

PREDICTIVE FACTORS OF HEALTH DISCHARGE OUTCOMES FOR COLORECTAL CANCER PATIENTS IN A ROMANIAN HOSPITAL

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Abstract: In-hospital data on colorectal cancer from Romania demonstrate differences from other European countries, especially in the mean age of patients, discharge rates and length of stay. Our study aimed to investigate possible factors that could predict the health outcomes at the discharge of colorectal cancer patients hospitalized in a Romanian county hospital. We retrospectively analysed 9009 colorectal cancer patients from a Romanian County Hospital. The model of binary logistic regression, a stationary or aggravated discharge disposition was associated with patients with age equal or higher than 60 years ($p=0.002$), the nonretirement status of patients ($p=0.004$), discharge from a surgical section ($p=0.000$), a surgical procedure performed during the hospitalization period ($p=0.000$) and a hospitalization period shorter than seven days ($p=0.000$). Potentially actionable demographic and hospital-level characteristics can predict colorectal cancer health outcomes of patients at discharge. Knowledge of this information would allow for several strategies that could improve the discharge planning.

INTRODUCTION

The disease burden of cancer in Europe has been increasing over time, and population ageing is a major contributing factor to this development.(1) Colorectal cancer is a significant worldwide public health problem, and the foreseen rise in the burden of disease related to economic and demographic transition is connected with widening disparities among and within countries.(2) Based on the GLOBOCAN estimations from 2018 of colorectal cancer incidence and mortality, produced by the International Agency for Research on Cancer, colorectal cancer ranked second in Europe in terms of incidence and mortality, with approximately 500,000 new cases diagnosed only in Europe, and 243,000 deaths. Based on this report, Romania had the 29th highest age-standardized incidence for both sexes, at all ages from Europe (26,7 cases per 100,000 individuals). Nevertheless, it had 12th highest age-standardized mortality rate in the European area (13,7 cases per 100,000 individuals). The 5-year prevalence from 2013-2018 increased to a total of 30,000 cases.(3)

Based on 2020 study of in-hospital data from Romania, the CRC mortality is much higher than the EU mean mortality, because of a probable delayed diagnosis due to the lack of well-managed screening program. The same study concluded that Romania has the highest discharge rates for colorectal cancer in Europe for the years between 2015-2018, and one of the most extended average lengths of stay, determined by a probable more severe stage of the disease.(4)

As well, a significant issue found is the high mean age of hospitalized CRC patients from Romania.(4) Older patients

have often medical comorbidities and negative results, associated with post-treatment morbidity and mortality.(5,6) Elderly discharged CRC patients do not receive appropriate care needs, including functional deficits, social and emotional assistance, and economic resources to manage their recovery. Additionally, when post-discharge care plans do not adequately address the deterioration of physical function, there is an increased risk of readmission, leading to raised expenses for patients and health care systems.(7) More elderly patients are undergoing surgery because the progress in surgical and anaesthetic procedures have made it more secured to operate even in frail patients.(7)

Surgery is the current treatment for resectable colorectal cancer, and during the last decade, it has experienced some significant improvements on pre-operative assessment, instrument, surgical techniques, intra-operative monitor and post-operative care.(8)

AIM

We performed this study to investigate possible factors that could predict the health outcomes at the discharge of patients hospitalized and diagnosed with colorectal cancer. At the health system and hospital level, knowledge of this information would allow for a number of strategies that could possibly advance the quality and effectiveness of rehabilitation pathways and discharge planning. For example, preoperative risk stratification could identify a high-risk cohort for whom early, evidence-based interventions designed to prevent negative discharge outcomes could be implemented.(9) We hypothesize

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that readily available health information from hospital records could help physicians with better decision making in managing these patients. These factors could then be useful to plan a surgical or non-surgical CRC patient's discharge, increase efficiency and improve resource allocation.

MATERIALS AND METHODS

Data source

A secondary analysis was performed retrospectively reviewing the medical registry from the Regional Institute of Gastroenterology Hepatology Prof. Dr. "Octavian Fodor", Cluj-Napoca. The hospital database contains clinical, demographic and administrative data from 2009 to 2018, of a total of 9009 patients with colorectal cancer. It includes the typical information of patients that were hospitalised and discharged in this time frame. The appropriate institutional review board approved the use of the database information for research at the Regional Institute. It includes the use of operational level data on clinical sections (admission and discharge), the period of hospitalisation (the dates for admission, surgical intervention and discharge) and variables dependant on the type of admission (criterion, county health insurance house, kind of admission, service transfer). As well, it includes clinical data, like ICD-10-CM diagnoses and the name of the surgical intervention and several demographics measures (sex, age, educational level, residence information, and assurance type).

Sample selection

We included all adult subjects, aged 18 years or older, cared for by the following units: gastroenterology, internal medicine and general surgery, during their admission. The study period was defined as January 2009 through December 2018. Because of the lack of identification variables, independence of observations was not ensured, and there is the possibility that subjects were included in the analysis multiple times in different years. The exclusion criteria included subjects under the age of 18 and subjects whose discharge diagnoses were not colorectal cancer. The final sample included for analysis included 9009 subjects for the main study, and the final selected cases for the logistic regression model included 5238 patients (58.1%), because of the missing data.

Data analysis

Descriptive statistics were calculated for socio-demographic data, as well for administrative and clinical data from 9009 subjects included in the analysis. These data were described as frequencies and per cent. For data referring to age, central tendency and dispersion were measured as mean and standard deviation. For the inferential analysis between socio-demographic clinical and administrative data, the Chi-Square test was used to calculate the effect size with odds ratio. This test was used for comparison and association using the frequency of categorical data between the different subsamples.

A model of binary logistic regression was performed to assess the impact of a number of factors on the overall health state of patients when they were discharged home from the hospital. It was used between the several independent variables and the dependent variable, coded as subjects' state at discharge stationery, aggravated or deceased (1) and improved or cured (0).

Linear Modelling was utilised to create an explicative analysis model of the association power between the independent variables and the discharge disposition. It allows testing of the null hypotheses about the effects of other factors on the means of a single dependent variable. For regression analysis, the independent (predictor) variables are specified in table no. 1. To verify the adequacy of this integrated model, the Hosmer-Lemeshow model for goodness of fit test was applied, with a p-value of $p=0.236$, indicating a good fit for the model. A

p-value of < 0.05 was used to indicate statistical significance. All analyses were performed on SPSS (Version 22).

Table no. 1. Coding of independent variables used in the binary logistic model

Sex	Males	1
	Females	0
Age	Age equal to or over 60 years	1
	Age under 60 years	0
Retirement status	Not retired patients	1
	Retired patients	0
Place of residence	Urban area	1
	Rural area	0
Hospitalisation duration	Duration under 7 days	1
	Duration equal to or over 7 days	0
Admission criteria	Medical-surgical emergencies	1
	Other admission criteria	0
Admission unit	Surgical unit	1
	Non-surgical unit	0
Discharge unit	Surgical unit	1
	Non-surgical unit	0
Performing surgical procedure	With surgical procedure	1
	Without surgical procedure	0

RESULTS

Sample description

Socio-demographic characteristics for the 9009 cases of colorectal cancer are presented in table no. 2. Linear Modelling was utilised to create an explicative analysis model of the association power between the independent variables and the discharge disposition, ranging from 18 to 97 years of age ($SD = 10.89$). From the results, it is clear that most patients were retired (46.5%) and lived in an urban area (49.6%). Figure no. 1 which shows the population pyramid of the sample key findings emerge: colorectal cancer is more prevalent in males (57.9%) than in females (42.15); most patients (51%) were in the age group of 55-69 years, while only a minority of 17.2% were between 18 and 54 years. The mean age of the patients with colon cancers was significantly higher than the age of those with rectal cancer (64.45 vs. 63.40 years, $p < 0.0001$). As well, patients with left-sided tumours were significantly younger than those diagnosed with right-sided tumours (64.96 vs. 64.27 years, $p = 0.024$).

Table no. 2. Characteristics of the sample

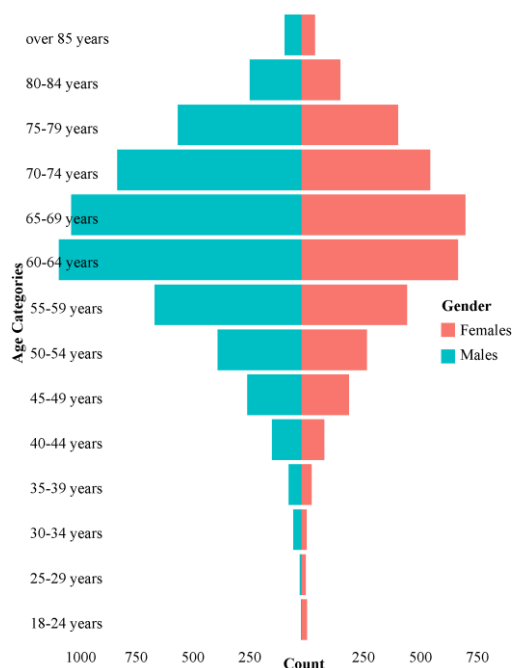
Characteristics	Categories	N = 9009	%
Gender	Females	3794	42.1
	Males	5215	57.9
Categories of occupation	Students	13	0.1
	Unemployed	281	3.1
	Freelancer or self-employed	64	0.7
	Employed or business owner	1123	12.4
	Retired	4193	46.5
	Missing data	3335	37
Residence type	Rural area	1954	21.7
	Urban area	4468	49.6
	Missing data	2587	28.7

At admission, a small percentage of cases were diagnosed with other ICD-10 CM codes than those for colorectal cancer ($N=1164$, 12.92%), from whom 229 had only signs and symptoms related to the digestive system or general signs. The commonest primary at discharge site was the colon ($N = 4833$, 53.64%), followed by the rectum ($N = 3227$, 35.8%) and the recto-sigmoid junction ($N = 949$, 10.5%).

From the inpatient hospitalisation administrative data, the mean duration of hospitalisation was 8.15 days ($SD = 6.227$) and a median of 7 days. However, 27.2% were hospitalised only

between 2 and 4 days, while around 5% of the cases were hospitalised between 20 and 93 days. From the total sample, for 5407 patients (60,01%) surgical procedures were performed. Most patients (49,2%) were admitted to the hospital-based on a medical referral note from the general physician, followed by those who were referred by a specialist physician (28,3%). Around 20% of patients did not have any medical recommendation and were admitted based on emergency criteria. The majority of the sample were admitted to the general surgery unit (62.2%), while 19,3% and 18,5% were admitted to the gastroenterology unit, respectively to the internal medicine unit. It is important to note that the majority of patients (58,3%) had an improved health state at discharge, while more than 20% were noted as cured. Almost 19% remained stationary during the hospitalisation period, and 0.5% had an aggravated state of disease. The rate of hospitalised patients that died in our sample was 1.8%.

Figure no. 1. Population pyramid of the sample of colorectal cancer patients



Inferential analysis

Certain socio-demographic and administrative data from the medical registry database have been identified and included as predictor variables in a binary logistic regression model (table no. 3). The analysis was carried out in order to assess the impact of these factors on the likelihood that the colorectal cancer patient would have a stationary / worsen state of health at discharge or dying during the hospitalisation period, or an improved or cured health status at discharge. The applied model with all predictors was significant, with $\chi^2 = 819.626$ (df = 9, N = 5238, $p < 0.0001$). The general accuracy of this model to predict patients having a stationary/worsen state of health at discharge with a predicted probability of 0.5 is 82%, indicating that this model is capable of distinguishing between patients diagnosed with colorectal cancer and their discharging outcomes. The sensitivity of the current model is 98.6%, while the positive predictive value is 54.6% and the negative predictive value = 82.67%.

Based on the odds ratio value, the probability of having a stationary/worsen state of health at discharge increases approximately 1.5 times in patients with age equal to or over 50 years and in those that are not retired. It seems that sex and

residency of the patients do not influence the health state significantly at discharge. The administrative data that were linked to an increased probability of this result were the discharge from a surgical section, surgical procedures and a shorter hospitalisation period. The probability increases more than 6.5 times for the patient who had a surgical procedure during the hospitalisation period. As well, compared to those who were discharged from the gastroenterology or internal medicine unit, those discharged from a surgical unit were approximately three times more likely to have a stationary/worsen state of health. Apart from these factors, another important variable is the duration of the hospitalisation. The logistic regression model demonstrated that patients hospitalised less than seven days were more than two times likely not to improve their health state. Our results cast a new light on the effect of the length of stay on the health state at discharge.

DISCUSSIONS

The incidence of colorectal cancer increased dramatically in Romania and worldwide, is one of the highest in Europe. In Romania, recent trends from 2018 reported twice as many deaths than the European Union average. As well, the prevalence of Romanian patients diagnosed with colorectal cancer that are hospitalized continuously increased in the last years.(4) It is, therefore, a priority to ensure appropriate discharge planning for these hospitalized patients and to improve patient flow due to the rising demand for services and the economic burden of this disease. The results demonstrated in this study confirm the importance of specific patient and hospital characteristics on the health state of colorectal patients at discharge. It is worth discussing these pieces of evidence revealed by the results of the logistic regression model.

Colorectal cancer, in particular, is mostly a disease of ageing.(10) Overall, older patients and those who are not yet retired were the demographic predictors for not having an improved discharge disposition. Others have shown that older age is a consistent predictor for readmission after colorectal surgery.(11) The capacity of the Romanian healthcare system is under pressure, due to limited financial resources, the demographic transition of the population and higher rates of cancer (12), and findings from this study indicate that older patients discharged from the hospital are more likely to have an inadequate discharge outcome, thus limiting the wellbeing of these patients in the long-term. In line with previous studies, those who were not retired were more likely to have a worsening state of health. This could be explained by previous research showing that these patients were more likely to have at least one risk factor than those who were retired.(13)

From the results, it is clear that colorectal surgery with the possible postoperative complications and delayed recovery, discharge from the surgical unit and could be used as predictors for the wellness at discharge. The overall morbidity rate of colorectal surgery was reported to be as high as 25%, while for surgical emergencies, the rate can increase to up to 48.3%.(14,15) Even though we did not replicate previously reported research, our results could be explained by the higher rate of colorectal cancer patients that need emergency surgery, although there is a lack of data in the literature about the association of admission for medical-surgical emergencies and discharge disposition. Additionally, because data referring to the curative or palliative intent of the surgery was not available, we did not consider this information. Due to this result, we might consider that the health status of the patient at discharge can depend on the technical conduct of the operation and surgical volume. Moreover, these results may indicate the utilization of less intrusive surgical approaches (i.e., local excision) in the elderly.

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Table no. 3. Predictive model for the health status at discharge of patients with colorectal cancer

Predictor independent variable	Regression coefficient	χ^2	Variable for comparison	Confidence level of 95%		
				Inferior	Exp(B)	Superior
Males	.089	.262	Females	.935	1.094	1.278
Age equal to or over 60 years	.380	.002	Age under 60 years	1.147	1.463	1.865
Not retired patients	.309	.004	Retired patients	1.106	1.363	1.679
Urban area	-.045	.598	Rural area	.807	.956	1.131
Admission for medical-surgical emergencies	-.098	.419	Admission for other criteria	.715	.907	1.150
Admission to surgical section	.333	.054	Admission to non-surgical section	.994	1.395	1.957
Discharge from surgical section	1.039	.000	Discharge to non-surgical section	1.934	2.827	4.134
Surgical procedure performed	1.899	.000	Surgical procedure not performed	5.041	6.610	8.666
Hospitalisation duration less than 7 days	0.980	.000	Hospitalisation duration equal to or more than 7 days	2.106	2.664	3.369

Our findings suggest that for a successful discharge outcome, performing colorectal cancer surgery is one of the most important predictors for the outcome of discharge.

Another significant predictor for a successful discharge outcome was a long duration of hospitalization. In our sample, all patients had a mean length of hospitalization of around eight days. However, this difference in the length of stay could contribute to the outcome disparities between patients and lack of optimization inpatient care. Although for the majority of patients, early discharge could improve the overall recovery experience, it is essential to consider this approach from the point of feasibility and patient safety. In the case of a short hospitalization, it is important to coordinate outpatient monitoring, especially in those who had a surgical procedure and are in the postoperative period. However, the facilities that want to facilitate earlier discharge need to uptake short-stay protocols.(16) In the literature, higher hospital volume, as in our case, was associated with a length of stay reduction. It was found that a longer length of stay is associated with an increased risk of 30-day readmission.(17) Although a prolonged LOS is often associated with postoperative complications, advanced age and preoperative comorbidity (18), our findings on early discharge raise concerns about the risk for the health state of patients at discharge, and consequently on rates of readmission and postoperative morbidity. However, this finding requires further evaluation.

CONCLUSIONS

We have identified novel and potentially actionable demographic and hospital-level characteristics that can predict poor colorectal cancer outcomes at discharge in a Romanian hospital. More importantly, in this work, we identified contextual gaps in outcomes between certain demographic groups and medical services offered to these patients. Hospitals need to take into consideration these predictors and to direct additional interventions and resources for improving morbidity, mortality and other patient outcomes. By having the capacity to predict during the stay the discharge outcome after a specific hospitalization period for colorectal patients, we can increase the effectiveness of the patient management at these facilities.

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