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Educating Staff Nurses on the Early Recognition of Clostridium Difficile in Cancer Patients

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by

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Abstract

With rates of Clostridium difficile on the rise, and potentially devastating consequences of infection in cancer patients, it is essential for oncology nurses to detect this infection early in their patients. Recent research has added better understanding about the effects of chemotherapy on the intestinal tract with specific focus on the potential for the C-diff infection. Following a thorough literature review of these findings an educational poster presentation geared towards staff development was created and presented to oncology staff nurses. The purpose of this presentation was to assist nurses in gaining knowledge of the current evidence supporting the importance of early detection, treatment, and prevention of C-diff infection in cancer patients.

Introduction

Clostridium difficile (C-Diff) is a gram positive, spore-forming, anaerobic bacterium (Anasari, Choo, & Fernando, 2010; Chopra, Alangaden, & Chandrasekar, 2010; Raza, Baig, Russell, Gourdet, & Berger, 2010), which is responsible for creating complications ranging from dehydration to death (Winkeljohn, 2011). Over the last 10-15 years there has been a steady increase in the documented cases of C-diff. In 1996 there were 31 cases per 100,000 population, in 2003 that number increased to 61 cases per 100,000 (Chopra et al., 2010) and in 2005, there were 84 documented cases per 100,000 (Raza et al., 2010).

Anyone who is receiving antibiotics is at an increased risk for developing C-diff, new strains of C-diff have been discovered that are associated with higher death rates and greater resistance to antibiotics (Chopra, et al., 2010; Winkeljohn, 2011). In addition to antibiotic use, other risk factors for the development of C-diff include, cancer treatment (chemotherapy and radiation therapy), prolonged hospitalization, GI surgery, being immunocompromised, and advanced age (Chopra et al., 2010; Winkeljohn, 2011). Thus, this infection is most commonly identified in those who have been hospitalized or reside in long-term care facilities (Raza et al., 2010).

Complications of C-diff can include mild diarrhea, fulminant colitis with megacolon or perforation of the colon, and potentially death (Anasari et al., 2010; Chopra et al., 2010). C-diff infection cannot be dismissed as trivial, particularly when it occurs in patients who are being treated for cancer. It occurs frequently, is oftentimes severe, and contributes to debilitation and compromised care in treating the underlying cancer (Chopra et al., 2010).

Diagnosis and treatment of C-diff infection is often complicated, particularly in patients battling cancer, because it is often mistaken as chemotherapy-associated GI toxicity resulting in

nausea, vomiting and diarrhea. It is especially important to accurately detect and diagnose C-diff infections early in cancer patients because of weakened immune systems of the patients following treatment and the difficulty with treating C-diff (Winkeljohn, 2010). Nurses who work with cancer patients need to be able to differentiate C-diff infection from the side-effects related to cancer treatment so that changes in treatment can be implemented to prevent the worsening of symptoms and maintain the clinical stability of the patient.

This paper presents current evidence that informed a staff educational presentation to improve nursing knowledge about the physiological effects of cancer treatment specific to the development of C-diff infections. The educational presentation included recently identified risk factors for the development of C-diff and the clinical progression of the infection specific to oncology patients.

The next sections will describe the purpose, significance, and theoretical framework that drove this project. The critical review of literature will follow to build the evidence base of the educational presentation. Finally, a discussion will summarize the findings and will describe the educational presentation in detail.

Purpose

The purpose of this staff development presentation was to inform nurses of the increasing problem of C-diff in cancer patients. Differentiation between chemotherapy-related diarrhea and C-diff infection can be difficult clinically. A high degree of suspicion along with prompt testing for C-diff is required, especially for neutropenic patients presenting with diarrhea (Anasari, 2010). There are several characteristics associated with C-diff infections, including the time of clinical manifestation of symptoms and certain chemotherapy regimens as well as type of malignancy, that are common and can provide insight into the cause of symptoms. Oncology

nurses should know the basic pathogenesis of C-diff and be aware of the common types of therapies and diagnosis that are associated with the development of C-diff in order to be more aware of the potential for infection, and to promptly test and diagnose patients with C-diff. Nurses must be alert to the presence of C-diff infection so that the appropriate precautions and treatment are initiated.

The participants in this educational event are professionals with a foundation of clinical knowledge, therefore the educational presentation utilized Adult Learning Theory to inform staff about the chemotherapeutic agents and other risk factors related to the development of C-diff in oncology patients. In addition, the results of the recent research were reviewed to help the staff gain a better understanding of the pathophysiological changed related to C-diff, disease progression, potential complications and current treatment. The presentation included use and explanation of evidence-based tools to predict the patients who are at the highest risk for the development of C-diff.

Significance

Oncology patients are at increased risk not only for the development of C-diff infections but also more severe forms of C-diff. The risks are increased because of treatment option such as chemotherapy. Over recent years research has turned to focus on the cellular and microbial effects of cancer treatments. The therapeutic purpose of chemotherapy is to destroy cancer cells, stop cancer from spreading, or slow the growth of cancer cells (National Cancer Institute, 2008). However the side effects of chemotherapy create risks for this infection through two primary mechanisms. The current evidence related to the two mechanisms, direct cellular effects and indirect neutropenic effects follows.

Direct Effect of Chemotherapy that Increases Risk for C-diff Infection

Chemotherapy has been shown to cause disruptions in the cellular membrane of the gastrointestinal tract of animals leaving them more susceptible for C-diff to colonize (Anasari et al., 2010). Researchers have been able to demonstrate that chemotherapy causes disruption to the normal microbial flora in the intestines (Raza et al., 2010; Zwielehner, 2011) as well as histological changes (Boukhettala et al., 2009) which can leave patients more susceptible to C-diff infections. However, other chemotherapeutic agents cause similar changes to the microbial system which may actually protect patients from C-diff despite producing similar symptoms (Lin et al., 2012).

Indirect Effect of Chemotherapy that Increases Risk for C-diff Infection

Neutropenia is a common side effect of chemotherapy which decreases the body's natural ability to fight infections. As a result many cancer patients are prescribed antibiotics either prophylactically or when a patient develops a fever. Early detection of C-diff in the neutropenic patient is crucial because of the alterations in the response of the immune system (Apostolopoulou et al., 2011) and treatment of C-diff infection in this population presents an increasing challenge to the clinician (Chopra et al., 2010). Recent studies have shown that when mice colonized with c-diff are given antibiotics a "super shedder" state is produced. It is in this state when mice begin to develop symptoms of infection and are the most likely to spread the C-diff infection to others (Lawley et al, 2009).

Nursing Implications

C-diff that is left undiagnosed or untreated can go on to cause numerous problems in patients. Mild to severe diarrhea can cause shifts in fluid and electrolytes. Patients can develop toxic mega colon, potential for perforation of the colon (Anasari et al., 2010; Chopra et al.,

2010), even renal failure and acute respiratory distress has been noted (Lawley, et al, 2009), and ultimately death can result (Anasari et al., 2010; Apostolopoulou et al., 2011; Chopra et al, 2010; Loo et al., 2011). We know that patients who are treated with chemotherapy and particularly those who suffer from neutropenia are at increased risk of the development of infections, and that when infected with C-diff these patients tend to experience more significant consequences of the disease. It is crucial that the nursing staff caring for at risk patients are aware of the risk factors for the development of C-diff as well as the clinical signs and symptoms of disease in order to ensure that C-diff is treated promptly, worsening of infection is prevented as well as preventing the spread of infection to uninfected patients on the unit.

As we are learning more, we can expect to see more changes to oncology protocols and the way that we treat cancer patients. This paper presents the evidence for an educational presentation developed to inform nursing staff of the newest evidence to combat the serious threat that C-diff infections pose to cancer patients.

Theoretical Framework

Adult Learning Theory was used as the guide for the framework of this educational presentation. Knowles based his theory on the idea that adults learn differently than children and makes several assumptions about adult learners (Smith, 2002). These assumptions are that adults:

- are self-directed,
- need to have an identified problem or reason to learn new information,
- use their previous experience as a resource for learning,
- are oriented toward problem-centered learning, and

- seek information that is applicable to the problem and useful in their current role

(Mitchell & Courtney, 2005; Smith, 2002).

The Adult Learning Theory has been criticized for not really being a theory, but is more generalized principles or characteristics about adult learners (Kaufman, 2003). Yet there is much that can be learned about what adults need in order to learn new information, and this can be useful in developing a teaching plan and presentation for professional development. The Adult Learning Theory recognizes the need for adults to be able to draw upon their previous experiences to aid in learning. Integrating research with clinical knowledge brings the best potential for learning to occur as well as a change in behavior and attitudes when compared with presenting new information alone (Coomarasamy & Kahn, 2004).

Mitchell and Courtney (2005) noted that educational interventions that incorporate these features are more likely to positively affect learning outcomes. The objective for the educator becomes empowering the learners' to accept responsibility for their own learning. Therefore educators need to shift the focus away from "educating people" towards "helping them learn" (Smith, 2002). Kaufman (2003) comments that the role of the educator becomes one of encouraging and supporting learners' to identify their own resources, develop strategies to achieve their objectives and supporting them in carrying out their goals. So in this way the educator becomes more of a guide or facilitator of learning.

Adult Learning Theory provided a congruent framework to direct this educational effort because the information presented was particularly relevant to the current job and responsibilities of the audience for which this program was designed. Specifically, the discussions were created to provide new evidence-based information to fill in the gaps of knowledge, or correct misunderstandings, and build upon nurses' experiences and current knowledge of C-diff. The

presenter facilitated learning by assisting the nurses to connect their previous experiences and knowledge with new information in a relevant way. In this way the presenter not only informed the learners, but also assumed the role of a facilitator. The educational presentation was structured by the six guiding principles for teaching practice based upon the Adult Learning Theory that Kaufman (2002) outlined (p. 215):

1. The learner should be an active contributor to the educational process
2. Learning should closely relate to understanding and solving real life problems
3. Learner's current knowledge and experience are critical in new learning situations and need to be taken into action
4. Learners should be given the opportunity and support to use self-direction in their learning
5. Learners should be given opportunities and support for practice, accompanied by self-assessment and constructive feedback from teachers and peers
6. Learners should be given opportunities to reflect on their practice; this involves analyzing and assessing their own performance and developing new perspectives and opinions

A poster presentation was used to facilitate the learning of new, evidence-based, and pertinent information. This method provided an outline that guided discussion during the presentation. Group discussion throughout the presentation helped to build new knowledge that was integrated with nurses' previous experiences and knowledge of C-diff. This mutual interaction was helpful in evaluating the level of learning that was occurring because the facilitator was available to immediately address areas identified as needing further information. In addition, this format provided time for nurses' to reflect upon their experiences and ways to

apply new information. The poster was made available to be posted on the unit so to be readily available for staff nurses' for continued reference. More importantly, the hope was that the most current research that informed the poster would stimulate additional thinking and discussion among all nurses on the unit.

Literature Review

Introduction

The intent of this review was to develop a current evidence base for an educational presentation to inform oncology nurses about the threat that C-diff infections pose to patients on an inpatient oncology unit. A review of current protocols was conducted to ensure that the current protocol reflects the most recent evidence-based recommendations.

Process

A review of current literature was conducted using PubMed, CINAHL, Cochrane database of systematic review, ERIC, Academic Search Premier. Search terms used included "Clostridium Difficile", C-diff, "C. difficile-associated diarrhea", "nosocomial diarrhea", oncology, neutropenia, chemotherapy, immunosuppression, "Adult Learning Theory", "staff education", "adult learning", "professional development", and "continuing education".

Search limits were placed on information for clostridium-difficile and cancer treatments to include only those articles published in the previous 6 years. A greater emphasis was placed upon the most current research studies and results published within the previous 3 years. Articles were limited to include only studies that involved adult cancer patients and/or cancer treatment, as well as inpatient hospital setting as opposed to community-acquired C-diff.

Search limits for the educational component including the Adult Learning Theory were limited to articles published since 2000. Articles were also limited to include only those involving adult learners and learning in the workplace as opposed to academic setting.

Physiological Effects of Cancer Treatment and the Relationship to C-Diff Infection

Several studies have been conducted to understand the effects of chemotherapy and antibiotics on the cellular level of the gastrointestinal tract. This section will critically analyze 4 studies that establish evidence for the purpose and significance of this project.

Zwielehner et al. (2011) studied the effect of chemotherapy on the fecal microbial system both during and after chemotherapy, with particular interest in the potential for C-diff infection. Boukhetta et al. (2009) looked specifically at how Methotrexate alters protein metabolism and histological damages throughout the intestinal tract. Lin et al. (2012) analyzed the changes in the intestinal tract caused by Irinotecan treatments, with and without oral glutamine. The role of antibiotics in the development of C-diff as well as disease transmission was studied by Lawley et al. (2009).

Methods.

Zwielehner et al. (2011) followed 17 patients receiving chemotherapy for the treatment of a variety of malignancies. Each patient was matched with a healthy control according to age, gender, body-mass index, health status (acute and chronic disease), lifestyle (alcohol consumption and physical activity level), and dietary habits. Average age of the chemotherapy patient was 59 years; the average age of the healthy control group was 65 years. Excluded from the control group was use of antibiotics, probiotics, and chemotherapy. Each person had fecal samples monitored for shifts in microbiota at four points in time, before and after chemotherapy and at 2 other points during one cycle of chemotherapy. As a strength of this study, the controls

were well matched to the subjects. The researchers also used DNA fingerprinting to identify each strain of organism and monitored the strains closely for shifts in microbiota overtime throughout the course of chemotherapy. As a weakness, a small number of participants were included in this study and multiple chemotherapy regimens were studied, making it difficult to identify specific chemotherapeutic agents linked to increased risk of C-diff infection.

Boukhettala et al. (2009) used male mice as the subject of their study. Each mouse was similar in age, weight and provided a similar diet prior to the study. The mice were housed in individual cages and injected with either Methotrexate or normal saline. On days 0, 4 and 7 the mice were euthanized in order to sample tissue from the duodenum and jejunum for histologic and immunologic study. Strengths of this study include that the rats used in this study were given a dose appropriate amount of chemotherapy, based upon body weight and similar to what humans would receive during cancer treatments. In addition to studying the effects of the chemotherapy they also looked at actual tissue samples to determine the specific physiological effects of treatment. A weakness is that rats were used in the study and the information is generalized to the human population.

The study by Lin et al. (2012) used 344 female rats similar in age and caged separately. The rats were injected subcutaneously with tumor pieces in the flank area, followed by a dose-intensive chemotherapy intravenously. Rats were euthanized at set points in time throughout each cycle to assess the intestinal microbiota via fecal and cecal samples. Strengths in this study include using a weight appropriate dosage of chemotherapy, actual tissue samples were collected to determine specific changes and damages that occur as the result of cancer treatment, all specimens were analyzed independently. A weakness is generalizing the results from a study conducted with rats to the human population.

To study the effects of antibiotic use, Lawley et al. (2009) also used mice. In this study some mice were pretreated with neomycin to induce a C-diff carrier state followed by infection with C-diff via gastric lavage. The C-diff used in this study was similar to the strain isolated from a multi-hospital outbreak in Ireland. These mice were then house in separate cages, handled aseptically, and the cages were cleaned once a week. Following infection with C-diff the mice were given clindamycin in their drinking water and fecal specimens were obtained to monitor the amount of C-diff spores. C-diff naïve mice were housed in cages with C-diff infected mice to determine host-to-host transmission. To determine environmental transmission, infected mice were placed in a cage for one hour, the mice and feces were removed and naïve mice were placed in the same cage before being moved to a sterile cage and given drinking water with clindamycin. Mice were euthanized 4 and 7 days post-infection and the cecum and colon were examined for signs of epithelial damage. Strengths of this study include the use of a clinically relevant strain of C-diff to infect the mice prior to initiating treatment. The conditions of the study and the cage environments were closely regulated to prevent outside contamination or influence that may impact the results. As a weakness, the result of this study was the results of using mice were generalized to humans.

Results and Conclusions.

In the reviewed studies, chemotherapy and antibiotics contributed to a decrease in the intestinal microbiota leaving subjects susceptible to opportunistic infections such as C-diff. Interesting to note is that in the study by Lin et al. (2012), C-diff was undetected at all points in time, despite these microbial shifts, leaving the question of whether Irinotecan may actually protect from the development of C-diff. Further studies would need to be completed to identify

the specific reason. Glutamine was also shown to have a protective effect on the cecal microbiota and decreased the incidence of diarrhea, but lost effect 4 days after ingestion.

Alterations in the intestinal membrane were noted in the study by Boukhettala et al. (2009) who focused more on the cellular changes rather than microbial changes. Methotrexate was shown to cause necrosis, mucosal atrophy, and a decrease in protein synthesis and increased inflammation. Also, mucin content was impaired with a significant decrease in MUC2 gene expression with a significant increase in the MUC 3 & 4 gene expression. Zwielehner et al. (2011) noted that microbiota recovered in 5-9 days, though the subjects of their study involved a variety of chemotherapy protocols and might not be an accurate representative of changes Boukhettala et al. noted in their study with Methotrexate.

There were several notable results of the Lawley et al. (2009) study. This study demonstrated that C-diff can exist in an asymptomatic and persistent carrier state. This carrier state is not considered to be contagious due to excreting such low levels of spores, and antibiotics can trigger a contagious, "super shedding" state even without clinical signs of disease. Removing the antibiotic allowed the intestinal microbiota to rediversify, suppressed C-diff levels, and returned the mice to a carrier state. A severe form of C-diff infection was observed in several mice which resulted in multiple-organ dysfunction syndrome, renal failure, and acute respiratory distress.

These studies have several important implications for oncology nurses and patients. These studies demonstrate specific physiologic changes that occur at the cellular and microbial levels after chemotherapy that leave patients vulnerable to the development of C-diff infection. Therefore chemotherapy can be considered an independent risk factor for C-diff. C-diff can exist in an asymptomatic carrier state and can be triggered to active symptoms by antibiotic use

and return to a carrier state when antibiotics are withdrawn. It is when symptoms are present that a person is most contagious and likely to spread to another patient. During an asymptomatic carrier state C-diff spores continue to be shed, but at such a low level that patients are unlikely to infect another person.

Additional research is necessary to determine if a neutropenic patient, who is more susceptible to developing infection, is more likely to develop C-diff infection from an asymptomatic carrier. Also, additional research could provide evidence if the use of probiotics is effective to provide protection during chemotherapy treatment.

Risk Factors for the Development of C-diff Infection

Predicting patients who are at high risk for developing C-diff infection is crucial to initiate the appropriate precautions and treatment. It is especially important to diagnose C-diff early among cancer patients who often have fragile immune systems caused by their malignancy or the cancer treatment. In an attempt to identify risk factors researchers have conducted studies to identify common associations among people with C-Diff infection. This section of the review of literature critically analyzes 4 retrospective studies and 1 prospective study related to common risk factors for the development of C-diff infection.

Methods.

Gifford and Kirkland (2006) reviewed the charts of 47 patients who were admitted to an adult oncology/hematology unit in New England, over a 24 month period, and developed C-diff positive diarrhea at any point throughout their hospital admission. For a control group, 161 patients who were admitted to the same unit during the similar time period, who also developed diarrhea during their hospital stay however tested negative for C-diff. Controls appeared to be well matched on anemia, renal function, and types of malignancies. Charts were reviewed to

determine antibiotic administration along with the duration and timing, chemotherapy within 30 days or during hospitalization. Patients were excluded from the study if they had a prior diagnosis of C-diff. Gifford and Kirkland bolstered the strength of their research, by conducting data collection on an inpatient oncology/hematology unit and limiting the participants to those with a new diagnosis of C-diff, which directly related with the purpose of the project. They conducted a thorough chart review and matched the control group with the subjects, however they did not control for the severity of comorbid conditions. The relatively small sample size and lack of identification of specific chemotherapeutic agents weakened the study by preventing comparison of these results with other studies. Finally, the greatest weakness of this study was the lack of pretesting patients for C-diff upon admission to rule out an asymptomatic carrier state.

In a five year retrospective study of hospitalized patients, Chaudhry et al. (2008) reviewed the charts of 524 patients suspected to have C-diff. The charts were reviewed to determine the underlying cause of diarrhea. Review included fecal lab results, admitting diagnosis, unit admitted to, and list of medications. All patients were hospitalized in India, and approximately 53% were male, 47% female. All age groups were represented, though 82.5% of the subjects were 12-60 years old with a median age of 39 years. Strengths of this study include a sample size that was large enough to provide sufficient statistical power. On the other hand, the unconfirmed admission of C-diff diagnosis was a major weakness in this study.

To identify risk factors and assess three systems for accuracy of predicting C-diff infection, Apostolopoulou et al. (2011) examined the records of 102 patients hospitalized in Greece. All patients had a hematological malignancy (33.3% Acute Myelogenous Leukemia) and had been admitted to a hematology unit over a seven month period. Of the patients

approximately half male (52%), with a median age of 53.3 years (age range 17-85 years), all were inpatient for at least 48 hours. All patients were monitored for C-diff upon admission, weekly throughout hospitalization, if diarrhea developed, and at discharge. Those patients who were admitted more than once during the study period were excluded. Data collected included underlying disease; duration and severity of neutropenia; diabetes; use of Hickman catheter; all chemotherapeutic agents or antibiotics, antifungals, and corticosteroids administered; vital signs; microbiology testing; and staff notes. This study was conducted on a oncology/hematology unit, adding to the strength of effort. Data collected from the participating patients was compared with control patients with similar diagnosis. The researchers studied only hematological malignancies which can provide valuable information related to this group of malignancies and treatments. Conversely, this narrow focus also presents a limitation because it prohibits generalization to other groups of patients. The small sample size of participants is a recognized weakness, and furthermore, no information regarding asymptomatic colonized patients was reported.

Recognizing that C-diff infection can progress and cause more severe problems, Dallal et al. (2002) sought to define the clinical presentation and identify the common characteristics of patients who died or underwent a colectomy as a result of fulminant C-diff colitis. Researchers reviewed the cases of 2,334 total adult patients who were diagnosed with nosocomial C-diff over a 12 year period in a Pittsburgh, PA hospital. Of these 2,334 patients, 44 patients underwent a colectomy for C-diff, and 44 patients had C-diff as the cause of death confirmed upon autopsy. Only adults were included in this study. Strengths of this study include the large sample size, long study period, and that researchers looked specifically at the progression of C-diff to systemic infection despite treatment. As a weakness, this study is not specific to cancer patients,

and does not account for the overall health status of the patients prior to hospital admission. Of the 2,334 patients diagnosed with nosocomial c-diff included in this study, 314 died during hospitalization (13.5%). An autopsy was performed to confirm C-diff as the cause of death. Sixty-five percent of these patients were immunocompromised, 35% did not have the correct premorbid diagnosis and 20% did not have diarrhea but instead presented with an ileus and abdominal distention.

Loo et al. (2011) performed a 15-month prospective study in six Canadian hospitals. A total of 4143 patients were included in the study, 117 (2.8%) had health-care associated C-diff infection, and 123 (3.0%) had health-care associated colonization. Stool samples or rectal swabs were collected and tested for C-diff at admission, weekly, at development of symptoms, and at discharge. C-diff positive patients were matched with similar controls. All patients were over the age of 18 years, and units that were included were those that historically have a high or low incidence of C-diff infection. Patients who were hemodynamically unstable, neutropenic, receiving palliative care, or those who were unable to give consent were excluded from the study. In addition, sixty patients were excluded due to C-diff infection within 72 hours of admission, and 70% of the patients were excluded due to prior hospitalization within 3 months. The design strength of this study was the inclusion and monitoring of asymptomatic colonized patients as well as implementation of pre-testing of patients upon admit. Unfortunately a weakness recognized in this study was that controls were matched only on length of hospital stay and similar unit, and not by diagnosis or comorbid conditions. Additional weaknesses identified were that some patient participants were lost to the study follow up due to discharge, and the asymptomatic patients were not retested for the potential presence of spores, which may have resulted in underestimation of the incidence of healthcare acquired colonization.

Results and Conclusions.

The previously reviewed studies provided evidence that help identify risk factors for C-diff, which can assist oncology nurses with identifying patients at high risk, monitor cancer patients for the subtle, early signs of C-diff infection, and initiate the appropriate treatment and precautions to prevent the spread to other vulnerable patients. There is agreement that common risk factors for the development of C-diff infection are advanced age, multiple antibiotic use (especially with Cephalosporin), prior hospitalization within 60 days, and neutropenia (Apostolopoulou et al, 2011; Chaudhry et al, 2008; Gifford & Kirkland, 2006; Loo et al, 2011).

The study by Gifford and Kirkland (2006) found an increased risk of C-Diff infection in patients with lung and abdominal cancers, and treatment with IL-2. Gifford and Kirkland (2006) noted that lung cancer patients often receive the same chemotherapeutic agents that have been shown in other studies to cause significant rates of severe C-diff in breast and ovarian cancer patients; this increased risk is quite possibly related to the treatment regimen rather than the lung cancer itself, and further studies would need to be conducted to differentiate the cause. They did identify that there was not an increased risk of C-diff among those who received both chemotherapy and antibiotics when compared with those who received chemotherapy alone, confirming chemotherapy as an independent risk factor.

When reviewing the C-diff cases in the hospital in India, Chaudhry et al. (2008) found that 67.5% of all positive C-diff specimens were isolated from patients in the oncology unit, followed by GI surgery, neurology, and nephrology. Of the total number of cases, 95% were receiving antibiotics at the time. During this study the hospital initiated a stringent C-diff surveillance and antibiotic policy, the incidence of C-diff cases decreased following this implementation.

Loo et al. (2011) identified linked proton pump inhibitors with the incidence of C-diff as well as a previous C-diff infection, previous hospitalized within 60 days and chemotherapy. This study which included asymptomatic colonized patients suggests that the incidence of this group of patients is underestimated because currently patients are not tested for C-diff unless they are experiencing symptoms, most notably diarrhea. Also identified during this study was that in colonized patients, C-diff Toxin B was significantly less likely to progress to infection than was Toxin A.

Apostolopoulou et al. (2011) found that a longer duration of neutropenia (≥3 days) was statistically significant. Diabetes and Non-Hodgkins Lymphoma were also identified as contributing to C-diff, as was receiving multiple antibiotics or chemotherapy. The length of hospital stay was two-fold higher in C-diff positive patients versus those without C-diff. However, the study design did not allow a clear conclusion if the increased length of stay was due to C-diff infection or a risk factor for the development of C-diff.

Dallal et al. (2002) did not focus as much on the development of C-diff, but rather on the progression to systemic inflammatory syndrome and death or those requiring a colectomy. Several risk factors were identified for disease progression and poorer prognosis. Age > 65 years, no patient under the age of 50 years died after a colectomy, and no patient > 80 years survived; there was no difference between the genders. Dallal et al. (2002) found that some patients with C-diff did not have the characteristic symptom of diarrhea, but rather presented with abdominal distention and ileus. This study demonstrated that nurses cannot rely on diarrhea as the sole indicator of C-diff infection and need to have a keen awareness of the potential for C-diff and subtle signs that may point towards this infection.

From these studies we recognize that there are common risk factors that can alert an oncology nurse to the potential of C-diff. The risk factors that were revealed during this literature review included receiving antibiotics (especially cephalosporins and quinolones) and/or chemotherapy protocols (especially Doxorubicin, Cyclophosphamide, 5FU, Methotrexate, Platinum, and Taxanes), recent hospitalization or prolonged hospitalization, previous C-diff infection, age greater than 60 years, neutropenia, and recent surgery. If left undiagnosed C-diff can progress to serious systemic complications and can cause death or contribute to death. The early detection of C-diff is crucial for initiating the appropriate treatment and monitoring patients for disease progression.

Environmental-to-Host Transmission Factors in the Development of C-Diff

Healthcare personnel have frequently been implicated in the spread of C-diff infection, mainly on their hands after touching contaminated surfaces (Centers for Disease Control and Prevention, 2012). C-diff spores can remain in the environment up to 40 days creating the potential to infect new patients (Hooker, 2007). As the previous review of literature demonstrated, oncology patients already have many risk factors for developing C-diff infections. Therefore it is important that oncology nurses have a solid appreciation of how C-diff spreads to patients, and how to ensure that the appropriate precautions are maintained. This section of the review of literature analyzes studies that provide information related to the transmission of C-diff from the environment to patients.

Methods.

Vaishnavi and Singh (2012) studied the prevalence of C-diff contamination in the environment of patients with C-diff infection, and the potential for patients to develop nosocomial infection from the environment. Fecal samples were obtained from 79 patients upon

admission to medical and surgical units of a hospital over a 14 month period. A second fecal sample was obtained from those who developed diarrhea (≥3 unformed stools within a 24 hour period) more than 48 hours after admission. Participants ranged from 15-75 years, 44 were males, 35 were female, and 63 participants were on antibiotics during their hospitalization. Excluded from the study were patients who were unable to produce a stool specimen upon admission, predominantly from the surgical unit, as well as patients who were discharged before the onset of diarrhea. Environmental swabs were also collected from the hands of 48 hospital personnel and 176 swabs from hospital beds. Of the 79 participants in Vaishnavi and Singh's (2012) study, 75% were C-diff positive by stool culture, and 62.5% of these were positive for both toxins A and B. Environment swabs revealed that positive cultures were obtained from 62.5% of the hands of hospital personnel and 51% of the patients' beds. The strict focus on the environmental exposure in the transmission of C-diff, and fecal samples obtained at admission, establishing whether or not a patient was previously infected or colonized prior to admit, are recognized strengths of this study. A weakness is the limited results as many patients were lost to follow-up after discharge. This study was also the only study included in this literature review that included patients who developed diarrhea after 48 hours, whereas the other studies excluded patients who developed symptoms within 72 hours of admission.

Best, Fawley, Parnell, and Wilcox (2010) studied air samples as well as environmental samples to determine a link between patients and their surroundings and the possibility for C-diff aerosolization. Air sampling was intermittently conducted in spaces adjacent to patients with C-diff infection for a total of 180 hours, and 101 hours for control subjects. Throughout sampling activity was observed and recorded to identify any specific times when air samples peaked. Environmental samples were obtained from surfaces adjacent to the patient and from common

areas throughout the nursing unit. The most positive air samples were from patients who were C-diff positive with active symptoms, and no positive air samples were obtained from the control subjects. Air samples were the highest during periods of time with increased activity such as changing bed linen, meal tray delivery, and visiting hours. Environmental samples demonstrated high levels on surfaces that are frequently touched such as patient beds, tray tables, and sinks, though IV pumps, privacy curtains, the floor. Infrequently touched surfaces also tested positive for C-diff spores. Among the strengths of this study is that the air sampling plate rotated constantly and the location of the colonies made it possible to link them to the activities near the sampler; the machine was also cleaned daily with sporicidal disinfectant; and the study was able to confirm highly related strains of C-diff in patient fecal samples with the air and environmental samples. The positioning of the air sampling tubes which could be easily displaced and may have resulted in the loss of particles is a recognize weakness of this study method. This study was dependent upon the healthcare workers informing the research team of the presence of symptoms in order to accurately mark the air samples, and the small sample size are also limiting factors.

Results and Conclusions.

These studies show that early detection of C-diff and initiation of appropriate precautions, cleaning regimens, and isolation in private rooms can help prevent the spread of C-diff to other patients, especially cancer patients who already have a higher risk for C-diff infection and higher mortality in those with neutropenia. C-diff spores can be disseminated via airborne to contaminate infrequently touched surfaces and have been demonstrated to remain dormant in the environment for weeks (E. Best et al., 2010). As Vaishnavi and Singh (2012) demonstrated, patients can become infected with C-diff after coming in contact with these

surfaces. Staff and patient education, initiation and maintenance of isolation precautions, environmental cleaning, and enforcing hand washing are all necessary in the prevention of the spread of infection.

Use of Poster Presentations to Disseminate Information to Adult Learners

Poster presentations have a unique advantage in that the posters can be made available to learners to access and reference after the initial presentation is complete. Learners are able to take time to reflect upon the content and can stimulate discussions among colleagues. This section of the literature review will critically analyze 3 studies that will provide evidence for the effective use of this method to disseminate information.

Methods.

Kerr, Eves, and Carroll (2000) examined the use of health information posters to promote change in the behavior of participants. Posters regarding the benefits of physical activity were placed near escalators in a shopping mall. A total of 658 participants were interviewed at the top of the escalators and nearby stairs to assess baseline activity, self-reported readiness to change level of exercise, and the reason participants chose the stairs or the escalator. The results of this study demonstrated that stair use statistically increased, while the poster was displayed, and stair use decreased after the poster had been removed. People who reported a lower level of physical activity increased stair use as a result of the posters. In this study, participants who reported that they were not contemplating a change in activity level (40.2%) reported not even seeing the poster versus only 8.6% of participants who were considering a change in activity level. Immediate feedback was made at the point of the intervention, which is a strength of this study. Weaknesses of this study include the use of five interviewers gathering data which could influence participants and vary their responses, and that a randomized control trial was not used.

Hess, Tosney, and Liegel (2009) studied the potential benefits of poster presentations compared with oral presentations, as well as the characteristics of an effective poster as a visual communication tool. The authors examined 142 posters at a national professional society conference for overall appearance, ease of locating information, and compared poster presentations with oral presentations. A 60-second evaluation of each poster was conducted along with a 15-second scoring of visual appeal and organization of content. The 15-second scoring correlated with the 60-second more detailed poster evaluation. This study found that many posters were cluttered, sloppy, and the print was too small to comfortably read. When compared with oral presentations, the benefits of poster presentations included reaching a larger audience, information could be presented in a variety of ways, presenters could respond immediately to feedback, posters promoted group discussions, and the posters could be viewed when the presenter was not present. Strengths of this study are that the same evaluators evaluated the posters and a consensus was reached among the evaluators. As weaknesses, only one evaluator viewed all of the posters at the conference and the results were based upon subjective evaluation.

Willett, Paranjape, and Estrada (2008) developed a study to test an evaluation tool to measure the quality of poster presentations and identify the specific components most in need of improvement. This study used 45 faculty members to evaluate a total of 347 posters in 4 annual academic conferences. Each evaluator used a 10-point evaluation tool to measure poster quality, content, discussion, and format. The common areas identified to improve poster quality include clearly stating the learning objectives, and the conclusions should be clearly related to the objectives and supported by the content. Clear communication includes using an appropriate amount of words to convey the message without cluttering the poster. The evaluation tool used

was reported to have high internal consistency, and faculty rated posters in similar ranges which add to the validity and reliability of the study. The major limitation of this study was, only case report posters were evaluated and the feedback provided to presenters was not anonymous which may have influenced the critique and overall score of the poster.

Results and Conclusions.

The results of the study by Kerr, et al. (2000) demonstrated that posters can be useful in prompting a change in behavior. However in this study the poster needed to be on display and near the location of change. Therefore it will be important to allow the poster to remain on display for an extended period of time to allow staff time to review, reflect and practice. In addition to this proper signs should be placed on the doors to patient rooms and visible upon entering and exiting rooms to serve as a reminder for appropriate precautions. As in the study by Kerr, et al. (2009), when the poster was not present behavior returned to previous levels. Another factor noted by Kerr, et al. (2009) was the self-reported readiness for change in participants, as those who were less likely to see the poster were also less likely to have considered the need for change. Participants need to identify the reason for change as a motivational focus for changing their behavior.

To be effective, the posters need to be free of clutter with clearly stated objectives, section headings to organize content, and easy to read text and size (Hess, et al. 2009; Willett, et al. 2008). Hess, et al. (2009) found that graphs added a visual element which effectively illustrated the main points. There is a need to make certain that the objectives, headings, content, and conclusion are clearly related which helps the presenter stick to the purpose of the presentation (Willett, et al. 2008).

Adult Learning Theory as the Theoretical Framework for Staff Education

Adult learning theory is based upon a set of characteristics about how adults learn (Kaufman, 2003). This theory has been applied to several studies to either increase knowledge or produce a change in behavior. This section of the literature review will provide studies that demonstrate the effectiveness of using adult learning theory in educational curriculum.

Methods.

J. Best et al. (2011) used adult learning theory as a basis for staff education regarding the critical need for the early initiation of antibiotics in neutropenic febrile patients presenting through the emergency room or those who were currently admitted. The educational plan relied on a multidisciplinary team and included the use of poster presentations, either group or one-on-one in-service presentations, and follow-up with the clinical nurse specialist or nurse educator. Charts were reviewed and 30 neutropenic febrile patients were identified prior to the staff education, and 23 patients after the staff education were identified. Research teams identified the length of time from when the orders for antibiotics were placed to when the antibiotics were actually given. Following the staff education the time period significantly decreased for both the length of time from admission to administration of antibiotics and, for patients already admitted, the length of time from the placement of the order to administration of the antibiotics. A strength of this study was the use of a multidisciplinary team, which was able to identify various barriers to the initiation of antibiotics and implement barriers to reduce these barriers. A limitation is that due to the various interventions it is difficult to relate the results of the study to a specific intervention.

Freedman, Echt, Cooper, Miner, & Parker (2012) studied the effect of various teaching strategies to influence a change in health related behavior in adult students enrolled in a health

literacy class. Students who already completed 12 hours of the class and were fluent in English, enough to be able to complete the interviews, were eligible to participate. The study consisted of ten 2-hour classroom observation sessions with the use of a guide to record educator strategies and student response to the strategies. Interviews with learners were conducted to explore their attitudes of the educator strategies, including their perception of the classroom environment, and the opportunity to use new information and skills they learned in class. Interviews were also conducted with educators to explore the philosophy of teaching and educational strategies. The results of these methods were then coded to identify themes and commonality among the effective strategies. The result of the study demonstrated those learners who reported a change in health behavior or weight loss also reported feeling more engaged in the education, were comfortable participating in discussion, drew from previous knowledge and had practical application suggestions for new information. Evaluators found that instructors set up the chairs in the classroom in such a way to facilitate discussion, and used multiple modes of instruction to engage a variety of learners. Strength of this study included the use of a focus group to discuss and validate the preliminary findings and to solicit feedback on the accuracy of the interpretation. A limitation to the generalizability of the results of this study was the self-reported change in behavior that was assessed qualitatively and not directly measured or observed. Also the study was conducted on a small group of people and may not represent the population as a whole.

Results and Conclusions.

Several key findings about the usefulness of adult learning theory have been demonstrated that can apply to staff education. Drawing from learners own clinical experience along with the clinical significance helps the learners understand why they need to learn

something and take responsibility for their learning (J. Best et al., 2011; Freedman et al., 2012). Freedman et al., 2012 demonstrated that educators promote learning and influence a change in behavior by presenting information a variety of ways, and by establishing an environment conducive to discussion, which can encourage participation and empower students. J. Best et al. (2011) found that staff education was essential to the successful implementation of practice change and the incorporation of current evidence to guide practice.

These results relate to the adult learning theory because the focus of learning is on the learner. In adult learning theory the emphasis is on what the learner needs to know, builds upon what they already know, and the educator takes on the role of a facilitator (Smith, 2002). For optimal learning to occur, the learner needs to be focused on a real-life problem, be motivated and able to apply the knowledge to a life situation, and be in control of their learning (Mitchell & Courtney, 2005). Each of the three studies in this section draw from the principles of adult learning theory, and demonstrate the usefulness of this theory as a foundation for adult education and thus as the theoretical foundation for this staff education effort.

Discussion

With rates of C-diff climbing nationally and cancer patients leading among all groups of patients (Chaundhry et al., 2008), it is more important than ever for oncology nurses to be aware of the potential for C-diff in this high risk group. C-diff can be transmitted from patient to patient on the hands and equipment of healthcare workers, early detection can allow nurses to take the appropriate precautions and place patients in isolation to minimize the risk of the spread of infection. Through early detection the consequences of this infection can also be minimized, medications can be changed to those that are less likely to contribute to infection, and nurses are

aware of the need to monitor for the early and more subtle signs that the infection has progressed to organ failure.

Research studies have shown that chemotherapy causes physiological changes in the intestinal tract that leave a cancer patient vulnerable to C-diff infection Boukhettala, et al., 2011; Lawley, et al., 2009; Lin et al., 2012; Zwielehner, et al., 2011). Retrospective studies have also identified common characteristics of patients who are more likely to become infected with C-diff (Apostolopoulou, et al., 2011; Chaudhry, et al., 2008; Gifford & Kirkland, 2006; Loo, et al., 2011). When oncology nurses are aware of those who are at high risk for C-diff they are more likely to identify C-diff earlier and prevent the spread to others (Best, et al., 2010; Vaishnavi & Singh, 2012), and patients can then receive the appropriate treatment needed to overcome this infection or prevent it altogether. The purpose of this project was to educate staff nurses on detecting cancer patients who are at high risk for the development of C-diff so that infection can be detected early and treatment and precautions initiated immediately.

A poster presentation framed by Adult Learning Theory was used to present information to staff nurses. This method has been demonstrated to be an effective way to ensure that all nurses receive this education (Best, et al, 2011; Freedman, et al., 2012; Kerr, et al, 2009). The poster was left visible to nurses for several days prior to the beginning of the actual presentation sessions. In this way the nurses who were unable to attend a presentation session were still able to receive the information. Making the poster available before the presentation also allowed nurses the opportunity to think about the participant's current knowledge about C-diff, and experiences of caring for patients with C-diff, and finally how the new information acquired from the poster might be integrated into this past understanding. During the presentation the discussion was facilitated by the presenter to incorporate the new information with what was

already known by the staff, and to clarify any misunderstandings or questions as they arose. Adult learning theory proved to be a good foundation to use for this presentation. This framework kept the focus of the presentation on learner. The discussion generated was centered on the previous experience and knowledge base of the participants. Throughout the discussion the participants incorporated new information into the practical application of the care of cancer patients, including the possibility of a change to unit policy and practice (Mitchell & Courtney, 2005; Smith, 2002). Specific content of the discussion follows.

The poster itself was designed to be easy for staff to read and understand, along with all of the important pieces of information the nurse participants need to know to be able to detect C-diff early in their cancer patients and to prevent the transmission of the infection to other patients. The poster included an overview of recent research findings related to the specific importance to this group of patients. Sections of the poster were dedicated to the evidence related to the physiology of chemotherapy on the intestinal tract (Boukhettala, et al., 2009; Lawley, et al., 2009; Zwielehner, et al., 2011), the high risk chemotherapeutic agents (Lawley, et al., 2009; Lin, et al., 2012; Zwielehner, et al., 2011), high risk groups of patients (Apostolopoulou, et al., 2011; Chaudhry, et al., 2008; Dallal, et al., 2002; Gifford & Kirkland, 2006), and information regarding how to prevent the spread of C-diff to uninfected patients (Best, et al., 2010; Vaishnavi & Singh, 2012). The poster was then used as a guide during the presentation to help facilitate the discussion.

Discussions were generated from the information presented on the poster and nurses were encouraged to discuss their past experiences of taking care of oncology patients with C-diff infection. Staff focused discussions around the recent research related to the physiological changes associated with C-diff and how to use this knowledge to protect patients from C-diff

infection through nutrition and medications. Some staff expressed concerns regarding how common it is to spend a shift caring for a patient only to come back the next day to find that same patient in enteric precautions when they were not having active symptoms of C-diff the day before. This was related to a concern of sharing patient equipment (such as blood pressure cuffs, pulse oximeters, and stethoscopes), as C-diff spores are able to be transported on the hands and equipment of healthcare workers and infect other patients (Best, et al., 2010; Vaishnavi & Singh, 2012) and not simply relying on active symptoms as the only indicator of C-diff infection as some patients with active C-diff may not have active symptoms (Hooker, 2007). A recommendation was made to ensure that working blood pressure cuffs and thermometers are available in each patient room, and that any equipment that is shared between patients should be wiped down with a disinfectant between each patient to prevent the potential spread of C-diff and other pathogens to uninfected patients (CDC, 2012).

According to comments made by multiple RNs, expressed during and following the presentation, the hospital Infectious Disease (ID) department stated that oncology patients are not at a higher risk of developing C-diff, and in particular, that chemotherapy is not a risk factor for the development of C-diff infection. These staff members commented that they felt somewhat relieved to know that the increased prevalence of C-diff on their oncology unit is a nationwide problem, and not specific to their staff and institution, which was their understanding of the conclusions communicated by the ID department and hospital administration. The members from the oncology Unit Based Quality Team (UBQT) stated that they would take the concerns and recent educational material to the ID department to discuss if any changes to policy and protocol are necessary to help aid in the early detection of C-diff and prevent the

transmission to other patients. A list was provided to all participants of all the journal articles cited in the poster.

Conclusion

C-diff causes a wide range of complications ranging from dehydration to death (Winkeljohn, 2011). This infection can be especially devastating to cancer patients who, due to immunosuppression, are at an increased risk of more severe forms of C-diff (Chopra, et al., 2010). Thus, it is especially important for oncology nurses to be cued into the early and more subtle signs and symptoms, which may otherwise be overlooked as a side effect of cancer treatment (Winkeljohn, 2011). Hospital policies are in the process of being reviewed with the ID department to determine if changes need to be made to the current practice in the oncology setting. In addition to an overall greater awareness and discussion related to the problem with C-diff in this population, RNs have placed a greater focus on preventative precautions and are educating unlicensed nursing staff on the potential for spread of infection. The inpatient oncology unit educators are in the process of developing an educational tool for C-diff, among other infectious diseases that are commonly treated on this unit, for new employee orientation.

As a result of recent research, we now have a better understanding of what exactly chemotherapy does to the intestinal tract (Boukhettala, et al., 2009; Lawley, et al., 2009; Lin, et al., 2012; Zwielehner, et al., 2011). Studies looking into these areas may help provide the knowledge to alter treatment protocols in such a way that will protect the intestinal tract from the effects of chemotherapy that would otherwise leave patients vulnerable to C-diff infections (Boukhettala, et al., 2009; Lin, et al., 2012). Research is also needed to clarify if neutropenic patients are at risk of developing C-diff from an asymptomatic carrier patient, which may change hospital protocols around the use of shared equipment, the process for early testing of C-diff,

how nursing assignments are created, preventative precautions, and education for this population of patients.

With appropriate education of C-diff in this population of patients, nurses are better prepared to detect C-diff infection early in patients and implement the appropriate protocols. This ensures that cancer patients have the best chance to receive prompt treatment to potentially minimize further complications related to this infection, as well as prevent the spread of infection to other patients.

This project has provided an avenue to initiate change to the practices on this unit. The presentation of current evidence was specific to necessary changes for one threat to a particular patient group, but perhaps this process using Adult Learning Theory can serve as a template for future learning needs in order to provide evidence-based solutions to improve the health and well-being of patients, families and communities.

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