Prof. Dr. rer. med. Karel Kostev
Dipl.-Inf. Oliver Laduch
Prof. Dr. med. Mark Lüdde MHBA

Hospital mortality in patients with heart failure in Germany - cross-sectional study

Heart failure (HF) is a chronic and life-threatening heart disease that occurs very frequently in older people. More than 64 million people worldwide are affected by this disease and the prevalence of HI is up to 3% (1). According to the German Heart Report, 439,000 people died from HI in Germany in 2021. This makes HI the sixth most common cause of death in Germany (2). HI is a multifactorial disease that can be attributed to several causes, including ischaemic heart disease (3), high blood pressure (4), valvular heart disease (5) and cardiomyopathies (6). Key findings in HI research include survival and mortality rates as a function of different forms of HI, comorbidities, geographic regions and treatments. In a prospective study conducted from 2011 to 2013 and including data from 21 European countries, the overall mortality rate for patients with HI was between 7% and 16% (7). In another prospective study, the 1-year mortality of patients with HI was between 6% and 9% (5). A number of studies have analysed hospital mortality in 'real world' populations of HI patients. Lombardi et al. reported an estimated hospital mortality of 8% at 30 days in acute HI patients in Italy (8), while the overall hospital mortality in acute HI patients in a study by de Matteis et al. was 13% (9). Buddeke et al. analysed the hospital mortality of HI patients in the Netherlands in 2000 and 2008 and showed a decrease in the mortality rate from 16% to 13% in men and from 16% to 14% in women (10).

>> Although there is already a lot of literature on this topic, some questions still need to be clarified: Firstly, most of the studies were conducted outside Germany, so their results may not be transferable to the German situation. Secondly, most of the studies on hospital mortality are from the distant past, so the mortality rates they report may not reflect current trends. Thirdly, the most recent studies in this field have analysed mortality rates in acute but not in HI patients. Fourth, there is still no scientific consensus on the impact of chronic comorbidities on patient mortality. In view of these limitations, it is clear that further data on hospital mortality and its influencing factors in Germany are needed.

The aim of this retrospective cross-sectional study was therefore to investigate the prevalence of HI in hospitalised patients and to identify factors associated with hospital mortality.

Methods

The multicentre cross-sectional study is based on hospital data from the company IQVIA, which at the time of the analyses contained the § 21 data sets of fourteen hospitals from all over Germany. The § 21 dataset comprises the patient information transmitted by the hospitals to the Institute for the Hospital Remuneration System (InEK) in a standardised data format in accordance with § 21 KHEntgG. The individual treatment cases contained in the § 21 dataset (e.g. case and patient number) are anonymised by IQVIA before transmission for data protection reasons.

The study included patients with a main diagnosis of HI (ICD10: I50) who were hospitalised between January 2019 and July 2023.

The aim of the study was to determine the prevalence of hospital mortality. The dataset includes death as one of the discharge types. The proportion of patients who died was analysed for the total population and for six age groups (≤70, 71-75, 76-80, 81-85, 86-90, >90 years), women, men and the most frequently documented types of heart failure including secondary heart failure (ICD (ICD-10: I50.01), left ventricular HI with symptoms during mild exercise (ICD-10: I51.13) and left ventricular HI with symptoms at rest (ICD10: I51.14).

Multivariate logistic regression analyses were performed to investigate the associations between demographic and clinical variables and hospital mortality. The models with mortality (yes, no) as the dependent variable included age groups, gender, type of heart failure and secondary diagnoses documented in at least 5% of the study population (diabetes mellitus, dyslipidemia, hypokalaemia, essential hypertension, hypertensive heart disease, chronic ischaemic heart disease, pulmonary heart disease (ICD-10: I27), non-rheumatic mitral valve disease, atrial fibrillation and flutter, renal insufficiency, obesity, pleural effusion, respiratory insufficiency and pneumonia).

P-values <0.05 were considered statistically significant. All analyses were performed with SAS 9.4 (SAS Institute, Cary, US).

Results

A total of 19,288 hospitalisations (15,431 patients) were included in the study. The average age was 79.4 years (SD: 10.8) and 49.9% of patients were female. The average length of hospitalisation was 10.5 days (SD: 8.6). Overall, 45.4% of patients were treated in the Department of Internal Medicine, 34.4% in Cardiology, 6.2% in Geriatrics, 5.9% in Pneumology and 8.2% in other departments. The most common HI diagnosis was secondary heart failure (45.0%), followed by left ventricular failure with symptoms at rest (25.8%) and left ventricular failure with symptoms during mild exercise (24.7%). The most common secondary diagnoses were atrial fibrillation and flutter (59.5%), essential hypertension (56.3%), renal failure (48.2%), diabetes mellitus (36.7%) and coronary artery disease (36.6%) (Table 1).

Figure 1 shows the proportion of patients who died. Of 19,288 inpatients, 1,868 (9.7%) were registered as deceased. The mortality rate rose sharply from 4.2% in the age group ≤65 years to 15.1% in the age group >90 years. The difference in mortality between women (10.0%) and men (9.5%) was small.

The application of a multivariate regression model showed that different variables were associated with hospital mortality. The age groups of 71-75 years (OR: 1.78; 95% CI: 1.32-2.38), 76-80 years (OR: 2.30; 95% CI: 1.76-2.99), 81-85 years (OR: 3.12; 95% CI: 2.44-4.00), 86-90 years (OR: 3.34; 95% CI: 2.60-4.30) and >90 years (OR: 3.90; 95% CI: 2.99-5.07) were associated with higher mortality than the age group ≤65 years. Compared to left ventricular HI with symptoms during mild exercise, both left ventricular HI with symptoms at rest (OR: 2.45; 95% CI: 2.06-2.90) and secondary heart failure (OR: 1.91; 95% CI: 1.61-2.26) were associated with an increased risk of death. Among the secondary diagnoses and complications, the strongest effect was seen for acute renal failure (OR: 4.53; 95% CI: 4.01-5.12), followed by respiratory insufficiency (OR: 3.17; 95% CI: 2.58-3.53), pneumonia (OR: 1.78; 95% CI: 1.58-2.00) and pleural effusion (OR: 1.40; 95% CI: 1.26-1.56). Paradoxically, in the multivariate regression analysis, several chronic cardiovascular and metabolic diseases - including hypertensive heart disease, essential hypertension, pulmonary heart disease, obesity, dyslipidemia and diabetes - were associated with a lower risk of death as secondary diagnoses (Table 2).

Characteristics of the study patients.

Variable	Hospitalisierungen (N=19,288)*
Durchschnittsalter (Standardabweichung)	79,4 (10,8)
≤ 65 Jahre	2.134 (11,1)
66–70 Jahre	1.373 (7,1)
71–75 Jahre	1.947 (10,1)
76–80 Jahre	3.020 (15,7)
81–85 Jahre	4.850 (25,2)
86–90 Jahre	3.735 (19,4)
>90 Jahre	2.169 (11,3)
Frauen	9.599 (49,9)
Männer	9.629 (50,1)
Klinikabteilung	
Innere Medizin	8.722 (45,4)
Kardiologie	6.613 (34,4)
Geriatrie	1.183 (6,2)
Pneumologie	1.131 (5,9)
Andere Abteilungen	1.579 (8,2)
Durschnittsdauer des Klinikaufenthaltes (Standardabweichung)	10,5 (8,6)
Sekundäre Rechtsherzinsuffizienz	8.643 (45,0)
Linksherzinsuffizienz mit Beschwerden bei leichterer Belastung	4.754 (24,7)
Linksherzinsuffizienz mit Beschwerden in Ruhe	4.968 (25,8)
Andere HI	863 (4,5)
Sekundärdiagnosen	
Diabetes mellitus	7.051 (36,7)
Adipositas	1.268 (6,6)
Störungen des Lipoproteinstoffwechsels	5.020 (26,1)
Essenzielle Hypertonie	10.827 (56,3)
Hypertensive Herzkrankheit	2.430 (12,6)
Chronische ischämische Herzkrankheit	7.046 (36,6)
Pulmonalklappenkrankheiten	2.345 (12,2)
Nichtrheumatische Mitralklappenkrankheiten	2.417 (12,6)
Vorhofflimmern und -flattern	11.431 (59,5)
Niereninsuffizienz	9.260 (48,2)
Akute Niereninsuffizienz	2.177 (11,3)
Chronische Insuffizienz	8.221 (42,8)
Pleuraerguss	6.728 (35,0)

Tab. 1: Characteristics of the study patients. *Unless otherwise stated, the figures are absolute numbers and percentages.

Discussion

Heart failure is a common and serious cardiovascular disease that remains a major public health problem. The key finding that the mortality rate is 9.7% (with a recognisable increase in older age groups) is consistent with previous publications reporting mortality rates between 8% and 14% (8-10). As with other diseases, mortality rates are generally higher in older HI patients than in younger patients (11, 12). For example, in the study by Teixeira et al., 30-day mortality increased from 8.1% in the <65 years age group to 16.3% in the 85-94 years age group (11).

Both chronic and acute renal failure occurred very frequently in the study patients. In our study, acute renal failure was strongly associated with increased hospital mortality in HI patients, which is consistent with other published studies. Chronic renal failure is considered the most important comorbidity in HI patients (4, 13, 14). A meta-analysis from 2022, based on 37 studies with more than 3.5 million HI patients, reported an incidence rate of acute renal failure of 24% to 35% in HI patients. Patients with HI and acute renal insufficiency had a higher hospital mortality rate than HI patients without acute renal insufficiency in the same meta-analysis (15). Specifically, patients with acute renal insufficiency had a 1.65-fold increased risk of hospital mortality compared to HI patients without acute renal insufficiency (16).

A second condition that is strongly associated with an increased risk of mortality is respiratory insufficiency, which represents a critical and complex interaction between the cardiovascular and respiratory systems in HI patients. The impaired pumping function of the heart in HI can lead to a cascade of events that affect the respiratory system. The failure of the heart can lead

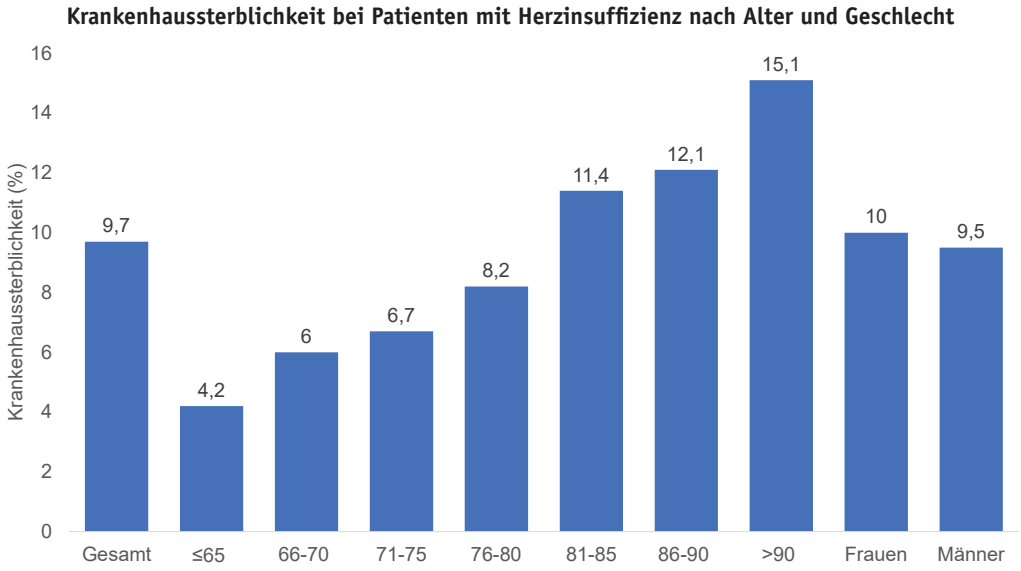


Abb. 1: *Krankenhaussterblichkeit bei Patienten mit Herzinsuffizienz nach Alter und Geschlecht.*

to pulmonary congestion, where fluid builds up in the lungs. This condition is known as pulmonary oedema and impairs the exchange of oxygen and carbon dioxide in the lungs, leading to breathing problems (17). As HI progresses, respiratory symptoms become more prominent. Patients may experience dyspnoea (shortness of breath), orthopnoea (difficulty breathing when lying down) and paroxysmal nocturnal dyspnoea (sudden episodes of severe shortness of breath during sleep). These symptoms are indicative of the challenge that heart failure poses to the respiratory system, especially when the patient is supine (18). Miller et al. studied HI patients with respiratory failure who required mechanical ventilation and reported that the use of mechanical ventilation was associated with increased 30-day mortality (OR: 10.40) (19).

In the present study, an association was found between pneumonia and an increased risk of death in HI patients. Pneumonia represents a significant and often life-threatening risk for older people, particularly those with underlying HI. The combination of advanced age, impaired cardiac function and respiratory problems can result in pneumonia having more serious consequences and leading to increased mortality (20). Pneumonia is characterised by inflammation and infection of the lung tissue, leading to symptoms such as cough, shortness of breath and fever. In the context of HI, these symptoms can exacerbate an existing respiratory disease and put additional strain on an already weakened cardiovascular system (20). The relationship between HI and pneumonia in the elderly is bidirectional. On the one hand, HI can increase the risk of pneumonia due to impaired lung function and weakened immunity. On the other hand, pneumonia may exacerbate HF by causing systemic inflammation, increasing cardiac workload and potentially leading to acute decompensation (21). Shen et al. investigated the impact of pneumonia on mortality in HI patients and found that a first pneumonia was associated with a fourfold increase in mortality (22).

Finally, we found a significant association between pleural effusion and mortality in HI patients. Pleural effusion is a common and significant complication in HI patients that can exacerbate HI symptoms such as shortness of breath and dyspnoea. The accumulated fluid in the pleural space puts additional pressure on the lungs and impairs their ability to fully expand. This in turn leads to impaired gas exchange and reduced oxygenation of the blood, further compromising the overall function of the cardiovascular system (23, 24).

The counterintuitive finding of this study is the negative association between codiagnoses (obesity, dyslipidemia and hypertension) and mortality in HI patients. Contrary to conventional expectations, our studies show that HI patients with codiagnoses, especially obesity, dyslipidemia and hypertension, have lower mortality than patients without these diagnoses. Bozkurt et al. have already discussed some such paradoxes in their research on heart failure. For example, they mentioned that higher blood pressure and cholesterol levels may be associated with a better prognosis in HI patients and that obesity is not a risk factor for an unfavourable outcome in HI patients (25). In the prospective study of 9,134 HI patients by Chioncel et al., low systolic blood pressure and low body mass index were independently associated with higher mortality in HI patients (5).

To unravel the mystery behind the lower mortality rates we observed, possible mechanisms that could explain the protective effect of codiagnosis in HI need to be explored. Another hypothesis is that individuals with these comorbidities may receive more intensive medical care, leading to better management and early interventions.

Strengths and limitations

The strengths of our study are the sample size, the use of data from 14 hospitals in different federal states, the documentation of HI subdiagnoses and comorbidities, and the availability of mortality data. However, the present study also has some limitations that should be taken into account. Firstly, the diagnoses and codiagnoses were based exclusively on the ICD-10 classification. The availability of further information on symptoms (e.g. duration and severity) would have allowed for more detailed analyses. Secondly, no data on ejection fraction were available, which meant that stratification into HI patients with preserved or reduced ejection fraction was not possible. Thirdly, no data was available on socioeconomic status and lifestyle variables such as smoking status and physical mobility. Fourthly, no information on medication was

Association between demographic and clinical variables and hospital mortality in patients hospitalized for heart failure			
Variable	**Sterblichkeit im Krankenhaus (%)**	**Odds Ratio (95% Konfidenz-intervalle)**	**P-Wert**
Alter: ≤ 65 Jahre	4,2	Referenz	
Alter: 66–70 Jahre	6,0	1,39 (1,01–1,92)	0,046
Alter: 71–75 Jahre	6,7	1,78 (1,32–2,38)	<0,001
Alter: 76–80 Jahre	8,2	2,30 (1,76–2,99)	<0,001
Alter: 81–85 Jahre	11,4	3,12 (2,44–4,00)	<0,001
Alter: 86–90 Jahre	12,1	3,34 (2,60–4,30)	<0,001
Alter: >90 Jahre	15,1	3,90 (2,99–5,07)	<0,001
Frauen	10,0	Referenz	
Männer	9,5	1,07 (0,96–1,20)	0,204
Sekundäre Rechtsherzinsuffizienz	10,2	1,91 (1,61–2,26)	<0,001
Linksherzinsuffizienz mit Beschwerden bei leichterer Belastung	4,3	Referenz	
Linksherzinsuffizienz mit Beschwerden in Ruhe	14,9	2,45 (2,06–2,90)	<0,001
Diabetes mellitus	8,9	0,85 (0,76–0,96)	0,006
Adipositas	5,7	0,68 (0,52–0,88)	<0,001
Störungen des Lipoproteinstoffwechsels	5,6	0,58 (0,51–0,68)	<0,001
Essenzielle Hypertonie	7,9	0,56 (0,50–0,62)	<0,001
Hypertensive Herzkrankheit	5,7	0,42 (0,34–0,50)	<0,001
Pulmonalklappenkrankheiten	8,4	0,72 (0,61–0,85)	<0,001
Akute Niereninsuffizienz	28,5	4,53 (4,01–5,12)	<0,001
Chronische Niereninsuffizienz	9,9	0,85 (0,76–0,94)	0,002
Pneumonie	19,7	1,78 (1,58–2,00)	<0,001
Pleuraerguss	13,1	1,40 (1,26–1,56)	<0,001
Respiratorische Insuffizienz	19,9	3,17 (2,58–3,53)	<0,001

Fig. 2: *Association between demographic and clinical variables and hospital mortality in patients hospitalized for heart failure (multivariate logistic regression).*

available to analyse the effects of different drugs on mortality. Fifthly, due to the fact that the data set only contains information from hospitals, the study results cannot be extrapolated to the outpatient population. <<

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Authors' declaration

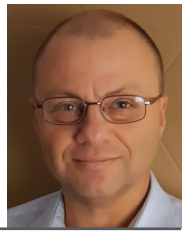
The authors declare that there are no conflicts of interest.

Citation

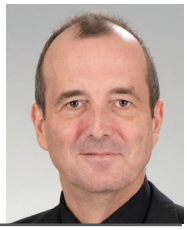
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Prof. Dr. rer. med. Karel Kostev ORCID: 0000-0002-2124-7227
ist Senior Scientific Principal bei IQVIA in Frankfurt. Er hat Soziologie und Statistik studiert, in Medizin promoviert und habilitiert. Er lehrt epidemiologische und medizinische Fächer an der Universität Marburg. Sein Arbeitsschwerpunkt ist die Versorgungsforschung im Bereich der chronischen Erkrankungen.

Kontakt: Karel.Kostev@iqvia.com



Dipl.-Inf. Oliver Laduch ORCID: 0009-0007-4311-7435
ist selbstständiger IT-Consultant in Essen. Er hat Wirtschaftsinformatik an der Bundeswehr-Hochschule in München studiert. Er unterstützt Unternehmen und Experten bei der Verarbeitung von Daten im Big-Data-Umfeld. Sein Schwerpunkt ist die Analyse und Auswertung von medizinischen Daten.
Kontakt: Oliver.Laduch@infocon-laduch.gmbh



Prof. Dr. med. Mark Lüdde MHBA ORCID: 0000-0002-8149-8087
hat Humanmedizin an der Medizinischen Hochschule Hannover studiert. Nach der Facharztausbildung am Universitätsklinikum Heidelberg und weiterer Station am Universitätsklinikum Schleswig-Holstein, Campus Kiel, wo er auch für das Fach Innere Medizin habilitierte, arbeitet er nun im Cardiologicum Bremerhaven und in der Medizinischen Klinik I des Universitätsklinikums Gießens. Besonders interessiert er sich für die Herzinsuffizienz und Komorbiditäten. Kontakt: Mark.Luedde@web.de

