Journal of Diabetes and Its Complications 29 (2015) 1130–1135

Contents lists available at ScienceDirect

Journal of Diabetes and Its Complications

journal homepage: WWW.JDCJOURNAL.COM

Impact of diabetes mellitus and its complications: survival and quality-of-life in critically ill patients

Katharina Bannier [a], Michael Lichtenauer [b], Marcus Franz [a], Michael Fritzenwanger [a], Bjoern Kabisch [a], Hans-Reiner Figulla [a], Ruediger Pfeifer [a], Christian Jung [a,*]

[a] Friedrich-Schiller-University, Clinic of Internal Medicine I, Jena, Germany
[b] University Clinic of Internal Medicine II, Paracelsus Medical University, Salzburg, Austria

ARTICLE INFO

Article history:
Received 15 January 2015
Received in revised form 12 August 2015
Accepted 13 August 2015
Available online 15 August 2015

Keywords:
Critically ill
Intensive care
Diabetes mellitus
Follow-up
Quality of life

ABSTRACT

Purpose: Diabetes mellitus represents an increasing problem for patients and health care systems worldwide. We sought to investigate the effect of diabetes and its associated comorbidities on long-term survival and quality of life following an admission to a medical intensive care unit (ICU).
Methods: A total of 6662 consecutive patients admitted to ICU between 2004 and 2009 were included (patients with diabetes n = 796, non-diabetic patients n = 5866). The primary endpoint of the study was death of any cause. Data on mortality was collected upon review of medical records or phone interviews. Moreover, a questionnaire was sent to 500 randomly selected patients addressing Health related Quality of Life (HrQoL) after ICU treatment.
Results: Overall mortality did not differ significantly between diabetic and non-diabetic patients after ICU treatment (mean follow-up time: 490 days). For a subgroup of patients already exhibiting comorbidities associated with diabetes, the mortality rate was significantly higher ($p = 0.022$). Regarding quality of life, no differences were found between groups.
Conclusions: Diabetes was not associated with increased mortality or reduced quality of life in a general population of medical ICU patients. However, once comorbidities associated with diabetes occurred, the survival rate of patients with comorbidities associated with hyperglycemia was significantly reduced.

1. Introduction

The incidence of Diabetes mellitus (DM) worldwide was about 6,4% (285 million people) in 2010 and it is supposed that it will increase to 7.7% in 2030 (Shaw, Sicree, & Zimmet, 2010). Because of this projected rise, it would be of interest to evaluate the impact of diabetes on survival and Health related Quality of Life (HrQoL).

Diabetes is associated with a number of challenges. The disease has a great influence on the patient's daily life, their relatives, nurses and physicians. Moreover, the treatment of a diabetic patient is much more expensive than a non-diabetic patient (Kolu, Raitanen, Rissanen, & Luoto, 2012). The costs of treatment of diabetes and its complications continued to rise over the last years (Lesniowska, Schubert, Wojna, Skrzekowska-Baran, & Fedyna, 2014). Furthermore, comorbidities like hypertension, depression, peripheral artery occlusive disease, retinopathy, polyneuropathy and chronic heart and kidney disease occur more frequently in patients with diabetes (Barnett et al., 2012; Druss et al., 2001; Jung et al., 2009; Schneider, O'Donnell, & Dean, 2009). Recent results showed that the prevalence of comorbidities in diabetic patients is remarkably high. Magnan *et al.* reported a comorbidity rate of up to 92% in a collective of 23.340 diabetic patients (Magnan et al., 2015).

The treatment of these comorbidities is essential for the patients' HrQoL. Studies have shown that HrQoL of patients with diabetes is not automatically worse than that of non-diabetic patients: the control of risk factors, especially vascular diseases, influences the HrQoL score (Fujita et al., 2012; Morgan et al., 2006; Oliva, Fernandez-Bolanos, & Hidalgo, 2012). In addition to the previously named problems, therapy and outcome of diabetic patients treated at an intensive care unit (ICU) is a further major challenge. Ways to measure the outcome are first, mortality and second, HrQoL. Although in a general population overall mortality of diabetic patients at an ICU seems to be similar to patients without diabetes (Vincent, Preiser, Sprung, Moreno, & Sakr, 2010), some studies showed it is higher when associated with other diagnoses like myocardial infarction (Norhammar, Lindback, Ryden, Wallentin, & Stenestrand, 2007). Contrary to mortality, the HrQoL of diabetic patients after admission from ICU is not so well documented and discussed in the literature. Most studies evaluating the

Conflict of interests: None.

* Corresponding author at: Clinic of Internal Medicine I, Friedrich-Schiller-University, Erlanger Allee 101, D – 07747 Jena, Germany. Tel.: +49 3641 9324559; fax: +49 3641 9324102.
E-mail address: christian.jung@med.uni-jena.de (C. Jung).

http://dx.doi.org/10.1016/j.jdiacomp.2015.08.010
1056-8727/

survival of general ICU patients have not yet put a special emphasis on diabetes. Even though HrQoL after hospitalization at the ICU seems to re-improve over time, it remains lower in comparison to a control group of subjects who were not treated at an ICU (Oeyen, Vandijck, Benoit, Annemans, & Decruyenaere, 2010). Even after discharge from ICU, HrQoL remains worse than before hospital admission, however, with time it begins to re-improve again (Fildissis et al., 2007). In contrast to HrQoL, anxiety and depression caused by staying at an ICU does not improve and a minority of patients still experiences a psychological impairment (Eddleston, White, & Guthrie, 2000; Larsson, Wallin, Rubertsson, & Kristofferzon, 2014).

The aim of the current study was to investigate the influence of diabetes mellitus and associated comorbidities on long-term survival and HrQoL following an admission to a large medical ICU.

2. Methods

2.1. Study subjects

6662 consecutive patients admitted to our tertiary medical university hospital Intensive Care Unit between January 2004 and December 2009 were included in this registry. The study sample was divided into two subgroups: diabetic (n = 796) and non-diabetic (n = 5866) subjects. Patients were assigned to the diabetic group either if patients were currently taking anti-diabetic medication (oral anti-diabetic drugs or insulin) or the diagnosis was documented in the patient's records (i.e. dietary treatment of diabetes). Furthermore, patients were sub-classified according existing comorbidities associated with diabetes mellitus according to our hospital records using the classifications made according to ICD-10 codes. Hypertension (I10), diabetic retinopathy (E11.3), neuropathy (E11.4), peripheral artery disease (I73.9), coronary artery disease (I25.1), diabetic nephropathy (E11.2), Stroke (I63) and diabetic foot syndrome (E11.62) were graded as comorbidities associated with associated with diabetes.

Follow-up of patients was performed retrospectively between May 2013 and November 2013. The primary endpoint of the study was all cause mortality. Mean follow-up time was 490 days. Data on mortality was collected upon review of medical records or phone interviews. Letters of contact, which included information about the study, an invitation to participate, informed consent, questions about mortality and HrQoL were sent to 500 randomly selected patients in May 2013 (between 4 and 9 years after patients were discharged from our ICU). The study was approved by the local ethics committee of the Medical Faculty of the Friedrich Schiller University of Jena.

To measure the HrQoL, we used the EQ-5D-5L questionnaire form. It is a viable instrument in many different medical areas because it contains questions about a patients' perceived physical and mental health, mobility, self-care, usual activities, pain/discomfort, anxiety/depression and a visual analogue scale from 0 to 100 to rate the general health. Every item has five levels from the best (=1) to the worst (=5) state. An important advantage of EQ-5D-5L is its easy manageability and comprehensibility for patients, especially those who are handicapped. On the other hand, the main drawback is its superficiality by which all etiologies of current health are measured and not only those that we wanted to evaluate. Moreover, due to the concept of our study, EQ-5D-5L cannot be used to differentiate between health outcomes in different groups. Nevertheless, EQ-5D-5L was used because of its effectiveness concerning the rating on HrQoL (Fujita et al., 2012; Janssen et al., 2013).

2.2. Statistical analysis

Continuous variables are expressed as mean ± standard deviation for normally distributed data. Differences between independent groups were calculated using Student's t-test. Non-normally distributed continuous variables are expressed as medians (interquartile range) and compared with Mann-Whitney-U test. Categorical data are expressed as numbers (percentage) and chi-square test was applied to calculate differences between groups. Survival rates were estimated using the Kaplan–Meier method, and log-rank test was applied to test for statistical significance. All statistical analyses were performed using SPSS version 21.0 (IBM, USA).

3. Results

3.1. Study population

Baseline characteristics of the study population are presented in Tables 1 and 2. Table 1 summarizes characteristics of patients with (n = 796) or without diabetes (n = 5866) who were admitted to the ICU of our hospital. Diabetic patients presented with higher age, body weight ($p < 0.001$) and BMI ($p < 0.001$). Reasons for ICU admission differed between groups for gastrointestinal bleeding, decompensated heart failure and acute myocardial infarction. Bleeding disorders showed a higher predominance in non-diabetic patients whereas diabetic patients showed higher rates of heart failure and myocardial infarction. Moreover, patients suffering from diabetes showed a lower hemoglobin concentration compared to non-diabetic controls ($p < 0.001$).

Table 1
Patient characteristics of the patient population.

	All (n = 6662)	No diabetes (n = 5866)	Diabetes (n = 796)	Comparison diabetes versus no diabetes
Age (years)	64.2 ± 15.5	63.4 ± 15.9	70.4 ± 10.4	P < 0.001
Sex, male (%)	60.9	61.0	60.5	n.s.
Weight (kg)	79.1 ± 17.8	78.3 ± 17.5	83.8 ± 19.0	P < 0.001
BMI (kg/m^2)	27.2 ± 5.3	27.0 ± 5.2	29.0 ± 5.9	P < 0.001
Reason for ICU admission n (%)				
Gastrointestinal bleeding	279 (4.2)	258 (4.4)	21 (2.6)	P = 0.025
Heart rhythm disorders	374 (5.6)	326 (5.6)	48 (6.0)	n.s.
Decompensated heart failure	470 (7.0)	390 (6.7)	80 (10.0)	P = 0.001
Pulmonary embolism	136 (2.0)	128 (2.1)	8 (1.0)	P = 0.03
Acute myocardial infarction	1886 (28.3)	1631 (27.8)	255 (32.0)	P < 0.001
Pneumonia	207 (3.1)	190 (3.2)	17 (2.1)	n.s.
Sepsis	461 (6.9)	406 (6.9)	55 (6.9)	n.s.
Cardiopulmonary resuscitation	339 (5.1)	297 (5.1)	42 (5.2)	n.s.
Clinical characteristics at admission				
Hemoglobin (mmol/l)	7.1 ± 1.3	7.1 ± 1.2	6.9 ± 1.2	P < 0.001
WBC (×10^6/µl)	11.3 ± 9.7	11.3 ± 9.2	11.4 ± 12.1	n.s.
Serum lactate	1.9 ± 2.6	1.8 ± 2.2	1.9 ± 4.1	n.s.
Heart rate (bpm)	84 ± 18	84 ± 18	84 ± 20	n.s.