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# Differences in CEA Levels and Nutritional Status in Stage III Rectal Cancer Patients Undergoing Different Types of Therapy

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**ABSTRACT:**
**Background:** Rectal cancer is a type of malignancy with a higher rate of local recurrence compared to colon cancer. Various therapies such as surgery, chemotherapy, and radiotherapy are commonly used for treatment. Monitoring the effectiveness of these therapies can be supported by clinical parameters such as Carcinoembryonic Antigen (CEA) levels and nutritional status measured by Body Mass Index (BMI).
**Aims:** This study aimed to examine the differences in CEA levels and nutritional status among rectal cancer patients receiving different types of therapies.
**Methods:** This was an observational analytic study with a cross-sectional design. The sample consisted of 56 patients with stage III rectal cancer at Sultan Agung Islamic Hospital Semarang during the period of 2018-2024. Data were collected from medical records and included patients who received either surgery + chemotherapy (n = 33) or surgery + chemotherapy + radiotherapy (n = 23). CEA levels were analyzed using the Mann-Whitney U test, and nutritional status was analyzed using the Independent Sample T-Test.
**Result:** The results showed no statistically significant difference in CEA levels between the two therapy groups (p = 0.405). However, a significant difference was found in nutritional status, with patients undergoing radiotherapy showing lower BMI values compared to those without radiotherapy (p = 0.000).
**Conclusion:** CEA levels did not significantly differ between types of therapy in stage III rectal cancer patients. However, radiotherapy was associated with a significant decline in nutritional status. These findings highlight the importance of integrating nutritional monitoring in the management of rectal cancer patients receiving combined therapy.

**Keywords:** Rectal cancer, Carcinoembryonic Antigen (CEA), Nutritional status, Body Mass Index (BMI), Chemotherapy, Radiotherapy, Surgical therapy, Combined therapy

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## INTRODUCTION

Rectal cancer is a type of malignancy in the digestive system that is included in the colorectal cancer group (Aswan & Hanriko, 2023; Budiono et al., 2018; M. Rizki Fazrian Danu & M. Sayuti, 2023a; Sayuti & Nouva, 2019) . The disease generally starts from precursor lesions such as polyps that develop into cancer within 10 to 15 years. In Indonesia, the incidence of rectal cancer continues to increase, and according to the Ministry of Health in 2018, an estimated 1 in 20 people suffer from rectal cancer. In addition, the 2020 GLOBOCAN report states that rectal cancer ranks as the second highest cause of cancer deaths globally (Adila & Mustika, 2023; Bray et al., 2018; Cao et al., 2021; Hashiguchi et al., 2020) . This condition shows the urgency in improving the effectiveness of rectal cancer management, especially in advanced stages, one of which can be assessed through biological biomarkers such as Carcinoembryonic Antigen (CEA) levels and patient nutritional status (AL-Nafakh et al., 2020; Kankanala et al., 2024; Muley et al., 2018) .

There is a lack of local studies comparing the impact of therapy modalities—such as surgery and chemotherapy alone versus the addition of radiotherapy—on both CEA levels and nutritional status. This is significant because different therapies may carry distinct side effects that influence metabolic health and overall quality of life.

This study leverages the availability of retrospective medical data from stage III rectal cancer patients treated between 2018 and 2024 at Sultan Agung Islamic Hospital and Ken Saras Hospital. It offers a timely opportunity to perform an analytical observational study examining the dual outcomes of CEA and BMI, which are often studied separately.

Previous literature tends to analyze these parameters independently, leaving a research gap in studies that evaluate both biomarkers concurrently across therapy types in the Indonesian healthcare context. This study addresses that gap, providing novel insights into how therapy combinations influence biochemical and nutritional profiles in advanced rectal cancer patients.

The selection of the type of therapy as an independent variable is based on the consideration that the combination of surgery and chemotherapy alone compared to the combination of surgery, chemotherapy, and radiotherapy has the potential to have a different impact on CEA levels and BMI. Radiotherapy, although effective in reducing the risk of local recurrence, has the potential for greater side effects on patient metabolism and nutritional intake (Genia et al., 2025; Syakir & Zuhan, 2024; Wijaya et al., 2024) . Therefore, scientific studies are needed to assess its effectiveness and impact on the patient's biological status holistically.

This study aims to determine whether there are significant differences in CEA levels and nutritional status in stage III rectal cancer patients based on the type of therapy undertaken. Theoretically, the findings of this study can enrich the treasure of knowledge in the field of clinical oncology and medical nutrition. Practically, the results are expected to be the basis for making more comprehensive and targeted medical decisions, as well as improving the effectiveness of treatment as well as the quality of life of patients. This study also contributes to the development of local data that can be used as a reference for similar studies in national and regional contexts.



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## METHOD

### Research Design

This study used an analytical observational approach with a cross-sectional design (Adha et al., 2021; Ridwan & Suryaalamsah, 2023; Yuniarly et al., 2019) . The study aims to analyze differences in CEA levels and nutritional status in stage III rectal cancer patients based on the type of therapy received.

### Participants

The subjects in this study were stage III rectal cancer patients who underwent therapy at Sultan Agung Islamic Hospital Semarang and radiotherapy at Ken Saras Hospital during the period 2018-2024. The total number of participants was 56, consisting of surgery+chemotherapy group (33 patients) and surgery+chemotherapy+radiotherapy group (23 patients).

### Population, Sampling Method, and Instrumentation:

- The target population was all patients with stage III rectal cancer.
- The target population was patients with complete medical record data at Sultan Agung Islamic Hospital and Ken Saras Hospital for the period 2018-2024.
- The sampling technique used was consecutive sampling, where all subjects who met the inclusion criteria and did not meet the exclusion criteria were included as samples.
- Inclusion criteria: Stage III patients undergoing combination therapy, having complete data, aged 19-64 years, and histologically verified diagnosis of adenocarcinoma.
- Exclusion criteria: Patients with other cancers, or had metastasis based on CT scan results.
- The minimum sample size calculated by the unpaired numerical analytic formula was 34 samples, but 56 samples were used in this study.
- Instrumentation: There was no questionnaire. Data were obtained from medical records, including laboratory results of CEA levels and Body Mass Index (BMI) measurements. Scoring was based on clinical classification: CEA level (normal ≤ 5 ng/ml) and BMI category based on WHO standard.

### Research Instruments

The research instrument was a secondary data recording form obtained from the patient's medical record, including: type of therapy, post-therapy CEA levels, and BMI data.

- CEA levels were obtained from hospital laboratory results using the immunohistochemistry method.
- Nutritional status was assessed based on BMI = $\frac{\text{Weight (kg)}}{\text{Height}^{(2)\ \text{m}(2)}}$

### Research Procedure and Time

- Data collection was carried out after obtaining Ethical Clearance from the Faculty of Medicine, Sultan Agung Islamic University.
- The study was conducted from July 4 to November 14, 2024.
- Data were taken from the medical records of rectal cancer patients who had undergone therapy at Sultan Agung Islamic Hospital and radiotherapy at Ken Saras Hospital.
- Data were recorded and classified according to the research variables, then analyzed to determine differences between therapy groups.



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**Analysis Plan**

- Data analysis was performed using SPSS version 27.
- Normality test was performed using Shapiro-Wilk Test.
- If the data were normally distributed, the Independent Sample T-Test was used.
- If the data was not normal, the Mann-Whitney U Test was used.
- The significance value is determined by p-value <0.05. If $p < 0.05$ then there is a significant difference between groups.

## RESULTS AND DISCUSSION

**Result**

This study aims to determine differences in CEA levels and nutritional status in stage III rectal cancer patients based on the type of therapy undertaken. The sample in this study was 56 patients consisting of two therapy groups: surgery + chemotherapy group (33 patients) and surgery + chemotherapy + radiotherapy group (23 patients). Data were obtained from the medical records of Sultan Agung Islamic Hospital and Ken Saras Hospital for the period 2018-2024.

1. Sample Characteristics

The following are the demographic characteristics and nutritional status of the two therapy groups:

**Table 1. Sample Characteristics**

| Characteristics | Surgery + Chemotherapy (n = 33) | Surgery + Chemotherapy + Radiotherapy (n = 23) |
|---|---|---|
| Age | | |
| Adult (18-45) | 7 (21,2%) | 4 (17,4%) |
| Pre-elderly (45-59) | 9 (27,3%) | 9 (39,1%) |
| Gender | | |
| Male | 14 (42,4%) | 5 (21,7%) |
| Female | 19 (57,6%) | 18 (78,3%) |
| Nutritional Status (BMI) | | |
| Underweight (<18.5) | 10 (30,3%) | 12 (52,2%) |
| Normal (18.5-22.9) | 14 (42,4%) | 7 (30,4%) |
| Overweight (23-24.9) | 5 (15,2%) | 3 (13%) |
| Obesity I (25-29.9) | 4 (12,1%) | 0 (0%) |
| Obesity II (≥30) | 0 (0%) | 1 (4,3%) |

2. Classification of CEA Levels

CEA levels were assessed based on laboratory results with classification:

- Normal: 0 - 5 ng/ml
- Abnormal: > 5 ng/ml

**Table 2. Distribution of CEA Levels**

| CEA Level | Surgery + Chemotherapy (n = 33) | Surgery + Chemotherapy + Radiotherapy (n = 23) |
|---|---|---|
| Normal (0-5 ng/ml) | 12 (36,4%) | 9 (39,1%) |
| Abnormal (>5 ng/ml) | 21 (63,6%) | 14 (60,9%) |

3. Test for Differences in CEA Levels

Statistical tests used Mann-Whitney U Test because the data were not normally distributed. The results of the analysis showed that there was no significant difference in CEA levels between the two therapy groups.



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**Table 3. Mann-Whitney Test of CEA Levels**

| Therapy Group | Mean CEA (ng/ml) | Statistical Test | p-value |
|---|---|---|---|
| Surgery + Chemotherapy | (value not stated) | Mann-Whitney U | 0,405 |
| Surgery + Chemotherapy + Radiotherapy | (value not stated) | | |

4. Test of Difference in Nutritional Status (BMI)
   Nutritional status was compared using the Independent Sample T-Test test because the data was normally distributed. The results of the analysis showed that there was a significant difference in nutritional status between the two therapy groups.

**Table 4. T-Test on Nutritional Status**

| Therapy Group | Mean BMI ($kg/m^2$) | Statistical Test | p-value |
|---|---|---|---|
| Surgery + Chemotherapy | (value not stated) | Independent Sample T-Test | 0,000 |
| Surgery + Chemotherapy + Radiotherapy | (value not stated) | | |

**Discussion**

The results of this study showed that there was no significant difference in Carcinoembryonic Antigen (CEA) levels between stage III rectal cancer patients who underwent surgery + chemotherapy and those who underwent surgery + chemotherapy + radiotherapy), the administration of additional radiotherapy did not significantly affect CEA levels post-therapy. In addition, it was shown that although CEA levels may decrease after chemoradiation, the values may increase again a few weeks post-therapy. This confirms that CEA levels, although an important biomarker for cancer monitoring (Dal Bello et al., 2019; Feng et al., 2017; Gao et al., 2017; Hester et al., 2021) . are not necessarily sensitive enough to evaluate differences in outcomes of therapy types in the short term.

In contrast to CEA levels, nutritional status measured through Body Mass Index (BMI) showed a significant difference between the two groups. Patients who underwent therapy with additional radiotherapy had a BMI that tended to be lower than the group without radiotherapy (Hendrawati et al., 2020; Novitasari et al., 2016; Yulideswati & Nurbaiti, 2024) . This shows that combination therapy, especially chemoradiation, can have a negative impact on the nutritional status of patients because it reduces appetite, disrupts digestive function, and increases body metabolism. The physiological impact of radiotherapy on the digestive system can worsen nutrient absorption, cause malnutrition, and ultimately affect the healing process (Aji, 2018; Christiyanty et al., 2021; Erliana et al., 2025; M. Rizki Fazrian Danu & M. Sayuti, 2023b) . Thus, in this context, nutritional status proved to be more sensitive in revealing the impact of therapy on the patient's overall body condition.

The implications of these findings are significant for clinical practice. Evaluation of successful rectal cancer therapy should not only rely on CEA levels, but also include regular monitoring of nutritional status, especially in patients undergoing radiotherapy. This emphasizes the importance of a multidisciplinary approach in the management of advanced rectal cancer, involving not only oncologists and surgeons, but also clinical nutritionists. Appropriate nutritional intervention strategies can be a preventive measure against excessive weight loss and post-therapy malnutrition.

This study makes an important contribution in filling the gap of local data on the impact of combined rectal cancer therapy on CEA levels and nutritional status simultaneously. Most previous studies have only examined one of these two indicators separately. Thus, this study adds new insights



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in the context of a teaching hospital in Indonesia, that nutritional status can be a valid clinical indicator in evaluating the physiologic burden of therapy and can complement laboratory parameters such as CEA that are biochemical in nature (Masuke et al., 2021; Piqueras et al., 2021; Tallulembang et al., 2021) .

However, this study has a number of limitations that need to be considered. First, the data used were retrospective and derived from medical records, so the possibility of confounding variables such as smoking habits, initial nutritional status, and food intake could not be optimally controlled. Second, the lack of longitudinal measurement of CEA and BMI levels meant that the dynamics of post-therapy changes could not be comprehensively traced. Third, the limited sample size and study location, which only included two hospitals, limit the generalizability of the results of this study to a broader context.

Therefore, it is recommended that future studies use a prospective longitudinal design to monitor changes in CEA levels and BMI from before to several weeks after therapy. The study should be complemented with a structured nutritional intervention in order to evaluate its effect directly on the success of therapy and the quality of life of patients. Multicenter studies with larger sample sizes are also needed to improve the external validity and generalizability of these findings. Thus, the results of future studies can provide more robust and applicable clinical recommendations in the holistic management of rectal cancer.

## CONCLUSION

Based on the results of a study conducted on 56 patients with stage III rectal cancer at the Sultan Agung Islamic Hospital Semarang, it can be concluded that there is no significant difference in *Carcinoembryonic Antigen* (CEA) levels between patients undergoing surgery + chemotherapy and patients undergoing surgery + chemotherapy + radiotherapy. This finding suggests that CEA levels as a biomarker do not directly differentiate the effectiveness of both types of therapy in the short term.

However, there was a significant difference in the nutritional status of patients based on Body Mass Index (BMI) values. Patients who received additional radiotherapy experienced a greater decline in nutritional status than patients without radiotherapy. This confirms that radiotherapy has a real physiological impact on the nutritional condition of patients, so nutritional monitoring and intervention should be an integral part of rectal cancer management, especially in combination therapy.

## AUTHOR CONTRIBUTION STATEMENT

AR was responsible for the formulation of the research idea, data collection, and writing the initial draft of the article. VM contributed to methodological supervision, data analysis, and critical review of the article content. CH provided guidance in literature review, validation of results, and final editing of the manuscript. All authors have read and approved the final version of the article for publication.



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