Effect of hyperdynamic LVEF on ICU outcomes

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Abstract

Objective To study the effect of hyperdynamic left ventricular function on ICU outcomes.

Keywords: Intensive Care Unit, Hyperdynamic

1. Background

In a recent meta-analysis review by Huang et al. (2013) [**?**] the authors attemped to answer the question whether ventricular depression or dilation is associated with lower mortality rates. A total of 62 studies were reviewed and 14 included in the analysis. The meta-analysis failed to find any evidence to support the view that the survivors from severe sepsis or septic shock had lower ejection fractions. This study aims to further explore this research question using the MIMIC-II clinical database from the Beth Israel Deaconness Medical Center in Boston, MA [**?**].

2. Methods

We conducted a retrospective cohort study using the Multiparameter Intelligent Monitoring in Intensive Care II (MIMIC II) database. MIMIC II is a large open-access database, which includes data from electronic medical records of patients admitted to the ICUs at Beth Israel Deaconess Medical Center since 2001. The creation and use of the MIMIC database was approved by the institutional review boards of both Beth Israel Deaconess Medical Center and Massachusetts Institute of Technology (IRB protocol 2001-P-001699/3).

All adult patient records who underwent an echocardiograph in the database were screened for purposes of inclusion. Patients were excluded if their left-ventricular function was suppresed The cohort characteristics used in this study is shown in Figure 2. The study outcome was 28-day mortality among the entire patient cohort.

All statistical analysis was performed using R. Baseline comparisons were performed using Fisher tests for categorical variables with results reported as numbers and percentages. Continuously normally distributed variables were compared using t-tests and reported as median, while non-normally distributed

data were compared using Mann-Whitney tests and reported as medians and interquartile range (IQR).

3. Results

Table **??** highlights the results of the univariate analysis for all patients with hyperdynamic EF. Table **??** highlights the results of the univariate analysis for all patients with acute hyperdynamic EF. Significant values ($P < 0.05$) are shown in bold. Hyperdynamic patients are more likely to be female, be admitted to MICU, SICU and ventilated. Hyperdynamic patients also have higher risk of mortality, SOFA and SAPSI scores and stay longer in ICU. Table **??** looks at potential confounders for the cohort: hyperdynamic patients are more liekly to have congestive heart failure, hypertension and cancer.

Table **??** highlights the results of the univariate analysis for all septic patients. Significant values ($P < 0.05$) are shown in bold. Hyperdynamic septic patients have a higher 28-day and ICU/hospital mortality are more likely to be administered more fluids. The confounder analysis in Table **??** is inconclusive.

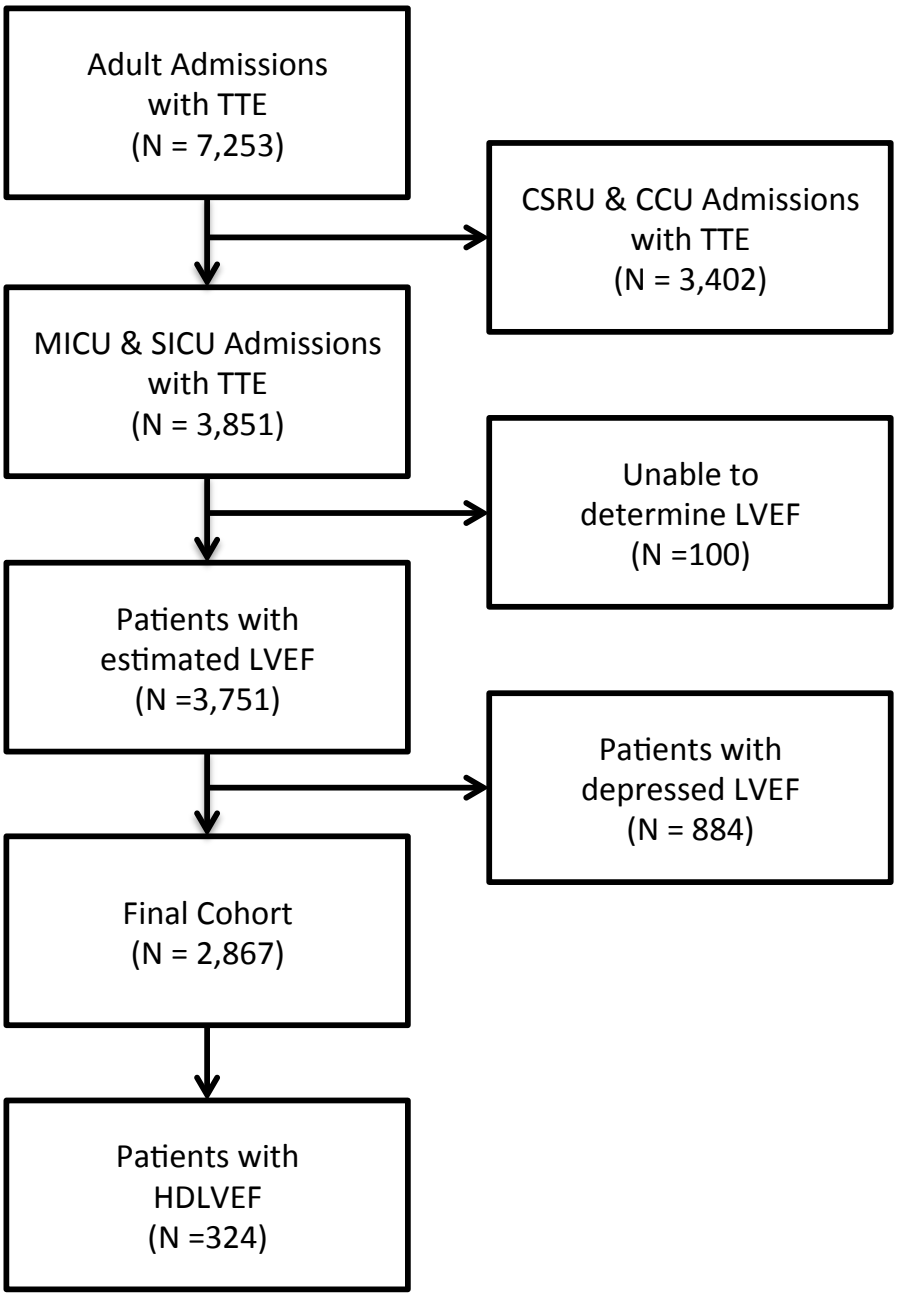

Figure 1: Patient record selection. Using the MIMIC II database we identified 2,481 patients that had a echo report.

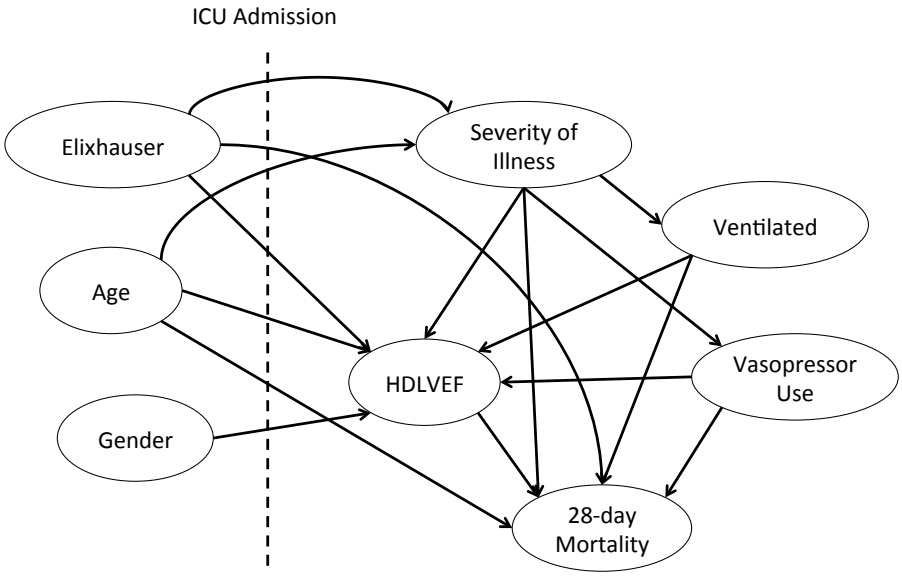

Figure 2: Direct Acylic Graph showing confounding factors.

	NLVEF (N=3527)	**HDLVEF** (N=324)	*P*-value
	N (%) or median [IQR]		
Age	67 [53 - 79]	69 [56 - 78]	0.6
Gender (Male)	1833 (52 %)	134 (41 %)	< **0.01**
Care Unit			0.9
MICU	2416 (69 %)	221 (68 %)	
SICU	1111 (31 %)	103 (32 %)	
Time to echo (days)	1.1 [0.1 - 3.2]	0.9 [0.0 - 4.2]	0.5
Time to vasopressors (days)	0.1 [0.0 - 0.4]	0.1 [0.0 - 0.7]	0.5
Co-morbidities by ICD9 & DRG Codes			
Diabetes	860 (24 %)	89 (27 %)	0.2
Alcohol abuse	193 (5 %)	19 (6 %)	0.7
Arrhythmias	1039 (29 %)	82 (25 %)	0.1
Valvular disease	418 (12 %)	38 (12 %)	1.0
Hypertension	1126 (32 %)	134 (41 %)	< **0.01**
Renal failure	342 (10 %)	29 (9 %)	0.8
Chronic pulmonary	754 (21 %)	68 (21 %)	0.9
Liver disease	255 (7 %)	32 (10 %)	0.1
Cancer	170 (5 %)	28 (9 %)	< **0.01**
Psychosis	142 (4 %)	15 (5 %)	0.6
Depression	177 (5 %)	12 (4 %)	0.3
CHF	1363 (39 %)	127 (39 %)	0.9
Illness			
SOFA	6 [3 - 9]	7 [4 - 10]	< **0.01**
Septic	1496 (42 %)	150 (46 %)	0.2
Vital Signs			
Max HR (bpm)	113 [98 - 130]	120 [102 - 139]	< **0.01**
Median HR Day1 (bpm)	87 [75 - 99]	90 [79 - 105]	< **0.01**
Min MAP	56 [48 - 64]	52 [44 - 62]	< **0.01**
Max Temperature (C)	37.8 [37.3 - 38.5]	37.9 [37.3 - 38.4]	0.4
Lab Results			
Max WBC	13.3 [9.6 - 18.4]	14.6 [10.2 - 20.5]	0.01
Max lactate	2.2 [1.5 - 3.8]	2.6 [1.6 - 4.8]	< **0.01**
Max creatinine	1.1 [0.8 - 2.0]	1.2 [0.8 - 2.0]	0.5
Treatments			
Vasopressor	1121 (32 %)	131 (40 %)	< **0.01**
Received Dobutamine	92 (9 %)	13 (11 %)	0.5
RRT	414 (12 %)	50 (16 %)	0.05
Ventilated	1767 (51 %)	195 (62 %)	< **0.01**
IVF first 24hr (ml)	2240 [682 - 5142]	2500 [771 - 5702]	0.2
IVF first 72hr (ml)	7339 [3620 - 12582]	8949 [5108 - 14585]	< **0.01**

Table 1: Characteristics of normal versus all HDLVEF patients

	TTE (N=2867)	**No TTE** (N=11707)	*P*-value
	N (%) or median [IQR]		
Age	65 [51 - 78]	61 [45 - 77]	< **0.01**
Gender (Male)	1380 (48 %)	6277 (54 %)	< **0.01**
Care Unit			< **0.01**
MICU	1941 (68 %)	6420 (55 %)	
SICU	926 (32 %)	5287 (45 %)	
Time to vasopressors (days)	0.1 [0.0 - 0.5]	0.1 [0.0 - 0.4]	0.01
Co-morbidities by ICD9 & DRG Codes			
Diabetes	679 (24 %)	2264 (19 %)	< **0.01**
Alcohol abuse	172 (6 %)	1010 (9 %)	< **0.01**
Arrhythmias	782 (27 %)	1911 (16 %)	< **0.01**
Valvular disease	293 (10 %)	655 (6 %)	< **0.01**
Hypertension	986 (34 %)	3944 (34 %)	0.5
Renal failure	242 (8 %)	535 (5 %)	< **0.01**
Chronic pulmonary	604 (21 %)	1854 (16 %)	< **0.01**
Liver disease	231 (8 %)	779 (7 %)	< **0.01**
Cancer	148 (5 %)	775 (7 %)	< **0.01**
Psychosis	132 (5 %)	559 (5 %)	0.7
Depression	160 (6 %)	782 (7 %)	0.03
CHF	968 (34 %)	1716 (15 %)	< **0.01**
Illness			
SOFA	6 [3 - 9]	4 [1 - 7]	< **0.01**
Septic	1175 (41 %)	2265 (19 %)	< **0.01**
Vital Signs			
Max HR (bpm)	114 [99 - 131]	107 [94 - 122]	< **0.01**
Min MAP	56 [47 - 64]	60 [51 - 68]	< **0.01**
Max Temperature (C)	37.8 [37.3 - 38.5]	37.6 [37.2 - 38.2]	< **0.01**
Lab Results			
Max WBC	13.4 [9.5 - 18.6]	12.1 [8.8 - 16.3]	< **0.01**
Max lactate	2.2 [1.5 - 3.8]	2.1 [1.4 - 3.6]	0.1
Max creatinine	1.1 [0.8 - 1.8]	0.9 [0.7 - 1.3]	< **0.01**
Treatments			
Vasopressor	866 (30 %)	1806 (15 %)	< **0.01**
RRT	338 (12 %)	481 (4 %)	< **0.01**
Ventilated	1496 (52 %)	4665 (40 %)	< **0.01**
IVF first 24hr (ml)	2250 [687 - 5377]	2355 [790 - 5000]	0.8
IVF first 72hr (ml)	7591 [3736 - 13000]	5701 [2594 - 10153]	< **0.01**
Mortality			
ICU Stay	304 (11 %)	924 (8 %)	< **0.01**
Hospital Stay	501 (17 %)	1354 (12 %)	< **0.01**
28-days	536 (19 %)	1768 (15 %)	< **0.01**
1-year	1045 (36 %)	2719 (23 %)	< **0.01**

Table 2: Characteristics of patients who did and did not receive an transthorasic echocardiograph (TTE)

	Odds-ratio (95% Confidence Interval)	P-value
Age	1.011 (1.007,1.015)	**<0.001**
Gender (Male)	1.007 (0.845,1.202)	0.9
Elixhauser Score	1.065 (1.050,1.080)	**<0.001**
SOFA	1.075 (1.045,1.106)	**<0.001**
Ventilated	1.370 (1.093,1.719)	**0.006**
Max Vasopressor Dose	1.639 (1.380,1.950)	**<0.001**
Median HR Day1	1.005 (0.999,1.010)	0.1
HDLVEF	1.213 (0.902,1.617)	0.2

Table 3: Multivariate logistic regression model predicting 28-day mortality for all patients with max vasopressor dose

	Odds-ratio (95% Confidence Interval)	P-value
Age	1.010 (1.006,1.014)	**<0.001**
Gender (Male)	1.006 (0.850,1.192)	0.9
Elixhauser Score	1.062 (1.048,1.077)	**<0.001**
SOFA	1.113 (1.082,1.144)	**<0.001**
Ventilated	1.300 (1.048,1.613)	**0.02**
Vasopressor Use	1.267 (1.029,1.559)	**0.03**
HDLVEF	1.245 (0.938,1.639)	0.1

Table 4: Multivariate logistic regression model predicting 28-day mortality for all patients with vasopressor use

	Odds-ratio (95% Confidence Interval)	P-value
Age	1.010 (1.006,1.014)	**<0.001**
Gender (Male)	1.016 (0.857,1.204)	0.9
Elixhauser Score	1.063 (1.049,1.078)	**<0.001**
SOFA	1.091 (1.060,1.122)	**<0.001**
Ventilated	1.337 (1.077,1.660)	**0.009**
Vasopressors No.	1.310 (1.167,1.471)	**<0.001**
HDLVEF	1.247 (0.939,1.644)	0.1

Table 5: Multivariate logistic regression model predicting 28-day mortality for all patients with number of vasopessors

	Odds-ratio (95% Confidence Interval)	*P*-value
Age	1.010 (1.007,1.014)	<**0.001**
Gender (Male)	1.013 (0.854,1.200)	0.9
Elixhauser Score	1.063 (1.049,1.078)	<**0.001**
SOFA	1.099 (1.069,1.131)	<**0.001**
Ventilated	1.340 (1.079,1.666)	**0.008**
Vasopressor Duration	1.006 (1.003,1.010)	<**0.001**
HDLVEF	1.259 (0.949,1.659)	0.1

Table 6: Multivariate logistic regression model predicting 28-day mortality for all patients with vasopressor duration

	Hazard ratio (95% Confidence Interval)	**P-value**
Age	1.0060 (1.0040,1.0080)	<**0.001**
Gender (Male)	1.0410 (0.9675,1.1202)	0.3
Elixhauser Score	1.0359 (1.0283,1.0435)	<**0.001**
SOFA	1.0239 (1.0106,1.0373)	<**0.001**
Ventilated	0.9350 (0.8523,1.0258)	0.2
Max Adjusted Vasopressor Dose	0.9943 (0.8926,1.1075)	0.9
HDLVEF	1.0681 (0.9321,1.2240)	0.3

Table 7: Multivariate Cox Hazard model predicting one-year mortality for all 28-day survivors