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Small Intestinal Bacterial Overgrowth Testing Strategies

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Final Scholarly Project: Small Intestinal Bacterial Overgrowth Testing Strategies

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Doctor of Nursing Practice

DNP Final Scholarly Project Team:

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Abstract

Small Intestinal Bacterial Overgrowth (SIBO) is an overgrowth of bacteria in the small intestine. Symptoms such as bloating, abdominal pain and discomfort, malabsorption, nausea, constipation, or diarrhea overlap with several common GI complaints. SIBO affects millions of people worldwide. Many providers are not aware of SIBO or the guidelines that standardize testing and diagnosing.

The Final Scholarly Project (FSP) was based on a literature review that discovered evidence-based literature on SIBO testing strategies such as gut aspirate and culture, clinical symptom presentation, breath testing, nutrient challenge test, and scintigraphy with either lactulose or hydrogen breath testing. To implement the project, pre-educational chart review was conducted in a Functional Medicine Practice where Advanced Practice Nurse's (APRN) treat patients with SIBO, IBS, and common gastrointestinal (GI) complaints. The pre-educational chart review looked to determine if SIBO testing and diagnosing guidelines were being used in practice. An educational program outlining the evidence-based literature reviewed on SIBO testing and diagnosing and the results of the pre- educational program chart review was collated and shared with the APRN's at the Functional Medicine Practice. A post-educational chart review was conducted four weeks later to measure compliance with the standards.

The FSP aimed to create SIBO awareness through education and determine if SIBO testing and diagnosing guidelines were being incorporated into practice. The APRN's in a Functional Medicine Practice were receptive to the educational program offered and interested in implementing SIBO testing guidelines into their practice.

Key words: SIBO treatment, SIBO, SIBO testing, SIBO diagnosing, breath testing

Introduction

Small intestinal bacterial overgrowth (SIBO) is a gastrointestinal (GI) condition that can be difficult to detect. SIBO is a pathologic bacteria overgrowth in the small intestine that affects millions of individuals throughout the United States (Achufusi, 2020). SIBO causes discomfort and bowel dysfunction. The bacteria overload in the small intestine produces gases from the fermentation of starches and carbohydrates, which produces inflammation and microvilli damage to the small intestine (Mehmet, 2019). Gastrointestinal symptoms of SIBO include bloating, abdominal pain, fullness, nausea, diarrhea, vomiting, and gas (Amieva-Balmori et al., 2019). SIBO signs and symptoms almost mirror irritable bowel syndrome (IBS) symptoms of cramping, abdominal pain, bloating, gas, and diarrhea or constipation or both (Mayo Clinic, 2020). However, IBS is a condition of the large intestine, whereas SIBO is a condition of the small intestine. Further complicating the issue, up to 78% of patients with IBS have SIBO (Mehment, 2019). SIBO symptoms are like many other common GI complaints, further complicating detection, testing, and treatment.

There are several mechanisms throughout the GI track that can protect a person from SIBO. Mehmet (2019) identified the following protective GI mechanisms:

- Ileocecal valve located at the end of the small intestine leading the beginning of the large intestine that allows product to flow through to the large intestine.
- Hydrochloric acid in the stomach kills the incoming bacteria.
- The gut immune system
- Enzymes such as pepsin that digest proteins (Heda et al., 2022)
- The migrating motor complex (MMC) which is the mechanism responsible for sweeping the bacteria out of the small intestine and into the large intestine.
- Intestinal mucosa, which is the intestinal barrier that absorbs nutrients and limits transport of harmful microorganism (Vancamelbeke & Vermeire, 2017)

Disruptions in any of the above mechanisms can create a risk for SIBO to occur.

SIBO can also occur due to structural complications, decreased gut motility, illness, surgery, or medication. The MMC may be disrupted due to the back up of bacteria from the large intestine, increased bacteria growth in the small intestine, certain medications and from systemic disease's such as diabetes, cirrhosis, and chronic kidney disease. A mass, fissure, or scar tissue can also impede the MMC's ability to clear the small intestine. The ineffective sweeping of the bacteria from small intestine to large intestine can trigger SIBO (Roland et al., (2017). Gut motility can be impaired from chronic constipation or inflammation from autoimmune diseases such as Lupus, Crohn's disease, and Sjogren's syndrome. Long term use of proton pump inhibitor (PPI) is found to cause SIBO due to reduction in stomach acid and additionally, the use of opioids slows down the gut processes. The small intestine, simply stated, is just not as able as the large intestine to clear bacteria.

Advanced Practice Nurses (APRN) are often not aware of SIBO illness or SIBO detection, testing, or interpretation guidelines. As a result, SIBO may not be identified or tested in a timely manner, leading to high recurrence rates and further damage to the small intestine (Mehmet, 2019). SIBO cannot be effectively diagnosed or treated without using specific testing methods to identify if there is SIBO bacteria causing the patient's distress. Currently, consistent SIBO testing is not taking place throughout practice (Ruscio, 2019). Guidelines for SIBO diagnostic testing were established, however there remains to be multiple testing strategies being used in practice (Schindler et al., 2020). Standardized diagnostic testing used to detect SIBO are gut aspirate and culture, clinical symptom presentation, breath testing, nutrient challenge test, and scintigraphy with either lactulose or hydrogen breath testing.

To investigate compliance in central Ohio, APRN's in a Functional Medicine Practice were chosen due to their prevalence for treatment of SIBO patients. A pre- educational chart review took place in the Practice to determine the documentation of diagnostic testing used to diagnose SIBO and the frequency of patients with common GI complaints including detection and management. An educational program was designed and delivered to the APRN's of the practice to increase their awareness of SIBO indications, testing methods, and interpretations as set forth by guidelines established by the North

American Consensus (NAC), which consisted of scientists and GI experts. A post- educational chart review took place four weeks following the education session to determine if there was a change in use of the SIBO diagnostic guidelines.

Problem Statement

SIBO is not a well-known condition with Health Care Providers. SIBO can be the result of long-term IBS, food poisoning, a structural malformation, medication, or illness. SIBO symptoms mirror many other common GI complaints experienced by patients, making symptom presentation not a reliable diagnostic tool. SIBO is commonly misdiagnosed since standardized diagnostic criteria, testing strategies or interpretation guidelines were not available prior to 2017 (Hao et al., 2021). The gold standard of SIBO testing of upper gut aspirate is costly, invasive, and difficult to obtain (Mehmet, 2019). Breath testing can detect elevated levels of gas and is useful in clinical settings (Ruscio, 2019). Guidelines were developed to provide a consistent approach to identifying, testing, and diagnosing SIBO, with adoption in clinical practice less than universal.

PICOT Question

The following question was created to guide this evidence-based project for the FSP:
For experienced certified APRN's (P) will an educational program of current SIBO testing and diagnosing guidelines (I) compared to no educational program of current SIBO testing and diagnosing guidelines (C) increase SIBO testing compliance in accordance with current guidelines (O) over a 4-week time frame (T)?

Background & Significance

A search for evidence began with the FSP student's University Library website, and the use of OneSearch. A second local University library website, and the use of Discover Search, took place as well. Keywords used to assist in finding research were SIBO treatment, SIBO, SIBO testing, SIBO diagnosing, and breath testing. Boolean search words included "AND" to aid in narrowing the search.

The original search began by using the word SIBO alone which generated 22,228 articles using OneSearch on the FSP student's University website. Using the advanced search and Boolean key words, the search was narrowed down, and keeper articles were found in Scopus, PubMed, CINNAHL plus with Full Tet, and Science Direct.

Literature Review

Testing and diagnosing SIBO is challenging to APRN's since there were no published clinical guidelines or consensus on SIBO indications, testing methods, and interpretation of results in North America until recently. Several articles mentioned at least once that guidelines were lacking. Multiple research articles report that misdiagnosis, under and over diagnosis, under and over treatment is due to a lack of diagnosing and testing criteria which then leads to unknown prevalence of SIBO throughout communities.

SIBO diagnostic criteria remains to be debatable. Hao et al (2021) described that there is not a universally accepted cut-off point for breath testing result ranges. Hao et al. (2021) expressed misdiagnosing SIBO is common due to absent diagnostic criteria. Ruscio (2019) also reported that there is not consistent SIBO breath testing standards and further expressed that overdiagnosis of SIBO and treatment occurs. Mehmet (2019) stated there may be numerous APRN's who are not aware of SIBO, which explains why under diagnosing is occurring. Achufusi (2020) agreed and stated it is difficult to prove a diagnosis of SIBO without clear testing and diagnosing criteria. Rezaie et al. (2019) acknowledged how the lack of consensus with SIBO indications, methods, and testing interpretation led to various substrates being used for breath testing. Rezaie et al. (2019) added how breath testing is being done on unestablished indicators. Currently, a variety of testing ranges are being used among clinics and tertiary centers.

Gold Standard for SIBO Testing

Small bowel aspirate is considered the gold standard for SIBO testing. Small bowel aspirates are collected and cultured by an endoscopic procedure. Many articles agreed that small bowel aspirate and

culture is invasive, costly, and often not able to be done in a clinic setting. Schindler (2021) further stated that aspiration of the small bowel is limited to the proximal small bowel and misses potential distal small bowel SIBO. Achufusi (2020) added that there is a possibility of oropharyngeal flora contamination with small bowel aspirate and that the endoscope is not able to culture all bacteria due to the patchy distribution of bacteria through the small bowel. Rezaie et al. (2019) reported that small bowel aspirate cultures can be falsely negative since the endoscopes cannot reach the entire small bowel.

Other SIBO Testing Strategies

Research on multiple SIBO testing strategies was reviewed. Studies using small bowel aspirate, breath testing, symptom reporting, cluster analysis, nutritional challenge test, and scintigraphy were compared. The articles implied that breath testing, albeit not the gold standard, is acceptable to use for diagnosing SIBO. Hao et al. (2021) used results from 1,101 lactulose breath tests to apply artificial intelligence/machine learning (AI/ML) in the form of cluster analysis. The cluster analysis of breath testing demonstrated strong clustering tendency and Hao et al. (2021) determined clustering analysis was suitable for breath testing. Calderon et al. (2021) performed a retrospective study to determine if an association could be made between gut aspirate testing and gastric emptying by scintigraphy (a radioactive tracer that obtains an image of an organ or records the function of the body system). Calderon et al. (2021) reported that delayed gastric emptying didn't appear to increase the risk of a positive gut aspirate culture or that SIBO promoted delays in gastric emptying. There were conflicting reports in several articles on delayed gastric emptying causing or affecting SIBO. Amieva -Balmori et al. (2019) conducted a study to use breath tests to diagnose SIBO or absorption intolerances, as well as to see if pretest symptoms were an indicator of a SIBO diagnosis, and additionally to study the occurrence of symptom changes during the breath tests. Amierva-Balmori et al. (2019) assessed 1,230 participants over 4 years and concluded that pretest symptoms were not predictive of breath testing results, breath tests did diagnose SIBO, and that the occurrence of symptoms during a positive test were not too much different from a negative test. Amieva-Balmori et al. (2019) also found that glucose breath testing correlated with

small bowel aspirate culture with 84% specificity. Ruscio (2019) reviewed a meta-analysis that included 11 studies which concluded that breath testing was more abnormal among IBS patients. The Rome Foundation (a large group of Gastrointestinal experts) reported that there is a 30-46% occurrence of SIBO in IBS patients (Ruscio, 2019). Schindler et al. (2021) conducted a study to see if lactulose challenge test (NCT) was equivalent to scintigraphy- lactulose hydrogen breath test (ScLHBT) to diagnose SIBO. Data was studied on 81 patients who underwent ScLHBT and NCT over 4 years. Schindler et al. (2019) determined that NCT is more cost effective, and radiation free compared to ScLHBT, however, NCT is not equivalent to ScLHBT. Mehmet (2019) conducted a single case study where breath testing confirmed SIBO. Mehmet (2019) stated that breath tests are user friendly, readily available, more cost effective, and less invasive than small bowel aspiration. Achufusi (2020) additionally supported breath testing, stating breath testing is simple and patient friendly to diagnose SIBO. Rezaie et al. (2019) indicated that a systematic review of 13 case-controlled studies used breath testing to diagnose SIBO. Several studies favored the use of breath testing throughout outpatient practice.

North American Consensus Testing Recommendations

The North American Consensus (NAC) is a body of Gastrointestinal (GI) experts who practice, research, and set guidelines for GI complaint management. In 2015, there was a call for a consensus to review current SIBO protocols and to determine guidelines to streamline how SIBO should be managed as well as standard indicators used for consistent testing and established test ranges used to diagnose SIBO. What tests should be used to aid in diagnosing SIBO, and what the end points should be used to diagnose SIBO were also determined. However, as stated in multiple articles, there continues to be a variety of indicators, testing methods, and interpretations used in clinical practice. Numerous articles also pointed out that providers may continue to not have awareness of SIBO as well.

The NAC met and determined that breath testing was useful, inexpensive, and safe to use in the evaluation of common GI conditions (Rezaie et al., 2019). Multiple studies, systemic reviews, and meta-analysis were analyzed during the NAC. Rezaie et al. (2019) provided NAC statements that include

indications for breath testing, substrates to be used in breath testing, and determined endpoints to be used to diagnose SIBO. The NAC statements are the guidelines for North America and can be used to standardize the testing and diagnosing of SIBO. The purpose of the FSP is to educate APRN's with the NAC guidelines and provide supporting research for indications, methods, and interpretations of SIBO testing to increase consistency in practice.

Project Description & Design

The FSP utilized the quasi-experimental design. The quasi-experimental design allowed for observations to be made before and after implementation of the change (Ambroggio et al., 2018). An example of a quasi-experimental study is the pre-post design which is when the outcome will be able to be recorded before the intervention is in place, implement the intervention, and then record the outcome after the intervention implementation (Ambroggio et al., 2018). The FSP conducted a pre and post education chart review at the Functional Medicine Practice to learn about current SIBO testing and diagnosing strategies. An educational program on current SIBO indications, testing methods, and interpretations as set forth by the NAC was presented to the APRN's within the practice and then a post educational chart review was conducted to monitor for documented changes made with SIBO testing and diagnosing practices.

Theoretical Framework

The FSP is a quality improvement project with the purpose of improving consistency with SIBO testing methods by providing an educational program on SIBO indications, testing methods and interpretations. The framework used for the FSP will be the Plan-Do-Check-Act (PDCA). The Deming method is a good fit for the FSP due to the expansion of the Shewart cycle (Deming, 1952). The Shewart cycle appeals to the FSP student because the process is streamlined (Moen & Norman, n.d.). The process became known as the PDCA, which is a four-step quality improvement cycle.

The PDCA will provide a framework for the FSP to guide the project. The PDCA cycle is a frequently used quality improvement tool in health care settings that will assist the FSP project through completion (Coury et al., 2017). The PDCA can be used multiple times to assist in implementing a change to improve quality.

Project Objectives

Increasing awareness of SIBO diagnostic standards as set forth by the NAC among certified APRNs will increase their ability to identify, test, and treat SIBO more consistently. Increased awareness can lead to adoption of evidence-based practice protocols into their practice. An educational program was presented to APRN's to assist in creating increased SIBO testing consistency.

Objectives of this DNP project include:

- Identify EBP current guidelines on testing for SIBO
- Conduct a pre-educational chart review to identify current SIBO documentation of testing criteria
- Develop an independent study to increase SIBO testing knowledge to assist in creating consistent testing methods according to the guidelines
- Conduct a post educational chart review to measure congruency with current SIBO testing standards

The goal of the FSP was to identify evidence-based research and apply it towards the creation of an educational program incorporating current guidelines for SIBO testing methods to increase consistency in SIBO indications, testing, and data interpretation.

Methodology

A mixed research method was utilized including both quantitative and qualitative research. The quantitative research will provide statistical data gathered from systematic reviews and meta-analysis of chart reviews. Qualitative data was used to understand the facts of SIBO indications, testing methods, and interpretations assisted in generating evidence for practice (Moran et al., 2020).

The FSP student conducted a pre- and post- educational chart review to analyze the data of SIBO documentation and presented the chart review results to the APRN's at the Functional Medicine Practice.

Population & Sample

A pre-educational chart review was conducted at a Functional Medicine Practice where APRN's treat SIBO patients. The pre-educational chart review included patients who were 18 years or older, had a diagnosis of SIBO or IBS, or a general GI complaint. Criteria evaluated were the number of IBS, SIBO, and general GI complaint patients treated and what diagnostic tests were used to render a diagnosis (if any). Additional criteria included length of illness for SIBO and IBS patients and how many follow up visits were completed. The ideal sample size was minimally 15 charts to review.

An educational program was provided to the APRN's within the care site with the aim of providing current testing and diagnosing strategies for SIBO. Four weeks following the educational program, a post-educational chart review took place to look for the information as indicated above to determine if awareness of current SIBO guidelines increased documentation of current testing strategies implemented into practice.

Convenience sampling was used for the chart review and educational session. Medical charts were reviewed from a Functional Medicine Practice who treats SIBO patients. With this sampling method, charts were audited based on availability and accessibility of the student researcher of the FSP (Elfil & Negida, 2017). All charts were reviewed that have common GI complaints, SIBO or IBS diagnosis from 2020 to 2023.

Data collection and instrument

Convenience sampling was used for the chart review and educational session. Medical charts were reviewed from a Functional Medicine Practice who treats SIBO patients. Data from the charts such as testing methods, diagnosis, length of illness and the number of follow ups were collected and assembled in an excel spreadsheet where charts can be generated to compare the first set of data and the second set of data.

The total patient charts in the EMR used for the pre-educational chart review were 143, of which 96 patients were active with patient information. An algorithm to assist in narrowing down the search was not needed since the number of charts were obtainable for the FSP student to review manually and stay in line with the FSP timeline. Therefore, validation tests were not needed to check accuracy of a system search since algorithm's were not used. The chart reviews were reviewed manually which excludes any possible bias due to misclassification of data in a system. The pre- and post-educational chart reviews were completed by the FSP student.

Tools to Analyze Data

The paired t-test was the inferential statistic used for the FSP. Inferential statistics were used to assist in drawing conclusions on the sample from the population to evaluate SIBO awareness (study.com, 2022). The paired t-test helped in determining if there was a null hypothesis or if there was no significant difference in results of the two chart reviews, or if there was a significant difference, or alternative hypothesis, between the two chart reviews (Gleichmann, 2020).

The t-test indicated a null hypothesis. The number variation was due to the number of charts reviewed in the pre-educational review of 143 compared to the post-educational chart review charts audited of 48. According to the paired t-test, the output for the pre-educational program is 41 and the post educational program is 12.625. The p-value (0.03974661) is less than the standard significance level of 0.05, indicating that the null hypothesis can be rejected (Frost, 2023). The small p-value indicates the differences between the two data sets are most likely not a result of sampling error.

Instrumentation

For the chart review, manual EMR searches were completed at the APRN's Functional Medicine office to identify patients with general GI complaints or have a SIBO or IBS diagnosis. The charts were examined to determine length of illness, what type of testing was used (if any), indications, and interpretations of testing, and if treatment was successful. An educational program was provided to the APRN's that included current diagnostic guidelines and information on how to obtain testing and what

labs to use. Four weeks following the initial chart review, a post-educational chart review was conducted to look for patients over the age of 18 with SIBO, IBS or general GI complaints. Further information reviewed included length of illness, and number of follow-up visits. Results were computed to determine the effectiveness of the educational program and to additionally determine if SIBO testing and diagnosing guidelines were being implemented.

Human Subject Protection

Recruiting took place in the form of reaching out to an APRN who treats SIBO patients in an outpatient setting to see if their organization would allow a chart review to be conducted to determine current testing and diagnosing practices for SIBO patients. No human participants were needed to be present for the FSP data collection requirements. Data was collected from patients' medical records located in an electronic medical record (EMR) database within a private clinic. The inclusion criteria were patients over the age of 18, have a SIBO, IBS or general GI complaint diagnosis. There were no personal identifiers attached or used in the FSP data collection. Patients' identity remained strictly confidential, all information was obtained at the provider site and approved by the APRN's prior to being used in the FSP.

IRB Approval

An Institutional Review Board (IRB) Approval was submitted on behalf of the FSP. The FSP is considered an exempt review since there is no risk to human participants (Moran et al, 2020). A pre- and post-educational program chart review was completed and did not require any interaction from human participants. The IRB application was approved.

Variance from Original Budget & Timeline

There were variances of the original proposed FSP timeline. Approval of the FSP project was originally planned to occur in December of 2022. However, revisions were needed to meet requirements for the FSP. The FSP was presented at the end of January of 2023 and approval was then granted. The delay of the proposed FSP approval consequently then delayed obtaining IRB approval and the time to

begin the chart reviews. The IRB approval was granted in February of 2023, opposed to the originally planned January of 2023. The pre-educational program chart review immediately began following the IRB approval in February of 2023, opposed to January of 2023. The post-educational program chart finished in March 2023 as opposed to February of 2023.

A grant was not sought after by the FSP student. The FSP approval took place after the deadline for applying for a grant. Therefore, cost reduction methods were used to keep expenses minimal. Materials were kept digital to eliminate printing costs. Sample breath tests were not provided due to the expense. The token of appreciation to the APRN's was in the form of current research materials for reference within the practice.

Outcomes & Evaluations

The FSP project was implemented in the Functional Medicine Practice. The APRN's within the practice were instrumental in the completion of the FSP by allowing the FSP student to conduct the chart reviews, being available for assistance, as well as attending the educational program. The educational program was a presentation on SIBO testing indications, methods, and interpretations. Information provided in the presentation included the following:

- Background of SIBO
- SIBO Testing
- Diagnostic Outcomes Synthesis Table
- NAC Guidelines
- Breath Testing Options
- Various laboratory information providing breath testing for patients and results
- SIBO Overview
- SIBO resources

The APRN's were appreciative of the information provided in the educational program and will be applying the NAC SIBO testing guidelines to practice.

During the pre-educational chart review, the EMR database was discovered to contain 96 patient charts with visit information. Of the 96 patient charts, there were no patients diagnosed with SIBO. There were 62 charts with common GI complaints. There were 20 previously diagnosed IBS patients being seen at the Functional Medicine Practice. Breath testing was not used at the Functional Medicine Practice. The GI Mapping stool diagnostic tool was used in 48 charts. The GI Map is helpful when testing for gut dysbiosis by identifying normal and abnormal bacteria for the gut, fungus, parasites, IgA, zonulin levels, and inflammatory markers. Of the 62 patients with common GI complaints, the FSP student discovered 25 charts that could benefit from breath testing, based on symptoms, prior IBS diagnosis, and continuation of symptoms following treatment plans. There were 37 additional charts that could benefit from breath testing as well, however, further follow up from the patient was needed to verify if prescribed treatment plan was effective or if symptoms exacerbated following a successful treatment plan.

A SIBO educational program was developed and provided to the APRN's following the pre-educational chart review. The APRN's indicated the information provided by the FSP student was valuable and clarified SIBO indications, testing methods, and testing interpretations to them. Current literature was provided to the APRN's to allow them to consistently identify and diagnose SIBO. The APRN's were receptive to the information provided and expressed interest in applying the guidelines to practice.

The number of patients experiencing common GI complaints was expected to range from 30-40% of total active patients. However, the chart review revealed that the percentage was 65% of patients with common GI complaints.

The FSP objectives of current EBP guidelines for SIBO testing interpretations were able to be presented in the educational program to the APRN's in the Functional Medicine Practice. The FSP

objective of conducting the pre-educational chart review was accomplished and results were shared with the APRN's in the Functional Medicine practice during the educational session.

The post-educational program chart review was completed in March 2023 and the results were shared with the APRN's in the Functional Medicine Practice as well. The post educational program chart review discovered there were 4 patients not included in the pre-educational program chart review. Of the 48 patient charts not reviewed in the pre-educational chart review, 45 patient charts were active. There was not any SIBO diagnosis. However, there were 3 SIBO breath test recommendations made to patients. There were 24 patients with common GI complaints and 6 patients who were previously diagnosed with IBS. Of the 30 patients with common GI complaints and previous IBS diagnosis, the FSP student determined 8 patients would benefit from breath testing and an additional 12 patients may also benefit from breath testing, however, further follow up and evaluation would be needed prior to recommending. The post educational chart review demonstrated increased documentation of SIBO testing, therefore, indicating the FSP was successful in increasing consistency with current SIBO testing standards.

Barriers were incurred during the creation and implementation of the FSP project. The timing of approvals and timing of the implementation of the project were unforeseen barriers. With the assistance of the FSP Mentor, the FSP student was able to amend the FSP to fulfill the requirements, gain the acceptance needed and begin implementation of the FSP as promptly as possible. The timing of the FSP approval did not allow a timely application of Grant funds. The FSP student was able to make provisions to achieve the materials needed.

Conclusions

To conclude, SIBO affects millions of people worldwide. SIBO symptoms are like many common GI complaints. SIBO testing needs to be conducted to correctly diagnose SIBO, symptom presentation alone is not sufficient. SIBO testing guidelines were established by the NAC to create more congruency with SIBO identification, testing methods and testing interpretation. However, many

Providers remain unaware of SIBO and additionally, symptoms of SIBO overlap with many illnesses, creating misdiagnoses and inconsistency in detecting and treating SIBO.

Several SIBO testing strategies such as gut aspirate, scintigraphy, symptom presentation, AI Clustering, delayed gastric emptying, nutrient challenge test and metagenomics are used in practice. Gut aspirate remains the gold standard, however, is costly, invasive, and not able to be performed in an outpatient setting. Breath testing is considered acceptable and is a preferred testing method for patients that can be performed in the outpatient setting or in the patient's home. As set forth by the NAC, breath testing, or if needed gut aspirate testing, needs to be performed to accurately diagnose and treat SIBO.

Based on the evidence discovered during the completion of the FSP and the guidelines that were created by the NAC, it is recommended for providers to use breath testing when SIBO is suspected. SIBO should not be diagnosed without testing to ensure adequate treatment will be provided. Following the NAC guidelines will create consistency amongst providers on how SIBO is identified, tested for and how test results are interpreted. Breath testing is accurate and acceptable to be used in practice. Breath testing is less costly and invasive compared to gut aspirate testing. SIBO results can be determined more rapidly, and patients can begin SIBO specific treatment sooner.

The pre- and post-educational program chart reviews completed during the FSP implementation revealed that patients experience common GI complaints consisted of nearly 2/3 of the patient population, which was much higher than the FSP student predicted. Providers need to be aware of SIBO indications, testing methods and testing interpretations. Many patients would benefit from increased provider knowledge of SIBO as well as increased SIBO testing and diagnosing consistency through practice.

Recommendations

The FSP project successfully completed the goal of increasing awareness of SIBO indications, methods, and interpretations according to the NAC guidelines. Following successful completion of the FSP project, the FSP student will begin to work within the Functional Medicine Practice providing SIBO care to patients in accordance with the NAC guidelines. While doing so, the FSP student will focus on

sustaining consistent testing practices for SIBO within the Functional Medicine Practice. The FSP student will also continue disseminating the knowledge gained during the FSP project through means of professional presentations, being available to be a guest speaker in educational forums, present a guest lecture on SIBO for FNP programs to educate students, present poster presentations at conferences, and completing a professional article outlining the FSP project and findings. The FSP student will continue to increase Providers awareness and consistency of SIBO indications, testing methods, and interpretations throughout Functional and Traditional Medicine as well as personal practice.

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Appendix A. Level of Evidence Synthesis Table

X (copy symbol as needed)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Level I: Systematic review and meta-analysis				X	X		X								
Level II: Randomized controlled trial				X											
Level III: Controlled trial without randomization			X			X									
Level IV: Case-control or cohort study	X	X		X				X							
Level V: Systematic review of qualitative or descriptive studies				X											
Level VI: Qualitative or descriptive study, CPG, Lit Review, QI or EBP project				X	X		X								
Level VII: Expert opinion															

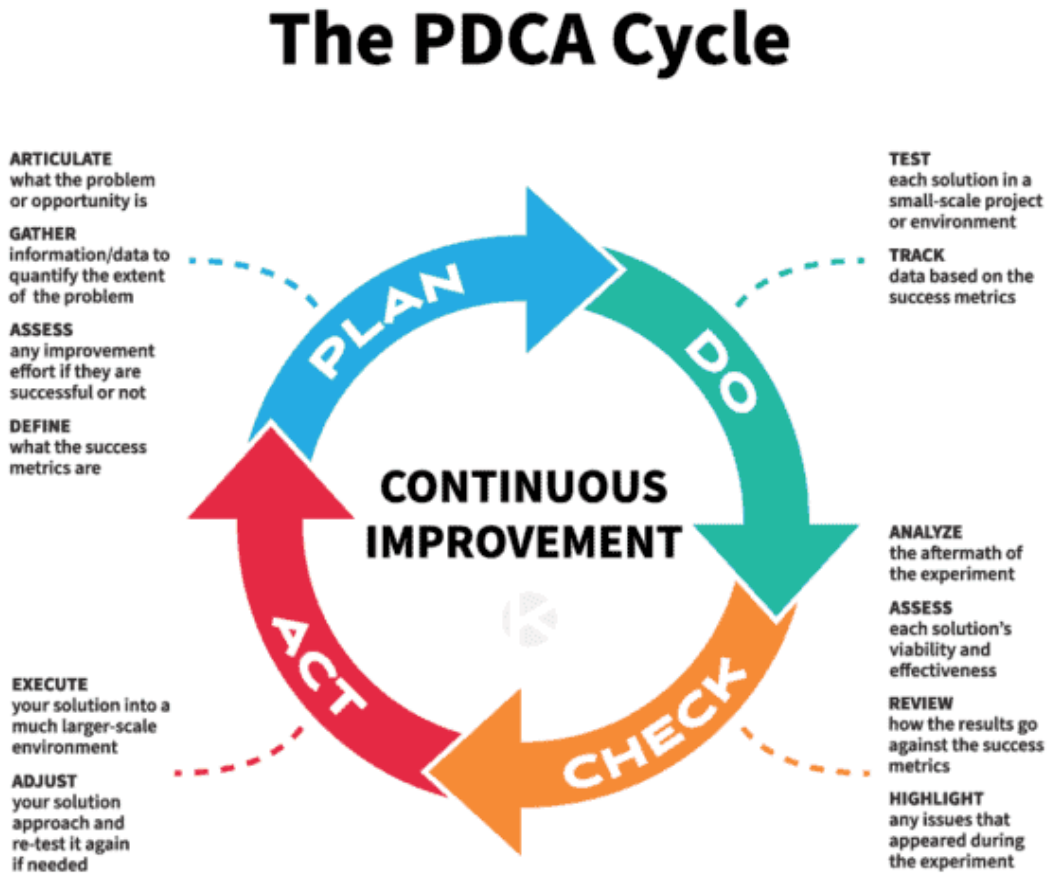
LEGEND: *(1-Hao et al, 2021; 2-Calderon, 2021; 3-Amieva-Balmori et al, 2019; 4-Ruscio, 2019; 5 Rezaie et al, 2019; 6-Schindler, 2020; 7-Achufusi, 2020; 8-Mehmet, 2019)*

Appendix B. Diagnostic Outcomes Synthesis Table

SYMBOL KEY
↑ ↑ = Increased, ↓ ↓ = Decreased, — = No Change, NE = Not Examined, NR = Not Reported,
✓ = applicable or present

LEGEND: *(1-Hao et al, 2021; 2-Calderon, 2021; 3-Amieva-Balmori et al, 2019; 4-Ruscio, 2019; 5- Rezaie et al, 2019; 6-Schindler, 2020; 7-Achufusi, 2020; 8-Mehmet, 2019)*

Appendix C. PDCA Cycle (Boiser, 2021)



Appendix D. IRB Approval Letter

OTTERBEIN UNIVERSITY

INSTITUTIONAL REVIEW BOARD

☒ Original Review
☐ Continuing Review
☐ Amendment

Dear Dr. Chavez,

With regard to the employment of human subjects in the proposed research:

HS # 22/23-50
Chavez & Bonczak: Small Intestinal Bacterial Overgrowth Testing Strategies

THE INSTITUTIONAL REVIEW BOARD HAS TAKEN THE FOLLOWING ACTION:

☒ Approved
☐ Approved with Stipulations*
☐ Limited/Exempt/Expedited Review
☐ Disapproved
☐ Waiver of Written Consent Granted
☐ Deferred

*Once stipulations stated by the IRB have been met by the investigator, then the protocol is APPROVED.

1. As Principal Investigator, you are responsible for ensuring all individuals assisting in the conduct of the study are informed of their obligations for following the IRB-approved protocol.
2. It is the responsibility of the Principal Investigator to retain a copy of each signed consent form for at least four (4) years beyond the termination of the subject's participation in the proposed activity. Should the Principal Investigator leave the university, signed consent forms are to be transferred to the IRB for the required retention period.
3. If this was a limited, exempt, or expedited review, there is no need for continuing review unless the investigator makes changes to the proposed research.
4. If this application was approved via full IRB committee review, the approval period is one (1) year, after which time continuing review will be required.
5. You are reminded you must promptly report any problems to the IRB and no procedural changes may be made without prior review and approval. You are also reminded the identity of the research participants must be kept confidential.

Signed: Noam Shpancer IRB Chairperson Date: 2-15-2023

Appendix E. Project Timeline (Moran et al, 2020)

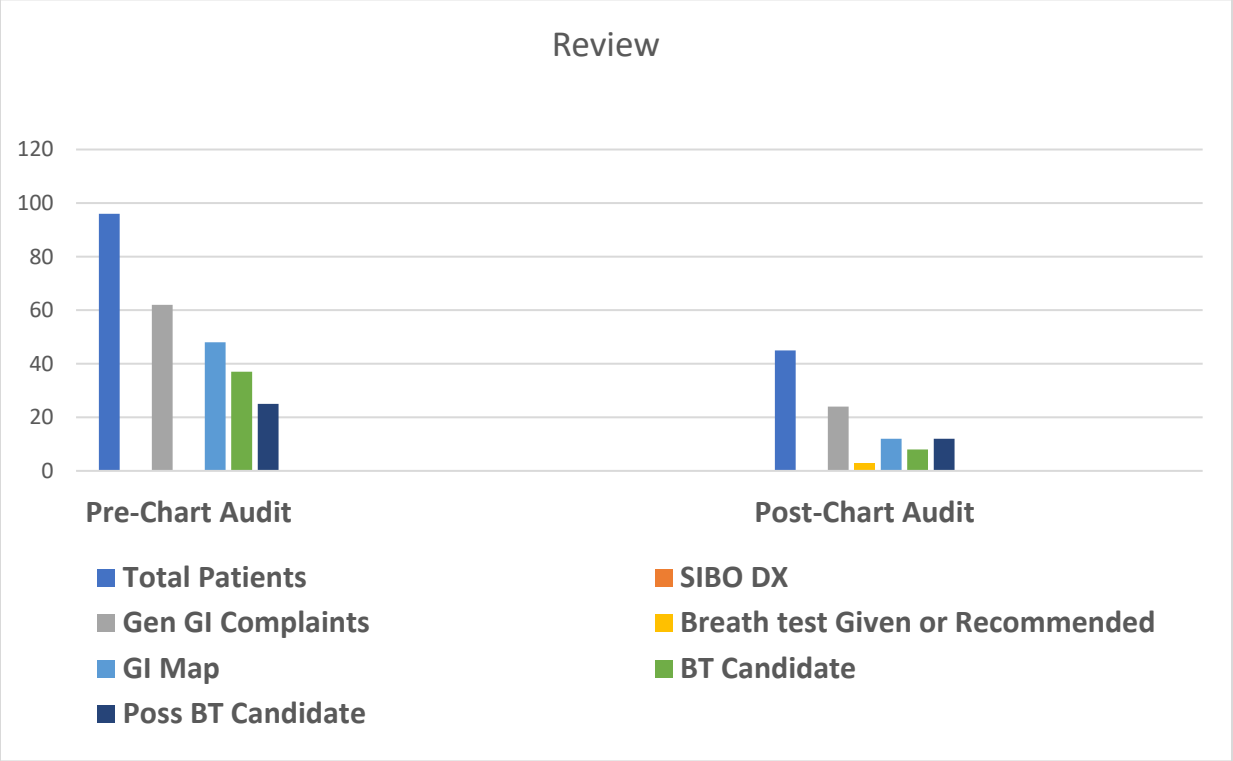
Stage	Milestone	Oct 22	Nov 22	Dec 22	Jan 23	Feb 23	March 23	April 23
Initiation	App C Approved			x	x			
Planning	SIBO Seminar	x	x	x	x	x	x	x
	IRB approved				x	x		
	EBP Immersion		x	x				
Implementation	• First Chart review take place • Educational Session Provided • Second Chart Review takes place					x x x x x	x	
Monitor	First Chart Review results				x	x		
	Second chart review results						x x	
Closing	Review and Compare all Results						x x	
	Complete FSP							x
	Poster Presentation							x

Symbol Key: x=no change in timing; x = planned; x = actual

Appendix F. Budget (Moran, et al, 2020)

	Planned	**Actual**
Handout materials and printing cost to give participants	$25	$0
Breath Tests samples to APRN's at Functional Medicine Clinic allowing the chart review	$200	$0
Gift to provider and mentor for FSP assistance	$150	$0
Total Costs	**$375**	**$0**

Appendix G. Pre and Post Chart Review Results



Appendix H. Paired T-test results

t-Test: Two-Sample Assuming Equal Variances		
	143	*48*
Mean	41	12.625
Variance	982.6666667	226.8392857
Observations	7	8
Pooled Variance	575.6826923	
Hypothesized Mean Difference	0	
df	13	
t Stat	2.285034007	
P(T<=t) one-tail	0.019873305	
t Critical one-tail	1.770933396	
P(T<=t) two-tail	0.03974661	
t Critical two-tail	2.160368656	