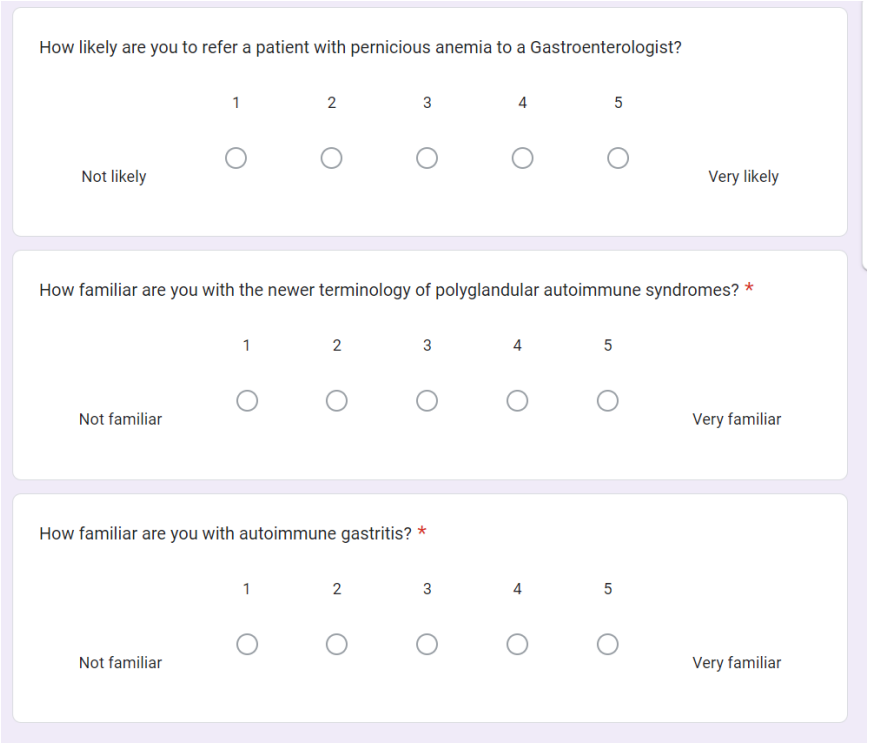


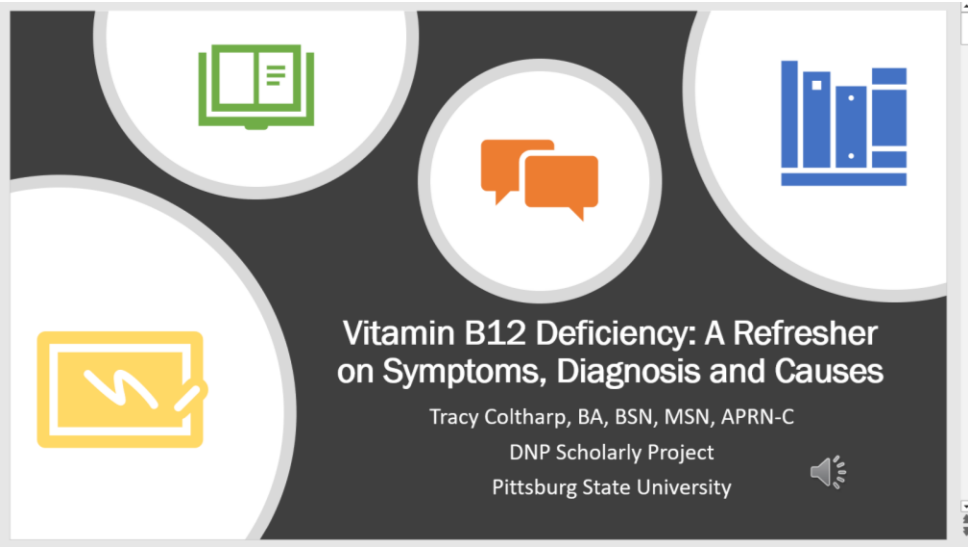
Questions 6, 7 & 8:



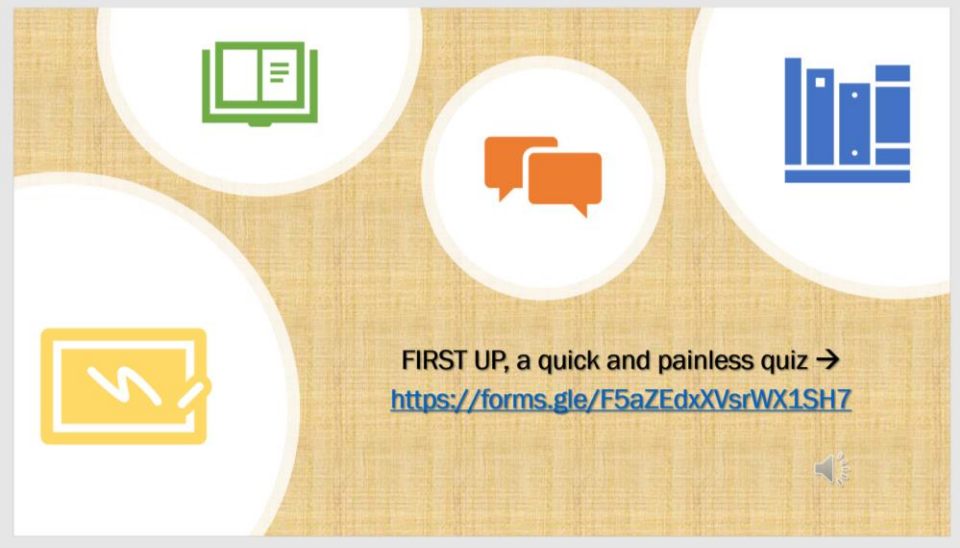
Appendix B

Educational slides

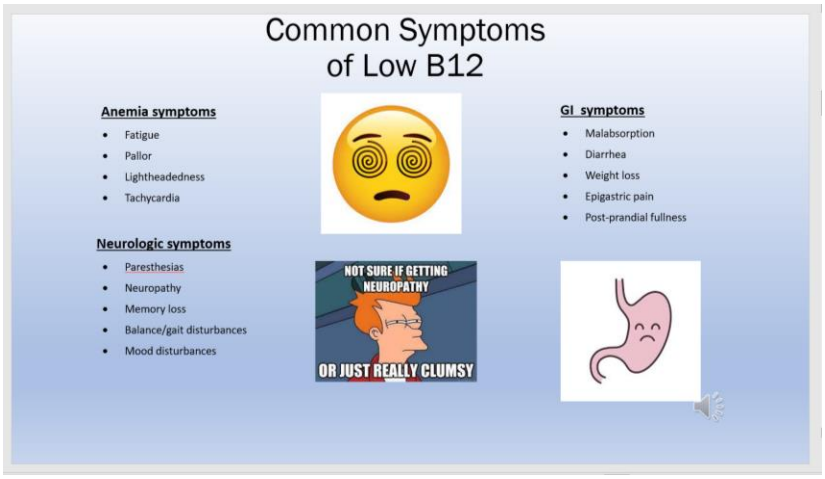
Introductory slide

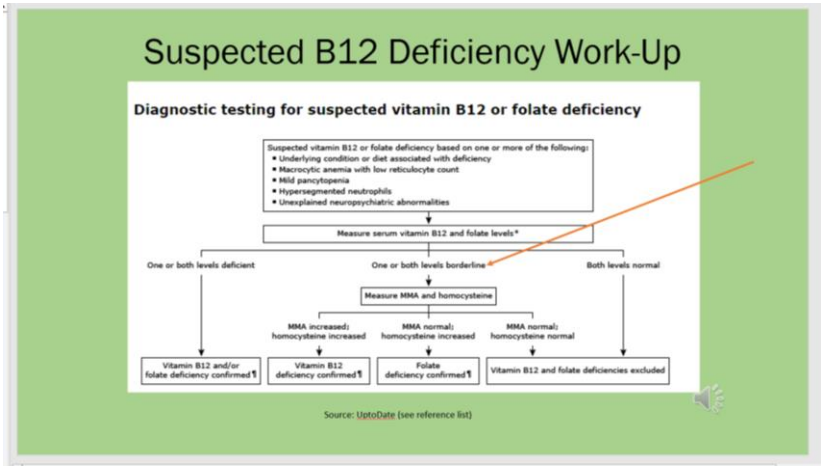


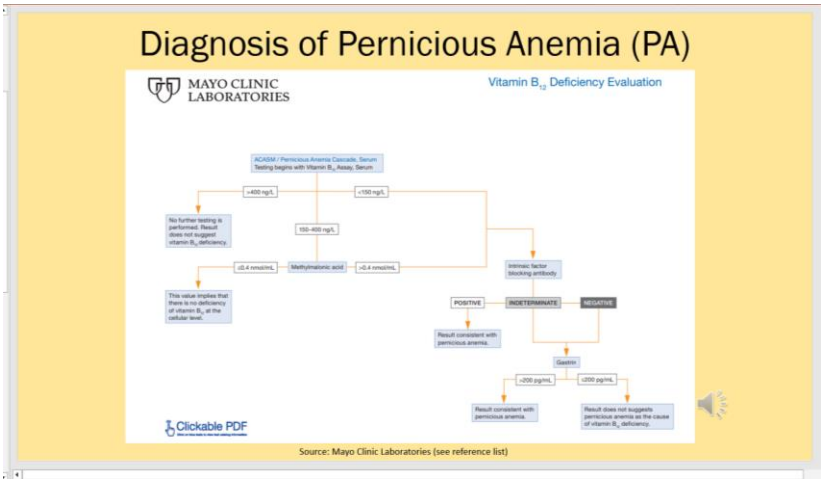
Slide 1 – link to pre-test



Informational slides







Fast Facts about Pernicious Anemia (PA)

- The most common cause of vitamin B12 (cobalamin) deficiency in the world
  - Incidence is higher in northern European decent whites
  - **UNDERDIAGNOSED**
- Autoimmune condition that prevents formation of the vitamin B12-intrinsic factor complex (Intrinsic factor deficiency)
- Vitamin B12 deficiency
  - Low serum B12
- Macrocytic anemia
  - Decreased hemoglobin or hematocrit
  - Elevated MCV
- Autoantibodies in individuals with PA *may be directed against intrinsic factor or against gastric parietal cell antigens*
  - Serum antibodies: anti-intrinsic factor are insensitive and anti-parietal cell antibodies are non-specific

Picture Source: Pernicious Anaemia Society website https://pernicious-anaemia-society.org/b12deficiencyandperniciousanaemia/

Treatment for Patients with PA

- **ORAL, SUBLINGUAL OR NASAL SPRAY OPTIONS are poorly absorbed and utilized by the body due to inadequate secretion of intrinsic factor necessary for vitamin B12 absorption**
- Best option: cyanocobalamin 1000 mcg parenterally once per week until the deficiency is corrected and then every other week or once per month

Polyglandular Autoimmune Syndromes

Synonyms: autoimmune polyglandular syndromes, polyglandular failure syndromes, and polyglandular autoimmune diseases

- Distinguished by the gland(s) affected
- Categorization depends on the combination of deficiencies

Most common:
- Hashimoto's thyroiditis
- Grave's disease
- Hypoparathyroidism
- Addison's disease
- Vitiligo

Less commonly known:
- **Autoimmune gastritis [AIG]**
  - Synonyms: autoimmune atrophic gastritis [AAG], chronic atrophic autoimmune gastritis [CAAG])

Autoimmune Gastritis (AIG)

- "Silent" due to lack of symptoms → **delay in diagnosis**
- Presence of one or more antibodies
- **Leads to B12 deficiency**
- Iron deficiency anemia (IDA)
- **Increased cancer risk**
  - Neuroendocrine tumors (NETs)
  - Gastric adenocarcinoma
- Impacts 0.5-5% of population
  - **Women > Men**
  - Incidence increases with age
  - Often associated with another autoimmune condition

Table 1
Autoimmune diseases associated with CAAG. The strongest association is found with autoimmune thyroiditis and type-1 diabetes mellitus. (CAAG: chronic atrophic autoimmune gastritis; PSC: primary sclerosing cholangitis; PBC:primary biliary cholangitis).

Autoimmune diseases associated with CAAG	Stenght of association
Chronic autoimmune thyroiditis (Hashimoto's thyroiditis) and Graves' disease	+ + + + (some cohort studies, two cross-sectional studies and two case-control studies)
Type-1 diabetes mellitus	+ + + (one case-control study and some cohort studies)
Vitiligo	+ + (one cohort study and some case reports)
Alopecia	+ + (some cohort studies)
Celiac disease	+ + (some cohort studies)
Myasthenia gravis	+ (only case reports)
Connective tissue disease	+ + (one cohort study and case reports)
Primary biliary cholangitis	+ + (case reports and one cohort study)
Primary sclerosing cholangitis	+ (only case reports)
Autoimmune hepatitis	+ (only case reports)
Addison's disease	+ (only case reports)
Primary ovarian failure,	+ (only case reports)
Primary hypoparathyroidism,	+ (only case reports)
Lambert-Eaton syndrome	+ (only case reports)
Oral erosive lichen planus	+ (only case reports)

Source: Massironi et al., 2019, p.216

Delay in Diagnosis Quantified

Lenti et al. (2019) reviewed 291 patients with AIG

- Female:Male ratio = 2.3:1
- Diagnostic delay was 14 months
- Factors associated with longer median overall diagnostic delay were:
  - female sex (17 months)
  - previous misdiagnosis (36 months)
  - history of infertility/miscarriages (33 months)
- Additional delay: First evaluation by a gastroenterologist was associated with a median longer diagnostic delay (6 months) compared to an internist (3 months) and a hematologist (1 month)

Study Conclusions: *AAG is burdened by substantial diagnostic delay, especially in female patients, and due to lack of awareness, particularly among gastroenterologists. Uncommon vitamin B12 deficiency-related manifestations are overlooked and may prolong the diagnostic delay.*

Diagnostic Work-up

Endoscopic	Non-endoscopic
• Obtain topographical biopsies to determine anatomic extent and histologic severity for risk stratification	• Test for *H pylori*, treat if positive and confirm eradication
	• Evaluate for anemia

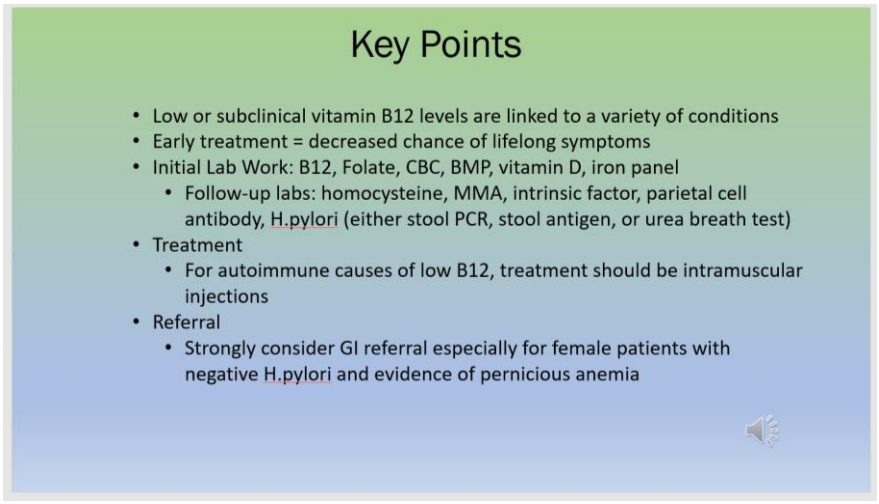
• Surveillance endoscopy should be considered in patients with*
  • Advanced AG: every 3 years
  • AIG: interval based on individualized assessment (see text)
	• Evaluate for micronutrient deficiencies, such as iron and vitamin B12 (irrespective of anemia)

• In patients with newly diagnosed PA, upper endoscopy should be considered for risk stratification and to evaluate for prevalent gastric neoplasia and NETs	• In patients with AIG
	  • Screen for autoimmune thyroid disease
	  • Low threshold to evaluate other autoimmune diseases based on clinical presentation (e.g. type I diabetes)

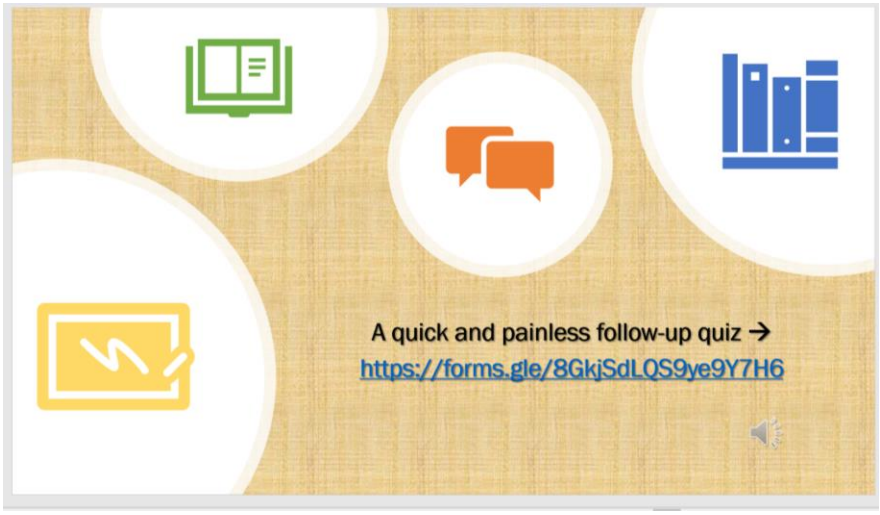
• Evaluate for NETs and manage accordingly (see text)	• Check PCA and IFA in patients with endoscopic/ histologic findings consistent with AIG**

*For AIG and advanced AG, surveillance should be based on shared decision-making and individual risk assessment. Advanced AG is defined based on 1) anatomic extent and 2) histological grade.
**Endoscopic findings include corpus-predominant pattern with antral sparing; histological findings include oxyntic mucosa atrophy with lymphoplasmacytic infiltrate.

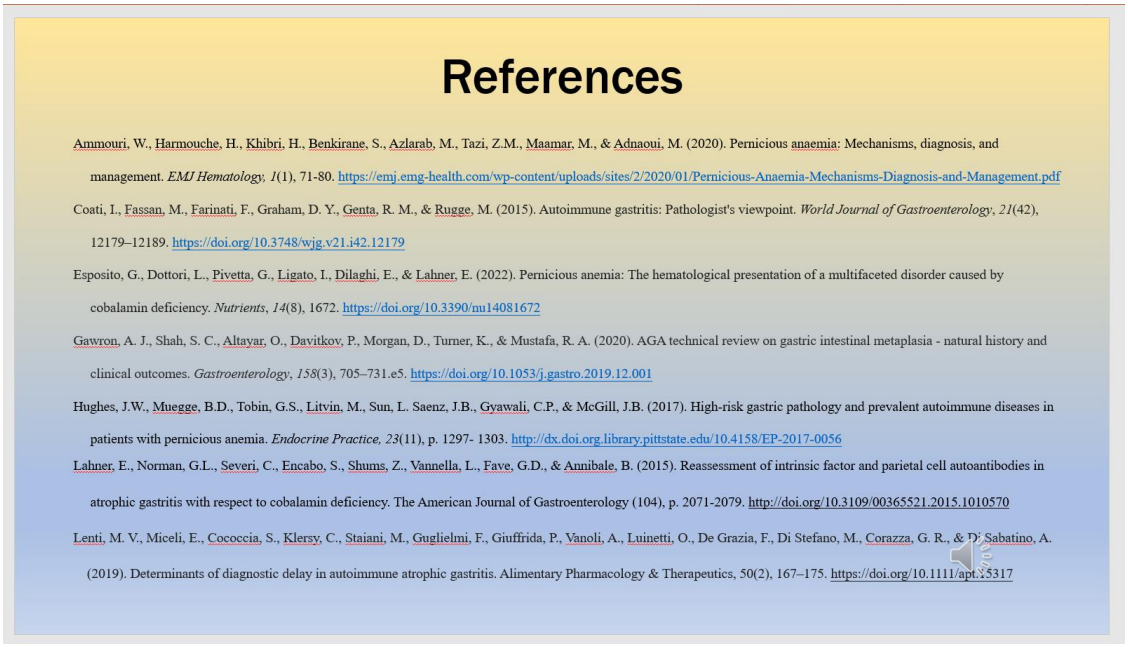
Source: Shah et al. (2021) p.1331



Link to post-test



Reference slides



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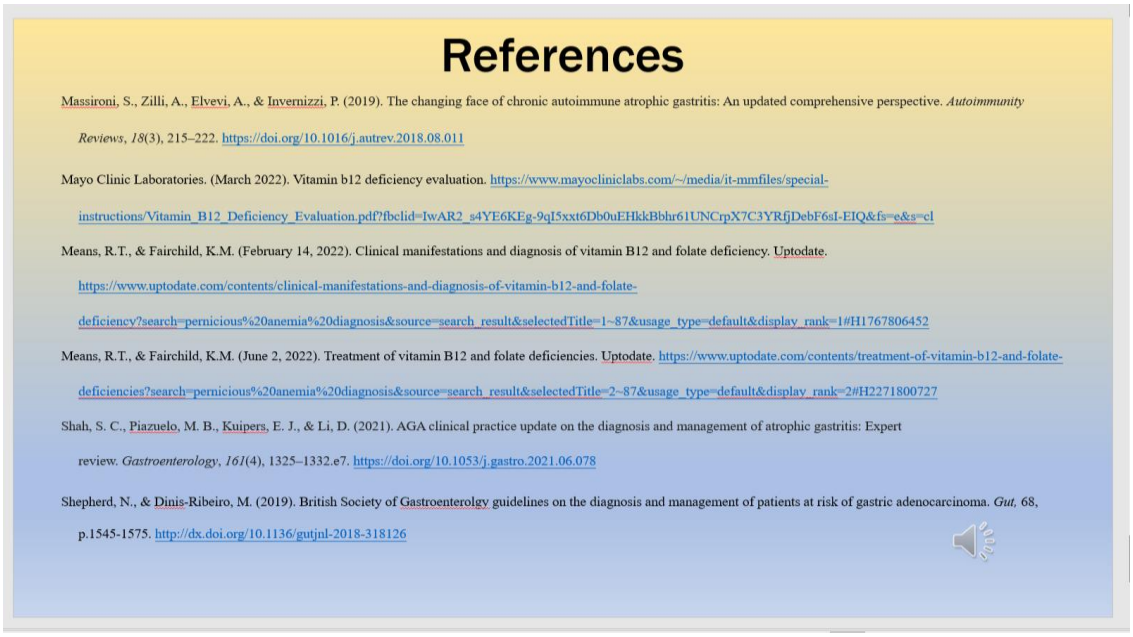

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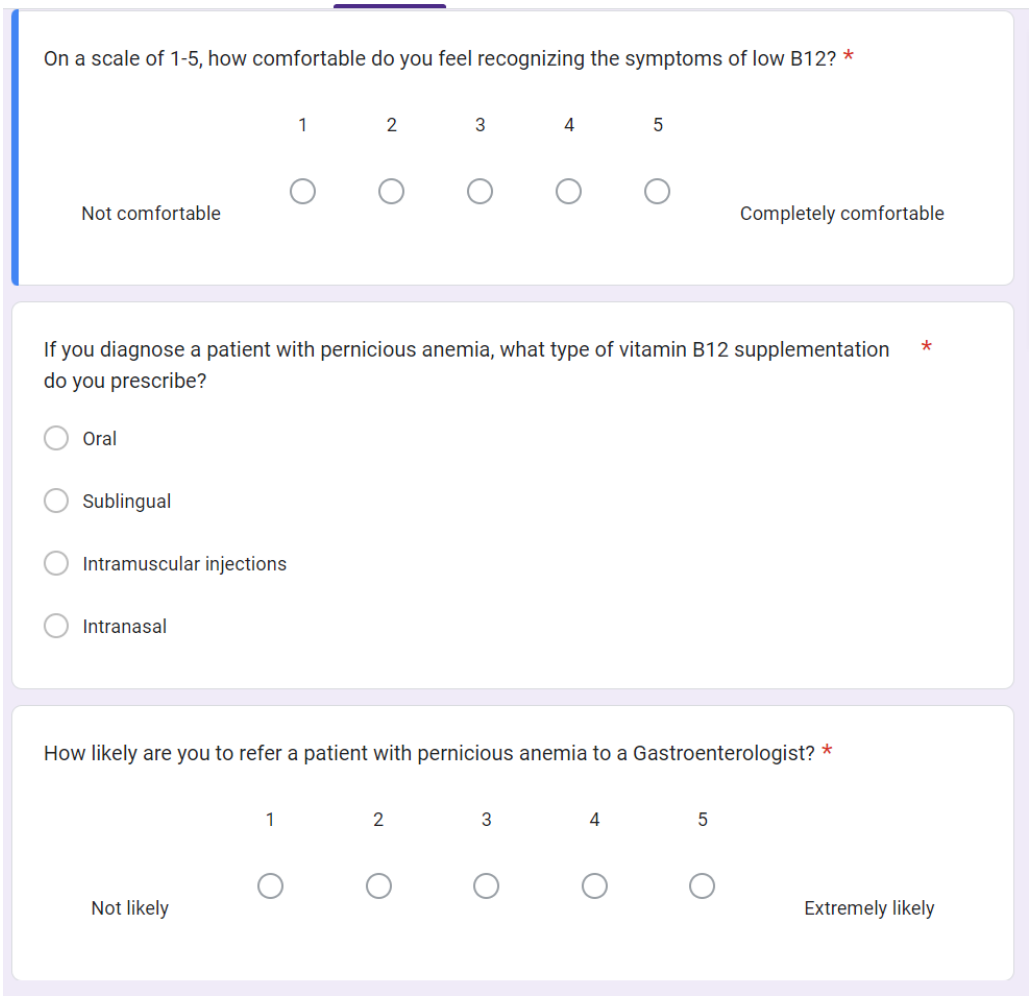
Appendix C

Post-test

Questions 1-3:



Questions 4-6:

How familiar are you with the newer terminology of polyglandular autoimmune syndromes? *

	1	2	3	4	5	
Not familiar	○	○	○	○	○	Very famililar

How familiar are you with autoimmune gastritis?

	1	2	3	4	5	
Not familiar	○	○	○	○	○	Very familiar

Did this presentation provide information that will improve your practice? *

- ○ Yes
- ○ Uncertain
- ○ No

Question 7:

Any additional comments

Long answer text