



Prevalence of resuscitation in cancer patients at the end of life—a population-based observational study from Germany

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Background: Cardiopulmonary resuscitation (CPR) is a medical emergency intervention aimed at ending a life-threatening cardiovascular arrest as quickly as possible. However, the medical ethics of starting CPR in patients who have incurable and terminal disease is a matter of controversy. This ethical dilemma affects cancer patients in particular, as they are often suffering from advanced disease in a palliative situation. Few data are as yet available concerning the prevalence of CPR in patients with terminal cancer.

Methods: A population-based cross-sectional study was carried out on the basis of death certificates of two large cities in Germany evaluated for 2017. Medical data on resuscitation and cause of death were analyzed. Cancer patients with or without a palliative situation were identified, and the prevalence of resuscitation in these patients was determined. In addition, factors influencing resuscitation were calculated using binary multivariate regression.

Results: A total of 8,496 persons died, 32.1% of whom [2,723] were cancer patients. A palliative situation was present in 80.9% of the cancer patients [2,202]. A total of 163 cancer patients and 1,006 individuals without cancer were resuscitated at the end of life, representing prevalences of 6.0% (95% CI, 5.1–6.9%) and 17.4% (95% CI, 16.4–18.4%), respectively. Cancer patients with a palliative disease status received CPR in 3.4% of cases (95% CI, 2.6–4.2%). More than half of the resuscitations were performed in hospital (57.7% of resuscitated persons and 68.7% of cancer patients). Sex, age, presence of a palliative situation, and care provided by a specialized outpatient palliative service were found to be independent influencing factors.

Conclusions: Six in 100 cancer patients, and slightly more than three in 100 cancer patients with a palliative disease status, undergo CPR at the end of their lives. Thus, the indication for resuscitation in advanced cancer patients is handled with care and responsibility in Germany.

Keywords: Resuscitation; prevalence; cancer patients; end-of-life care

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Introduction

Cardiopulmonary resuscitation (CPR) is a medical emergency intervention that is aimed at ending a life-threatening cardiovascular arrest as quickly as possible. Epidemiological data from the United States put the absolute frequency of sudden cardiovascular arrest in adults at 356,000 cases per year for out-of-hospital treatment and 209,000 cases per year for in-hospital treatment (1,2). In Europe, data show a mean of 84 out-of-hospital cases per 100,000 population (3-6).

CPR is primarily successful in approximately 30–50% of patients, with the return of spontaneous circulation (ROSC). However, the percentage of patients who survive cardiac arrest is low. Data from the Cardiac Arrest Registry to Enhance Survival (CARES) in the United States show that more than half of resuscitated people already died on site, on the way to hospital, or in the emergency room. Only 16.1% of the individuals admitted to hospital with stabilized circulation were actually able to leave the hospital alive. One-fifth of those discharged had a poor neurological status (7).

Resuscitation is always linked to a curative treatment intent. The priority is to preserve life and avoid serious physical complications. In palliative patients with incurable, very advanced, life-limiting disease, however, unconditional prolongation of life is often no longer a primary aim. Instead, the focus is on alleviating physical and psychological symptoms and thereby maintaining the individual's quality of life. From the point of view of medical ethics, starting resuscitation in patients with an unfavorable prognosis is therefore a matter of controversy.

In Germany, slightly over 1% of the total population die every year. Current figures from the Federal Statistical Office show that there were 954,914 deaths in 2018 in a population of 82.9 million (8). Cancer is the second most frequent cause of death, after cardiovascular diseases (9). In the field of hospice and palliative care, patients with malignant tumors represent by far the majority of those being cared for.

Observational studies on the outcome in resuscitated patients show a poorer prognosis for cancer patients in comparison with non-cancer patients, and the patients' general physical condition and tumor status have a strong influence on the mortality risk (10-16). Bruckel *et al.* showed that cancer patients with in-hospital cardiac arrest and advanced tumor status were only able to leave the hospital alive in 7.4% of cases. In comparison, the survival

probability for non-cancer patients was 13.4% (10). A meta-analysis of a total of 42 resuscitation studies (11) identified 1,707 resuscitated cancer patients, 105 of whom were able to leave the hospital alive, representing a relative frequency of 6.2%. Recently published data from a French research group (12), evaluating hospital data for 133 cancer patients with out-of-hospital and in-hospital resuscitation, with successful cardiovascular stabilization and subsequent treatment in intensive care, show a very high in-hospital survival rate of 18.0%. However, it should be noted here that this figure is subject to selection bias, since the study only included intensive care unit (ICU) patients who had a ROSC, and thus a better outcome, after resuscitation.

The published literature only includes a few studies on the prevalence of CPR in patients with terminal cancer (14,17-25), and a large proportion of the data refer to hospital patients (17-21). The CPR prevalence vary widely (3.2–39.0%) depending on disease status, tumor entity, observation period, and in-hospital treatment setting. Only a few studies are based on epidemiological data for the general population (14,22-25).

The aim of the present study was to assess the prevalence at the population level of resuscitation at the end of life in cancer patients without or with a palliative situation. Death certificates were used as the data source, and the medical data included on the certificates regarding resuscitation treatment and cause of death were evaluated. A further objective was to identify factors that influence the initiation of resuscitation at the end of life. We present the following article in accordance with the STROBE reporting checklist (available at <http://dx.doi.org/10.21037/apm-20-1208>).

Methods

Ethical approval

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Ethics Committee of the Ruhr University of Bochum (Germany) (No. 19-6668). In this context, the informed consent of deceased study subjects was also included and accepted.

Study design

The study design was based on a retrospective cross-sectional survey, evaluating death certificates from the study region (observational study).

Study region

The study region comprised the university towns of Bochum (BO) and Muenster (MS) in the Federal State of North Rhine-Westphalia (Germany). As of 31 December 2017, the total population of the two cities was 679,088 (26).

Data source

The study was based on an evaluation of a complete set of archived death certificates for the year 2017 (1.1.2017–31.12.2017). A total of 8,496 (BO 4,651, MS 3,845) death certificates were available (data set from the general population). The physician performing the postmortem examination documented the type of death as natural in 83.7% of the certificates, unexplained in 13.6%, and non-natural (accidents, suicide, homicide) in 2.7%.

Cancer patients

Individuals with a malignant tumor were identified on the basis of the medical information regarding the cause of death. All available information was included in the evaluation. This included information on the underlying disease as well as on the causal chain and direct cause of death. The medical epicrisis was also included in the evaluation. The patients identified in this way were then subdivided according to the malignant neoplasm present (C00–C96) in accordance with the International Classification of Diseases (ICD-10).

Cancer patients with a palliative disease status

In cancer patients, research was carried out to determine whether they had been in a far advanced, life-limiting stage of disease representing a palliative situation. By definition, a palliative situation was present if the following keywords were used in the death certificate: metastasis; advanced tumor, cancer or carcinoma; palliative chemotherapy; palliative radiotherapy; inoperable tumor, cancer or carcinoma; tumor, cancer or carcinoma in the final or terminal stage; unfavorable prognosis; palliative overall situation; care provided by a specialized outpatient palliative service; treatment on a palliative care unit; died in a palliative care unit or in a hospice.

Resuscitation

Whether or not a resuscitation had taken place was

determined using the item “Resuscitation treatment performed” (yes/no), which is listed in the confidential part of the death certificate. In addition, medical data were collected on the cause of death, place of death, and the last medical person/institution to administer treatment (general practitioner, hospital, hospital department, specialized outpatient palliative service). In addition, the signature stamp was used to determine who had issued the death certificate (e.g., family physician, emergency physician, physician from the specialized outpatient palliative service, hospital physician). This information was used to determine whether resuscitation had been performed outside the hospital and/or in hospital.

No medical information concerning resuscitation was given in 10.4% of all the death certificates issued. Comparative analyses of death certificates with and without CPR details showed that physicians did not document it more often when individuals had died at home. No differences between the two groups with regard to age, sex, or type of death were noted. Precise time details for the resuscitation event were mostly lacking, but in the vast majority of the death certificates the period between CPR and death could be derived from the context of the medical data. In most cases, the resuscitation event had taken place a few hours to a few days (sometimes also a few weeks) previously. The CPR had taken place more than 6 months previously, or could not be determined, in only in a few individual cases.

Statistical analysis

The overall study population was classified into selected subgroups (cancer *vs.* non-cancer patients; cancer patients with *vs.* without a palliative situation; resuscitated persons with *vs.* without cancer), and the subgroups were analyzed for significant differences in sociodemographic and medical characteristics. For categorical variables, absolute and relative frequencies were calculated and the Chi-squared test was used, or Fisher’s exact test if there were small numbers (<5) in each cell. For continuous variables, the unpaired *t*-test was used (for normally distributed data) or the Mann-Whitney U test (for data without a normal distribution). The significance level was set at $P < 0.01$ (two-sided) to take into account the global increase in the likelihood of alpha error (type 1 error) due to multiple testing.

The prevalence of CPR was presented as a proportion of the population of interest (relative frequency), and 95% confidence intervals were calculated for this frequency.

Direct age standardization was carried out in order to allow comparative analyses between groups of individuals. The “New European Standard Population (EU-27 + EFTA)” was used as the standard population (27).

Factors influencing the primary outcome “resuscitation carried out”—yes [1] *vs.* no [0]—were calculated using multivariate logistic regression. The following influencing factors were included in the regression model: sex, age, type of death, any tumor entities, the presence of a palliative disease status, and the presence of care by a specialized outpatient palliative service. Subsequently, a backward stepwise model was applied. The models were calculated for all deceased persons, for cancer patients, and for cancer patients in the palliative situation. The odds ratio score with the corresponding 95% confidence intervals was generated from the regression model analyzed. The results were presented univariately and multivariately. To evaluate the quality of the multivariate model, the log likelihood (−2LL) and Nagelkerke’s pseudo- R^2 coefficient were calculated. All of the analyses were carried out using the IBM SPSS Statistics program, version 25.

Results

Deceased persons

A total of 8,496 people died. Slightly more women died than men. Women had a mean age at death of 80.2 (± 14.6) years and men 73.9 (± 15.7) years; 32.1% of the patients [2,723] had been diagnosed with cancer. The mean life expectancy in these patients was 73.7 (± 13.6) years, a reduction of 5.1 years in comparison with persons without cancer. Individuals in the general population mainly died in hospital. The second most frequent place of death was a nursing home. Only about one in five individuals died in the home environment. In cancer patients, the proportion of deaths at home was only 17.2%. However, cancer patients often died in a palliative care unit (15.7%) or in a hospice (13.2%) (Table 1).

Cancer patients

The disease stage was far advanced in 80.9% of the cancer patients (2,202/2,723), so that a palliative disease status was present. These patients died at a mean age of 73.3 years, and the average life expectancy for oncological patients receiving palliative treatment was 1.9 years shorter in comparison with cancer patients who were not in a palliative situation.

The most frequent condition was malignant disease of the digestive organs (C15–C26), followed by cancer of the respiratory organs (C30–C39). Almost half of all cancer patients, at 42.9%, were receiving specialized outpatient palliative care in the palliative situation. The hospital was the most frequent place of death. Cancer patients who were receiving palliative care died in hospital less frequently than patients who were not in the palliative situation (54.1% *vs.* 77.2%; $P=0.001$) (Table 2).

Prevalence of CPR

A total of 13.8% of all deceased persons (95% CI, 13.1–14.5%; 1,169/8,496) underwent resuscitation at the end of their lives. In cancer patients, the prevalence of CPR was 6.0% (95% CI, 5.1–6.9%; 163/2,723). The resuscitation frequency in cancer patients who had a palliative disease status was 3.4% (95% CI, 2.6–4.2%) in comparison with 16.9% in patients without an advanced tumor stage (95% CI, 13.7–20.1%; $P<0.001$). CPR was initiated in 17.4% of all individuals without a tumor disease (95% CI, 16.4–18.4%; 1,006/5,773) (Figure 1).

After direct age standardization, the following notional values were obtained relative to 100,000 inhabitants: 220 for all deceased, 68 for cancer patients, 294 for individuals without a tumor disease, 33 for cancer patients with a palliative disease status, and 137 for cancer patients not in the palliative situation.

Resuscitated persons

A total of 1,169 CPRs were documented. Men were resuscitated more frequently than women, at 61.3% [717]. More than half (57.7%) of all resuscitations took place in hospitals; the proportion of out-of-hospital resuscitations was 42.1%. Underlying cardiac disease was the reason for the resuscitation in 41.1% of cases, and hypoxia in 16.3%. Hypoxic brain damage developed after successful cardiovascular stabilization in 8.9% of the resuscitated persons. Almost two-thirds of all individuals with CPR died in hospital, and nearly half in an ICU. Resuscitated patients were significantly younger in comparison with those without resuscitation and included a larger percentage of men, and they died more frequently in hospital or in a public place, but less frequently in a nursing home, hospice, or palliative care unit (data not shown).

Cancer patients were more frequently resuscitated in hospital (68.7% *vs.* 56.0%; $P=0.002$), and less frequently

Table 1 Characteristics of the deceased, stratified by cancer versus non-cancer disease

	Total (n=8,496)		Cancer patients (n=2,723)		Non-cancer patients (n=5,773)		P
	%	N	%	N	%	N	
Type of death							
Natural	83.7	7,109	95.1	2,589	78.3	4,520	0.001
Unexplained	13.6	1,158	4.7	127	17.9	1,031	0.001
Non-natural	2.7	229	0.3	7	3.8	222	0.001
Gender							
Female	51.3	4,355	47.1	1,282	53.2	3,074	0.001
Male	48.7	4,140	52.9	1,441	46.8	2,699	0.001
Age							
All (mean/SD)	77.1	15.4	73.7	13.6	78.8	16.0	0.001
Woman (mean/SD)	80.2	14.6	74.7	13.6	82.5	14.4	0.001
Men (mean/SD)	73.9	15.7	72.7	13.6	74.5	16.6	0.001
<40 years	2.6	217	1.8	48	2.9	169	0.001
≥40 and <60 years	9.4	792	11.7	316	8.3	476	0.001
≥60 and <80 years	36.5	3,084	51.7	1,402	29.3	1,682	0.001
≥80 years	51.5	4,352	34.9	946	59.4	3,406	0.001
Specialized outpatient palliative care							
Yes	19.6	1,661	34.7	945	12.4	716	0.001
Place of death							
Home	18.2	1,543	17.2	468	18.6	1,075	0.110
Hospital	57.1	4,852	58.5	1,594	56.4	3,258	0.071
ICU	19.2	1,628	11.7	319	22.7	1,309	0.001
Palliative care unit	6.5	552	15.7	428	2.1	124	0.001
Hospice	4.5	379	13.2	359	0.3	20	0.001
Nursing home	19.0	1,611	10.9	296	22.8	1,315	0.001
Other	1.3	110	0.2	6	1.8	104	0.001

ICU, intensive care unit.

Table 2 Characteristics of deceased cancer patients with and without a palliative disease status

	Cancer patients with a palliative disease status (n=2,202)		Cancer patients without a palliative disease status (n=521)		P
	%	N	%	N	
Type of death					
Natural	97.0	2,135	87.1	454	0.001
Unexplained	2.9	64	12.1	63	0.001
Non-natural	0.1	3	0.8	4	0.028
Gender					
Female	48.9	1,077	39.3	205	0.001
Male	51.1	1,125	60.7	316	0.001

Table 2 (continued)

Table 2 (continued)

	Cancer patients with a palliative disease status (n=2,202)		Cancer patients without a palliative disease status (n=521)		P
	%	N	%	N	
Age					
All (mean/SD)	73.3	13.1	75.2	15.4	0.011
Woman (mean/SD)	74.2	13.2	77.2	15.1	0.009
Men (mean/SD)	72.4	13.0	73.9	15.5	0.136
<40 years	1.6	34	2.7	14	0.093
≥40 and <60 years	12.2	268	9.2	48	0.058
≥60 and <80 years	53.1	1,165	45.7	237	0.002
≥80 years	33.1	726	42.4	220	0.001
Tumor entity (ICD-10)					
C00–C14	2.3	50	2.1	11	1.000
C15–C26	31.6	695	27.6	144	0.082
C30–C39	22.5	496	13.8	72	0.001
C40–C41	0.4	8	0.4	2	1.000
C43–C44	1.6	35	0.4	2	0.033
C45–C49	1.6	36	1.2	6	0.553
C50	8.0	177	5.4	28	0.042
C51–C58	4.9	108	1.3	7	0.001
C60–C63	6.8	150	5.4	28	0.278
C64–C68	8.1	179	6.5	34	0.239
C69–C72	2.9	63	0.8	4	0.004
C73–C75	0.2	5	0.4	2	0.625
C76–C80	2.8	62	0.8	4	0.004
C81–C96	9.2	202	31.9	166	0.001
Unknown	1.0	21	2.9	15	0.002
Specialized outpatient palliative care					
Yes	42.9	945	0	0	–
Place of death					
Home	18.2	402	12.7	66	0.002
Hospital	54.1	1,192	77.2	402	0.001
ICU	7.4	162	30.1	157	0.001
Palliative care unit	19.3	426	0.0	0	–
Hospice	16.3	359	0.0	0	–
Nursing home	11.0	243	10.2	53	0.639
Other	0.3	6	0.0	0	–

C00–C14: malignant neoplasms of lip; oral cavity and pharynx; C15–C26: malignant neoplasms of digestive organs; C30–C39: malignant neoplasms of respiratory and intrathoracic organs; C40–C41: malignant neoplasms of bone and articular cartilage; C43–C44: melanoma and other malignant neoplasms of skin; C45–C49: malignant neoplasms of mesothelial and soft tissue; C50: malignant neoplasms of breast; C51–C58: malignant neoplasms of female genital organs; C60–C63: malignant neoplasms of male genital organs; C64–C68: malignant neoplasms of urinary tract; C69–C72: malignant neoplasms of eye; brain and other parts of central nervous system; C73–C75: malignant neoplasms of thyroid and other endocrine glands; C76–C80: malignant neoplasms of ill-defined; other secondary and unspecified sites; C81–C96: malignant neoplasms of lymphoid; hematopoietic and related tissue. ICD, International Classification of Diseases; ICU, intensive care unit.

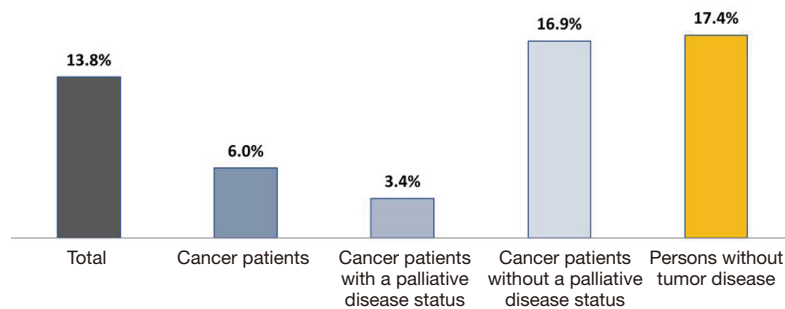


Figure 1 Prevalence of resuscitation at the end of life.

outside of the hospital (28.2% vs. 44.2%; $P=0.001$). Underlying cardiac disease was also less frequently noted as the reason for resuscitation in the death certificate in these patients (21.5% vs. 44.2%; $P<0.001$).

Comparison of resuscitated cancer patients with or without a palliative situation showed that palliative patients were on average younger. In six cases, CPR was initiated in cancer patients in the palliative situation, even though care was being provided by the specialized outpatient palliative service (Table 3).

Factors influencing the initiation of resuscitation

Men and younger individuals (<70 vs. ≥ 70 years) were more likely to undergo resuscitation at the end of their lives. By contrast, the presence of cancer in a palliative situation was associated with a reduced probability of CPR. Patients who had been cared for by a specialized outpatient palliative service before their death were also less likely to undergo resuscitation at the end of their lives (overall population: OR, 0.06, 95% CI, 0.04 to 0.12, $P=0.001$; cancer patients: OR, 0.13, 95% CI, 0.06 to 0.31, $P=0.001$; cancer patients in the palliative situation: OR, 0.14, 95% CI, 0.06 to 0.33, $P=0.001$) (Table 4).

Discussion

On the basis of an analysis of death certificates, the present study shows that 6.0% of cancer patients and 3.4% of cancer patients with a palliative disease status underwent resuscitation at the end of their lives. The prevalence of CPR was 13.8% in the total population and 17.4% in individuals without cancer. More than half of all CPRs were carried out in hospital.

In an international comparison, the results of the present study show a fairly low prevalence of CPR. A research

group in Asia (22,23) reported a CPR prevalence of 10.6% in cancer patients, with information being collected at the population level and subanalyses being carried out for deceased patients with malignant cancer, similar to the present study. A total of 242,530 cancer patients who had died between 2000 and 2006 were included. A declining trend was observed over the period considered; the prevalence of CPR was still 13.1% in 2000 and fell to 8.4% in 2006. As the main explanation for this, the authors mention the implementation of a “Hospice Palliative Care Act”. This law, which came into force in 2000, assigned a right to palliative care to seriously ill, dying patients in Taiwan and allowed life-prolonging measures to be dispensed with for the first time in this setting.

Sato *et al.* (17) evaluated CPR data from the hospital sector. The study included slightly more than 60% of all Japanese hospitals. Methodologically, the hospitals were subdivided according to the number of annual deaths of cancer patients: <100 (group 1), 25–99 (group 2), <25 (group 3) deaths per year. A total of 248,978 hospital patients were found to have died. Of these, 6.3% (group 1), 6.8% (group 2), and 8.9% (group 3) had undergone CPR within the last 30 days before death, and 5.8% (group 1), 6.4% (group 2), and 8.3% (group 3) within the last 14 days before death.

The frequency of resuscitation in cancer patients with advanced disease status was investigated by Lee *et al.* (19). In a study based on cancer registry data, the authors identified a total of 106,404 patients with stage IV cancer, 3,446 of whom underwent resuscitation due to cardiac arrest in hospital. This resulted in a raw resuscitation rate of 3.2%. Research results from Germany on the prevalence of resuscitation in cancer patients are available in a single-center study from a large university hospital (18), which investigated the frequency of medical interventions and diagnostic measures in tumor patients at the end of their

Table 3 Characteristics of resuscitated individuals

	Total (N=1,169)		Cancer patients (N=163)		Non-cancer patients (N=1,006)		P	Cancer patients with a palliative disease status (N=75)		Cancer patients without a palliative disease status (N=88)		P
	%	N	%	N	%	N		%	N	%	N	
Type of death												
Natural	62.2	727	74.8	122	60.1	605	0.001	77.3	58	72.7	64	0.588
Unexplained	33.0	386	23.9	39	34.5	347	0.009	22.7	17	25.0	22	0.854
Non-natural	4.8	56	1.2	2	5.4	54	0.017	0.0	0	2.3	2	-
Gender												
Female	38.7	452	31.3	51	39.9	401	0.038	33.3	25	29.5	26	0.616
Male	61.3	717	68.7	112	60.1	605	0.038	66.7	50	70.5	62	0.616
Age												
All (mean/SD)	71.7	16.5	70.7	13.7	71.9	16.9	0.331	68.6	12.2	72.5	14.8	0.067
Woman (mean/SD)	74.0	16.8	72.1	14.8	74.2	17.0	0.361	70.8	12.2	73.4	17.0	0.538
Men (mean/SD)	70.3	16.1	70.1	13.3	70.4	16.6	0.837	67.5	12.1	72.1	13.9	0.063
<40 years	4.6	53	2.5	4	4.9	49	0.223	2.7	2	2.3	2	0.999
≥40 and <60 years	13.5	157	10.4	17	14.0	140	0.265	14.7	11	6.8	6	0.126
≥60 and <80 years	46.7	543	66.3	108	43.5	435	0.001	70.7	53	62.5	55	0.320
≥80 years	35.2	409	20.9	34	37.5	375	0.001	12.0	9	28.4	25	0.012
Specialized outpatient palliative care												
Yes	0.9	11	3.7	6	0.5	5	0.002	8.0	6	0.0	0	-
Place of death												
Home	18.8	220	19.0	31	18.8	189	0.914	21.3	16	17.0	15	0.550
Hospital	72.3	845	80.4	131	71.0	714	0.014	77.3	58	83.0	73	0.431
ICU	45.4	531	49.1	80	44.8	451	0.351	44.0	33	53.4	47	0.272
Palliative care unit	0.7	8	3.1	5	0.3	3	0.002	0.0	0	2.3	2	-
Hospice	0.0	0	0.0	0	0.0	0	-	0.0	0	0.0	0	-
Nursing home	4.6	54	0.0	0	5.4	54	-	0.0	0	0.0	0	-
Other	4.3	50	0.6	1	4.9	49	0.010	1.3	1	0.0	0	-

Table 3 (continued)

Table 3 (continued)

	Total (N=1,169)		Cancer patients (N=163)		Non-cancer patients (N=1,006)		P	Cancer patients with a palliative disease status (N=75)		Cancer patients without a palliative disease status (N=88)		P
	%	N	%	N	%	N		%	N	%	N	
CPR—place												
Outpatient	42.1	492	28.2	47	44.2	445	0.001	32.0	24	26.7	23	0.488
Home	23.0	269	21.5	35	23.3	234	0.688	24.0	18	19.3	17	0.567
Nursing home	5.6	65	1.8	3	6.2	62	0.025	1.3	1	2.3	2	1.000
Other	6.2	72	1.2	2	7.0	70	0.002	1.3	1	1.1	1	1.000
Hospital	57.7	675	68.7	112	56.0	563	0.002	65.3	49	71.6	63	0.403
outpatient/in-patient	6.9	81	3.1	5	7.6	76	0.044	4.0	3	2.3	2	0.662
Unknown	7.1	83	5.5	11	7.4	74	0.510	6.7	5	4.5	4	0.734
CPR—resuscitator												
Emergency physician	40.9	478	28.2	46	42.9	432	0.001	32.0	24	25.0	22	0.384
Hospital physician	60.5	707	73.0	119	58.4	588	0.001	68.0	51	77.3	68	0.217
CPR—cause												
Cardial	41.1	480	21.5	35	44.2	445	0.001	14.7	11	27.3	24	0.057
Hypoxic	16.3	191	16.0	26	16.4	165	1.000	16.0	12	15.9	14	1.000
CPR—CNS damage												
Hypoxic brain injury	8.9	104	7.4	12	9.1	92	0.553	8.0	6	6.8	6	0.774

ICU, intensive care unit; CPR, cardiopulmonary resuscitation; CNS, central nervous system.

Table 4 Factors associated with resuscitation at the end of life

	Univariate			Multivariate		
	OR	95% CI	P	OR	95% CI	P
Total						
Gender: male [1] vs. female [0]	1.81	1.59–2.05	0.001	1.56	1.37–1.80	0.001
Age: ≤70 [1] vs. >70 [0] years	1.82	1.60–2.01	0.001	1.56	1.35–1.80	0.001
Type of death: unexplained or non-natural [1] vs. natural [0]	4.02	3.58–4.71	0.001	2.33	2.01–2.70	0.001
Cancer: yes [1] vs. no [0]	0.30	0.25–0.36	0.001	0.86	0.67–1.10	0.223
Presence of a palliative care situation: yes [1] vs. no [0]	0.17	0.13–0.21	0.001	0.31	0.23–0.44	0.001
Specialized outpatient palliative care: yes [1] vs. no [0]	0.03	0.02–0.06	0.001	0.06	0.04–0.12	0.001
Goodness of fit: (–2LL/Nagelkerke's R ²)					5,856.161/0.185	
Cancer patients						
Gender: male [1] vs. female [0]	2.03	1.45–2.86	0.001	1.63	1.14–2.33	0.008
Age: ≤70 [1] vs. >70 [0] years	1.57	1.14–2.16	0.005	1.56	1.11–2.19	0.011
Type of death: unexplained or non-natural [1] vs. natural [0]	8.92	5.92–13.43	0.001	4.77	3.09–7.36	0.001
Presence of a palliative care situation: yes [1] vs. no [0]	0.17	0.13–0.24	0.001	0.32	0.23–0.46	0.001
Specialized outpatient palliative care: yes [1] vs. no [0]	0.07	0.03–0.15	0.001	0.13	0.06–0.31	0.001
Goodness of fit: (–2LL/Nagelkerke's R ²)					1,017.354/0.209	
Cancer patients with palliative care						
Gender: male [1] vs. female [0]	1.96	1.20–3.19	0.001	1.59	0.96–2.63	0.072
Age: ≤70 [1] vs. >70 [0] years	2.05	1.29–3.25	0.002	1.74	1.07–2.81	0.025
Type of death: unexplained or non-natural [1] vs. natural [0]	12.18	6.62–23.39	0.001	8.04	4.29–15.10	0.001
Specialized outpatient palliative care: yes [1] vs. no [0]	0.11	0.05–0.25	0.001	0.14	0.06–0.33	0.001
Goodness of fit: (–2LL/Nagelkerke's R ²)					562.513/0.158	

–2LL, –2 log likelihood.

lives. Data for 532 cancer patients who died in 2014 were analyzed retrospectively. The analysis showed that 10.5% of the deceased had undergone resuscitation in hospital within the last month of life and 8.5% within the last week of life.

The present study showed that more than half of all resuscitations (57.7%) were performed in hospital. In cancer patients, the proportion was as high as 68.7%. By contrast, only 21.5% of cancer patients underwent resuscitation in the home setting. These percentages are surprising, since the absolute frequency of out-of-hospital resuscitation in resuscitation registries usually exceeds the number of in-hospital resuscitations. For example, the American Heart Association (AHA) states in its 2019 statistical report that the absolute number of annual cases of sudden cardiac arrest in the United States was 563,000, only 37.1% of

which involved in-hospital emergency events (1). Data from the resuscitation registry in Germany for 2017 have been published, with the set of out-of-hospital resuscitations totaling 14,314 patients and in-hospital resuscitations only showing 3,401 patients (5,6). The divergence might also be explained methodologically, since participation in the resuscitation registry in Germany is voluntary and emergency services are probably more likely to send data to the registry than hospitals are. It can be assumed that the high proportion of in-hospital CPR in the present study is largely due to the excellent in-patient care provided in the study region. There are two large university hospitals in the region, both of which are supra-regional extracorporeal membrane oxygenation (ECMO) centers. In addition, there are other hospitals offering acute and specialized care, so

that the regional availability of in-patient hospital beds—at 1,076 beds per 100,000 population in comparison with 606 beds per 100,000 for Germany as a whole (in 2016) (28)—must be rated as above average.

Independently of such considerations, the present data impressively confirm that the medical-ethics issue of “resuscitation in critically ill patients with a life-limiting disease” clearly affects hospitals. The issue is all the more important since hospitals in particular have personnel and technical resources available that allow rapid and effective treatment for patients with intensive care methods in crisis situations. On the other hand, emergency physicians and emergency services also face the problems of care in acute palliative situations with dying patients. Estimates from Germany indicate that the proportion of palliative medical emergencies within the total numbers of outpatient emergency cases is approximately 3.0% (29-31).

It would therefore be desirable for physicians to be trained in and prepared for emergency care for palliative patients. A few aspects of this may be mentioned here—for example, symptom control, communications with patients and relatives, clarification of the treatment goal, preparation of an emergency plan, documentation of the patient’s wishes—e.g., through a “do not resuscitate” (DNR) order; and also familiarity with the legal basis for a “living will”, precautionary power of attorney, judicial support, familiarity with psychosocial stress factors, and an ability to recognize the terminal situation. In many emergencies, emergency and palliative medicine are not conflicting fields of medicine, but rather complementary. For example, a study by Wiese *et al.* has shown that closer integration of the two disciplines can lead to improved patient care (32).

Analysis of the present study data showed that sex, age, type of death, and care by a specialized outpatient palliative service were associated with resuscitation at the end of life. For example, men were more likely to undergo resuscitation than women. This may be due to the fact that cardiovascular arrest is usually due to ischemic heart disease and that men have greater morbidity than women in this context (1). Younger cancer patients were more likely to undergo resuscitation at the end of their lives than older patients. This result is not surprising, as patients with increasing age suffer more from comorbidities and physical frailty, which can strongly influence the medical indication for CPR in favor of limiting therapy.

A major task for specialists working in palliative care is to prepare patients and their relatives for potential end-of-life scenarios, leaving scope for their own wishes and ideas

and thus allowing confidence and dignity. Implementing this approach inevitably requires forward-looking discussions with patients and advance planning, and this forms the basis for the approach known as Advance Care Planning (ACP) (33,34). Within the framework of a professionally supervised discussion process, ACP gives those interested an opportunity to articulate their own preferences for future medical treatment through expert information and clarification, and to document these preferences effectively in case they later become unable to provide consent. The intention is that patients can in this way be protected from unintentional overtreatment or undertreatment, while relatives, authorized representatives, nurses, and physicians are relieved of the burden of making decisions on their behalf.

The importance of this explanatory process and the extent to which patients’ perceptions may diverge from clinical reality are illustrated by studies assessing the probability of survival following resuscitation. Adams and Snedden (35) interviewed older hospital patients in the United States. The vast majority of the respondents considerably overestimated life expectancy after in-hospital resuscitation, believing that the probability of survival would be 50% or more. In fact, only one in four patients survives sudden cardiac arrest in hospital (1). Data from the present study also show that although nine out of 100 resuscitated individuals survived the event, they subsequently developed hypoxic brain damage. Scientific research has confirmed that TV shows can contribute to public misconceptions of the prognosis after CPR by trivializing resuscitations cinematically and presenting the outcome too optimistically (36,37). By contrast, a study by Taubert *et al.* (38) has shown that seeing a realistic educational video on resuscitation can be extremely helpful for palliative patients, enabling them to take well thought-out therapy decisions at the end of life.

In specialized outpatient palliative care, preparing an emergency form is a customary task for the physician. The present study showed that among 945 cancer patients who were being cared for by the outpatient palliative service, 6 (0.6%) still underwent resuscitation at the end of their lives. These resuscitations were mainly carried out in the home environment. On the one hand, this may indicate that there are also palliative patients who deliberately insist on life-prolonging measures despite their advanced, life-limiting illness. On the other, it may shed light on the situation of relatives caring for the patient, who often feel helpless and overwhelmed in the face of a crisis and despite all the prior palliative medical discussions still succeed in

obtaining emergency medical help. It also illustrates the position of the emergency physician, who in the acute event of a cardiovascular arrest in a patient in a palliative disease setting has to take the decision on whether to initiate or refrain from resuscitation very quickly and prudently. A well-trained emergency physician with sufficient knowledge of palliative care and the legally binding nature of a living will is able to assess the situation better and take an appropriate treatment decision more easily.

Limitations

This study was designed as a population-based cross-sectional survey. Although this methodological approach is suitable for generating hypotheses, it is not possible to draw any causal inferences from it. The quality of the data on death certificates is generally viewed critically (39). Physicians often do not have any precise information about the deceased's medical history, although without this it is difficult to determine the exact cause of death. An answer to the question of whether resuscitation treatment had been carried out was provided by most of the physicians in the present study. However, one in ten of the death certificates lacked medical information about this. The physicians' documentation practices can thus be regarded as satisfactory. In most cases, it was possible to deduce from the medical data that a resuscitation had taken place in a direct time relation to the death, so that the study data do actually reflect the term "resuscitation at the end of life". This period mainly covered the day of death itself or the last few days, or occasionally also the final weeks, before death. It was only in individual cases that it was not possible to establish a temporal relationship between CPR and death. There is a limit to how far generalizations can be made on the basis of this study, because it is restricted to selected areas of Westphalia-Lippe and did not aim to represent the overall population of Germany.

Conclusions

In Germany, the CPR prevalence in cancer patients with a palliative disease status amounts to 3.4%. Accordingly, the indication for resuscitation in these patients is handled responsibly and with restraint at the end of life. However, a closer interdisciplinary cooperation between emergency medicine and palliative medicine would be desirable, and would contribute to improved medical care for patients at the end of their lives.

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013) and the Harmonized Tripartite Guideline for Good Clinical Practice from the International Conference on Harmonization. The study was submitted to the Ethics Committee of the Ruhr University of Bochum (Germany) and was approved after examination (No. 19-6668). In this context, the informed consent of deceased study subjects was also included and accepted. The local public health authorities granted access to the archived death certificates, in compliance with statutory data protection regulations. The dataset was anonymized prior to analysis.

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