

# Impact of the Chemotherapy-Induced Nausea and Vomiting on Functional Daily Living among Patients with Colorectal Cancer: A Narrative Review

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## ABSTRACT

**Context:** Chemotherapy-Induced Nausea and Vomiting (CINV) is a common and unpleasant negative consequence of cancer therapy among colorectal cancer patients. It has the potential to significantly impact the patient's quality of life and may lead to reduced adherence to established therapeutic guidelines.

**Aim:** The study aims to explore the impact of chemotherapy-induced nausea and vomiting on functional daily living among patients with colorectal cancer.

**Methods:** An extensive literature search was conducted utilizing various electronic databases to locate pertinent studies, including PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Medical Literature Online (MEDLINE), and Google Scholar.

**Results:** The review indicates that colorectal cancer (CRC) is one of the most prevalent malignancies worldwide, with increasing incidence particularly in low- and middle-income countries such as Saudi Arabia. Risk factors include age, genetics, and family history, along with modifiable behaviors such as unhealthy diet, obesity, smoking, alcohol intake, and physical inactivity. While early CRC is usually asymptomatic, advanced disease manifests with rectal bleeding, obstruction, and systemic complications. Preventive strategies such as screening and lifestyle modification reduce morbidity and mortality, and treatment varies by stage, incorporating surgery, chemotherapy, targeted therapy, and immunotherapy. Chemotherapy-induced nausea and vomiting (CINV) remains a major challenge, impairing daily functioning and quality of life. Still, evidence supports a combination of pharmacological, non-pharmacological, and nursing interventions to improve patient outcomes.

**Conclusion:** Chemotherapy-Induced Nausea and Vomiting (CINV) represent a prevalent and unpleasant negative consequence of cancer therapy among colorectal cancer patients. It can significantly affect the patient's quality of life and reduce treatment adherence. Therefore, a personalized approach to managing CINV should be implemented for colorectal cancer patients, tailored to each individual's specific needs and preferences. Ongoing research regarding new therapies and the optimization of existing management strategies is necessary to diminish the frequency and severity of CINV. These therapies lead to improved patient outcomes and enhanced quality of life.

**Keywords:** Chemotherapy-induced nausea and vomiting, functional daily living, impact

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## 1. Introduction

A literature review is a crucial and comprehensive evaluation of existing studies and academic writings on a specific topic or field of study. The principal aim of a literature review is to provide a thorough and up-to-date understanding of the existing body of knowledge, theories, and methodologies related to the research problem or question at hand. It should describe the existing knowledge on the topic, evaluate the quality of the sources, and identify the gaps. Furthermore, the literature review should not only summarize previous research but also synthesize the findings to answer research questions, identify patterns

and relationships in the data, and suggest areas for future research (Booth et al., 2016; Fink, 2019).

Literature reviews should encompass the major theories and approaches in the field, as well as the principal studies and conclusions pertinent to the research issue. The literature review chapter is an important component of research that helps identify knowledge gaps, evaluate the quality of existing sources, and synthesize previous research questions (Cooper et al., 2018; Xiao & Watson, 2017).

## 2. Significance of the study

The current narrative review is crucial for healthcare, research, and public health. Colorectal cancer (CRC) is the second most common cause of death globally, with predictions suggesting around 1.8 million new cases and

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0.9 million deaths anticipated in 2020 (Sung et al., 2021). Colorectal cancer is an important issue to address in Saudi Arabia. The prevalence rate of CRC in Saudi Arabia appears to be steadily increasing over the last several decades (Chaudhri et al., 2020).

This narrative review will offer essential insights for clinical decision-making by describing the impact of chemotherapy-induced nausea and vomiting on colorectal cancer patients' functional daily living. Chemotherapy, utilized as part of the treatment of colorectal cancer, can induce considerable adverse effects, such as nausea and vomiting. The presence of these side effects significantly impairs a patient's ability to engage in their usual activities and to tolerate and comply with treatment. Limited research has been undertaken on this subject in Saudi Arabia. The review not only directs future research and identifies gaps but also functions as an essential advisory resource for nurses caring for patients with colorectal cancer.

### 3. Aim of the study

The study aims to explore the impact of chemotherapy-induced nausea and vomiting on functional daily living among patients with colorectal cancer.

### 4. Research question

This current narrative review was guided by the following research question: What is the impact of chemotherapy-induced nausea and vomiting on functional daily living among patients with colorectal cancer?

### 5. Search Strategy

A literature review was conducted utilizing several electronic databases to identify related research. These databases included PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Medical Literature Online (MEDLINE), and Google Scholar. The search strategy used the following keywords and combinations to identify related articles: (Chemotherapy-induced nausea and vomiting OR CINV OR nausea OR vomiting OR emesis) AND (Colorectal cancer) AND (chemotherapy) AND (Impact OR Consequence) AND (functional daily living).

The criteria for selecting studies involved articles that investigated the impacts of chemotherapy-induced nausea and vomiting on functional daily living among adult patients with colorectal cancer. Articles written in English within the last five years, specifically from 2019 to 2024. Exclusion criteria included articles on pediatric patients and qualitative studies.

PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) was used to evaluate the selected literature. Initially, 1,852 articles were identified from several databases (PubMed, Medline, CINAHL, and Google Scholar). After duplication removal, 594 articles were examined, and 384 were excluded for being irrelevant to the study's research question. The researcher subsequently conducted a thorough screening of the remaining 210 publications—titles, abstracts, and full texts—selecting only those deemed appropriate.

Consequently, 174 articles were excluded from the current review due to factors such as absence of relevance to

the study's research question [(n=57), articles involving pediatric patients (n=15), medication-focused articles (n=50), studies focusing on individuals diagnosed with colon cancer alongside an additional health condition (n=40), and articles written in languages other than English (n=12)]. The final total comprised 36 studies retrieved and incorporated into this review.

## 6. Literature Review

### 6.1. Anatomy and physiology of the colon and rectum

The colon is a muscular, tubular structure that typically measures around 150 cm in length. The diameter varies across segments, decreasing from the proximal region (cecum, approximately 7 cm) to the distal region (sigmoid colon, approximately 2.5 cm). The colon is secondarily retroperitoneal on the right and left, whereas the transverse and sigmoid are comparatively mobile within the peritoneum (Bustos-Fernández, 1983; Carmichael & Mills, 2022; Mahadevan, 2020).

The cecum represents the initial segment of the colon, a sac-like segment situated beneath the ileocecal valve. The appendix is a small pouch that protrudes from the lowest point of the cecum and contributes to both immunological function and the composition of the colonic microbiota. The ascending colon measures around 15–18 cm, starts at the ileocecal valve, and ends at the hepatic flexure. The front surface is enveloped by visceral peritoneum, whilst the posterior surface is adhered to the retroperitoneum. The transverse colon is the longest segment, measuring approximately 45–50 cm. The structure spans the upper abdomen, beginning at the hepatic flexure on the right and concluding at the splenic flexure on the left. The visceral peritoneum completely envelops it (Omole et al., 2025).

The lower section of the colon measures about 25 cm in length from the splenic flexure downwards. The sigmoid exhibits considerable variability among the segments of the colon, typically measuring a length ranging from 35 to 45 centimeters. The sigmoid colon is enveloped by the visceral peritoneum, contributing to its mobility. The rectosigmoid junction marks the transition point between the sigmoid colon and the rectum, which is identifiable through the convergence of the taeniae coli and the termination of the epiploicae appendices (Salimoglu et al., 2021).

The rectum, an essential component of the digestive system, is conventionally categorized into three sections for surgical purposes: the upper, middle, and lower rectum. Despite lacking anatomical distinction, the divisions are essential in the context of surgical treatment for rectal cancer. The distal portion of the rectum extends from 0 to 7 cm from the anal margin, the mid-rectum from 7 to 12 cm, and the uppermost rectum from 12 to 15 cm. The rectal length can vary and could exceed 15 cm from the anal margin. The upper rectum is distinguished from the sigmoid colon by the lack of taenia coli and epiploic appendages. The greater part of the rectum is located external to the peritoneal cavity (Wang & Wiseman, 2025).

Nevertheless, the anterior and lateral surfaces of the superior rectum are enveloped by a coating of visceral peritoneum extending to the peritoneal reflection

(Nikolouzakis et al., 2019). The anal canal initiates at the dentate line and merges with the anal verge. It is derived from embryological and histological principles of the mucosa. From a surgical perspective, the anal canal is defined as extending from the anorectal ring to the anal borderline. The surgical anal canal consists of the inner and outer anal sphincters. The length differs between males and females (Chung, 2019).

The colon is supplied with blood by the superior mesenteric artery (SMA) and the inferior mesenteric artery (IMA), which circulate blood to the cecum, ascending, transverse, and descending colon. The inferior mesenteric artery, recognized as the third unattached segment of the aorta, supplies blood to several sigmoidal branches, including the left colic artery, which ultimately forms the superior hemorrhoidal (rectal) artery. Venous drainage parallels arterial circulation, along with the superior and inferior mesenteric veins draining the respective sections of the colon (Salimoglu et al., 2021). The colonic wall contains a complex arrangement of lymphatic plexuses that facilitate drainage into extramural lymphatic vessels. The sympathetic and parasympathetic neural systems innervate the colon, closely aligning with the arterial blood flow (Duan et al., 2021).

The colon plays a crucial role in several physiological functions, including maintaining fluid and electrolyte balance, digesting food, absorbing nutrients, and facilitating the propulsion and expulsion of waste products (Shahsavari & Parkman, 2022). The colon absorbs water and electrolytes, which are crucial for maintaining fluid and electrolyte balance in the body. This process primarily occurs in the right colon, near the cecum and the ascending colon. It also assimilates short-chain fatty acids generated by the bacterial breakdown of undigested carbohydrates, thereby contributing to energy metabolism. Furthermore, the colon stores fecal matter until it is socially convenient to eliminate it. This storage function is primarily managed by the left colon, including the descending, sigmoid, and rectal colon (Krogh & Laurberg, 2017).

## 6.2. Definition and Epidemiology of Colorectal Cancer

Colorectal cancer (CRC) represents a substantial global public health issue that affects the colon and rectum. It is currently the third most widespread malignancy across the globe and is projected to become the most common cancer by 2070 (Baidoun et al., 2021). The prevalence is higher in developed nations and is increasing in middle- and lower-income countries due to westernization. In 2020, the worldwide prevalence of new cases reached 1.9 million, accompanied by 0.9 million deaths. CRC ranks as the second leading cause of mortality following lung cancer and the third most frequently diagnosed cancer worldwide, after breast and lung cancers (Yang et al., 2020; Bulliard et al., 2023).

In 2020, the United States documented around 160,000 new cases of colorectal cancer (CRC), while China recorded 560,000 cases, and Japan had approximately 148,500 new cases. Countries with high CRC incidence rates include the Russian Federation (77213), India (65358), Germany (57528), Brazil (55102), the United

Kingdom (52128), Italy (48576), and France (48061). The literature expected increases in cases to 0.21, 0.91, and 0.16 million by 2040 in the USA, China, and Japan, respectively (Xi & Xu, 2021).

In Saudi Arabia in 2020, colorectal cancer (CRC) was the predominant cancer type in males and the third most prevalent in females, with as many as 73% of cases identified at an advanced phase. The incidence of colorectal cancer increased from 5.0 to 10.6 cases per 100,000 population between 2001 and 2014, with a 10-fold increase in new cases between 1990 and 2016 (Alsadhan et al., 2024; Althubiti & Nour Eldein, 2018; Herzallah et al., 2019). A systematic review and meta-analysis conducted from 2010 to 2019 indicated that the predominant cancers in Saudi Arabia include breast, colorectal, prostate, brain, lymphoma, kidney, and thyroid cancers (Althubiti & Nour Eldein, 2018).

Basudan et al. (2023) conducted a comprehensive retrospective analysis of colorectal cancer incidence patterns in Saudi Arabia, utilizing data acquired from the National Health Information Center (NHIC). They found a rapid escalation in the overall prevalence of CRC among Saudis, along with the count of cases rising by 335.6% from 2001 to 2018. Over the same period, the incidence of CRC among both genders increased by 56.4% from 7.8% in 2001 to 12.2% of all reported cancer cases in 2018. The rise was mainly observed in males (98%), compared with 24.1% in females. The Riyadh and Eastern Regions exhibited the highest CRC rates, with equal rates among both genders.

Alyabsi et al. (2021) conducted a study about trends in colorectal cancer incidence rates in Saudi Arabia using the Saudi National Registry: early-versus late-onset disease in KSA. There has been an increase from 2001 to 2016 in the incidence of early-onset CRC (diagnosed before age 50) from 1.32 to 2.02\100000, whereas incidence rates of late-onset CRC (diagnosed after age 50) increased from 3.54 to 9.14\100000 during the same period. Among patients with early-onset colorectal cancer, individuals aged 40-49 exhibited the highest prevalence, with women in this demographic demonstrating a greater incidence rate than men.

## 6.3. Classification of Colorectal Cancers

Colorectal cancer (CRC) can be classified based on histological subtype, location, molecular pathways, and the origin of mutations. The traditional WHO classification classified CRC based on histological subtypes, including mucinous, medullary, signet ring cell, adenosquamous, spindle cell, micropapillary, serrated, and cribriform comedo-type. Colorectal adenocarcinoma represents the predominant subtype. CRC can also be classified based on location and embryological origin. Also, colon cancer can be divided into midgut (proximal colon) and hindgut (distal colon) cancers (Alzahrani et al., 2021).

## 6.4. Signs and Symptoms of Colorectal Cancer

Early colorectal cancer (CRC) is typically asymptomatic; however, as the condition advances, symptoms such as hematochezia, intestinal obstruction, and abdominal mass may manifest. Hematochezia is the

presence of a small amount of blood in the stool that may not be visible to the naked eye. Intestinal obstruction is a hallmark of advanced colorectal cancer. An abdominal mass, usually connected with right colon cancer, is characterized by palpable mass enlargement. Systemic symptoms, such as tumor proliferation, cachexia, anemia, and emaciation, are common as the disease progresses. These symptoms can lead to a prolonged and challenging course of the disease (Duan et al., 2022).

A study in six European countries revealed that rectal bleeding has a high specificity of 99.4% for detecting colorectal cancer. At the same time, fecal occult blood in stool or anemia could suggest the presence of internal bleeding. The sensitivity rate stands at 57.5% when considered alongside other symptoms, which is notably higher at 69.2% for identifying cancer in the distal colon. Symptoms such as weight loss and abdominal pain are less specific (Holtedahl et al., 2021).

### 6.5. Common Risk Factors for Colorectal Cancer

Colorectal cancer risk factors are primarily influenced by behavioral and environmental factors, with non-modifiable factors such as age over 50, sex, race, family history, and hereditary mutations being more significant. Modifiable risk factors include a high-fat diet, salt, red meat consumption, smoking, excess alcohol, obesity, and physical inactivity (Denis, 2022; Lewandowska et al., 2022). Individuals with a familial predisposition to colon cancer, especially among first-degree relatives, exhibit an elevated risk of developing the condition. Specific genetic syndromes, such as Lynch syndrome and familial adenomatous polyposis (FAP), can elevate an individual's susceptibility to colon cancer (Goosenberg et al., 2025).

Approximately 35% of CRC risk is attributed to hereditary factors; around 30% of the UK population has a familial background of CRC. In the US, up to 10% of adults have a first-degree relative who has been diagnosed with CRC, leading to a two-fold increase in CRC risk, whereas multiple first-degree relatives diagnosed with the disease further increase the risk and lead to incidence at a younger age. Some CRC-related genetic syndromes, including Lynch syndrome, familial adenomatous polyposis, MYH-associated polyposis, Peutz-Jeghers syndrome, and adolescent polyposis, are caused by specific germline gene mutations, accounting for 5%-10% of all CRC cases in China (Yang et al., 2020).

In terms of modifiable risk factors, evidence suggests that a nutrition plan abundant in red and processed meats, along with a deficiency in fruits, vegetables, and whole grains, has been linked to a heightened risk of colon cancer (Schwingshackl et al., 2018). Additionally, obesity and insufficient physical activity are related to an elevated risk of colon cancer, likely due to the correlation between these factors and insulin resistance, inflammation, and excess estrogen production, as well as obese people have diminished amounts of ghrelin and adiponectin, which suppress the proliferation of cells, increasing their chance of developing CRC. Furthermore, obesity can negatively impact the gut's microbial flora so promoting carcinogenesis (Amin et al., 2019).

Cigarette smoking and excessive alcohol intake have been attributed to a higher chance of colon cancer (Amitay et al., 2020). A meta-analysis of 16 studies revealed that the potential for colorectal cancer (CRC) escalates with the intensity and frequency of cigarette smoking; however, quitting smoking can reduce this risk. Smoking significantly heightens the chance of CRC that develops through the microsatellite instability pathway (Tudosie et al., 2022). A study conducted examined 121 confirmed cases of colorectal cancer in the main hospital's referral in KSA, reported that colon polyps, chronic constipation were risk variables associated with CRC (Alqahtani et al., 2020).

### 6.6. Prevention of Colorectal Cancer

Early screening for CRC is a critical approach to decreasing both the fatalities and prevalence rates of this malignancy. In Australia, a CRC screening model demonstrated that early screening could prevent thousands of cases and deaths, highlighting its economic efficiency of early screening compared to colonoscopy (Lew et al., 2017). Therefore, CRC is a suitable candidate for population screening, and early screening represents a key approach to combat this malignancy.

According to Elwali et al. (2023), the prevalence of CRC is increasing in Saudi Arabia, impacting younger age groups and both genders. This prevalence emphasizes the need for effective CRC control programs in the country. A comprehensive program can raise awareness of CRC, encourage healthy habits, and promote early detection to minimize its impact.

Screening is essential for the early identification of colorectal cancer, as CRC may result from pre-existing adenomatous polyps in the colon (Anipindi et al., 2023; Siskova et al., 2020). Imaging modalities such as Sonography, Computed Tomography, Magnetic Resonance Imaging, and Positron Emission Tomography can be used for monitoring, staging, and surveillance of colorectal cancer (Dindyal, 2019; Oncel, 2021; Ponnatapura & Lalwani, 2021). Prevention and screening have effectively diminished the prevalence and mortality rates of colorectal cancer (Roshandel et al., 2024).

Western lifestyles and nutritional considerations, such as higher intake of red and processed meat, alongside insufficient ingestion of fiber, contribute to elevated colorectal cancer (CRC) rates. In addition, overweight conditions, inadequate exercise, smoking habits, drinking alcohol in excess, and sleep deprivation increase the risk of developing CRC. Therefore, lifestyle modifications are recommended, such as replacing red meat with fish, poultry, or vegetables and fruits, and avoiding smoking and alcohol (Carr et al., 2018). Physical activity can reduce inflammation, increase metabolic efficiency, and reduce insulin resistance, potentially reducing the risk of colon cancer (Jurdana, 2021).

A fiber-rich diet, regular physical activity, and regular intake of aspirin, anti-inflammatory drugs, magnesium, folate, fruits, vegetables, dairy products, and fiber may help prevent CRC. However, no evidence supports the protective impacts of tea, coffee, garlic, seafood, or soy products against CRC. The protective effects of aspirin,  $\beta$ -carotene, and selenium are moderate (Chapelle et al., 2020).

Although certain medications like NSAIDs and aspirin have shown a decrease in the likelihood of colon cancer development, they also come with potential side effects. Therefore, individuals should utilize these medications only under the supervision of a healthcare provider (*American Cancer Society, 2024*).

### 6.7. Tumor, Nodes, Metastasis (TNM) Staging System for Colorectal Cancer

The TNM staging system is a commonly utilized approach for determining the stage of colorectal cancer. It evaluates the tumor (T), nodes (N), and metastasis (M) stages of the disease. T stages include T1 (growth into the submucosa), T2 (growth into the muscular layer), T3 (growth through the muscular layer and into the outermost layer), and T4 (growth into adjacent organs or tissues). N stages include N0 (absence of regional lymph nodes), N1 (1-3 regional lymph nodes), and N2 (4-5 regional lymph nodes). M stages include M0 (absence of distant metastases) and M1 (presence of distant metastases). According to the *National Cancer Institute (2025)*, the overall stage of colorectal cancer is determined by combining the TNM stages. Stage I indicates early, localized disease, and stage IV indicates advanced, metastatic disease.

### 6.8. Treatment of Colorectal Cancer

The treatment of colon cancer varies depending on the disease's stage. Stage 0 and I require surgery, while Stage II requires surgery and adjuvant chemotherapy. Stage III requires surgery, often with clinical trials. Liver metastases may require a combination of surgery, neoadjuvant chemotherapy, and local ablation. Stage IV and recurrent cancers require surgery, systemic therapy, and immunotherapy (*National Cancer Institute, 2025*).

Preventive removal of precancerous lesions through endoscopic screening has been shown to lead to a decline in the recurrence and mortality rates of colorectal cancer (*Click et al., 2018*). Immunotherapy has emerged as a crucial treatment approach for various solid tumors, particularly colorectal cancer (CRC). Two PD-1-blocking antibodies, pembrolizumab and nivolumab, have been approved by the FDA for accelerated clinical trials based on their efficacy in treating metastatic CRC in patients with dMMR-MSI-H (deficient mismatch repair and microsatellite instability). Immunotherapy provides sustained remission in a specific group of patients, emphasizing its efficacy in managing dMMR-MSI-H metastatic CRC (*Ganesh et al., 2019*).

Chemotherapy is a treatment approach that uses drugs to suppress the proliferation of cancer cells, either by destroying them or by obstructing their mitotic division, and can be delivered through multiple methods. Chemotherapy is categorized into neoadjuvant, adjuvant, and palliative therapy. Neoadjuvant chemotherapy reduces tumor stage, improves patient quality of life, and reduces the risk of recurrence after surgery. Adjuvant chemotherapy, also referred to as preventive chemotherapy, is a cancer treatment administered post-surgery, radiation, or other primary therapies to eliminate remaining tumor cells after surgery, consolidating the effect. Palliative

chemotherapy administered in a non-curative context aims to alleviate symptoms, enhance patient quality of life, and prolong survival time. Common chemotherapy drugs include fluorouracil, irinotecan, oxaliplatin, and raltitrexed. Combination drug regimens include Folfox, Folfiri, Capeox, and Folfoxiri (*Duan et al., 2022*).

A recent review by *Kim (2015)* found that chemotherapy is effective in extending survival and delaying progression in patients with advanced CRC. Adjuvant chemotherapy has the potential to lower the probability of recurrence by 30% in individuals diagnosed with stage 3 or high-risk stage 2 CRC. However, palliative chemotherapy provides minimal advantages over the long term, resulting in a life expectancy of less than 12 months. *Kim (2015)* reported that combination chemotherapy can be a reasonable consideration for the elderly with metastatic colorectal cancer (CRC). Targeted therapies for older adults with metastatic CRC show ability due to their potentially enhanced efficacy and diminished toxicity compared to conventional chemotherapy regimens (*Kim, 2015*). Neoadjuvant chemotherapy could offer potential advantages for patients diagnosed with localized advanced colon cancer exhibiting proficient mismatch repair mechanisms. However, selecting the appropriate patients for this approach remains a significant challenge (*Smith et al., 2024*).

#### 6.8.1. Chemotherapy-Induced Nausea and Vomiting (CINV)

Chemotherapy-Induced Nausea and Vomiting (CINV) refers to nausea and vomiting associated with chemotherapy treatment (Emetogenicity). It is a prevalent and distressing consequence that can continue to exist even with the administration of antiemetic medications. Nausea is characterized by epigastric discomfort or an unpleasant sensation that precedes vomiting. Vomiting is the retrograde ejection of gastric contents via the pharynx (*Gaschen, 2022; National Cancer Institute, 2011*).

The process of chemotherapy-induced nausea and vomiting (CINV) includes interactions involving several neurotransmitters and receptors throughout the central nervous system and the gastrointestinal tract. Chemoreceptors in the GIT detect chemical signals and initiate the release of chemical agents, such as 5-hydroxytryptamine type 3 (5-HT<sub>3</sub>), substance P, and cholecystokinin, from enterochromaffin cells. The vagal pathways to the vomiting center transmit these signals. The peripheral 5-HT<sub>3</sub>-related pathway is predominantly involved in acute emesis; the central NK-1 receptor-mediated pathway is mostly responsible for delayed CINV, although it can also induce acute emesis. When chemotherapy drugs damage enterochromaffin cells in the GIT, serotonin is released and binds to 5-HT<sub>3</sub>, triggering the peripheral 5-HT<sub>3</sub>-related pathway and acute CINV (*Gautam et al., 2023; Wu et al., 2024*).

Chemotherapy-induced nausea and vomiting (CINV) can manifest in two distinct phases: The acute phase occurs within the first 24 hours following chemotherapy, and the delayed phase typically occurs between 24 and 120 hours post-chemotherapy (*Badarudin et al., 2024; Chow et al., 2023; Huang et al., 2021*). The occurrence of CINV

depends on the drug's emetogenicity. The term "emetogenicity" refers to the propensity of a chemotherapy regimen to induce nausea and/or vomiting in patients receiving cancer treatment. It is a crucial consideration in cancer therapy, as nausea and vomiting are significant adverse outcomes that can profoundly impact a patient's quality of life and their adherence to the therapeutic regimen (Badarudin et al., 2024; Hesketh, 1999; Suliman et al., 2018).

There are other types of chemotherapy-induced nausea and vomiting (CINV), which include breakthrough, anticipatory, and refractory CINV. Breakthrough/refractory CINV manifests when patients suffer nausea or vomiting even after adhering to prescribed antiemetic protocols. Anticipatory CINV presents before treatment, emerging as a conditioned response, and can be observed in up to 45% of patients. Refractory CINV manifests following chemotherapy, even with the proper administration of antiemetic prophylactic and rescue therapies (Tilleman et al., 2018).

Cancer patients commonly experience chemotherapy-induced nausea and vomiting (CINV) as a detrimental effect of their therapy. The severity of chemotherapy-induced nausea and vomiting (CINV) can range from moderate discomfort to severe manifestations that could make it difficult for a patient to finalize their chemotherapy regimen (PDQ Supportive & Palliative Care Editorial Board, 2025). Therefore, certain elements related to chemotherapy-induced nausea and vomiting (CINV) include the following:

The intensity and frequency of chemotherapy-induced nausea and vomiting (CINV) can be affected by the type, dose, and route of chemotherapy administered. In addition, Chemotherapy schedule and frequency may significantly influence the onset and duration of CINV. As mentioned before, certain chemotherapy agents exhibit a higher propensity to induce CINV than others, reflecting their emetogenic potential (Gautam et al., 2023).

Patient characteristics such as age (<55 years) and gender (the risk of CINV is greater in female patients than in male patients). A Body Mass Index (BMI) <27.5 kg/m<sup>2</sup> is associated with a higher risk of CINV (Gautam et al., 2023; Kawazoe et al., 2018; Mosa et al., 2020). Chemotherapy-induced nausea and vomiting (CINV) is influenced by characteristics of the patient and their medical history, encompassing alcohol consumption, sleep limitations, prior chemotherapy treatments, nausea during pregnancy, and experiences with motion sickness. Female gender is a significant risk factor, and uncontrolled CINV increases the likelihood of experiencing CINV in subsequent cycles. Prophylactic treatment is crucial, particularly for individuals with multiple risk factors (Mahendra & Setiawan, 2023).

The potential for developing specific diseases may be influenced by an individual's family medical history, lifestyle factors, pre-existing medical conditions, anxiety, and employment status. Although sixteen studies have attempted to investigate the relationship between different types of chemotherapy-induced nausea and vomiting (CINV) and variations in candidate genes, there is limited conclusive evidence due to difficulties in these

investigations. Lifestyle factors like smoking, inadequate nutrition, and inadequate levels of physical activity can profoundly affect a patient's health and elevate the risk of CINV. Pre-existing medical conditions, such as nausea/vomiting, motion sickness, or nausea and vomiting associated with pregnancy, also increase the potential for CINV to develop. Moderate to high anxiety has been recognized as a risk factor for CINV (Gala et al., 2022; Mosa et al., 2020; Simino et al., 2020).

Furthermore, patient adherence to administered antiemetic medications can significantly influence the efficacy of treatment for CINV. Adhering to the prescribed dosage schedule is essential for patients, and it is important to communicate with the healthcare provider if adverse effects occur or symptoms remain inadequately controlled (Gautam et al., 2023). Cancer types, stages, tumor size (≥ 2cm), and recurrence all contribute to the risk of CINV. Colorectal and breast cancer patients tend to exhibit enhanced potential for CINV in comparison to gynecological malignancies (Mosa et al., 2020).

Despite advancements in oncotherapy, chemotherapy-induced nausea and vomiting (CINV) remain a major obstacle for patients, where 70–80 % of patients suffer from these symptoms throughout treatment (Wu et al., 2024). Previous studies conducted in China reported that the prevalence of CINV in colorectal cancer patients without antiemetic prophylaxis varied from 20.8 % to 63.5 %, depending on the type of chemotherapy (Wu et al., 2024). Individuals with CRC are more susceptible to being vulnerable to nausea and vomiting. CINV is a distressing and undesirable manifestation that can negatively affect the patient's quality of life and impede treatment compliance. CINV may result in dehydration, electrolyte imbalances, and nutritional deficiencies, which can exacerbate a patient's condition if left unaddressed (Wu et al., 2024; Han et al., 2020).

Chow et al. (2023) conducted two meta-analyses involving 2048 patients. Of these, 65% received highly emetogenic chemotherapy (HEC), while 35% received moderately emetogenic chemotherapy (MEC). Out of those receiving HEC, 24% experienced acute nausea, 49% delayed nausea, and 33% long-delayed nausea in one study. In comparison, 8% had acute vomiting, 14% had delayed vomiting, and 7% had long-delayed vomiting in the second study. Among those receiving MEC, 75% experienced acute nausea, 38% delayed nausea, and 24% long-delayed nausea in one study, while 22% reported acute nausea, 14% delayed nausea, and 6% long-delayed nausea in the second study. The intensity of nausea during the long-delayed phase was similar to that observed in the delayed phase. Patients who exhibited nausea and vomiting on days 4 and 5 faced considerable potential for developing long-delayed chemotherapy-induced nausea and vomiting (CINV).

Another multicenter, prospective study was conducted by Tsuji et al. (2017), which analyzed data from 190 patients with colorectal cancer scheduled for moderately emetogenic chemotherapy (MEC) in Japan. The study revealed that 13.8% of patients encountered acute nausea, whereas 2.1% suffered acute vomiting. Delayed CINV was relatively high, with 71% patients experiencing delayed nausea and 12.6% experiencing delayed vomiting. Motion

sickness emerged as a notable independent risk factor contributing to delayed nausea. Adherence to CINV guidelines in Japan resulted in effective management of chemotherapy-induced vomiting; however, the occurrence of delayed nausea continued to be elevated among patients undergoing MEC.

## 6.8.2. Management of CINV

### 6.8.2.1. Pharmacological

Treatment of chemotherapy-induced nausea and vomiting (CINV) can be approached efficiently through various methods. Studies have shown that prolonged administration of the NK-1 receptor antagonist, in combination with a 5-HT<sub>3</sub> receptor antagonist and dexamethasone, is more effective at preventing delayed CIN. Additionally, combining acupuncture with antiemetic drugs has demonstrated efficacy in reducing the prevalence of CINV, improving patient quality of life, and minimizing the adverse effects of antiemetic medications (Gao et al., 2023; Kong et al., 2022).

At present, there are clinically effective medications that can prevent or manage CINV. These include 5-hydroxytryptamine type 3 receptor antagonists (5-HT<sub>3</sub> RA), neurokinin one receptor antagonists (NK1 RA), dexamethasone, and the antipsychotic agent olanzapine. Furthermore, various medication categories, including cannabinoids and benzodiazepines, may be administered to treat CINV (Filetti et al., 2023; Yokoe et al., 2019).

### 6.8.2.2. Non-Pharmacological

Non-Pharmacological Interventions (NPIs) encompass a diverse range of science-based, non-invasive approaches to health. They prioritize holistic well-being, focusing on physical, mental, emotional, and social aspects. NPIs, such as psychotherapy, physical therapy, and nutritional interventions, aim to prevent, treat, or cure health problems without relying on medication. They emphasize patient-centered care, requiring active participation and collaboration (Castellano-Tejedor, 2022).

A systematic review of twenty articles was performed to assess the efficacy of non-pharmacological approaches, including acupressure, yoga, ginger, concord grape, therapeutic music, and distraction, in reducing CINV. The findings from these articles were mixed, suggesting that the existing evidence and studies are inadequate to support the application of these methods as standalone interventions for CINV. However, due to their affordability, ease of use, tolerance, and non-toxicity, they have potential as a complementary approach to pharmacological methods (Ayers & Olowe, 2015).

In addition, Maulidawati et al. (2023) conducted a scoping review and found that several non-pharmacological interventions positively reduced the severity and frequency of CINV. However, the mechanisms of action underlying diminished CINV severity remain unclear. Nurses can offer these interventions without instruments, including auricular acupressure, acupressure bands, respiratory techniques, massage, peppermint oil-guided imagery, reflexology, breathing exercises, and a holographic bracelet. A previous Randomized Controlled Trial (RCT) study by Soliman et

al. (2017) in Egypt reported that acupressure is an efficacious non-pharmacological method that can be used as a supportive nursing intervention to relieve chemotherapy-induced nausea. Belluomini et al. (2024) reported that non-pharmacological approaches like physical exercise, nutrition, psychological support, and acupuncture/acupressure can be effective adjuncts to standard antiemetic therapy for CINV.

Mazzege-Fabbro et al. (2023) conducted a randomized controlled trial involving 384 patients with cancer. They concluded that an integrated nursing strategy effectively facilitated the self-management of chemotherapy-induced nausea and vomiting (CINV) in cancer patients, demonstrating a moderate positive effect. This intervention requires minimal resources in terms of both cost and time. The findings suggest that CINV can be alleviated by providing patients with education and written support resources. A previous study in Jeddah, KSA, revealed that practices related to religion (74.4%), dietary modifications (57.7%), and relaxation methods (44.9%) were the most prevalent alternative approaches to drug management of CINV (Ilyas et al., 2020).

## 6.9. Effects of CINV on Functional Daily Living

Activities of daily living (ADLs) refer to routine tasks in everyday life that include basic ADLs (mobility and self-care) and instrumental tasks (occupational skills, financial management, shopping, transportation, technology use, and household management duties) (Merrilees, 2014). Impaired functioning due to cancer symptoms and treatment negatively impacts a person's health-related quality of life (HRQOL). Functioning includes various aspects of body functions, anatomical structures, activities, and participation. Activities can be categorized into domestic responsibilities, leisure, work, and education, whereas participation refers to engagement in community activities and societal involvement (Efverman, 2023).

Chemotherapy-induced nausea and vomiting (CINV) remains a considerable obstacle for patients receiving chemotherapy, despite advances in antiemetic treatment. This distressing side effect not only diminishes the quality of life for patients but also poses the risk of physical and psychosocial complications such as electrolyte imbalance, oral infections, lack of nutrition, and extended hospitalization. Inadequate management of CINV can exacerbate symptoms of cancer-related exhaustion, anxiety, and depression, while also reducing food consumption, leading to heightening the risk of malnutrition (Marx et al., 2016).

Consequently, the overall impact compromises the functional of daily living, cancer treatment outcomes, and overall survival. As a result, prioritizing adequate and appropriate nursing care from the beginning of treatment is essential for the effective prevention and management of CINV (Ay et al., 2023; Evans et al., 2020; Ruggiero et al., 2021). The literature revealed that chemotherapy-induced nausea and vomiting (CINV) can lead to early discontinuation, poor quality of life, dehydration, and electrolyte imbalances, resulting in reduced treatment efficacy and increased expenses. Prevention is essential to minimize morbidity and improve quality of life (Mahendra

& Setiawan, 2023).

Sustaining ADL independence is crucial for a person's quality of life and identity, as loss of independence can lead to a sense of worthlessness, diminished self-esteem, hospitalization, institutionalization, and increased mortality risk. Nursing practitioners are essential in facilitating and respecting an individual's capacity to manage their activities of daily living, despite their diagnosis, cultural background, or healthcare environment. Providing ADL care also involves maximizing comfort, a multidimensional concept that encompasses both positive emotions and physical distress. ADL care can lead to emotional and physical distress. Nursing professionals play a crucial role in understanding and addressing an individual's comfort needs during activities of daily living (Cremer et al., 2023).

Shawki et al. (2019) conducted a study involving 48 patients admitted to Qena Health Insurance Hospital's internal oncology department to evaluate the impact of chemotherapy-induced nausea and vomiting on patients' functional daily living. The findings indicated that approximately one-third of the patients had inadequate nutrition, an electrolyte imbalance, Mallory-Weiss Syndrome (31.3%), delayed intervention, salivation, fever, and increased therapeutic expenses. These effects significantly affected their functional daily living, with 97% experiencing deteriorating conditions before chemotherapy, and all patients exhibiting worsened symptoms post-chemotherapy. The study recommends intensive nursing care and methodologies to minimize the negative impacts and improve daily functional living for colorectal cancer patients. A descriptive qualitative study in India investigated the impact of chemotherapy-induced nausea and vomiting on cancer patients' daily lives, conducted with 25 participants, revealed that CINS has a significant impact on patients' eating, physical, emotional, and social functioning, with each patient's impact being unique (Gour et al., 2023).

Nurses play a significant role in preventing chemotherapy-induced nausea and vomiting (CINV) by assessing risks, adhering to guidelines, and overcoming barriers. Nurses are integral members of the multidisciplinary team responsible for caring for patients undergoing chemotherapy treatment. Nurses fulfill a preventive function by administering physician-prescribed antiemetic medications in accordance with established recommendations. They provide information and guidance to patients regarding administering antiemetic drugs. Oncology nurses are assigned to evaluate patients' mobility, pain levels, functional daily living, and side effects experienced during exercise. This information enables nurses to propose safe and useful physical activities to enhance treatment tolerance (Siegel et al., 2021).

Nurses play a vital role in evaluating patients before chemotherapy, identifying risk factors, categorizing the emetic risk associated with chemotherapy, and collecting initial information (Cope, 2022). They continue to monitor during chemotherapy sessions, administer breakthrough antiemetic medications, offer supportive care to patients, and document in patient records. Knowledge enables nurses to take appropriate actions to meet patient needs. They provide high-quality patient care through collaboration with

physicians and other members of the multidisciplinary team (Dielenseger et al., 2019).

Educational nursing interventions have been shown to significantly reduce chemotherapy side effects. Empowering patient education (EPE) is an approach in which nurses assist patients in using their expert knowledge and power to make informed decisions that affect their lives and choices about their health. The process promotes individual learning through respectful interactions, where the needs of patients are acknowledged and management is tailored to their levels of understanding, abilities, attitudes, and values (Tuominen et al., 2023).

Nurses' prompt patient education through daily exercise, initiating early discussions about exercise at home, providing educational resources, and emphasizing the significance of maintaining an active lifestyle throughout and after treatment can all greatly benefit the patient's experience (Forner et al., 2021; Haas et al., 2016; Prip et al., 2019; Turner et al., 2018). Their tasks encompass prevention, patient education, early assessment, and patient stabilization. Insufficient awareness of recommendations and inadequate patient follow-up are among the issues that nurses encounter in practice (Joseph et al., 2022).

## 7. Conclusion

Chemotherapy-Induced Nausea and Vomiting (CINV) represent a prevalent and unpleasant negative consequence of cancer therapy among colorectal cancer patients. It can significantly affect the patient's quality of life and reduce treatment adherence.

## 8. Recommendations

Therefore, a personalized approach to managing CINV should be implemented for colorectal cancer patients, tailored to each individual's specific needs and preferences.

Ongoing research into new therapies and the optimization of existing management strategies is necessary to diminish the frequency and severity of CINV. These therapies can lead to improved patient outcomes and enhanced quality of life.

## 9. References

- Alqahtani, M. Z., Mohammed, A. G., Alsamghan, A. S., Bharti, R. K., Alsharm, A. A., Alshahrani, M. T., Alzahrani, M. A., Ayed, A. A. N., Alsaleem, M. A., & Ghazwani, E. Y. (2020). Risk factors of colorectal cancer among Saudi Population: Case-control study. *Journal of Family Medicine and Primary Care*, 9(9), 5035–5040. [https://doi.org/10.4103/jfmpc.jfmpc\\_895\\_20](https://doi.org/10.4103/jfmpc.jfmpc_895_20)
- Alsadhan, N., Alhurishi, S. A., Pujades-Rodriguez, M., Shuweihdi, F., Brennan, C., & West, R. M. (2024). Demographic and clinical characteristics associated with advanced stage colorectal cancer: A registry-based cohort study in Saudi Arabia. *BMC Cancer*, 24(1), 533. <https://doi.org/10.1186/s12885-024-12270-1>
- Althubiti, M. A., & Nour Eldein, M. M. (2018). Trends in the incidence and mortality of cancer in Saudi Arabia. *Saudi Medical Journal*, 39(12), 1259. <https://doi.org/10.15537/smj.2018.12.23348>

- Alyabsi, M., Algarni, M., & Alshammari, K. (2021).** Trends in colorectal cancer incidence rates in Saudi Arabia (2001–2016) using Saudi National Registry: Early-versus late-onset disease. *Frontiers in Oncology*, *11*, 730689. <https://doi.org/10.3389/fonc.2021.730689>
- Alzahrani, S. M., Al Doghather, H. A., & Al Ghafari, A. B. (2021).** General insight into cancer: An overview of colorectal cancer (Review). *Molecular and Clinical Oncology*, *15*(6), 271. <https://doi.org/10.3892/mco.2021.2433>
- American Cancer Society. (2024).** Testing for Colorectal Cancer | How Is Colorectal Cancer Diagnosed? Retrieved May 23, 2024, from <https://www.cancer.org/cancer/types/colon-rectal-cancer/detection-diagnosis-staging/how-diagnosed.html>
- Amin, M. N., Hussain, M. S., Sarwar, M. S., Rahman Moghal, M. M., Das, A., Hossain, M. Z., Chowdhury, J. A., Millat, M. S., & Islam, M. S. (2019).** How the association between obesity and inflammation may lead to insulin resistance and cancer. *Diabetes & Metabolic Syndrome*, *13*(2), 1213–1224. <https://doi.org/10.1016/j.dsx.2019.01.041>
- Amitay, E. L., Carr, P. R., Jansen, L., Roth, W., Alwers, E., Herpel, E., Kloor, M., Bläker, H., Chang-Claude, J., Brenner, H., & Hoffmeister, M. (2020).** Smoking, alcohol consumption and colorectal cancer risk by molecular pathological subtypes and pathways. *British Journal of Cancer*, *122*(11), 1604–1610. <https://doi.org/10.1038/s41416-020-0803-0>
- Anipindi, M., Doreswamy, S., Ali, R., Jilani, A., & Bitetto, D. (2023).** Colorectal cancer screening history, methods and future perspectives. *Archives of Clinical and Medical Case Reports*, *7*(1), 216–239. <https://doi.org/10.26502/acmcr.96550604>
- Ay, A., Boztepe, H., Özbay, S. Ç., Yilmaz, P., Karadavut, B., Burhanogullari, D., & Akyüz, C. (2023).** Determining the factors affecting chemotherapy-induced nausea and vomiting in children with cancer. *Journal of Pediatric Nursing*, *73*, e426–e434. <https://doi.org/10.1016/j.pedn.2023.10.011>
- Ayers, M. L., & Olowe, O. F. (2015).** A systematic review: Non-pharmacological interventions for chemotherapy-induced nausea and vomiting. Semantic Scholar. Available at: <https://www.semanticscholar.org/paper/A-Systematic-Review%3A-Non-pharmacological-for-Nausea-Ayers-Olowe/3288c05d204af014e0d2546c3d3d5a812f8ad7c9>
- Badarudin, S., Shah, N. M., Ismail, F., Islahudin, F., & Tahir, N. A. M. (2024).** Challenges in chemotherapy-induced nausea and vomiting (CINV) management: A systematic review. *Tropical Journal of Pharmaceutical Research*, *23*(3), 653–668. <https://doi.org/10.4314/tjpr.v23i3.21>
- Baidoun, F., Elshiwiy, K., Elkerai, Y., Merjaneh, Z., Khoudari, G., Sarmini, M. T., Gad, M., Al-Husseini, M., & Saad, A. (2021).** Colorectal cancer epidemiology: Recent trends and impact on outcomes. *Current Drug Targets*, *22*(9), 998–1009. <https://doi.org/10.2174/1389450121999201117115717>
- Basudan, A. M., Basuwidan, A. M., Abudawood, M., Farzan, R., & Alfihli, M. A. (2023).** Comprehensive retrospective analysis of colorectal cancer incidence patterns in Saudi Arabia. *Life (Basel, Switzerland)*, *13*(11), 2198. <https://doi.org/10.3390/life13112198>
- Belluomini, L., Avancini, A., Sposito, M., Pontolillo, L., Tregnago, D., Trestini, I., Insolda, J., Carbognin, L., Milella, M., Bria, E., & Pilotto, S. (2024).** Integrating nutrition, physical exercise, psychosocial support and antiemetic drugs into CINV management: The road to success. *Critical Reviews in Oncology/Hematology* *201*, 104444. <https://doi.org/10.1016/j.critrevonc.2024.104444>
- Booth, A., Sutton, A., & Papaioannou, D. (2016).** *Systematic approaches to a successful literature review*. (2<sup>nd</sup> ed). SAGE, Los Angeles.
- Bulliard, J.-L., Alhomoud, S., & Hahnloser, D. (2023).** Colorectal cancer: Burden, epidemiology and priority interventions. In: N. Banatvala, & P. Bovet (2<sup>nd</sup> ed.), *Noncommunicable Diseases*. Routledge. Pp. 106–111. <https://doi.org/10.4324/9781003306689>
- Bustos-Fernández, L. (1983).** *Colon: Structure and function*. Springer Science & Business Media. New York.
- Carmichael, J. C., & Mills, S. (2022).** *Anatomy and Embryology of the Colon, Rectum, and Anus*. In *ASCRS Textbook of Colon and Rectal Surgery* (4th ed.). Springer Nature Switzerland AG. [https://www.ascrsu.com/ascrs/view/ASCRS-Textbook-of-Colon-and-Rectal-Surgery/2285001/all/Anatomy\\_and\\_Embryology\\_of\\_the\\_Colon\\_Rectum\\_and\\_Anus](https://www.ascrsu.com/ascrs/view/ASCRS-Textbook-of-Colon-and-Rectal-Surgery/2285001/all/Anatomy_and_Embryology_of_the_Colon_Rectum_and_Anus)
- Carr, P. R., Weigl, K., Jansen, L., Walter, V., Erben, V., Chang-Claude, J., Brenner, H., & Hoffmeister, M. (2018).** Healthy lifestyle factors associated with lower risk of colorectal cancer irrespective of genetic risk. *Gastroenterology*, *155*(6), 1805–1815. e5. <https://doi.org/10.1053/j.gastro.2018.08.044>
- Castellano-Tejedor, C. (2022).** Non-Pharmacological interventions for the management of chronic health conditions and non-communicable diseases. *International Journal of Environmental Research and Public Health*, *19*(14), 8536. <https://doi.org/10.3390/ijerph19148536>
- Chapelle, N., Martel, M., Toes-Zoutendijk, E., Barkun, A. N., & Bardou, M. (2020).** Recent advances in clinical practice: Colorectal cancer chemoprevention in the average-risk population. *Gut*, *69*(12), 2244–2255. <https://doi.org/10.1136/gutjnl-2020-320990>
- Chaudhri, E., Fathi, W., Hussain, F., & Hashmi, S. K. (2020).** The increasing trends in cases of the most common cancers in Saudi Arabia. *Journal of Epidemiology Global Health*, *10*(4), 258–262. <https://doi.org/10.2991/jegh.k.200515.001>
- Chow, R., Yin, L. B., Baqri, W., Huang, R., Boldt, G., Younus, J., Lock, M., Prsic, E., Zimmermann, C., & Herrstedt, J. (2023).** Prevalence and predictors of long-delayed (> 120 h) chemotherapy-induced nausea and vomiting (CINV)-A systematic review and individual patient data meta-analysis. *Supportive Care in Cancer*:

*Official Journal of the Multinational Association of Supportive Care in Cancer*, 31(8), 505. <https://doi.org/10.1007/s00520-023-07978-y>

**Chung, Ch. S. (2019).** Anorectal Anatomy. Practices of Anorectal Surgery 1–11. In: K. L. Dong (eds). *Practices of Anorectal Surgery*. Springer. <https://doi.org/10.1007/978-981-13-1447-6>

**Click, B., Pinsky, P. F., Hickey, T., Doroudi, M., & Schoen, R. E. (2018).** Association of colonoscopy adenoma findings with long-term colorectal cancer incidence. *JAMA*, 319(19), 2021–2031. <https://doi.org/10.1001/jama.2018.5809>

**Cooper, C., Booth, A., Varley-Campbell, J., Britten, N., & Garside, R. (2018).** Defining the process to literature searching in systematic reviews: A literature review of guidance and supporting studies. *BMC Medical Research Methodology*, 18(1), 85. <https://doi.org/10.1186/s12874-018-0545-3>

**Cope, D.G. (2022).** Clinical updates in nausea and vomiting. Presented at the *Seminars in Oncology Nursing*, 38(1), 151249. <https://doi.org/10.1016/j.soncn.2022.151249>

**Cremer, S., Vluggen, S., Man-Van-Ginkel, J. M., Metzeltin, S. F., Zwakhalen, S. M., & Bleijlevens, M. H. C. (2023).** Effective nursing interventions in ADL care affecting independence and comfort—a systematic review. *Geriatric Nursing (New York, N.Y.)*, 52, 73–90. <https://doi.org/10.1016/j.gerinurse.2023.04.015>

**Denis, B. (2022).** Risk and protective factors for colorectal cancer. *La Revue Du Praticien*, 72(8), 889–897.

**Dielenseger, P., Börjeson, S., Vidall, C., Young, A., & Jahn, P. (2019).** Evaluation of antiemetic practices for prevention of chemotherapy-induced nausea and vomiting (CINV): Results of a European oncology nurse survey *Supportive Care in Cancer: Official Journal of the Multinational Association of Supportive Care in Cancer*, 27(11), 4099–4106. <https://doi.org/10.1007/s00520-019-04697-1>

**Dindyal, S. (2019).** Positron emission tomography, computed tomography, magnetic resonance imaging and staging in colorectal cancer. Doctorate Thesis, University College London.

**Duan, B., Zhao, Y., Bai, J., Wang, J., Duan, X., Luo, X., Zhang, R., Pu, Y., Kou, M., Lei, J., & Yang, S. (2022).** Colorectal cancer: An overview. In J. A. Morgado-Diaz (Ed.), *Gastrointestinal Cancers*. Exon Publications. 1–12 <https://doi.org/10.36255/exon-publications-gastrointestinal-cancers-colorectal-cancer>.

**Duan, H., Cai, X., Luan, Y., Yang, S., Yang, J., Dong, H., Zeng, H., & Shao, L. (2021).** Regulation of the autonomic nervous system on intestine. *Frontiers in Physiology*, 12(1), 700129. <https://doi.org/10.3389/fphys.2021.700129>

**Efverman, A. (2023).** Physical, leisure, and daily living activities in patients before, during, and after radiotherapy for cancer: Which patients need support in activities? *Cancer Nursing*, 47(3), 169–79. <https://doi.org/10.1097/NCC.0000000000001187>

**Elwali, N. E., Jarrah, O., Alzahrani, S. G., Alharbi, M. B., Alhejaily, A. G., Alsharm, A. A., & Elhassan, M. M. A.**

**(2023).** Colorectal cancer in Saudi Arabia: The way forward. *Asian Pacific Journal of Cancer Prevention: APJCP*, 24(1), 13–19. <https://doi.org/10.31557/APJCP.2023.24.1.13>

**Evans, A., Vingelen, M. B., Yu, C., Baird, J., Murray, P., & Bryant, P. (2020).** Nausea in numbers: Electronic medical record nausea and vomiting assessment for children with cancer. *Journal of Pediatric Oncology Nursing*, 37(3), 195–203. <https://doi.org/10.1177/1043454219900467>

**Filetti, M., Lombardi, P., Giusti, R., Falcone, R., Scotte, F., Giannarelli, D., Carcagni, A., Altamura, V., Scambia, G., & Daniele, G. (2023).** Efficacy and safety of antiemetic regimens for highly emetogenic chemotherapy-induced nausea and vomiting: A systematic review and network meta-analysis. *Cancer Treatment Reviews*, 115, 102512. <https://doi.org/10.1016/j.ctrv.2023.102512>

**Fink, A. (2019).** *Conducting research literature reviews: From the internet to paper*. Sage Publications. 5<sup>th</sup> ed. SAGE. Los Angeles

**Forner, J. K., Doughty, A., Dalstrom, M., Messer, B. L., & Lizer, S. K. (2021).** Quality of life: A nurse-led physical activity coaching program to improve the quality of life of patients with cancer during the COVID-19 pandemic. *Clinical Journal of Oncology Nursing*, 25(5), 571–577. <https://doi.org/10.1188/21/CJON.571-577>

**Gala, D., Wright, H. H., Zigori, B., Marshall, S., & Crichton, M. (2022).** Dietary strategies for chemotherapy-induced nausea and vomiting: A systematic review. *Clinical Nutrition (Edinburgh, Scotland)*, 41(10), 2147–2155. <https://doi.org/10.1016/j.clnu.2022.08.003>

**Ganesh, K., Stadler, Z. K., Cercek, A., Mendelsohn, R. B., Shia, J., Segal, N. H., & Diaz, L. A. Jr (2019).** Immunotherapy in colorectal cancer: Rationale, challenges and potential. *Nature Reviews Gastroenterology & Hepatology*, 16(6), 361–375. <https://doi.org/10.1038/s41575-019-0126-x>

**Gao, A., Guan, S., Sun, Y., Wang, L., Meng, F., Liu, X., Gu, L., Li, G., Zhong, D., & Zhang, L. (2023).** Prolonged usage of fosaprepitant for prevention of delayed chemotherapy-induced nausea and vomiting (CINV) in patients receiving highly emetogenic chemotherapy. *BMC Cancer*, 23(1), 609. <https://doi.org/10.1186/s12885-023-11070-3>

**Gaschen, F. (2022).** Vomiting. In M. Schaer, F. Gaschen, & S. Watson. *Clinical Medicine of the Dog and Cat*. (4<sup>th</sup> ed.). CRC Press. Pp. 90–94. <https://doi.org/10.1201/9781003254591>

**Gautam, S., Sharma, K. K., & Amanat, M. (2023).** Management of chemotherapy induced nausea vomiting (CINV) in breast cancer patients: An imperative factor in patient compliance. *Journal of Radiology Nursing*, 42(3), 315–320. <https://doi.org/10.1016/j.jradnu.2023.04.002>

**Goosenberg, E., Kaur, A., & Babiker, H. M. (2025).** A review of hereditary colorectal cancers. In *StatPearls*. StatPearls Publishing.

**Gour, S., Kore, A., Das, A., Dane, J., & Maurya, R. K. (2023).** A qualitative study to explore patient’s experiences

- on chemotherapy-induced nausea and vomiting: Focusing impact on daily life. *Asian Pacific Journal of Cancer Care*, 8(1), 21–28. <https://doi.org/10.31557/apjcc.2023.8.1.21-28>
- Haas, B. K., Hermanns, M., & Kimmel, G. (2016).** Incorporating exercise into the cancer treatment paradigm. *Clinical Journal of Oncology Nursing*, 20(6), S17–S24. <https://doi.org/10.1188/16.CJON.S2.17-24>
- Han, C. J., Yang, G. S., & Syrjala, K. (2020).** Symptom experiences in colorectal cancer survivors after cancer treatments: A systematic review and meta-analysis. *Cancer Nursing*, 43(3), E132–E158. <https://doi.org/10.1097/NCC.0000000000000785>
- Herzallah, H. K., Antonisamy, B. R., Shafee, M. H., & Al-Otaibi, S. T. (2019).** Temporal trends in the incidence and demographics of cancers, communicable diseases, and non-communicable diseases in Saudi Arabia over the last decade. *Saudi Medical Journal*, 40(3), 277–286. <https://doi.org/10.15537/smj.2019.3.23585>
- Hesketh, P. J. (1999).** Defining the emetogenicity of cancer chemotherapy regimens: Relevance to clinical practice. *The Oncologist*, 4(3), 191–196.
- Holtedahl, K., Borgquist, L., Donker, G. A., Buntinx, F., Weller, D., Campbell, C., Månsson, J., Hammersley, V., Braaten, T., & Parajuli, R. (2021).** Symptoms and signs of colorectal cancer, with differences between proximal and distal colon cancer: A prospective cohort study of diagnostic accuracy in primary care. *BMC Family Practice*, 22(1), 148. <https://doi.org/10.1186/s12875-021-01452-6>
- Huang, X., Li, X., Li, J., Luo, L., Chen, H., Tan, Y., Wei, T., Li, X., Guo, L., & Cheng, J. (2021).** Chemotherapy-induced nausea and vomiting in breast cancer patients: A multicenter prospective observational study. *Asia-Pacific Journal of Oncology Nursing*, 8(4), 433–437. <https://doi.org/10.4103/apjon.apjon-2120>
- Ilyas, A. B., Bahaj, R. K., Shaikh, A. A., Khawandanah, B. S., Al-Foheidi, M., & Omer, T. Y. (2020).** Breast cancer patients' perceptions of their experience with chemotherapy-induced nausea and vomiting and its impact on quality of life in Jeddah, Saudi Arabia. *Cureus*, 12(12), e12038. <https://doi.org/10.7759/cureus.12038>
- Joseph, R., Hart, N. H., Bradford, N., Agbejule, O. A., Koczwara, B., Chan, A., Wallen, M. P., & Chan, R. J. (2022).** Diet and exercise advice and referrals for cancer survivors: An integrative review of medical and nursing perspectives. *Supportive Care in Cancer*, 30(10), 8429–8439. <https://doi.org/10.1007/s00520-022-07152-w>
- Jurdana, M. (2021).** Physical activity and cancer risk. Actual knowledge and possible biological mechanisms. *Radiology and Oncology*, 55(1), 7–17. <https://doi.org/10.2478/raon-2020-0063>
- Kawazoe, H., Murakami, A., Yamashita, M., Nishiyama, K., Kobayashi-Taguchi, K., Komatsu, S., Aoki, R., Kusakabe, E., Yamasawa, H., Yakushijin, Y., Nakamura, T., & Kamei, Y. (2018).** Patient-related risk factors for nausea and vomiting with standard antiemetics in patients with breast cancer receiving Anthracycline-based chemotherapy: A retrospective observational study. *Clinical Therapeutics*, 40(12), 2170–2179. <https://doi.org/10.1016/j.clinthera.2018.10.004>
- Kim, J. H. (2015).** Chemotherapy for colorectal cancer in the elderly. *World Journal of Gastroenterology*, 21(17), 5158–5166. <https://doi.org/10.3748/wjg.v21.i17.5158>
- Kong, F., Wang, Z., Wang, N., Zhao, L., Mei, Q., Yu, Y., Zhang, D., Li, X., & Jia, Y. (2022).** The clinical observation of acupuncture combined with antiemetic drugs in the prevention and treatment of CINV in breast cancer patients. *Frontiers in Oncology*, 12, 888651. <https://doi.org/10.3389/fonc.2022.888651>
- Krogh, K., & Laurberg, S. (2017).** Physiology of colon, rectum, and anus. In: A. Herold, P-A. Lehur, K. E., Matzel, P. R., O'Connell (2<sup>nd</sup> eds). *Coloproctology*. European Manual of Medicine. Springer, Berlin, Heidelberg. [https://doi.org/10.1007/978-3-662-53210-2\\_3](https://doi.org/10.1007/978-3-662-53210-2_3)
- Lew, J.-B., St John, D. J. B., Xu, X.-M., Greuter, M. J., Caruana, M., Cenin, D. R., He, E., Saville, M., Grogan, P., Coupé, V. M. H., & Canfell, K. (2017).** Long-term evaluation of benefits, harms, and cost-effectiveness of the National Bowel Cancer Screening Program in Australia: A modelling study. *The Lancet Public Health*, 2(7), e331–e340. [https://doi.org/10.1016/S2468-2667\(17\)30105-6](https://doi.org/10.1016/S2468-2667(17)30105-6)
- Lewandowska, A., Rudzki, G., Lewandowski, T., Strykowska-Gora, A., & Rudzki, S. (2022).** Risk factors for the diagnosis of colorectal cancer. *Cancer Control: Journal of the Moffitt Cancer Center*, 29, 10732748211056692. <https://doi.org/10.1177/10732748211056692>
- Mahadevan, V. (2020).** Anatomy of the caecum, appendix and colon. *Surgery (Oxford)*, 38(1), 1–6. <https://doi.org/10.1016/j.mpsur.2019.10.017>
- Mahendra, N. B., & Setiawan, W. A. (2023).** Current Management of CINV. *European Journal of Medical and Health Sciences*, 5(3), 55–59. <https://doi.org/10.24018/ejmed.2023.5.3.1426>
- Marx, W., Kiss, N., McCarthy, A. L., McKavanagh, D., & Isenring, L. (2016).** Chemotherapy-induced nausea and vomiting: A narrative review to inform dietetics practice. *Journal of the Academy of Nutrition and Dietetics*, 116(5), 819–827. <https://doi.org/10.1016/j.jand.2015.10.020>
- Maulidawati, D., Rochmawati, E., & Granel, N. (2023).** Non-pharmacological management for chemotherapy-induced nausea and vomiting in patients with cancer: A scoping review. *Frontiers of Nursing*, 10(1), 9–20. <https://doi.org/10.2478/fon-2023-0002>
- Mazzega-Fabbro, C., Polesel, J., Brusutti, L., Malnis, E., Sirelli, C., Drigo, A., Manicone, M., Rizzetto, M., Lisanti, C., & Puglisi, F. (2023).** A randomized clinical trial investigating an integrated nursing educational program to mitigate chemotherapy-induced nausea and vomiting in cancer patients: The NIV-EC Trial. *Cancers*, 15(21), 5174. <https://doi.org/10.3390/cancers15215174>
- Merrilees, J. (2014).** Activities of Daily Living. In M. J. Aminoff and R. B. Daroff. *Encyclopedia of the Neurological Sciences* (2nd ed.). Edited by Oxford: Academic Press.
- Mosa, A. S. M., Hossain, A. M., Lavoie, B. J., & Yoo, I. (2020).** Patient-related risk factors for chemotherapy-

induced nausea and vomiting: A systematic review. *Frontiers in Pharmacology*, 11, 329. <https://doi.org/10.3389/fphar.2020.00329>

**National Cancer Institute. (2011).** Definition of nausea - NCI Dictionary of Cancer Terms - NCI. Retrieved April 15, 2024

(<https://www.cancer.gov/publications/dictionaries/cancer-terms/def/nausea>).

**National Cancer Institute. (2025).** Colon cancer treatment (PDQ®)— Health Professional Version. NCI <https://www.cancer.gov/types/colorectal/hp/colon-treatment-pdq>

**Omole, A. E., Mandiga, P., Kahai, P., & Lobo, S. (2025).** Anatomy, Abdomen and Pelvis: Large Intestine. In *StatPearls* [Internet]. StatPearls Publishing.

**Oncel, D. (2021).** Role of imaging in colorectal cancers. Colon Polyps and Colorectal Cancer, 123–151. In: O. Engin (ed.), *Colon Polyps and Colorectal Cancer*. Springer, Cham. 123-151. [https://doi.org/10.1007/978-3-030-57273-0\\_1](https://doi.org/10.1007/978-3-030-57273-0_1)

**PDQ Supportive and Palliative Care Editorial Board. (2025).** Nausea and Vomiting Related to Cancer Treatment (PDQ®): Health Professional Version. In *PDQ Cancer Information Summaries*. National Cancer Institute (US).

**Ponnatapura, J., & Lalwani, N. (2021).** Imaging of colorectal cancer: Screening, staging, and surveillance. *Seminars in Roentgenology*, 56(2), 128–139. <https://doi.org/10.1053/j.ro.2020.07.005>

**Prip, A., Pii, K. H., Moller, K. A., Nielsen, D. L., Thorne, S. E., & Jarden, M. (2019).** Observations of the communication practices between nurses and patients in an oncology outpatient clinic. *European Journal of Oncology Nursing: The Official Journal of European Oncology Nursing Society*, 40, 120-125. <https://doi.org/10.1016/j.ejon.2019.03.004>

**Roshandel, G., Ghasemi-Kebria, F., & Malekzadeh, R. (2024).** Colorectal cancer: Epidemiology, risk factors, and prevention. *Cancers*, 16(8), 1530. <https://doi.org/10.3390/cancers16081530>

**Ruggiero, K. M., Wong, J., Sweeney, C. F., Avola, A., Auger, A., Macaluso, M., & Reidy, P. (2021).** Parents' intentions to vaccinate their children against COVID-19. *Journal of Pediatric Health Care*, 35(5), 509–517. <https://doi.org/10.1016/j.pedhc.2021.04.005>

**Salimoglu, S., Tuncer, G. K., & Calik, B. (2021).** Anatomy of the colon, rectum, and anus. In: O. Engin (ed.), *Colon Polyps and Colorectal Cancer*. Springer, Cham. 1–22. [https://doi.org/10.1007/978-3-030-57273-0\\_1](https://doi.org/10.1007/978-3-030-57273-0_1)

**Schwingshackl, L., Schwedhelm, C., Hoffmann, G., Knüppel, S., Laure Preterre, A., Iqbal, K., Bechthold, A., De Henauw, S., Michels, N., Devleesschauwer, B., Boeing, H., & Schlesinger, S. (2018).** Food groups and risk of colorectal cancer. *International Journal of Cancer* 142(9), 1748–1758. <https://doi.org/10.1002/ijc.31198>

**Shahsavari, D., & Parkman, H.P. (2022).** Normal gastrointestinal tract physiology. In: C. Newberry, J. Laster, O. Pickett-Blakely (ed), *Nutrition, Weight, and Digestive Health*. Springer, Cham. [https://doi.org/10.1007/978-3-030-57273-0\\_1](https://doi.org/10.1007/978-3-030-57273-0_1)

94953-2\_1

**Shawki, M. S., Mekkawy, M., Wahman, M., Desouky, A. (2019).** Colorectal cancer: Consequences of chemotherapy induced nausea and vomiting on patients' functional daily living. *Assiut Scientific Nursing Journal*, 7(17), 1-12. <https://doi.org/10.21608/asnj.2019.61145>

**Siegel, R. L., Jakubowski, C. D., Fedewa, S. A., Davis, A., & Azad, N. S. (2020).** Colorectal cancer in the young: Epidemiology, prevention, management. *American Society of Clinical Oncology Educational Book*, American Society of Clinical Oncology. Annual Meeting, 40, 1-14. [https://doi.org/10.1200/EDBK\\_279901](https://doi.org/10.1200/EDBK_279901)

**Simino, G. P. R., Reis, I. A., Acurcio, F. A., Andrade, E. I. G., Brazil, N. M. L., & Cherchiglia, M. L. (2020).** Risk factors associated with antineoplastic chemotherapy-induced nausea and vomiting. *Revista de Saude Publica*, 54, 106. <https://doi.org/10.11606/s1518-8787.2020054002178>

**Siskova, A., Cervena, K., Kral, J., Hucl, T., Vodicka, P., & Vymetalkova, V. (2020).** Colorectal adenomas-genetics and searching for new molecular screening biomarkers. *International Journal of Molecular Sciences*, 21(9), 3260. <https://doi.org/10.3390/ijms21093260>

**Smith, H. G., Nilsson, P. J., Shogan, B. D., Harji, D., Gambacorta, M. A., Romano, A., Brandl, A., & Qvortrup, C. (2024).** Neoadjuvant treatment of colorectal cancer: Comprehensive review. *BJS Open*, 8(3), zrae038. <https://doi.org/10.1093/bjsopen/zrae038>

**Soliman, G. H., Alagizy, H., & Shehata, O. S. M. H. (2017).** Efficacy of non pharmacological technique on chemotherapy induced nausea, vomiting and retching among breast cancer patients. *IOSR Journal of Nursing and Health Science*, 6(6), 60-72. <https://doi.org/10.9790/1959-0605056072>

**Suliman, I., Phantumvanit, V., Rostamjad, L., Blouin, G., & Scullion, B. (2023).** Adult guidelines for assessment and management of nausea and vomiting. Dana-Farber Cancer Institute & Brigham and Women's Hospital.

**Sung, H., Ferlay, J., Siegel, R. L., Laversanne, M., Soerjomataram, I., Jemal, A., Bray, F. (2021).** Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA: A Cancer Journal of Clinicians*, 71(3), 209–249. <https://doi.org/10.3322/caac.21660>

**Tilleman, J. A., Pick, A., DeSimone, E. M., Price, S., & Runia-Bade, L. (2018).** Chemotherapy-induced nausea and vomiting. *US Pharmacist*, 43(2) (Speciality & Oncology Suppl), 2–5.

**Tsuji, Y., Baba, H., Takeda, K., Kobayashi, M., Oki, E., Gotoh, M., Yoshida, K., Shimokawa, M., Kakeji, Y., & Aiba, K. (2017).** Chemotherapy-induced nausea and vomiting (CINV) in 190 colorectal cancer patients: A prospective registration study by the CINV study group of Japan. *Expert Opinion on Pharmacotherapy*, 18(8), 753–758. <https://doi.org/10.1080/14656566.2017.1317746>

**Tudosie, M. S., Pauna, A., Stefani, C., & Staicu, I. M. (2022).** Diet and food chemicals increasing the risk of colorectal cancer—literature review. *Journal of Mind and*

*Medical Sciences*, 9(1), 118–124.  
<https://doi.org/10.22543/7674.91.P118124>

**Tuominen, L., Ritmala, M., Vahlberg, T., Mäkelä, S., Nikander, P., & Leino-Kilpi, H. (2023).** The effect of nurse-led empowering education on nutrition impact side effects in patients with colorectal cancer undergoing chemotherapy: A randomised trial. *Patient Education and Counseling*, 115, 107895.  
<https://doi.org/10.1016/j.pec.2023.107895>

**Turner, R. R., Steed, L., Quirk, H., Greasley, R. U., Saxton, J. M., Taylor, S. J. C., Rosario, D. J., Thaha, M. A., & Bourke, L. (2018).** Interventions for promoting habitual exercise in people living with and beyond cancer. *Cochrane Database of Systematic Reviews*, 9(9), CD010192.  
<https://doi.org/10.1002/14651858.CD010192.pub3>

**Wang, Y. H. W., & Wiseman, J. (2025).** Anatomy, abdomen and pelvis: Rectum. In StatPearls [Internet]. StatPearls Publishing. Retrieved from <https://www.ncbi.nlm.nih.gov/books/NBK537245/>

**Wu, Z., Fu, X., Jing, H., Huang, W., Li, X., Xiao, C., Li, Z., & You, F. (2024).** Herbal medicine for the prevention of chemotherapy-induced nausea and vomiting in patients with advanced colorectal cancer: A prospective randomized controlled trial. *Journal of Ethnopharmacology*, 325, 117853. <https://doi.org/10.1016/j.jep.2024.117853>

**Xi, Y., & Xu, P. (2021).** Global colorectal cancer burden in 2020 and projections to 2040. *Translational Oncology*, 14(10), 101174.  
<https://doi.org/10.1016/j.tranon.2021.101174>

**Xiao, Y., & Watson, M. (2017).** Guidance on conducting a systematic literature review. *Journal of Planning Education and Research*, 39(1), 93–112. <https://doi.org/10.1177/0739456X17723971>

**Yang, Y., Han, Z., Li, X., Huang, A., Shi, J., & Gu, J. (2020).** Epidemiology and risk factors of colorectal cancer in China. *Chinese Journal of Cancer Research*, 32(6), 729–741. <https://doi.org/10.21147/j.issn.1000-9604.2020.06.06>

**Yokoe, T., Hayashida, T., Nagayama, A., Nakashoji, A., Maeda, H., Seki, T., Takahashi, M., Takano, T., Abe, T., & Kitagawa, Y. (2019).** Effectiveness of antiemetic regimens for highly emetogenic chemotherapy-induced nausea and vomiting: A systematic review and network meta-analysis. *The Oncologist*, 24(6), e347–e357.  
<https://doi.org/10.1634/theoncologist.2018-0140>

**Nikolouzakis, T. K., Mariolis-Sapsakos, T., Triantopoulou, C., De Bree, E., Xynos, E., Chrysos, E., & Tsiaoussis, J. (2019).** Detailed and applied anatomy for improved rectal cancer treatment. *Annals of Gastroenterology*, 32(5), 431–440.  
<https://doi.org/10.20524/aog.2019.0407>