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One-Year Mortality of Cancer Patients with an Unplanned ICU Admission: A Cohort Analysis Between 2008 and 2017 in the Netherlands

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Research

Keywords: Intensive Care Unit, haematological malignancy, solid malignancy, cancer, unplanned ICU admission, 1-year mortality, ICU mortality, hospital mortality

Posted Date: November 23rd, 2020

DOI: https://doi.org/10.21203/rs.3.rs-111863/v1

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Abstract

Background

Over the last decades, a decrease in short-term mortality in cancer patients admitted to the ICU has been described in literature. However, it is unclear whether this decrease also results in a decrease in long-term mortality. Therefore, we examined the 1-year mortality of cancer patients (either haematological or solid) with an unplanned ICU admission.

Methods and data

All adult patients registered in the National Intensive Care Evaluation registry with an unplanned ICU admission in the Netherlands between 2008 and 2017 were included. The primary outcome was 1-year mortality, analysed with a mixed-effects cox-proportional hazard regression. We examined the trend in mortality rates over the inclusion period. Furthermore, we compared the 1-year mortality of cancer patients to that of patients without cancer.

Results

We included 470,305 patients: 10,401 with haematological cancer, 35,920 with solid tumours, and 423,984 without cancer. The 1-year mortality rates were 60.1%, 46.2%, and 28.3% ($p<0.01$), respectively. While no statistically significant trend was found ($p=0.58$), a visual inspection of the graph showed a slightly decreasing trend in 1-year mortality over the inclusion period. Although we found a statistical significant difference in 1-year mortality in patients with a solid tumour ($p<0.01$), visual inspection showed a wide variety per year. We found a decreasing trend in 1-year mortality in ICU patients without a malignancy ($p<0.01$). Cancer patients surviving their critical illness and hospital admission had a 30% mortality at 1 year.

Conclusion

The 1-year mortality in cancer patients with an unplanned ICU admission (either haematological or solid) was significantly higher than that of patients without cancer. A visual inspection showed a slight decrease in 1-year mortality in haematological patients, while the 1-year mortality in patients with a solid tumour varied per year. After hospital discharge, a considerable part of the patients with a malignancy died within 1 year. Physicians should discuss the long-term prognosis after an ICU admission with patients and relatives in order to manage treatments and expectations. Future research should focus on identifying cancer patients who will benefit from an ICU admission.

Background

Worldwide, approximately 40% of all people will be diagnosed with cancer during their lifetime (1). In general, malignancies remain a major cause of death in Europe and North America (2, 3). Fortunately, due to early detection and improved cancer treatment, long-term mortality of cancer patients has decreased

over the past decades (1, 4, 5). However, the probability of life threatening events related to therapy requiring intensive care has increased (6). Therefore, intensivists worldwide are increasingly confronted with cancer patients during treatment (7, 8).

From the eighties till the beginning of the zeros, patients with an advanced malignancy were generally perceived ineligible for intensive care treatment due to the unfavourable outcomes (9–11). Nowadays, around 10%-30% of the patients admitted to an Intensive Care Unit (ICU) have cancer (12–14). Several studies show that ICU and hospital mortality of cancer patients has decreased over the years (9, 14–19). In particular, a good prognosis in planned postsurgical cancer patients has been described in literature (8, 15, 18, 20). Therefore, these patients are nowadays generally accepted to the ICU for postoperative care.

However, studies regarding long-term mortality after an unplanned ICU admission in patients with a malignancy are scarce and outdated (18–23). An update of data regarding long-term outcome of cancer patients with an unplanned ICU admission is necessary for two reasons. Firstly, in an acute setting, ICU physicians may be confronted with critically ill cancer patients. An enhanced understanding of outcomes in this patient group may lead to improved treatment decisions of haematologists, oncologists and ICU physicians. Secondly, updated data may help to create realistic expectations towards patients and their relatives regarding ICU treatment and short-term and long-term mortality.

The aim of our study was to determine whether the observed decrease in short-term mortality in cancer patients with an unplanned ICU admission also results in a decrease in long-term mortality. Therefore, we examined the 1-year mortality of patients with either a haematological or a solid malignancy with an unplanned ICU admission.

Methods And Data

Patient data

The National Intensive Care Evaluation (NICE) registry was used to identify all adult patients with an unplanned admission to ICUs in the Netherlands from 2008 to 2017. This registry contains data of patients from 85% of the Dutch ICUs in 2008 to 100% of the Dutch ICUs in 2017 (24), and focuses on quality improvement of ICU care in the Netherlands. It contains whether the ICU admission was planned or unplanned, demographics, physiological and diagnostic data, ICU characteristics, and ICU and hospital mortality of patients. We linked a national administrative insurance database (i.e., Vektis data) to the NICE registry, to determine the 1-year mortality (25, 26).

We stratified the included patients into three cohorts: patients with haematological cancer, patients with a solid tumour, and patients without cancer.

Patients with a haematological cancer were defined by using the following three criteria: (i) patients referred from the haematological ward, (ii) patients with a haematological malignancy (e.g. Leukaemia or Lymphoma) as admission diagnosis, or (iii) patients with ‘haematological malignancy’ as comorbidity.

Patients with a solid tumour were defined by using the following three criteria: (i) patients referred from the oncology ward, (ii) patients with a solid malignancy as admission diagnosis, or (iii) patients with a comorbid condition ‘metastasized neoplasm’.

The ICU patients without cancer were all patients not included in the cohorts mentioned above.

All patients with a planned ICU admission (i.e. elective admissions) were excluded. Patients who underwent elective surgery and who subsequently had an unplanned admission to the ICU due to complications (e.g. after major bleeding during surgery) were included in this study.

Baseline characteristics and ICU admission characteristics

Baseline characteristics and ICU admission characteristics were included. A complete list of the characteristics and definitions can be found in Supplementary Material Table 1.

Primary and secondary outcomes

The primary outcome was 1-year mortality. Secondary outcomes were ICU and hospital mortality.

Ethics

The local Medical Ethical Committee (Erasmus MC, MEC-2019-0779) approved this study. No additional patient consent was required due to the retrospective, non-invasive nature of the study. The data were already stored at the NICE registry in a pseudonymized way and the analyses were performed on an encrypted dataset. All procedures are in line with the General Data Protection Regulation (GDPR, May 2018) and law and regulations of the Netherlands.

Statistical analysis

Baseline and ICU admission characteristics of the study population were reported as count (percentage) for categorical variables or as mean (standard deviation) for continuous variables. Differences between the three cohorts were analysed using the Chi-square test for categorical variables and the Wilcoxon test for continuous variables.

The 1-year mortality rates will be reported as count and percentages for the three cohorts separately, differences were calculated with the Chi-square test. We analysed the 1-year mortality trend over the inclusion period by using a mixed-effects Cox proportional hazard model with calendar year 2008–2017 as independent variable. The models were adjusted for APACHE IV mortality probability. We also included a random intercept for hospital in these models. Hazard Ratios (HR) and 95% Confidence Intervals (95% CI) were estimated. A post-estimation Wald test was performed in order to examine whether there were statistically significant differences in 1-year mortality over the inclusion period. However, this test does not provide any information on the course of the trend. Therefore, we performed a visual inspection of the graphs to determine whether the trend was increasing, decreasing or varying. Moreover, when using a post-estimation Wald test, statistically significant differences / p-values refer to sample variation. Since

we included all patients with an unplanned ICU admission to the Dutch ICUs during the study period, we did not use a sample. The post-estimation Wald test is therefore subordinate to the visual inspection.

The secondary outcomes ICU and hospital mortality were analysed by using a mixed-effects binary logistic regression analysis with calendar year (2008–2017) as independent variable. These models were adjusted for APACHE IV mortality probability as well. We also included a random intercept for hospital in these models. Odds Ratios (OR) and 95% CI were estimated. A post-estimation Wald test was performed in order to examine whether there were statistically significant differences in both ICU and hospital mortality over the inclusion period. For the reasons mentioned above, we performed a visual inspection of the graphs to determine the trend. All analyses were performed using R-studio 3.6.1. A p-value of < 0.05 was considered statistically significant.

Results

Baseline and ICU admission characteristics

During the study period, 470,305 patients were admitted to the ICU unplanned, of which 10,401 (2.2%) patients with haematological cancer, 35,920 (7.6%) patients with a solid tumour, and 423,984 (90.2%) patients without cancer. In Supplementary Material Table 2, we provide an overview of percentage of missing values for all cohorts.

Baseline and ICU admission characteristics of the three cohorts are summarized in Table 1. All differences between the cohorts were statistically significant ($p < 0.05$). However, notable differences that may be relevant from a clinical perspective will be discussed next. Firstly, the APACHE IV score was significantly higher in patients with haematological cancer than in patients with a solid tumour and patients without cancer, while the APACHE IV score was comparable in the last two groups. (median 86 versus 59 and 57, respectively, $p < 0.01$). Secondly, within 24 hours of the ICU admission, 20.7% of the patients with haematological cancer showed acute kidney failure (AKI), versus 10.2% in patients with a solid malignancy, and 11.1% in patients without cancer. Thirdly, mechanical ventilation was used in 50.3% of the patients with haematological cancer, in 36.5% of the patients with a solid tumour, and in 45.4% of patients without cancer. Finally, vasoactive drugs were used in 47.2% in patients with haematological cancer, in 36.7% in patients with a solid tumour, and in 34.6% in patients without a malignancy.

Table 1
Baseline and ICU admission characteristics

	Haematological malignancy	Solid malignancy	Without malignancy
	(n = 10,401)	(n = 35,920)	(n = 423,984)
Age [a]	63.9 (13.9)	67.5 (12.0)	62.3 (17.3)
Gender (male)	6,495 (62.5%)	20,805 (57.9%)	238,323 (56.2%)
BMI [a]	25.2 (4.8)	25.8 (5.1)	26.4 (5.9)
APACHE IV score [a]	86 [68–109]	59 [43–81]	57 [38–81]
Comorbidity			
COPD & respiratory insufficiency	1,405 (13.9%)	5,687 (15.8%)	75,214 (17.7%)
Renal insufficiency & dialysis	858 (8.2%)	1,651 (4.6%)	27,699 (6.5%)
Liver cirrhosis	110 (1.1%)	337 (0.9%)	7,806 (1.8%)
Cardiovascular insufficiency	328 (3.2%)	1,050 (2.9%)	21,645 (5.1%)
Immunological insufficiency	6,210 (59.7%)	6,121 (17.0%)	23,621 (5.6%)
Type haematological malignancy			
Leukaemia	1,342 (12.9%)		
Hodgkin lymphoma	118 (1.1%)		
Non-Hodgkin lymphoma	813 (7.8%)		
Bone marrow transplant	57 (0.5%)		
Haematological malignancy, not specified	8,071 (77.6%)		
Specification cohort 1			
Comorbidity: haematological malignancy	6,599 (63.4%)		
Referral specialism: hematology	284 (2.7%)		
Both comorbidity and referral specialism	802 (7.7%)		
APACHE IV diagnosis: haematological malignancy	2,330 (22.4%)		

	Haematological malignancy	Solid malignancy	Without malignancy
	(n = 10,401)	(n = 35,920)	(n = 423,984)
APACHE IV diagnosis: other	386 (3.7%)		

Table 1
(continued)

Type solid tumour			
Gastrointestinal malignancy		11,037 (30.7%)	
Pancreas malignancy		842 (2.3%)	
Renal/Urogenital malignancy		2,985 (8.3%)	
Neurological malignancy		2,144 (6.0%)	
Respiratory malignancy		4,696 (13.1%)	
Solid malignancy, not specified		14,216 (39.6%)	
Specification cohort 2			
Comorbidity: neoplasm		13,211 (36.8%)	
Referral specialism: oncology		183 (0.5%)	
Both comorbidity and referral specialism		344 (1.0%)	
APACHE IV diagnosis: solid malignancy		21,704 (60.4%)	
APACHE IV diagnosis: other		478 (1.3%)	
Admission reason			
Respiratory failure	1,038 (10.5%)	2,062 (9.8%)	33,287 (7.9%)
Sepsis	2,454 (24.9%)	3,484 (16.6%)	38,235 (9.0%)
Pneumonia	2,427 (24.6%)	2,323 (11.0%)	40,097 (9.5%)
Acute kidney injury/failure	163 (1.7%)	313 (1.5%)	4,408 (1.0%)
Complications of surgery	49 (0.5%)	730 (3.5%)	7,375 (1.7%)
Cardiac disease	582 (5.9%)	1,289 (6.1%)	36,370 (8.6%)
Cardiac arrest	351 (3.6%)	849 (4.0%)	27,074 (6.4%)
Neurological	465 (4.7%)	1,213 (5.8%)	38,350 (9.0%)
Medication related	17 (0.2%)	81 (0.4%)	15,493 (3.7%)
Gastro-intestinal	885 (9.0%)	4,388 (20.9%)	47,987 (11.3%)
Metabolic/endocrine	176 (1.8%)	578 (2.7%)	11,362 (2.8%)
Thromboembolism	146 (1.5%)	612 (2.9%)	11,548 (2.7%)
Other	1,111 (11.3%)	3,078 (14.6%)	111,798 (26.4%)

Table 1

(continued)

Admission type			
Medical	9,212 (88.7%)	13,540 (38.0%)	296997 (71.4%)
Emergency surgery	888 (8.6%)	7,435 (20.9%)	81295 (19.5%)
Elective surgery	280 (2.7%)	14,624 (41.1%)	37707 (9.1%)
Admitted from			
Emergency department	2,243 (21.9%)	4,286 (12.1%)	150,865 (36.6%)
Operation theatre	1,019 (10.0%)	19,353 (54.5%)	101,675 (24.6%)
Ward	6,101 (59.6%)	10,203 (28.7%)	122,253 (29.6%)
CCU/ICU	678 (6.6%)	950 (2.7%)	25,342 (6.1%)
Special/Medium Care	64 (0.6%)	299 (0.8%)	2,748 (0.7%)
Home	78 (0.8%)	191 (0.5%)	5,469 (1.3%)
Other	49 (0.5%)	231 (0.7%)	4,409 (1.1%)
Diagnoses at admission			
CPR	476 (4.6%)	1,130 (3.1%)	30,616 (7.2%)
Gastro-intestinal bleeding	365 (3.5%)	1,105 (3.1%)	12,960 (3.1%)
Cardiovascular	1,461 (14.1%)	3,290 (9.2%)	57,336 (13.5%)
Neurological	368 (3.5%)	1,950 (5.4%)	12,960 (3.1%)
Diabetes	1,318 (12.7%)	5,103 (14.2%)	68,826 (16.2%)
Diagnoses within 24h of ICU admission			
Acute renal failure	2,155 (20.7%)	3,663 (10.2%)	47,142 (11.1%)
Mechanical ventilation	5,236 (50.3%)	13,105 (36.5%)	19,2411 (45.4%)
Confirmed infection	4,116 (39.6%)	6,639 (18.5%)	83,919 (19.8%)
Vasoactive drugs	4,913 (47.2%)	13,186 (36.7%)	146,767 (34.6%)

a. Data are displayed as mean (standard deviation) for continuous and count (percentages) for categorical variables, all p-values were highly significant with a $p<0.01$.

Primary outcome

The 1-year mortality rates of patients with haematological cancer, a solid tumour, and without cancer were 60.1%, 46.2%, and 28.3%, respectively ($p < 0.01$, Table 2).

Table 2
Overview of mortality rates and ICU/Hospital length of stay

	Haematological malignancy	Solid malignancy	Without malignancy
	(n = 10,401)	(n = 35,920)	(n = 423,984)
ICU mortality	2,969 (28.6%)	4,890 (13.6%)	52,864 (12.5%)
Hospital mortality	3,724 (37.9%)	6,916 (20.0%)	65,026 (16.4%)
1-year mortality	5,916 (60.1%)	15,606 (46.2%)	111,328 (28.3%)
Mean ICU Length of stay (ICU LOS; days)	2.4 [0.9–6.2]	1.1 [0.8–2.9]	1.6 [0.7–3.8]
Mean Hospital Length of stay from admission ICU (days)	10.3 [4.3–20.5]	8.6 [4.4–15.4]	7.5 [3.2–15.4]

a. All p-values assessing statistical differences between cohorts were highly significant with a $p < 0.01$. These statistical tests do not take frailty of hospitals into account.

b. Patients who were lost to follow up are not included in this table.

Figure 1A presents the trends of 1-year mortality for the three cohorts over the inclusion period. The post-estimation Wald test showed no statistically significant differences in mortality over the inclusion period for haematological patients ($p = 0.58$). However, a visual inspection of the graph regarding the mortality over the inclusion period of these patients (Fig. 1A) showed a slight decrease over the inclusion period, with a clear decrease in 1-year mortality between 2008 and 2011, followed by stabilization from 2012 till 2017. We found a statistically significant difference of 1-year mortality over the inclusion period in patients with a solid malignancy ($p < 0.01$). However, a visual inspection showed a wide variety in 1-year mortality per year in patients with a solid tumour. Therefore, neither an increasing or decreasing trend was seen. We found a statistically significant difference of 1-year mortality over the inclusion period in patients without cancer ($p < 0.01$), a visual inspection of the graph confirmed this decreasing trend.

Secondary outcomes

The ICU mortality in haematological patients was 28.6%, in patients with a solid tumour 13.6%, and in patients without cancer 12.5% ($p < 0.01$, Table 2). Figure 1B presents the trends of ICU mortality for the three cohorts over the inclusion period. The post-estimation Wald test showed no statistically significant trend for patients with a solid malignancy ($p = 0.11$), while a signficantly decreasing trend is seen for patients with a haematological malignancy ($p < 0.01$) and patients without a malignancy ($p < 0.01$). A visual inspection showed a decreasing trend for all three cohorts.

The hospital mortality in haematological patients was 37.9%, in patients with a solid tumour 20.0%, and in patients without cancer 16.4%, ($p < 0.01$). Figure 1C presents the trends of hospital mortality for the

three cohorts over the inclusion period. The post-estimation Wald test shows statistically significant differences in hospital mortality over the inclusion period for all three cohorts ($p < 0.01$). A visual inspection confirmed a decreasing trend for all three cohorts.

Additional post-hoc observations

During the data analysis, we analyzed post-hoc three additional factors relevant for the interpretation of our results. First, when patients with cancer (either haematological or solid) survived the hospital admission, approximately one third died within the year following the ICU admission. In the patients without cancer, this number was considerably lower namely, around 12%.

Second, the APACHE IV mortality probability for each cohort over the inclusion period is presented in Fig. 2. The post-estimation Wald test shows statistically significant differences over the inclusion period for all three cohorts ($p < 0.01$). A visual inspection of the figure shows no major changes in illness severity at admission over the inclusion period for each cohort.

Third, the proportion of patients in the three cohorts was similar in each year during the inclusion period. Two to three percent of the patients have a haematological malignancy, 7–8% of the patients have a solid tumour, and around 90% have no cancer, which was comparable each year over the inclusion period. The results of this analysis are available in the Supplementary Material Table 3.

Discussion

We found significantly higher 1-year mortality rates in both cancer cohorts than in patients without cancer. A visual inspection showed a slight decrease in 1-year mortality in haematological patients, whereas neither an increasing or decreasing trend was observed in patients with solid cancer. We found a decrease in 1-year mortality rate in patients without cancer.

Literature regarding cancer patients in general showed a decrease in long-term mortality over the past decades (1, 4, 5). In our study, which included patients with an unplanned ICU admission, this trend was only observed in haematological patients and not in patients with a solid tumour. While no information on cancer treatment after ICU admission is available in the NICE register, it is tempting to speculate that the observed differences in 1-year mortality for haematological patients are secondary to novel and more efficient cancer treatments. The wide variety in types of solid malignancies and treatment options for those different malignancies might explain the absence of a decrease in 1-year mortality in patients with a solid tumour (19).

As noted before, large long-term mortality studies in cancer patients with an unplanned ICU admission are scarce and outdated (18–23). Potential differences in case-mix between our study and previous literature makes direct comparison difficult. For example, a large study performed in the United States with data from 2002–2011 (19) reported a decrease in 1-year mortality in patient with hematological cancer and solid cancers over time. However, in this study, both planned and unplanned ICU admissions were included. Other studies regarding long-term mortality do not describe a trend over time. For example,

Puxty et al. (18) compared mortality rates of surgical patients with and without cancer admitted to the ICU. The 1-year mortality was lower than in our study. A major difference compared to our study was that the majority of the patients had a planned ICU admission after surgery. A study from Belgium (20) showed comparable mortality for patients with haematological cancers to our study, while the 1-year mortality of patients with a solid tumour was lower than in our study. Again, the study of Oeyen et al. included both planned and unplanned ICU patients. Finally, the 1-year mortality of cancer patients in our study was lower than that of studies with smaller sample size from Spain, Austria and Switzerland (21–23). Apart from sample size, there is no evident difference in case-mix between our study and these studies, supporting an improvement in long-term survival in this population.

We found a decrease in hospital mortality over the inclusion period for all three cohorts. These results are in line with several other studies that showed a decreasing trend in hospital mortality of cancer patients (9, 14–19). Relevant to note is that when cancer patients (either haematological or solid) survived the hospital admission, approximately one third died within the year following the ICU admission. In patients without cancer, this number was considerably lower (around 12%). A large recent study (27) showed similar results. Among all diagnostic subgroups of the ICU population included in that study, patients with nonsurgical cancer had the lowest cumulative 1-year survival. We assume that a considerable part of the deaths within one year is directly or indirectly related to the underlying malignancy or its treatment.

A possible and not unlikely explanation for the decrease in hospital mortality and high 1-year mortality may be the physician's decision to discharge patients to a nursing home or hospice for the terminal phase, leading to a spurious reduction of mortality risk when using hospital death as outcome (28, 29). Unfortunately, we have no data available in the NICE register to support this hypothesis.

Two thirds of the patients who survive to hospital discharge is still alive 1 year after ICU admission. Earlier studies showed that severity of illness is more important than the underlying malignancy with regard to short-term mortality (9, 15, 18). Our study adds to the current literature that underlying cancer or its treatment is an important factor for long-term outcome in patients recovering from critical illness. However, ICU admissions of patients are often determined by short-term survival benefit, and not by long-term prognosis (30). In addition, physicians do not always communicate adequately about prognosis and benefits of treatments towards patients and relatives (31–33). Ideally, oncologists and haematologists discuss long-term outcomes after an ICU admission with patients and relatives well before an ICU admission, in order to manage expectations. All physicians should consider benefits and disadvantages of an ICU admission for each patient individually before ICU referral or admission.

A relevant observation was that haematological patients were more severely ill than the two other cohorts. These patients had a higher APACHE IV score, among other factors explained by a higher percentage of AKI, mechanical ventilation, and/or vasoactive drugs. As higher severity of illness scores influences short-term mortality (9, 15, 18), these factors are important for ICU physicians and may help physicians with treatment decisions and the management of expectations of patients and relatives.

Limitations

For interpreting the study results at least the following limitations should be considered. Firstly, since the NICE registry is originally a quality of ICU care registry in the Netherlands, not all clinically relevant factors for cancer patients are registered. For example, we were not able to include the exact type and stage of the malignancy, the continuation of cancer treatment, and the performance status prior to ICU admission.

Secondly, as with most studies regarding cancer patients with an ICU admission, the heterogeneity of the study is a limitation. We included a random intercept for hospital to correct for differences between hospitals. Further research should focus on various subgroups of this study in order to minimize heterogeneity. The actual numbers and proportions of cancer patients with an unplanned ICU admission were not different over the inclusion period. This suggests that at least the same number of cancer patients were admitted and no structural changes in admission decisions were made.

Recommendations and future research

Considering our results and limitations, critically ill cancer patients are still a vulnerable patient group. Because of the complexity of their condition and uncertain prognosis, care for critically ill cancer patients requires adequate interdisciplinary medical management (8, 34).

Linking the NICE data to the national cancer registry in the Netherlands may assist to enrich the data with clinically relevant factors, such as staging of cancer, treatment decisions, and type of malignancy. Such enrichment of the data may help to identify patients with a malignancy who benefit most from an ICU admission (6, 7). Due to the difference in case-mix in previous studies (e.g. planned vs. unplanned ICU admissions, surgical vs. non-surgical patients), direct comparison of mortality rates is difficult. For future research, it would be helpful to establish more uniform inclusion criteria to enable a viable comparison between countries.

Conclusion

The 1-year mortality in cancer patients with an unplanned ICU admission (either haematological or solid) was significantly higher than that of patients without cancer. A visual inspection showed a slight decrease in 1-year mortality in haematological patients, while the 1-year mortality in patients with a solid tumour varied per year. After hospital discharge, a considerable part of the patients with a malignancy died within 1 year. Physicians should discuss the long-term prognosis after an ICU admission with patients and relatives in order to manage treatments and expectations. Future research should focus on identifying cancer patients who will benefit from an ICU admission.

Abbreviations

ICU: Intensive Care Unit

National Intensive Care Evaluation (NICE)

Acute Physiology And Chronic Health Evaluation (APACHE)

Hazard Ratio (HR)

95% Confidence Intervals (95% CI)

Odds Ratio (OR)

Acute kidney failure (AKI)

Body Mass Index (BMI)

Chronic Obstructive Pulmonary Disease (COPD)

Coronary care unit (CCU)

Cardiopulmonary resuscitation (CPR)

Length of stay (LOS)

Declarations

Ethics approval and consent to participate

The Medical Ethics Review Committee of the Erasmus Medical Center (MERC Erasmus MC, registration number MEC-2019-0779) approved this study. No additional patient consent was required due to the retrospective, non-invasive nature of the study. The data were already stored at the NICE registry in a pseudonymized way and the analyses were performed on an encrypted dataset. All procedures are in line with the General Data Protection Regulation (GDPR, May 2018) and law and regulations of the Netherlands.

Consent for publication

Not applicable

Availability of data and materials

The data that support the findings of this study are available from National Intensive Care Evaluation register but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of National Intensive Care Evaluation register.

Competing interests

The authors declare that they have no competing interests.

Funding

Not applicable

Authors' contributions

EZ: conceptualization, design, interpretation of data, writing-original draft and writing- review and editing, FT: design, analysis and interpretation of data, and writing- review and editing. DB: interpretation of data, writing- review and editing, NK: design, analysis and interpretation of data, and writing- review and editing , JB: interpretation of data, and writing- review and editing EK: interpretation of data, and writing- review and editing, WR: conceptualization, design, analysis and interpretation of data, writing-original draft and writing- review and editing, JE: conceptualization, design, analysis and interpretation of data, writing-original draft and writing- review and editing. All authors read and approved the final manuscript.

Acknowledgements

Not applicable

Conflicts of Interest / Declaration of relevant financial ties

None.

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Figures

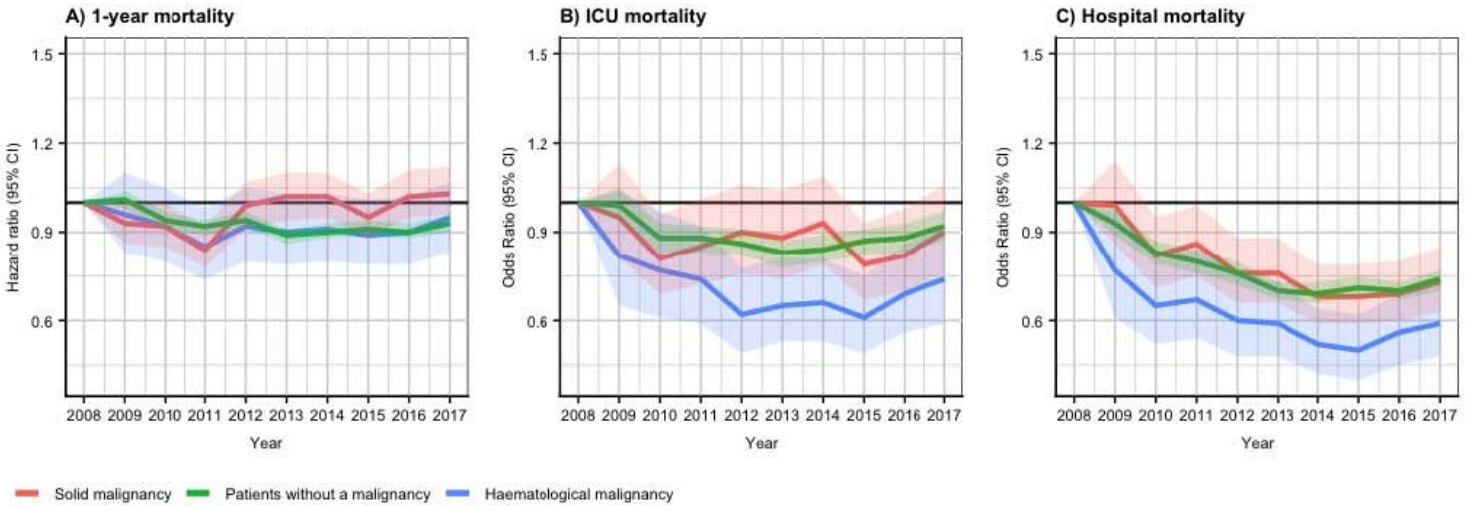
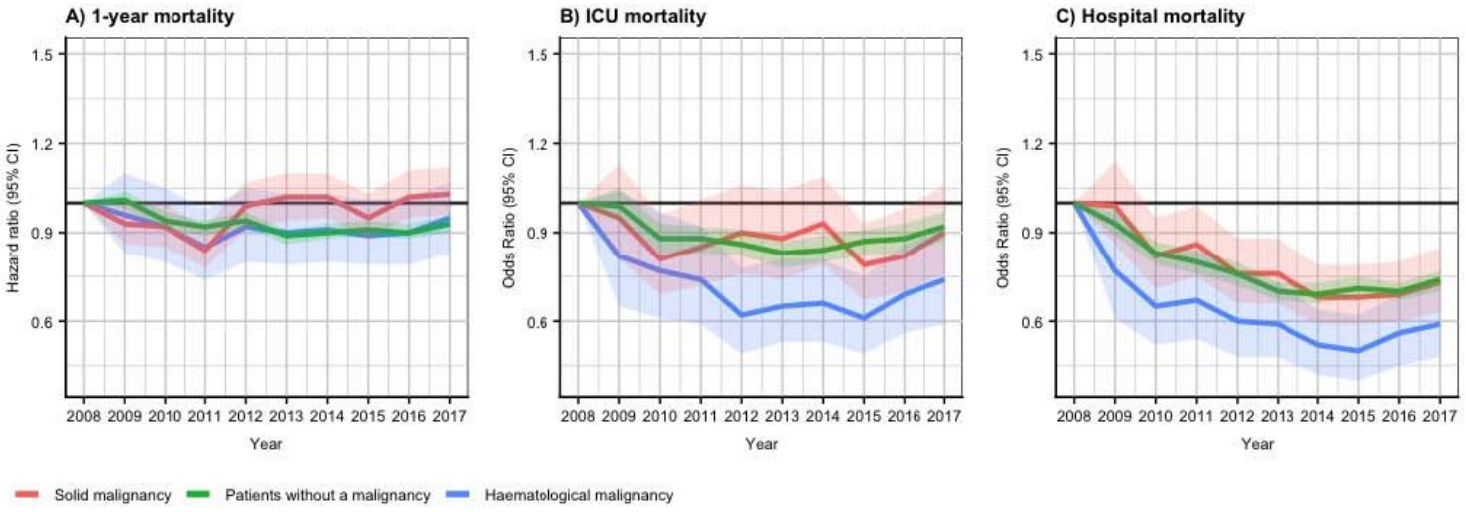


Figure 1

Mortality rates (1-year, ICU, and Hospital mortality) over the inclusion period for (A) 1-year, (B) ICU mortality, and (C) hospital mortality. Panel A shows the trend of Hazard Ratios for 1-year mortality over the inclusion period for the three cohorts (haematological patients, p=0.58; solid malignancy, p<0.01; patients without a malignancy, p<0.01). Panel B shows the trend of Odds Ratios for ICU mortality over the inclusion period for the three cohorts (haematological patients, p<0.01; solid malignancy, p=0.11; patients without a malignancy, p<0.01). Panel C shows the trend of Odds Ratios for hospital mortality over the inclusion period for the three cohorts (haematological patients, p<0.01; solid malignancy, p<0.01; patients without a malignancy, p<0.01). The actual hazard and odds ratios are available on request from the corresponding author.



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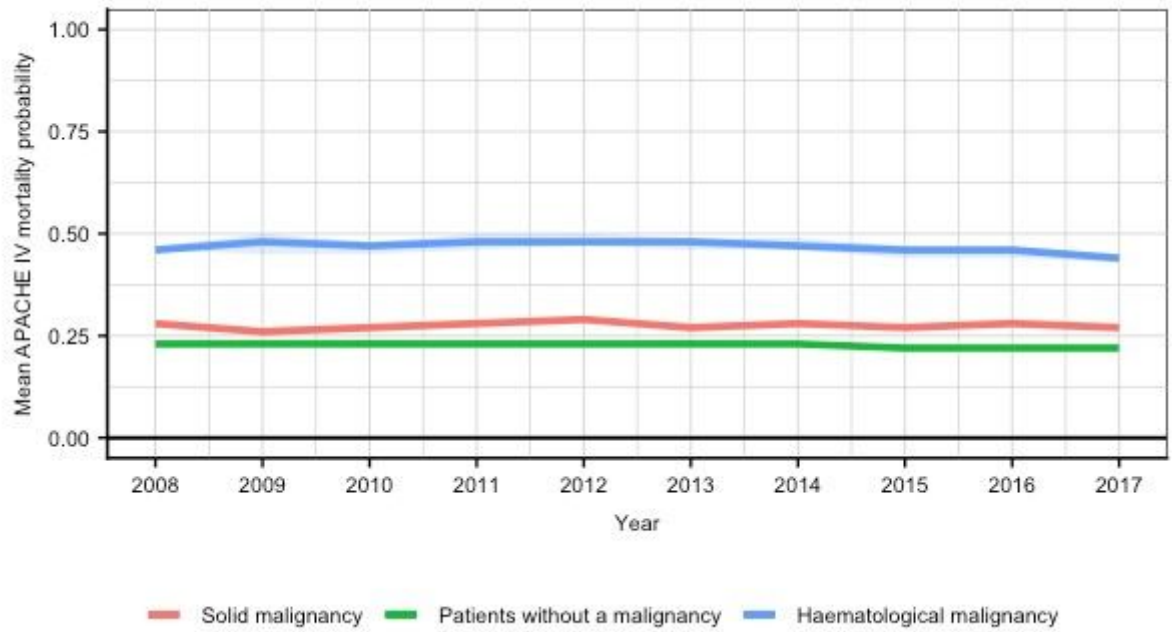

Figure 2

APACHE IV mortality probability over inclusion period for the three cohorts

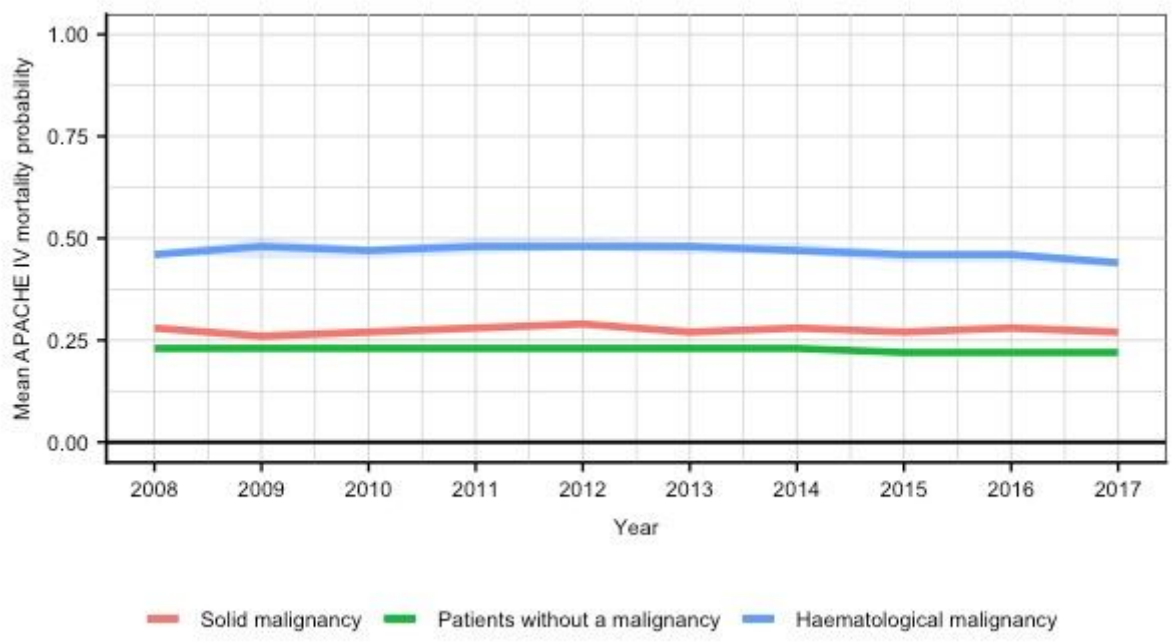

Figure 2

APACHE IV mortality probability over inclusion period for the three cohorts

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