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Epidemiologic trends and characteristics of cancer-related emergency department visits of older patients living with cancer in South Korea

Jung-In Ko[1,2], Sun Young Lee[3,4✉], Shin Hye Yoo[4,5], Kyae Hyung Kim[3] & Belong Cho[3,4]

We aimed to investigate the demographic characteristics, common chief complaints, and diagnosis of geriatric cancer-related emergency department (ED) visits and trends of ED outcomes. This retrospective observational study included all ED visits in South Korea between 2016 and 2020. The study population was older people ≥ 65 years living with cancer who visited ED with cancer-related problems. The demographics, common diagnoses, and ED outcomes were investigated. A multivariate logistic regression analysis was conducted to investigate factors associated with mortality. Geriatric cancer-related ED (GCED) visits were 746,416 cases over 5 years. The proportion of older adults among cancer-related ED visits increased from 50.1% in 2016 to 55.3% in 2020. The proportion of the "oldest old" (≥ 85 years) increased from 9.6 to 12.1%. For GCED, the ward admission rate after ED treatment was 60.2% and in-hospital mortality rate was 11.8%. Both of these increased with age group ("young old" (65–74), "middle old" (75–84), and "oldest old" (≥ 85 years) groups admission rates: 56.1%, 62.8%, and 68.0%; and mortality rates: 10.0%, 12.7%, and 15.7%, respectively). The most common diagnosis was pneumonia (4.9%). Old age and ambulance use were also associated with mortality. Older adults account for more than half of cancer-related ED visits, and their number is increasing every year. GCED visits are associated with high hospitalization and mortality, especially among the oldest old. It is important to prepare for a rise in GCED visits is necessary.

Keywords Cancer, Emergency department, Epidemiology, Geriatrics

In this aging era, the number of people living with cancer (PLWC) is increasing worldwide[1]. Cancer is a major public health burden, and its importance as a leading cause of death has increased[2]. It was estimated that the number of new cancer cases worldwide in 2020 was 19.3 million, and that approximately 10 million people were estimated to have died from cancer[3]. The global cancer burden is estimated to increase to 28.4 million cases by 2040[3]. Owing to the nature of cancer, which occurs more frequently with aging, a significant proportion of PLWC are older adults, and this proportion is expected to increase[4].

The emergency department (ED) is an important medical resource requiring considerable manpower, facilities, and equipment[5]. EDs operate 24 hours a day, 7 days a week; therefore, they not only treat emergent problems but also handle acute exacerbations of chronic diseases[6,7]. As the population ages, ED visits by patients with chronic diseases increase[8–10]. PLWC visit ED for various reasons[7,11]. Cancer can cause uncomfortable symptoms, and various complications and side effects arising during anti-cancer treatment can result in ED visits[12,13]. As the number of PLWC increases, their ED visits also increase[7,14]. Previous studies reported that cancer-related ED visits account for 3–5% of all ED visits[7,14,15]. Among PLWC, adults over 65 years (older PLWC) are more likely to experience various problems caused by cancer and its treatment, leading to an expected increase in ED visits[16]. Generally, older adults who visit the ED more frequently experience greater urgency, have longer ED stays, are more likely to be hospitalized or have repeated ED visits, and have higher rates of negative health outcomes

[1]Department of Emergency Medicine, National Medical Center, Seoul, South Korea. [2]Department of Medical Sciences, Graduate School of Kangwon National University, Chuncheon, South Korea. [3]Public Healthcare Center, Seoul National University Hospital, Seoul, South Korea. [4]Department of Human Systems Medicine , Seoul National University College of Medicine, Seoul, South Korea. [5]Center for Palliative Care and Clinical Ethics, Seoul National University Hospital, Seoul, South Korea. ✉email: sy2376@snu.ac.kr

after ED discharge[9]. While older PLWC are increasing and may have poorer ED outcomes, there is limited information about those older PLWC visiting the ED for cancer-related problems.

The increased ED visits and resulting overcrowding are critical problems for many healthcare systems[8,17]. For an ED to function properly, it is important to understand the characteristics of increased patient groups, such as older PLWC, and prepare an appropriate response according to the expected situation. To reduce ED visits for PLWC, it is necessary to identify the reasons behind their ED visits, considering that such experience can be stressful for both patients and their caregivers[11]. Understanding the trends and characteristics of cancer-related ED visits of older PLWC can be the first step toward improving the quality of cancer care and preparing for an appropriate ED operation. This study aimed to investigate the demographic characteristics, common chief complaints, and common diagnosis of geriatric cancer-related emergency department (GCED) visits and trends of ED outcomes using a nationwide ED database.

Methods

Study design and data sources

This retrospective observational study was conducted using data from the National Emergency Department Information System (NEDIS) database of South Korea. NEDIS is a nationwide ED database operated by the National Emergency Medical Center under the Ministry of Health and Welfare since 2013. Over 400 EDs were enrolled in NEDIS in 2022, and they usually transmit ED-related clinical and administrative information within 14 days of discharge from the ED or hospital[18]. The NEDIS database includes information on patient demographics (age and sex) and prehospital, ED, and disposition information. Designated trained coordinators manage data quality and the uploading processes in each institution[18].

Study setting

South Korea has an area of 100,210 km^2 and a population of 50 million. The proportion of the older adults aged 65 or older of the total population continues to increase from 13.6% in 2016 to 15.7% in 2020. South Korea has a national health insurance (NHI) system, which is a single insurer operated by the government that covers inpatient, outpatient, and emergency care. The EDs are classified into four levels according to resources and capacity. Level 1 is the ED with the most resources and capabilities. All citizens can visit the ED without restrictions under NHI coverage, ensuring high access to emergency care[19].

Study population

The study population was all older adult patients who visited the EDs with cancer-related problems between January 2016 and December 2020. Among the total ED visits during the study period, patients aged 65 years or older with cancer-related visits were included as the study population excluding patients with unknown age and patients who visit ED for issuance of medical documentation.

In South Korea, the NHI provides universal health coverage and additional benefits for designated chronic diseases, such as cancer[20]. Since PLWC has lower out-of-pocket expenditures when they use medical services, including emergency care for cancer-related problems, the doctor who directly treats a patient in an ED determines whether problems are directly related to cancer or not and applied a cancer diagnosis if they are related. The diagnosis entered by the doctor is periodically reevaluated by the Health Insurance Review and Assessment Services, and if entered incorrectly, insurance payment cannot be received, so doctors rigorously evaluate whether the visit is related to cancer and enter a correct diagnosis. The NEDIS database collects diagnosis codes at the time of discharge from the ED or hospital (up to 40) using the International Classification of Diseases, 10th edition (ICD-10). For patients discharged immediately from the ED, the diagnosis at the time of discharge from the ED is collected, and for patients hospitalized after ED treatment and then discharged, the diagnosis entered at the time of hospital discharge is used. Since a cancer diagnosis is entered only for ED visit for cancer-related problems, only those with diagnosis codes C00–C97 (malignant neoplasm) in the NEDIS database was defined as a cancer-related ED visit.

Among the 43,477,822 ED visits between 2016 and 2020, cancer-related ED visits totaled 1,421,501 (3.3%), Excluding patients with unknown age and cases for issuance of medical documentation, the total study population of cancer-related ED visits by older adults (GCED visits) was 746,416 (Supplement Fig. 1).

Outcome measures and variables

The exposure was the age group of older adults: "young old" (65–74), "middle old" (75–84), and "oldest old" (≥ 85 years) groups. The study outcomes were following: (1) in-hospital mortality including ED and hospital death, (2) total hospital admissions after ED treatment (ward and intensive care unit (ICU)), and (3) ICU admissions after ED treatment.

The following details were collected from the NEDIS database: (1) patient's demographic information (age, sex, and type of insurance [NHI, Medicaid, and other or unknown]); (2) prehospital and ED visit information (date and time of ED visit, use of ambulance accessed through 119 or not, region of ED [metropolitan or not], and level of ED [1,2,3,4]); (3) ED treatment information (mental status at ED arrival [alert, verbal, pain response, and unresponsive], chief complaint of ED visit, ED disposition [discharge, transfer-out, ward admission, ICU admission, death, and others], and ED discharge diagnosis code); (4) hospital treatment in case of hospitalization after ED treatment (hospital discharge disposition [discharge, transfer-out, death, and others], and hospital discharge diagnosis code). About insurance, basically all citizens are registered in NHI, and low-income people are enrolled in Medicaid, so their out-of-pocket costs are lower. If it was covered by car insurance, etc., it was classified as others. In South Korea, 119 ambulance is a public emergency medical sertice system operated exclusively by the National Fire Agency (NFA) and anyone can use it for free in emergencies. If a patient called the NFA dispatch center (number 119) and visited the ED by taking a 119 ambulance, it was defined as use

of 119 ambulance. In mental status at ED entrance, verbal and pain refer to whether patient is reponding to a vebal stimulus or to pain. Cases such as patients escaping from the ED or hospital were classified as others in disposition.

Statistical analysis

The trends in the proportion of geriatric cancer-related ED visits among total cancer-related ED visits and distribution of age groups among older adults were investigated by year: "young old" (65–74), "middle old" (75–84), and "oldest old" (≥85 years) groups. Temporal trends were evaluated by the Cochran-Armitage test for trends. The patient demographics and ED visit-related characteristics are presented according to age groups. Categorical variables are presented as counts and proportions and were compared and tested for statistical significance using the chi-square test. Non-parametric continuous variables are presented as medians and quartiles and were compared and tested for statistical significance using the Kruskal–Wallis test. The yearly trend of the study outcomes is presented by age group and tested by Cochran-Armitage test for trends. The top 15 most common chief complaints for visiting the ED and discharge diagnosis are presented by age groups. If a patient is discharged from the ED without being admitted to ward, the diagnosis upon discharge from the ED is used as discharge diagnosis, and if the patient is admitted to ward from the ED, the diagnosis at the time of discharge after hospitalization is used. When we investigated the diagnosis codes, if only a cancer diagnosis (ICD-10 code C) was included in the ED or hospital discharge diagnosis code, it was classified into the "only cancer diagnosis" category. The ED outcomes for each of the top 15 common diagnoses are presented by age groups. Multivariable logistic regression analysis was conducted to investigate the factors associated with mortality in the study population by applying factors known to affect ED outcome in previous studies as covariate[7]. Finally, age, sex, type of insurance, night-time visit, weekend visit, use of 119 ambulance, and level of ED were used as covariates[7].

Data management and statistical analyses were conducted using SAS software (version 9.4; SAS Institute Inc., Cary, NC, USA). The level of statistical significance was set at $p < 0.05$.

Results

Trends of geriatric cancer-related ED visits

The total number of GCED was 746,416. The proportion of older adults with cancer-related ED visits increased from 50.1% in 2016 to 55.3% in 2020 (p value < 0.01). Among older adults, the proportion of the "oldest old" also increased from 9.6% in 2016 to 12.1% in 2020 (p value < 0.01) (Fig. 1).

Characteristics of the study population

The median (IQR) age was 75 (70–80) years. 37.0% were female, and 8.5% were on Medicaid. Among the geriatric population, 47.8% were "young old", 41.4% were "middle old", and 10.8% were "oldest old".

The total admission rate to a hospital in-ward after ED treatment was 60.2%, and the older the patient, the higher the admission rate ("young old", 56.1%; "middle old", 62.8%; and "oldest old", 68.0%, p value < 0.01). The
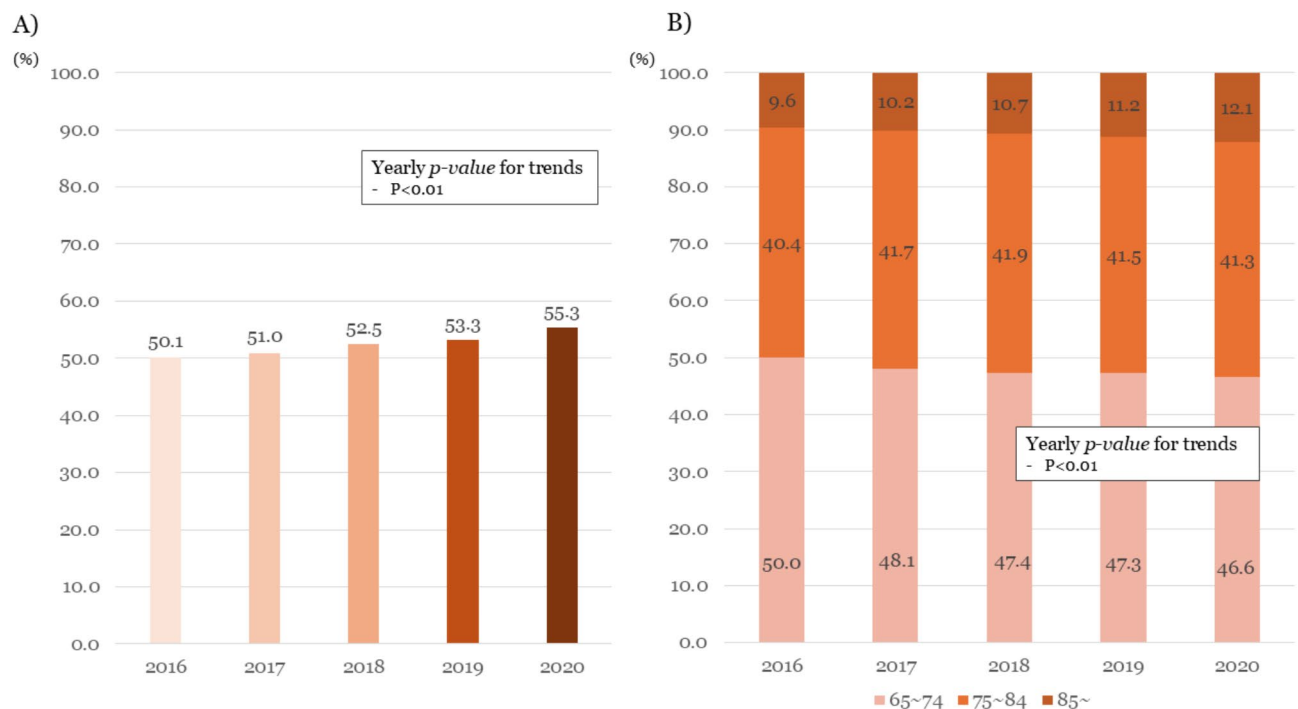
Fig. 1. Trends in geriatric cancer-related emergency department visits. (**A**) Proportion of older adults among the total number of cancer-related ED visits. (**B**) Distribution of age groups for geriatric cancer-related ED visits.

overall ICU admission rate was 6.6%, and the older the patient, the higher the ICU admission rate ("young old", 5.4%; "middle old", 7.3%; and "oldest old", 9.2%, p value < 0.01). The in-hospital mortality rate was 11.8% overall, and the older the patient, the higher the mortality rate ("young old", 10.0%; "middle old", 12.7%; and "oldest old", 15.7%, p value < 0.01) (Table 1).

The total admission, ICU admission, and mortality rate decreased from 2016 to 2019. However, they then slightly increased in 2020, with all outcomes being higher in the older age groups (Supplement Fig. 2).

| | Total | | 65–74 | | 75–84 | | ≥85 | | |
Variable	N	%	N	%	N	%	N	%	p value
Total									
N	746,416	100.0	356,641	100.0	308,986	100.0	80,789	100.0	
Age									
Years, Median (IQR)	75 (70–80)		69 (67–72)		79 (77–81)		87 (86–90)		< 0.01
Sex									
Female	276,141	37.0	118,963	33.4	117,352	38.0	39,826	49.3	< 0.01
Insurance									
Medicaid	63,270	8.5	28,683	8.0	25,671	8.3	8916	11.0	< 0.01
Year									< 0.01
2016	125,216	16.8	62,660	17.6	50,573	16.4	11,983	14.8	
2017	141,258	18.9	67,909	19.0	58,921	19.1	14,428	17.9	
2018	157,276	21.1	74,529	20.9	65,891	21.3	16,856	20.9	
2019	169,728	22.7	80,210	22.5	70,455	22.8	19,063	23.6	
2020	152,938	20.5	71,333	20.0	63,146	20.4	18,459	22.8	
Time of ED visit									
Night	211,280	28.3	107,336	30.1	83,431	27.0	20,513	25.4	< 0.01
Weekend	192,648	25.8	94,001	26.4	78,789	25.5	19,858	24.6	< 0.01
Use of 119 ambulance	174,087	23.3	70,177	19.7	78,461	25.4	25,449	31.5	< 0.01
Metropolitan ED	412,868	55.3	209,831	58.8	163,614	53.0	39,423	48.8	< 0.01
Level of ED									< 0.01
Level 1	246,950	33.1	116,191	32.6	105,149	34.0	25,610	31.7	
Level 2	380,361	51.0	186,409	52.3	154,167	49.9	39,785	49.2	
Level 3	117,403	15.7	53,455	15.0	48,821	15.8	15,127	18.7	
Level 4	1702	0.2	586	0.2	849	0.3	267	0.3	
Length of stay, hour									< 0.01
0–1	61,634	8.3	30,897	8.7	24,216	7.8	6521	8.1	
2–4	262,841	35.2	121,537	34.1	109,633	35.5	31,671	39.2	
5–8	209,839	28.1	97,931	27.5	88,614	28.7	23,294	28.8	
≥9	211,948	28.4	106,205	29.8	86,455	28.0	19,288	23.9	
Unknown	154	0.0	71	0.0	68	0.0	15	0.0	
Median, (IQR)	4.7 (2.5–9)		4.8 (2.5–9.5)		4.7 (2.5–8.9)		4.3 (2.4–7.8)		< 0.01
Mental status at ED arrival									< 0.01
Alert response	582,393	78.0	285,870	80.2	238,420	77.2	58,103	71.9	
Verbal response	13,255	1.8	4681	1.3	6282	2.0	2292	2.8	
Pain response	5441	0.7	2057	0.6	2588	0.8	796	1.0	
Unresponsive	25,252	3.4	9033	2.5	11,901	3.9	4318	5.3	
Unknown	120,075	16.1	55,000	15.4	49,795	16.1	15,280	18.9	
ED disposition									< 0.01
Discharge	259,982	34.8	139,355	39.1	99,194	32.1	21,433	26.5	
Transfer-out	28,368	3.8	13,608	3.8	11,676	3.8	3084	3.8	
Admission	449,220	60.2	200,251	56.1	194,038	62.8	54,931	68.0	
Death	8110	1.1	3075	0.9	3782	1.2	1253	1.6	
Others	736	0.1	352	0.1	296	0.1	88	0.1	
ICU admission	48,986	6.6	19,132	5.4	22,408	7.3	7446	9.2	< 0.01
Hospital death	87,727	11.8	35,782	10.0	39,277	12.7	12,668	15.7	< 0.01

Table 1. Demographic characteristics of the geriatric cancer-related emergency department visits from 2016 to 2020 by age group. ED, emergency department; IQR, interquartile range; ICU, intensive care unit.

Top 15 chief complaints and diagnoses for ED visits

The most common chief complaints were abdominal pain (11.9%), dyspnea (11.2%), and fever (9.7%). Among the "oldest old" patients, general weakness was more common than fever (general weakness, 8.3; fever, 7.3%) (Table 2). The most common diagnoses were pneumonia (4.9%), followed by other digestive diseases (2.9%) and gastroenteritis (2.7%).

Mortality and hospitalization rate for top 15 diagnoses

Among the top 15 diagnoses, those with the highest mortality rates were pneumonia (25.7%), dyspnea (22.5%), and acute renal failure (20.2%). Pneumonia was associated with higher hospitalization rates ("young old", 84.4%; "middle old", 86.9%; and "oldest old", 87.5%) and mortality rate ("young old", 23.6%; "middle old", 26.6%; and "oldest old", 29.0%) with age (Table 3).

Factors associated with in-hospital mortality owing to geriatric cancer-related ED visits

Of the patients, 11.8% died in the hospital. The odds of mortality were significantly higher in the "middle old" (AOR 1.24 (95% CI: 1.23–1.26)) and "oldest old" (AOR 1.52 (95% CI: 1.48–1.55)) groups than in the "young old" group. Ambulance use (AOR 2.31 (95% CI: 2.27–2.34)) was also associated with higher odds. Factors associated with lower risk of mortality included female sex (AOR 0.88 (95% CI: 0.86–0.89)), medical aid (AOR 0.88 (95% CI: 0.85–0.90)), night-time visit (AOR 0.91 (95% CI: 0.90–0.93)), and weekend visit (AOR 0.93 (95% CI: 0.91–0.94)) (Supplement Table 1).

Discussion

As the number of older PLWC has increased, this study investigated the characteristics and trends of GCED visits in South Korea using a nationwide ED database. During the five years from 2016 to 2020, the number of GCED visits was approximately 0.75 million, averaging 0.15 million visits per year. It accounted for more than half of all cancer-related ED visits. Overall, 60% of these patients were hospitalized, and more than 10% died in the hospital. The most common diagnosis was pneumonia. Understanding the reasons for cancer-related ED visits of older PLWC is essential for preparing for the increase in ED visits by older PLWC.

PLWC inevitably visit the ED for symptom control and management of complications caused by the treatment[21,22]. Previous studies reported that 3–5% of all ED visits are related to cancer, and PLWC are a high-burden population with higher hospitalization rates (over 50%) and ICU admission rates (over 5% after ED treatment)[7,14]. The risk of developing problems during anti-cancer treatment is high in older PLWC[23]. Although more than 50% of cancer-related ED visits were made by adults aged ≥ 65 years[7,14], there is limited information about older PLWC visiting ED with cancer-related problem. The strength of this study is that it investigates who visit the ED and for what reasons among older PLWC, who account for a significant proportion of cancer-related ED visits using a nationwide ED database. The number of GCED visits is increasing annually, and the proportion of the oldest old group among older PLWC is also increasing. Even among older PLWC, the oldest old age group has higher admission and mortality rates. The common reasons for ED visits among older PLWC were abdominal pain, dyspnea, and fever. However, in those aged 85 years or older, general weakness was more common than fever. Just as it is known that older adults often complain of non-typical symptoms associated with various diseases, such as myocardial infarction, older PLWC may also complain of non-typical symptoms. This is why caution is necessary when treating the oldest old PLWC in the ED[24].

Total			65–74			75–84			≥ 85		
Chief complaints	N	%	Chief complaints	N	%	Chief complaints	N	%	Chief complaints	N	%
Abdominal pain	88,781	11.9	Abdominal pain	43,341	12.2	Dyspnea	37,282	12.1	Dyspnea	10,354	12.8
Dyspnea	83,666	11.2	Fever	38,926	10.9	Abdominal pain	36,202	11.7	Abdominal pain	9238	11.4
Fever	72,316	9.7	Dyspnea	36,030	10.1	Fever	27,487	8.9	General weakness	6714	8.3
General weakness	50,730	6.8	General weakness	21,497	6.0	General weakness	22,519	7.3	Fever	5903	7.3
Dizziness	13,450	1.8	Abdominal distension	7046	2.0	Dizziness	5481	1.8	Hematuria	1530	1.9
Abdominal distension	12,768	1.7	Dizziness	6695	1.9	Abdominal distension	4825	1.6	Melena	1301	1.6
Vomiting	10,950	1.5	Vomiting	5213	1.5	Vomiting	4498	1.5	Dizziness	1274	1.6
Melena	9185	1.2	Diarrhea	4469	1.3	Hematuria	4131	1.3	Vomiting	1239	1.5
Hematuria	9070	1.2	Chest pain	4135	1.2	Melena	3856	1.2	Hematochezia	1236	1.5
Diarrhea	8494	1.1	Epigastric pain	4077	1.1	Hematochezia	3631	1.2	Jaundice	1204	1.5
Hematochezia	8390	1.1	Melena	4028	1.1	Chest pain	3436	1.1	Hematemesis	969	1.2
Chest pain	8359	1.1	back pain	3631	1.0	Epigastric pain	3354	1.1	Abdominal distension	897	1.1
Epigastric pain	8217	1.1	Hematochezia	3523	1.0	Jaundice	3341	1.1	Chest pain	788	1.0
Jaundice	7468	1.0	Hematuria	3409	1.0	Diarrhea	3285	1.1	Epigastric pain	786	1.0
Back pain	7257	1.0	Hematemesis	3276	0.9	Back pain	2996	1.0	Diarrhea	740	0.9
Total	746,416	100.0	Total	356,641	100.0	Total	308,986	100.0	Total	80,789	100.0

Table 2. Top 15 chief complaints following geriatric cancer-related emergency department visits based on the age group.

No.	Diagnoses	Total					65–74					75–84					≥85				
		Total		Adm	ICU	Death	Total		Adm	ICU	Death	Total		Adm	ICU	Death	Total		Adm	ICU	Death
		N	%	%	%	%	N	%	%	%	%	N	%	%	%	%	N	%	%	%	%
1	Pneumonia	36,775	4.9	85.9	13.2	25.7	14,876	4.2	84.4	11.4	23.6	16,812	5.4	86.9	13.9	26.6	5087	6.3	87.5	16.3	29.0
2	Other digestive diseases	21,816	2.9	85.9	16.8	9.7	9013	2.5	83.6	15.7	8.7	9368	3.0	87.2	17.2	10.4	3435	4.3	88.1	18.7	10.9
3	Gastroenteritis	19,962	2.7	59.2	3.5	6.1	9746	2.7	52.7	2.3	4.3	8076	2.6	63.5	4.1	7.2	2140	2.6	72.9	6.2	10.4
4	Fever	19,666	2.6	63.3	4.5	7.2	10,189	2.9	56.8	3.1	5.3	7597	2.5	68.4	5.5	8.5	1880	2.3	77.6	7.9	12.8
5	Abdominal pain	18,267	2.4	57.9	3.1	7.0	8513	2.4	52.1	2.0	5.6	7589	2.5	61.0	3.7	7.6	2165	2.7	69.7	5.1	10.8
6	Ileus	15,461	2.1	84.1	5.3	6.6	7588	2.1	82.7	3.8	4.7	6217	2.0	85.0	5.9	7.5	1656	2.0	86.9	9.7	11.9
7	Other biliary disease	15,160	2.0	89.1	4.9	6.6	6344	1.8	87.5	3.5	5.5	6780	2.2	90.1	5.8	6.9	2036	2.5	90.8	6.6	9.3
8	Diabetes	13,306	1.8	85.8	6.5	16.0	6372	1.8	84.6	5.8	14.9	5816	1.9	87.0	6.9	16.6	1118	1.4	86.2	8.6	18.4
9	Dyspnea	11,544	1.5	68.3	10.2	22.5	4699	1.3	64.1	8.9	20.5	5134	1.7	69.6	10.5	23.0	1711	2.1	76.1	13.2	26.5
10	Other urinary system diseases	11,437	1.5	67.6	6.7	7.2	4200	1.2	64.0	4.9	5.7	5269	1.7	68.4	6.9	7.1	1968	2.4	73.1	9.7	10.6
11	Anemia	9867	1.3	72.3	6.7	13.1	3369	0.9	71.8	5.6	13.7	4590	1.5	72.3	6.9	13.0	1908	2.4	73.0	8.0	12.3
12	Pleural effusion	9612	1.3	71.8	5.2	15.9	3639	1.0	67.0	3.9	14.1	4197	1.4	73.3	5.3	16.5	1776	2.2	78.2	7.7	17.9
13	Agranulocytosis	8396	1.1	85.1	5.6	9.6	5754	1.6	83.8	4.9	8.0	2486	0.8	87.7	7.1	13.0	156	0.2	94.2	5.8	16.7
14	Acute renal failure	8155	1.1	88.8	16.8	20.2	3223	0.9	89.2	15.3	19.5	3751	1.2	88.8	17.4	20.7	1181	1.5	87.9	19.2	20.5
15	Fatigue	6692	0.9	63.7	4.0	15.3	2646	0.7	60.8	2.9	13.9	2981	1.0	64.6	4.3	14.7	1065	1.3	68.5	5.4	20.6
	Only cancer	226,116	30.3	31.8	1.2	7.8	17,618	4.94	31.2	1.1	6.9	85,688	27.7	32.7	1.2	8.5	17,483	21.6	32.6	1.5	10.6

Table 3. Top 15 diagnoses following geriatric cancer-related emergency department visits based on the age group and associated outcome. The outcome percentage is the fraction of all study population visiting the ED. Admission includes ward admission and ICU admission together. Death is in-hospital mortality, which includes both ED deaths and hospitalized deaths. Pneumonia (J12–18), other digestive disease (K91–K93, R19), gastroenteritis (A09, K29, K52), fever (R50), abdominal pain (R10), ileus (K56), other biliary disease (K83, K87), diabetes (E11–14), dyspnea (R06), other urinary system disease (N30–37, N39), anemia (D50–53, D60–64), pleural effusion (J90–91), agranulocytosis (D70), acute renal failure (N17, N19), and fatigue (R53) based on ICD-10 codes. *Adm* admission, *ICU* intensive care unit.

Except for cancer, the most common diagnosis in the ED was pneumonia. The admission rate for GCED visits with pneumonia was over 80%, and one-fourth of the patients died in the hospital. In particular, the fact that one-third of the "oldest old" patients with pneumonia died indicates that the burden of emergency care may increase as the number of older PLWC increases. Previous studies have reported high hospitalization and mortality rates when patients with cancer-related ED visits were diagnosed with serious diseases, such as pneumonia and agranulocytosis[7]. This study found that the burden is even greater for oldest age group. The in-hospital mortality rate of GCED visits exceeded 10%, rising to over 15% for those aged over 85 years. This is more than 10 times higher than the mortality rate of 1.3% for all patients visiting the ED and 1.0% for patients without cancer[7]. When older PLWC visit the ED with cancer-related problem, 15 out of 100 die; they should be carefully observed and treated in the ED.

Another consideration is that the older PLWC examined in this study included patients at various cancer stages and treatment statuses. Since only cases that visited the ED for cancer-related problems were included, patients whose cancer was completely cured and who were cancer-free were excluded, but all older PLWC in different treatment status were included: curative treatment, palliative treatment, and no cancer treatment in the palliative stage at the end-of-life. Previous study reported that 55% of patients who died in the ED did not receive cardiopulmonary resuscitation before death, and 23% of such patients were PLWC[25]. It should be considered that some older PLWC may visit the ED at a stage when end-of-life care is needed instead of active treatment at an ED or first aid. The ED allows for the treatment of both the acute deterioration of chronic diseases and emergency conditions; however, for patients whose death is shortly predicted with incurable disease, there may be a more appropriate place to die, such as hospice. Even though this study was unable to identify such patient groups, it is important to prepare for end-of-life care in the ED while also providing appropriate palliative care for PLWC in settings other than the ED, given the rise in ED visits by older PLWCs. Additionally, more supportive care options other than ED are needed for PLWC whose stages do not require end-of-life care. Since it is well known that PLWC experience various cancer-related symptoms and anti-cancer treatment-related complications, in addition to active in-advance symptom control in the outpatient clinic, it is desirable to plan a telehealth program or home-based medical care program that allows patients to receive medical services continuously before visiting the ED[26]. Since a visit to the ED can itself be a traumatic experience for PLWC and their care partners, securing a variety of medical resources available outside of the ED can help not only reduce ED crowding but also improve the quality of care for PLWC.

This study had some limitations. Based on the diagnosis code entered into the NEDIS database, if a cancer diagnosis appeared in the ED discharge or hospital discharge code, it was classified as a cancer-related ED visit. If the diagnosis was entered incorrectly, the cancer-related ED visit may have been misclassified. However, in South Korea, where the NHI system is implemented, PLWC receive additional insurance coverage benefits for cancer-related treatments. Therefore, it is unlikely that a cancer diagnosis was omitted for PLWC or incorrectly recorded in their medical records. Second, NEDIS is an ED-based database that does not contain detailed information on cancer, such as stage, diagnosis timing, and treatment status. Therefore, it was unknown whether older PLWC who visited the ED were actively undergoing chemotherapy or required end-of-life care. Third, PLWC can visit the ED if multiple problems occur simultaneously. When multiple diagnoses other than cancer were present, the analysis was based on the first listed diagnosis in the NEDIS database, as the most important reason for visiting the ED was recorded first. Fourth, the COVID-19 pandemic happened in 2020 during the study period. During this period, in South Korea, patients suspected of COVID-19 were treated at a separate screening clinic rather than the ED to prevent the spread of infection through the ED. These strategies may have influenced the study results.

In conclusion, more than 50% of PLWC who visited the ED were aged 65 years or older, with this proportion increasing annually, particularly among the "oldest old". More than 60% of them are hospitalized and more than 10% die in the hospital. As the global population ages and the number of PLWC increases as medical technology advances, the number of older PLWC with high burden is expected to continue to increase. More planning is needed to improve the quality of cancer care for older PLWC in the ED and reduce the burden of the ED.

Data availability

The datasets analysed during the current study are not publicly available because it was used under license from the National Emergency Medical Center in South Korea for the current study but are available from the corresponding author on reasonable request.

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Declarations

Competing interests
The authors declare no competing interests.

Ethics approval
This study was approved by the Institutional Review Board of the Seoul National University Hospital (approval no. E-2209-047-1357). All methods were performed following the relevant guidelines and regulations.

Consent to participate
The requirement for informed consent was waived due to the retrospective nature of the study by the Institutional Review Board of the Seoul National University Hospital (approval no. E-2209-047-1357).

Additional information
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Correspondence and requests for materials should be addressed to S.Y.L.

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