



Contents lists available at ScienceDirect

Journal of Geriatric Oncology



Unplanned hospitalizations in older patients with cancer: Occurrence and predictive factors

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ARTICLE INFO

Article history:

Received 27 July 2020

Received in revised form 27 October 2020

Accepted 13 November 2020

Available online xxxx

ABSTRACT

Background: This study aims to investigate the occurrence of unplanned hospitalizations in older patients with cancer and to determine predictive factors.

Methods: A prospective Belgian multicentre ($n = 22$), observational cohort study was performed. Patients ≥ 70 years with a malignant tumor were included. Patients underwent G8 screening followed by geriatric assessment (GA) if abnormal at baseline and were followed for unplanned hospitalizations at approximately three months. Uni- and multivariable regression models were performed to determine predictive factors associated with unplanned hospitalizations in older patients with an abnormal G8.

Results: In total, 7763 patients were included in the current analysis of which 2409 (31%) patients with a normal G8 score and 5354 (69%) with an abnormal G8 score. Patients with an abnormal G8 were hospitalized more frequently than patients with a normal G8 (22.9% versus 12.4%; $p < 0.0001$). Reasons for unplanned hospitalizations

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were most frequently cancer related (25.7%) or cancer therapy related (28%). In multivariable analysis, predictive factors for unplanned hospitalizations in older patients with cancer and an abnormal G8 were female gender, absence of surgery, chemotherapy, ADL dependency, malnutrition and presence of comorbidities.

Conclusion: Older patients with cancer and an abnormal G8 screening present a higher risk (23%) for unplanned hospitalizations. Predictive factors for these patients were identified and include not only patient and treatment related factors but also GA related factors.

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1. Introduction

Hospitalizations may have a significant impact on a patient's quality of life and functional status and result in financial burdens. Unplanned hospitalizations are more frequent in older adults aged 65 years or more, representing approximately 36–38% of all hospitalisations each year in the USA [1]. Risk factors for hospitalizations in older adults are age of 75 years or older, more than one hospital admission in the previous six months, multiple comorbidities, living alone, poor social support, poor self-rating of health, functional impairment and/or history of depression [2,3]. In patients with newly diagnosed cancer, 35% experience an unplanned hospitalization during the first year after diagnosis, with a higher proportion in the age group older than 76 years (42.5%) [4].

Research on unplanned hospitalizations and possible predictive factors in older adults with cancer is limited. In a retrospective cohort study in 677 hospitalized older adults (≥ 65 years) with cancer, the 30-day unplanned readmission rate was 35% [5]. In this study, risk factors for unplanned readmissions were younger age ≤ 75 years, inappropriate medication, dependency in housekeeping on instrumental activities of daily living (IADL) and African American race.

Acknowledging and identifying patients with a higher risk for hospitalization may improve quality of life and quality of care, and reduce health care costs providing this leads to directed interventions. However, the previous study was limited to older patients with cancer, who were hospitalized at baseline and only report the unplanned readmissions rate at one month. In the present study, we investigate in a very large cohort of older patients with cancer, either hospitalized or not at baseline, and assess the incidence of unplanned hospitalizations approximately three months after treatment initiation, as well as possible associated predictive factors.

2. Methods

2.1. Patient Population

This prospective, multicenter, observational cohort study, with the main goal to investigate the adherence to geriatric recommendations based on a geriatric assessment (GA), was performed in 22 hospitals (eight academic, fourteen non-academic) in Belgium from November 2012 until February 2015 [6].

Patients 70 years and older with a solid tumor (including breast cancer, central nervous system tumors, carcinoma of unknown primary, digestive system tumors, gynaecologic tumors, head and neck tumors, musculoskeletal tumors, skin tumors, thorax tumors, and genitourinary tumors) or hematologic malignancy were included at the time a treatment decision (surgery, systemic therapy, radiotherapy, hormonal therapy, other therapy, a combination or best supportive care) had to be made. The ethical committees of all participating centers (B322201215495) approved the study.

Here we present a sub-study focusing on the incidence of unplanned hospitalizations and associated risk factors in older patients with a solid cancer, approximately three months after a treatment plan has been decided. An unplanned hospitalization was defined as a hospitalization that took place after the baseline time point and could not be foreseen. It may occur on a non-emergency or an emergency basis [7]. The

baseline time point was defined as the time of performance of the GA and could be in ambulatory or hospitalized setting. Data on unplanned hospitalizations were collected prospectively. For the present analysis patients with hematologic malignancy were excluded.

2.2. Baseline Assessment

At baseline, all included patients were screened using the G8 screening tool [8]. Patients with an abnormal G8 screening (score $\leq 14/17$) were referred for baseline GA, as previously described [6], assessed by a trained health care professional, attached to the oncology or geriatrics department. Patients with a normal G8 screening were not included in the multivariable analysis to identify predictive factors as it was suspected that patients with an abnormal G8 were at higher risk for unplanned hospitalizations.

The GA included following geriatric domains: functional status by activities of daily living (ADL) [9] (independent score 6 versus dependent score ≥ 7) and instrumental activities of daily living (iADL) [10] (independent score 5/5 in males and 8/8 in females versus dependent score < 5 in males and < 8 in females), the presence of falls in the past year (no falls versus at least one fall), the presence of pain and fatigue using a visual analogue score (VAS) (no pains versus presence of pain VAS $\geq 1/10$ and no fatigue versus presence of fatigue VAS $\geq 1/10$), cognition by mini mental state examination (MMSE) [11] (normal cognition score $\geq 24/30$ versus cognitive decline score $< 24/30$), mental status using the geriatric depression scale (GDS-15) [12] (no risk for depression score $< 5/15$ versus risk for depression score $\geq 5/15$), nutritional status using the mini nutritional assessment – short form (MNA-SF) [13] (no risk of malnutrition (score ≥ 12) vs risk of malnutrition (score 8–11) vs malnourished (score ≤ 7)), comorbidities using the Charlson Comorbidity index [14] (no comorbidities versus comorbidities score $\geq 1/37$) and polypharmacy by the number of drugs taken the week before inclusion (number of drugs < 5 versus ≥ 5) [15].

Classical patient characteristics such as age and gender as well as oncologic parameters such as Eastern Cooperative Oncology Group - Performance Status (ECOG-PS), tumor characteristics (type and stage), and treatment details (surgery / systemic therapy/ radiotherapy / hormonal therapy / other therapy/ combination) were recorded.

2.3. Statistical Analysis

Data were analysed using SAS v9.4. For continuous data, mean, median, 95% confidence intervals and range were assessed. For categorical data, frequency and 95% confidence interval were assessed.

Categorical data were compared using a Chi square test.

Determination of predictors of unplanned hospitalizations was performed using logistic regression. This analysis was limited to patients with an abnormal G8 (≤ 14) as we predicted that these patients were at highest risk of unplanned hospitalizations and predictive factors would be of higher relevance.

Univariable logistic regression was conducted on unplanned hospitalizations in older patients with solid tumor, abnormal G8, and available data for all covariates used in the regression analysis.

The following baseline categorical variables were used: age (70–74 / 75–79 / ≥ 80), gender (male vs female), living situation (home alone versus not alone), use of professional homecare (no vs yes), ECOG PS

(score 0–1 vs score 2–4), time-point of assessment (new diagnosis vs disease progression/relapse), stage (I-II vs III-IV), surgery (no vs yes), chemotherapy (no vs yes), radiotherapy (no vs yes), GA (no deficiency vs one or more deficiencies); baseline ADL (Independent vs dependent) and IADL (independent score vs dependent), fall history in the past twelve months (presence vs absence of falls), pain (presence vs absence), fatigue by VAS score (presence vs absence), cognition by MMSE (normal cognition vs cognitive decline), depression by GDS-15 (no risk of depression vs risk of depression), nutrition by MNA-SF (no risk of malnutrition vs risk of malnutrition vs malnourished), comorbidities by CCI (no comorbidities vs comorbidities), polypharmacy (<5 vs ≥5).

Multivariable logistic regression was conducted on the unplanned hospitalizations using a stepwise variable selection and *p*-values to enter and to stay in the model of 0.05. Only variables significant in the univariable setting were considered for the multivariable regressions.

In order to exclude multicollinearity between variables, variance of inflation factor (VIF) was calculated.

3. Results

3.1. Patient and Tumor Characteristics

The patient flow is presented in Fig. 1.

Of the 8451 patients included in this study, 7763 had a solid tumor. A total of 2409 patients (31%) had a normal G8 score, and in 2230 (92.6%) of these patients unplanned hospitalization data at follow-up were available. A total of 5354 patients (69%) had an abnormal G8 score, and in 4930 (92.1%) of these patients unplanned hospitalization data at follow-up were available.

Patients characteristics and GA results are presented in Table 1.

3.2. Incidence of Unplanned Hospitalizations

At approximately three months follow-up, a total of 1405/7160 patients (19.6%) experienced an unplanned hospitalization. We observed significantly less unplanned hospitalizations in patients with a normal G8 screening tool versus patients with an abnormal G8 screening tool, respectively 277/2230 (12.4%) versus 1128/4930 (22.9%) with $p < 0.0001$.

The majority of patients (1124/1405, 80%) experienced one unplanned hospitalization during the approximately three months follow up period. The remainder of patients experienced more than one

unplanned hospitalization: two for 237/1405 (16.9%), three for 36/1405 (2.6%), four for 5/1405 (0.3%) and five for 3/1405 (0.2%). For the patients that were hospitalized, there was no significant difference for the number of unplanned hospitalizations for patients with a normal G8 versus patients with an abnormal G8.

3.3. Reasons for Unplanned Hospitalizations

The reasons for unplanned hospitalizations are listed in Table 2. They include cancer related reasons in 359/1405 (25.7%), cancer therapy related reasons in 290/1405 (28%) or other reasons such as gastrointestinal events (9.4%), neurological events (9.8%), cardiac events (8.2%), pulmonary events (6.4%), infections (16.9%), and falls (8.8%) in 646/1405 (46.3%) of patients.

3.4. Predictors for Unplanned Hospitalizations

Table 3 describes the univariable and multivariable analysis for baseline predictors of unplanned hospitalizations in older patients with a solid tumor, an abnormal G8, and available data for all covariates used in the regression analysis ($n = 3694$).

In univariable analysis, patient characteristics (including age, gender and ECOG-PS) as well as tumor characteristics (including time point of diagnosis, cancer stage, treatment by surgery or chemotherapy) and geriatric assessment variables (functional status by ADL, nutritional status, presence of comorbidities and polypharmacy) were associated with the risk of unplanned hospitalizations.

In multivariable analysis, patients had a higher risk of unplanned hospitalizations if they were female, if they did not receive surgery, or if they were treated by chemotherapy. In addition, ADL dependency, the presence of risk for malnutrition or malnutrition, and the presence of comorbidities were associated with a higher risk of unplanned hospitalizations.

In the present analysis, there was no multicollinearity between the variables since all VIFs were < 3 .

4. Discussion

In this prospective study in older patients with cancer, we observed unplanned hospitalizations in approximately 20% of patients with a solid tumor during the first three months of their specific cancer treatment. This is comparable to the observations of Kim et al. in older patients with colorectal cancer (21%) [16], but lower than the 30 day unplanned

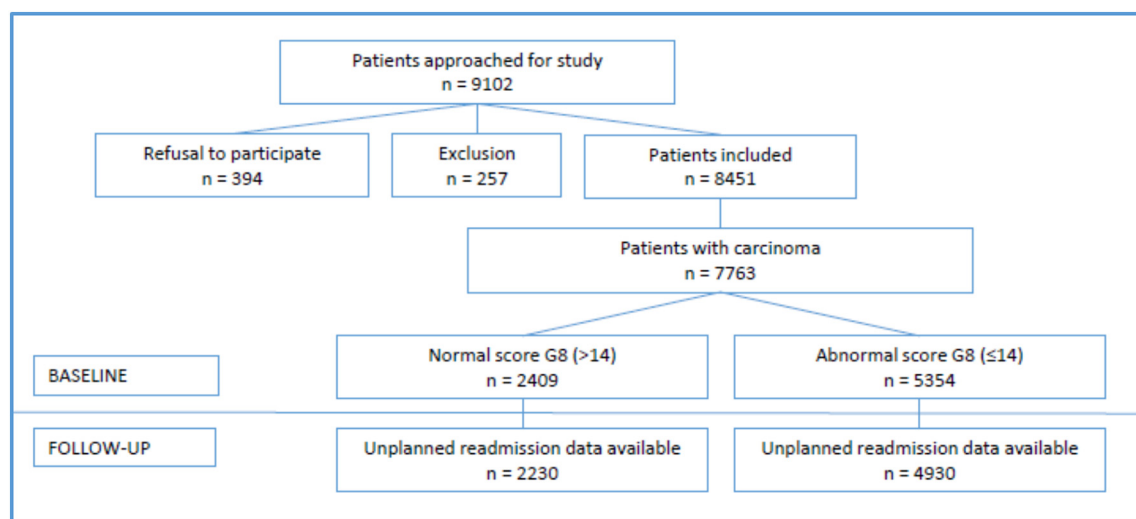


Fig. 1. Patient flowchart.

Table 1

Patient characteristics and results of geriatric assessments in patients with unplanned hospitalizations data available and a normal G8 ($N = 2230$) and an abnormal G8 score ($N = 4930$) respectively. Patients with normal G8 did not receive systematic geriatric assessment.

		Patients with normal G8 score ($N = 2230$)	Patients with abnormal G8 score ($N = 4930$)
Patient characteristics	Categories	N (%)	N (%)
Age	Median, range	75 (70–93)	80 (70–101)
Gender	Female	1174 (52.7%)	2688 (54.5%)
	Male	1056 (47.4%)	2242 (45.5%)
Living situation	Home with partner	1497 (67.1%)	2398
	Home with family member	88 (4.0%)	326
	Home alone	602	1757
	Assisted Living Community apartment	15	127
	Institution (e.g. nursing home)	15	266
	Other	10	54
	Missing	3	2
Professional homecare	No	1351 (60.6%)	2307 (46.8%)
	Yes	869 (39.0%)	2614 (53.0%)
	Missing	10 (0.5%)	9 (0.2%)
Tumor	Digestive system	576 (25.8%)	1754 (35.6%)
	Breast	688 (30.9%)	906 (18.4%)
	Genitourinary system	462 (20.7%)	800 (16.2%)
	Thorax	151 (6.8%)	589 (12.0%)
	Gynaecologic	169 (7.6%)	374 (7.6%)
	Head and Neck	83 (3.7%)	228 (4.6%)
	Skin	65 (2.9%)	108 (2.2%)
	CNS	9 (0.4%)	52 (1.0%)
	Musculoskeletal	20 (0.9%)	46 (0.9%)
	CUP	6 (0.3%)	71 (1.4%)
Time of inclusion	New diagnosis	1833 (82.2%)	3873 (78.6%)
	Progression/relapse	397 (17.8%)	1057 (21.4%)
Stage	Stage I	477 (21.4%)	530 (10.8%)
	Stage II	611 (27.4%)	890 (18.1%)
	Stage III	479 (21.5%)	1081 (21.9%)
	Stage IV	502 (22.5%)	2015 (40.9%)
	Missing	161 (7.2%)	414 (8.4%)
ECOG-PS	0–1	2065 (92.6%)	2500 (50.7%)
	≥ 2	165 (7.4%)	2427 (49.2%)
	Missing	–	3 (0.1%)
Surgery	No	785 (35.2%)	2665 (54.1%)
	Yes	1445 (64.8%)	2265 (45.9%)
Radiotherapy	No	1372 (61.5%)	3633 (73.7%)
	Yes	858 (38.5%)	1297 (26.3%)
Chemotherapy	No	1394 (62.5%)	3006 (61.0%)
	Yes	836 (37.5%)	1924 (39.0%)
Geriatric assessment	Operationalization	N (%)	N (%)
Functional status: ADL (6–24)	Independent: score = 6	271 (12.2%)	1985 (40.3%)
	Dependent: score ≥ 7	174 (7.8%)	2917 (59.2%)
	Missing	1785 (80.0%)	28 (0.6%)
Functional status: IADL (0–5 male/0–8 female)	Independent: score 5 (male) or 8 (female)	253 (11.4%)	1536 (32.2%)
	Dependent: score < 5 or < 8	192 (8.6%)	3330 (67.6%)
	Missing	1785 (80.0%)	64 (1.3%)
Falls previous year	No falls	333 (14.9%)	3054 (62.0%)
	Presence of falls	112 (5.0%)	1794 (36.4%)
	Missing	1785 (80.0%)	82 (1.7%)
Pain (VAS 0–10)	No pain	260 (11.7%)	2310 (46.9%)
	Presence of pain	184 (8.3%)	2471 (50.1%)
	Missing	1786 (80.1%)	149 (3.0%)
Fatigue (VAS 0–10)	No fatigue	193 (8.7%)	1104 (22.4%)
	Presence of fatigue	249 (11.2%)	3605 (73.1%)
	Missing	1788 (80.2%)	221 (4.5%)
Cognition: MMSE (0–30)	Normal cognition: score ≥ 24	379 (17.0%)	3356 (68.1%)
	Cognitive impairment: score < 24	42 (1.9%)	995 (20.2%)
	Missing	1809 (81.1%)	579 (11.7%)
Depression: GDS (0–15)	Not at risk for depression: score < 5	363 (16.3%)	2806 (56.9%)
	At risk for depression: score ≥ 5	66 (3.0%)	1670 (33.9%)
	Missing	1801 (80.8%)	454 (9.2%)
Nutrition: MNA-SF (0–14)	Normal nutritional status: score ≥ 12	2 (0.1%)	16 (0.3%)
	Risk for malnutrition < 12	461 (20.7%)	4874 (98.9%)
	Missing	1767 (79.2%)	40 (0.8%)
Comorbidity: CCI (0–37)	No comorbidity: score 0	944 (42.3%)	1281 (26.0%)
	Presence of comorbidity: score ≥ 1	1272 (57.0%)	3609 (73.2%)
	Missing	14 (0.6%)	40 (0.8%)
Polypharmacy	Number 0–4	1480 (66.4%)	1801 (36.5%)
	Number ≥ 5	712 (31.9%)	3048 (61.8%)
	Missing	38 (1.7%)	81 (1.6%)

Legend: N: Number of patients; ADL: Activities of Daily Living; IADL: Instrumental Activities of Daily Living; VAS: Visual Analogue Score; MMSE: Mini Mental state Examination; GDS: Geriatric Depression Scale; MNA-SF: Mini Nutritional Assessment – Screening Form; CCI: Charlson Comorbidity Index; CNS: Central Nervous System; CUP: Carcinoma of unknown primary.

Table 2

Reasons for the first unplanned hospitalizations in older patients with cancer (n = 1405).

Reported reason	N (%)
Cancer related	359 (25.7)
Cancer therapy related	390 (28)
Other	646 (46.3)
- Infection	109 (16.9)
- Decline general condition	102 (15.8)
- Neurological events	63 (9.8)
- Gastrointestinal events	61 (9.4)
- Fall	57 (8.8)
- Cardiac events	53 (8.3)
- Pulmonary events	41 (6.4)
- Musculoskeletal events	24 (3.7)
- Vascular events	22 (3.4)
- Hemorrhage/bleeding	20 (3.1)
- Renal/genitourinary events	19 (2.9)
- Pain	16 (2.5)
- Metabolic events	10 (1.6)
- Trauma	10 (1.6)
- Decline general condition and fall	9 (1.4)
- Fever	9 (1.4)
- Dermatology	6 (0.9)
- Blood disorders	5 (0.8)
- Surgical complication	5 (0.8)
- Lymphatics	4 (0.6)
- Constitutional symptoms	1 (0.2)

readmission rate (35%) observed by Chiang et al. [5] In the latter study, patients were hospitalized at inclusion while in our study both ambulant and hospitalized patients at baseline were included which may explain the difference [5]. In our study, the incidence of unplanned hospitalizations was significantly higher in patients with an abnormal G8 screening tool versus patients with a normal G8 (22 vs 12%; $p < 0.0001$), indicating that patients with a geriatric risk profile are at highest risk of unplanned hospitalization and should be closely monitored during treatment.

Reducing potentially avoidable hospitalizations is an important target for improving the quality of cancer care, especially in those patients at the highest risk such as patients with an abnormal G8. For this reason, the identification of potential risk factors for unplanned hospitalizations may guide specific interventions and follow-up in older patients with cancer. In multivariable analysis, in the subgroup of patients with an abnormal G8, patient related factors (gender) as well as treatment related factors (surgery and chemotherapy) and GA related factors (ADL, nutrition and comorbidities) were associated with the risk of unplanned hospitalizations. In our analysis, age was not retained as a predictive factor, which is in contrast to the findings of the community population where unplanned hospitalizations are more frequently observed in older adults, and with observations in older patients with colorectal cancer [1,16]. Other studies reported a decreased risk of unplanned hospitalization with increasing age [5,17,18]. In patients with non-metastatic lung cancer and colorectal cancer aged ≥ 66 years, the likelihood of an unplanned hospitalizations decreased with 4.7% and 6% respectively for each additional year, possibly linked to a bias towards less aggressive anticancer treatments in older patients [17,18]. For treatment related factors, the performance of surgery was associated with a lower risk of unplanned hospitalizations in our study, while the administration of chemotherapy was associated with a higher risk. The first observation is rather surprising but patient selection may be an explanation, especially since all patients had already an abnormal G8 at baseline. The latter observation on the other hand is not surprising. In older patients with breast cancer, patients treated with chemotherapy more frequently experienced unplanned hospitalizations than patients not treated with chemotherapy (20.1% versus 8.6%, $p < 0.001$) [19]. Finally in our study, functional status by means of an abnormal ADL, nutritional status by means of abnormal MNA and presence of comorbidities were associated with a higher risk of unplanned hospitalizations. Chiang et al. also observed that decreased functional status by means of dependency in housekeeping was associated with a higher risk of unplanned hospitalization [5]. Malnutrition was also identified in other studies in patients with cancer, regardless of age, as a risk factor for unplanned

Table 3

Univariable and multivariable baseline predictors of unplanned hospitalizations in older patients with cancer n = 3694. (Patients with solid tumor excluding hematological malignancies, abnormal score on G8 and all covariate used in the regression analysis available).

Variable	Operationalization	Univariate	Multivariate		
		p-Value	p-Value	OR	95%CI
Age	70–74 vs 75–79 vs 80–84 vs ≥ 85	<0.001	–		
Gender	Male-Female	<0.001	0.003	0.76	0.65;0.89
Living situation	Home alone vs not alone	0.1.0			
Professional homecar	Yes vs No	0.70			
ECOG-PS	0 or 1 vs 2–4	0.01	–		
Timepoint of diagnosis of Cancer	New diagnosis vs progression/relapse	0.001	–		
Cancer stage	I-II vs III-IV	<0.001	–		
Surgery	No surgery vs surgery	<0.001	<0.001	1.76	1.49;2.09
Chemotherapy	No chemotherapy vs chemotherapy	<0.001	<0.001	0.56	0.47;0.65
Radiotherapy	No radiotherapy vs radiotherapy	0.13			
GA	Normal vs abnormal	0.22			
ADL	Independent vs dependent	0.03	0.002	0.79	0.67;0.93
IADL	Independent vs dependent	0.06	–		
Falls	No falls vs falls	0.32			
Pain	No pain vs pain	0.49			
Fatigue	No fatigue vs fatigue	0.02	–		
MMSE	Normal vs mild severe cognitive decline	0.93			
GDS-15	Not at risk vs at risk for depression	0.01	–		
MNA-SF	Normal vs at risk for malnutrition	0.001	0.04	0.76	0.61;0.95
	Normal vs malnourished			0.75	0.58;0.96
	At risk for malnutrition vs malnourished			0.99	0.82;1.18
CCI	No comorbidities vs comorbidities	<0.001	<0.001	0.72	0.59;0.93
Polypharmacy	0–4 different drugs vs ≥ 5 different drugs	0.004			

Legend: OR: Odds Ratio; CI: Confidence Interval; ECOG-PS: Eastern Cooperative Oncology Group - Performance Status; GA: Geriatric Assessment; ADL: Activities of Daily Living, IADL: Instrumental Activities of Daily Living; MMSE: Mini Mental State Examination; GDS-15: Geriatric Depression Scale; MNA-SF: Mini Nutritional Assessment-Screening Form; CCI: Charlson Comorbidities Index.

Bold numbers indicate p-values < 0.05 .

hospitalizations [20,21]. In a systematic review, common causes of nutrition-related unplanned hospitalizations in patients treated with radiotherapy included dehydration and enteral feeding commencement and complications [20]. Finally, the presence of comorbidities was also associated with a higher risk in some studies although not in all [16,18,22]. Common reasons for unplanned hospitalizations in older patients with gastrointestinal cancers were congestive heart failure and chronic obstructive pulmonary disease [22]. In our study, the most frequent reasons for unplanned hospitalizations were either cancer therapy related (28%) or cancer related (25%). Other reasons also included gastrointestinal, cardiac and pulmonary events (respectively 9%, 8% and 6%). Lu-Yao et al. also demonstrated that polypharmacy (>5 medications) was associated with a higher rate of unplanned hospitalizations in patients treated with chemotherapy, although this was not confirmed in our study [23].

The identification of GA variables as risk factors for unplanned hospitalizations gives treating physicians an opportunity to perform guided interventions in an attempt to reduce this risk. In older patients discharged home from the emergency department, GA directed interventions resulted in a lower rate of hospitalizations and a higher degree of physical and mental function although no effect on mortality was observed. In older cancer patients [24], no single intervention seems effective in reducing unplanned hospitalizations but multi-component interventions have shown to be efficient [25,26]. Integrating GA and optimizing the geriatrician's contribution into cancer care for older patients may result in a more tailored treatment decision [27]. When compared to usual care, integrated GA and subsequent coordinated healthcare delivery in older patients with cancer treated with systemic anti-cancer treatment reduces emergency presentations with 39% and unplanned hospitalizations with 41% [28]. In addition, GA and guided interventions also reduce grade 3–5 treatment toxicity in older patients with cancer, which may also reduce unplanned hospitalizations [29,30].

Our study has some limitations. First, in the multivariable analysis to determine risk factors for unplanned hospitalizations, we included only patients with an abnormal G8, which is not a perfect screening tool (sensitivity 65–92%) to identify unfit patients according to GA. On the other hand, this may also be considered a strength of our study, since we focus on those patients that are potentially at the highest risk. Secondly, we excluded patients with hematologic malignancies because they were considered as a different entity with different treatments and risk of hospitalization. Thirdly, the population in this study is heterogeneous in types of cancer and treatments, which may limit the practical implementation of our findings. Each cancer type, stage and treatment may be associated with a different risk factor and effect on the amount of unplanned hospitalizations. However, we did include cancer stage and treatments such as surgery, radiotherapy and chemotherapy in the univariable and multivariable analysis. This heterogeneity may also be considered as a strength since our results are applicable to the generalized, large population of older patients with cancer. Additionally, we did not include the adherence to recommendations in our multivariable analysis because of the heterogeneity of the interventions and the short follow-up period, as we believe this impact may still be limited. Finally, we do not have data available on the number of patients that were ambulatory or hospitalized at baseline, so no differentiation between those subgroups was possible.

In conclusion, the present study is to our knowledge one of the largest studies to investigate the occurrence of unplanned hospitalizations and possible predictive factors in older patients with cancer. The study illustrates that older patients with an abnormal G8 are at higher risk of unplanned hospitalizations. Performance of GA may identify possible predictive factors in these patients and subsequent recommendations and interventions may reduce this risk.

Author Contribution List

Conception and design: LDC, CK, HW.

Data collection: all authors.

Analysis and interpretation of data: LDC, CK, JPL, EL.

Manuscript writing: EL, CK, LDC.

Approval of final manuscript: all authors.

Funding

This work was supported by Cancer Plan 2012–2015, grant provided by the Federal Public Service of Health, Food Chain Safety and Environment, Belgium (KPC_24_A_025).

Declaration of Competing Interest

The authors declare no conflict of interest.

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