In-hospital Hyperglycemia is Associated with Worse Outcomes in Patients Admitted with COVID-19

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OBJECTIVE:

Diabetes and outpatient diabetes treatment regimen have been identified as risk factors for poor outcome in patients with sepsis. However, little is known about the effect of a tight inpatient glycemic control in the setting of COVID-19. Therefore, we examined the effect of hyperglycemia in diabetic subjects hospitalized because of COVID-19.

RESEARCH DESIGN AND METHODS:

We analyzed data from 1,938 diabetic COVID-19 patients hospitalized from March to May 2020 at a large academic medical center in New York City. Patients were divided into two groups based on their inpatient glycemic values and a Cox proportional hazards regression model was used to assess the independent association of inpatient glucose levels with mortality (primary outcome) and the risk of requiring mechanical ventilation (MV, secondary outcome).

RESULTS:

In our analysis, 32% of the patients were normoglycemic and 68% hyperglycemic. Moreover, 31% of the study subjects died during hospitalization and 14% required MV, with inpatient hyperglycemia being significantly associated with both mortality and the requirement for MV. Additionally, in the Cox regression analysis, after adjustment for potential confounders including age, gender, race, BMI, HbA$_{1C}$, comorbidities, inflammatory markers, and corticosteroid therapy, patients with uncontrolled hyperglycemia had a higher risk of dying (hazard ratio [HR] 1.54, 95% confidence interval [CI] 1-2.36, P = 0.049) and of requiring MV (HR 4.41, 95% CI 1.52-2.81, P = 0.006) than those with normoglycemia.

CONCLUSIONS:

A tight control of inpatient hyperglycemia may be an effective method for improving outcomes in diabetic patients with COVID-19.

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VARIABLE	Total (n = 1,938)	Normoglycemic [glucose ≤ 180 mg/dl] (n = 622)	Hyperglycemic [glucose ≥ 180 mg/dl] (n = 1,316)	P for trend
Demographic characteristics				
Age (years)	68.08 ± 13.7	67.27 ± 14.71	68.46 ± 13.18	0.09
Gender				
Male	963 (49.69)	291 (46.78)	672 (51.06)	
Female	975 (50.31)	331 (53.22)	644 (48.94)	0.08
Race				
White	195 (18.77)	76 (21.47)	119 (17.37)	
Black	789 (75.94)	266 (75.14)	523 (76.35)	
Other	55 (5.29)	12 (3.39)	43 (6.28)	0.06
Ethnicity				
Spanish/Hispanic/Latino	691 (39.64)	207 (36.77)	484 (41.02)	
Not Spanish/Hispanic/Latino	1,052 (60.36)	356 (63.23)	696 (58.98)	0.09
Insurance				
Medicaid	827 (42.78)	260 (41.80)	260 (41.80)	
Medicare	915 (47.34)	290 (46.62)	625 (47.67)	
Commercial	191 (9.88)	72 (11.58)	119 (9.08)	0.23
Clinical characteristics and laboratory parameters				
BMI (Kg/m^2)	29.92 ± 7.25	30.48 ± 0.3	29.65 ± 0.2	0.02
HbA$_{1c}$ (%)	7.26 ± 1.95	6.05 ± 0.76	7.85 ± 2.07	<0.001
CRP (mg/L)	10.9 (4.9, 19.2)	7.6 (3.7, 14.7)	12.7 (5.8, 21)	<0.001
D-dimer (µg/ml)	1,74 (0.89, 3.34)	1,31 (0.7, 2.5)	1,74 (1.01, 3.62)	<0.001
Comorbidities				
Hypertension				
No	318 (16.41)	122 (19.61)	196 (14.89)	
Yes	1,620 (83.59)	500 (80.39)	1,120 (85.11)	0.009
Previous Stroke				
No	1,355 (79.19)	429 (80.94)	926 (78.41)	
Yes	356 (20.81)	101 (19.06)	255 (21.59)	0.23
Coronary artery disease				
No	1,206 (62.23)	416 (66.88)	790 (60.03)	
Yes	732 (37.77)	206 (33.12)	526 (39.97)	0.004
Peripheral artery disease				
No	1,757 (90.66)	594 (95.50)	1,163 (88.37)	
Yes	181 (9.34)	28 (4.50)	153 (11.63)	<0.001
Chronic kidney disease				
No	1,305 (67.34)	452 (72.67)	853 (64.82)	
Yes	633 (32.66)	170 (27.33)	463 (35.18)	<0.001

Table 1: Characteristics of study participants: total and stratified by inpatient glycemic values. Lab results represent those obtained on admission to the hospital. Data presented as median (IQR: 25th percentile, 75th percentile) for non-normally distributed continuous variables and as mean ± standard deviation for continuous variables normally distributed; n (%) reported for categorical variables. HbA$_{1c}$: most recent glycated hemoglobin: CRP: C-Reactive Protein.

Figure 1: Primary (A) and secondary (B) outcomes by inpatient glycemic values in diabetic patients hospitalized with COVID-19. *** P < 0.001.

	HR	95% CI Lower	95% CI Upper	P for trend
Hyperglycemia	1.54	1.00	2.36	0.049
Age	1.03	0.97	1.02	1.05
Gender	0.95	0.69	1.31	0.77
Race	0.83	0.63	1.09	0.17
BMI	0.98	0.001	0.95	1.02
HbA$_{1C}$	0.97	0.38	1.04	0.786
Hypertension	0.7	0.37	1.34	0.28
Chronic kidney disease	1.23	0.93	1.62	0.14
Chronic obstructive pulmonary disease	1.54	1.08	2.19	0.02
CRP	1.03	1.01	1.04	0.001
D-dimer	0.99	0.96	1.03	0.66
Corticosteroid therapy	1.2	0.89	1.61	0.23

Table 2: Cox proportional hazards model assessing the effect of inpatient hyperglycemia on mortality adjusting for potential confounders. HbA$_{1c}$: most recent glycated hemoglobin; CRP: C-Reactive Protein.

	HR	95% CI Lower	95% CI Upper	P for trend
Hyperglycemia	4.41	1.52	2.81	0.006
Age	0.99	0.97	1.01	0.238
Gender	1.54	0.94	2.53	0.09
Race	0.77	0.50	1.16	0.21
BMI	0.94	0.89	1	0.04
HbA$_{1C}$	1.00	0.89	1.12	0.21
Hypertension	0.71	0.25	1.97	0.51
Chronic kidney disease	1.25	0.81	1.93	0.31
Chronic obstructive pulmonary disease	1.55	0.86	2.79	0.15
CRP	1.03	1.01	1.04	0.001
D-dimer	0.98	0.93	1.04	0.46
Corticosteroid therapy	1.71	1.06	2.78	0.03

Table 3: Cox proportional hazards model assessing the effect of inpatient hyperglycemia on mechanical ventilation adjusting for potential confounders. HbA$_{1c}$: most recent glycated 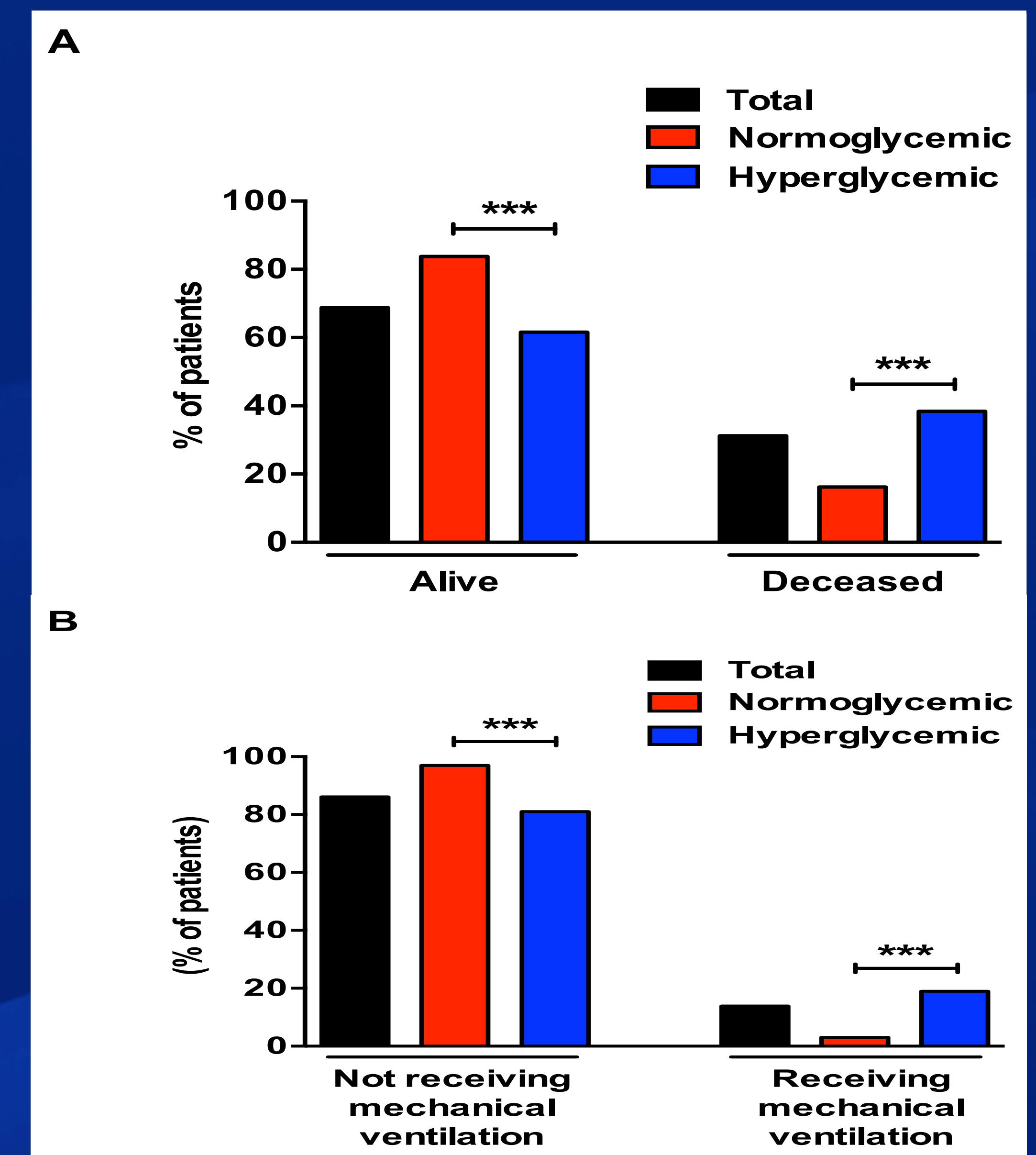hemoglobin; CRP: C-Reactive Protein.