

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 attempted 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 Deaconess 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 suppressed. 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

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

29 **3. Results**

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

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

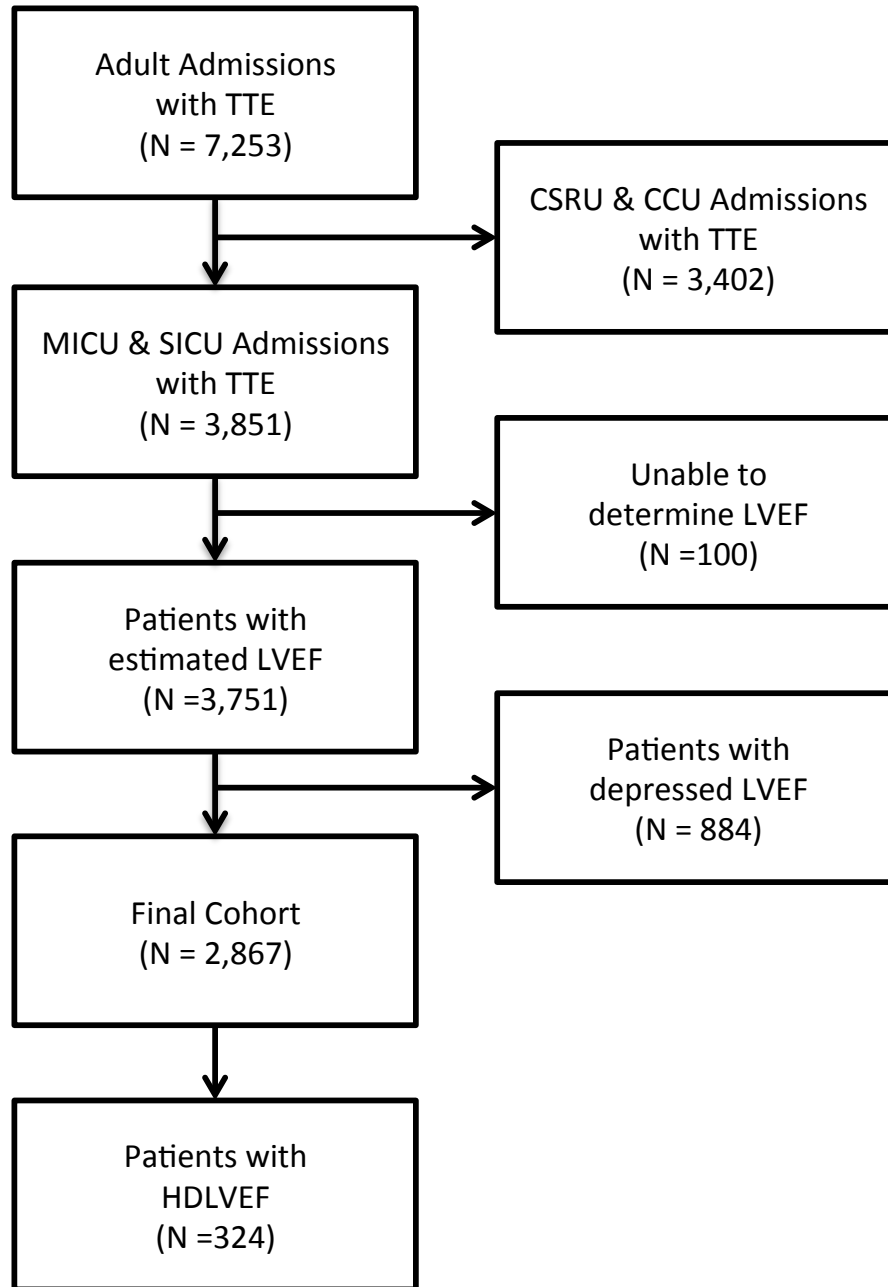


Figure 1: Patient record selection. Using the MIMIC II database we identified 2,481 patients that had a echo report.

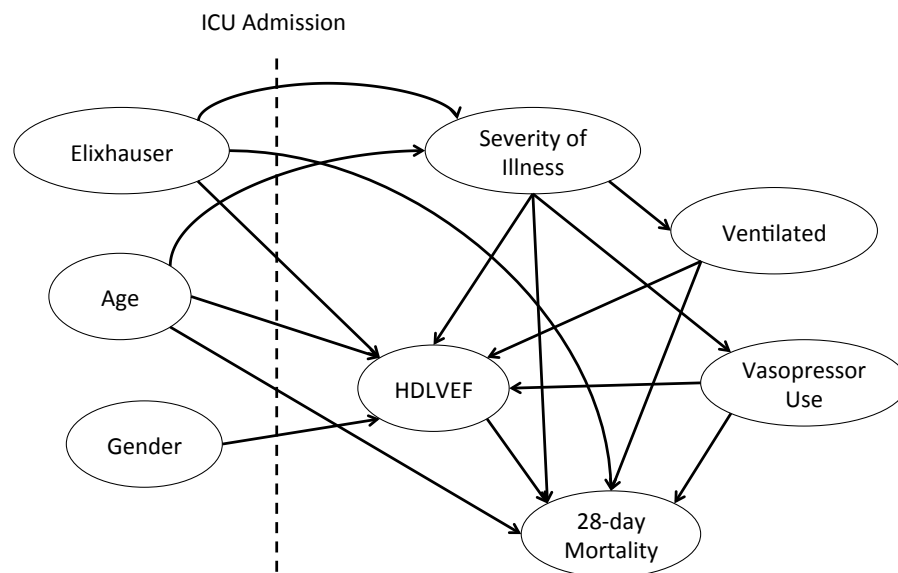


Figure 2: Direct Acyclic Graph showing confounding factors.

	NLVEF (N=2543)	HDLVEF (N=324)	<i>P</i> -value
	N (%) or median [IQR]		
Age	65 [51 - 78]	69 [56 - 78]	0.03
Gender (Male)	1246 (49 %)	134 (41 %)	< 0.01
Care Unit			0.9
MICU	1720 (68 %)	221 (68 %)	
SICU	823 (32 %)	103 (32 %)	
Time to echo (days)	1.1 [0.1 - 3.3]	0.9 [0.0 - 4.2]	0.4
Time to vasopressors (days)	0.1 [0.0 - 0.5]	0.1 [0.0 - 0.7]	1.0
Co-morbidities by ICD9 & DRG Codes			
Diabetes	590 (23 %)	89 (27 %)	0.1
Alcohol abuse	153 (6 %)	19 (6 %)	1.0
Arrhythmias	700 (28 %)	82 (25 %)	0.4
Valvular disease	255 (10 %)	38 (12 %)	0.3
Hypertension	852 (34 %)	134 (41 %)	< 0.01
Renal failure	213 (8 %)	29 (9 %)	0.7
Chronic pulmonary	536 (21 %)	68 (21 %)	1.0
Liver disease	199 (8 %)	32 (10 %)	0.2
Cancer	120 (5 %)	28 (9 %)	< 0.01
Psychosis	117 (5 %)	15 (5 %)	1.0
Depression	148 (6 %)	12 (4 %)	0.1
CHF	841 (33 %)	127 (39 %)	0.03
Illness			
SOFA	6 [3 - 9]	7 [4 - 10]	< 0.01
Septic	1025 (40 %)	150 (46 %)	0.04
Vital Signs			
Max HR (bpm)	113 [98 - 130]	120 [103 - 139]	< 0.01
Min MAP	56 [48 - 64]	52 [43 - 62]	< 0.01
Max Temperature (C)	37.8 [37.3 - 38.5]	37.9 [37.4 - 38.5]	0.6
Lab Results			
Max WBC	13.3 [9.4 - 18.3]	14.6 [10.2 - 20.5]	< 0.01
Max lactate	2.1 [1.4 - 3.7]	2.6 [1.6 - 4.8]	< 0.01
Max creatinine	1.1 [0.8 - 1.8]	1.2 [0.8 - 2.0]	0.04
Treatments			
Vasopressor	741 (29 %)	125 (39 %)	< 0.01
RRT	288 (11 %)	50 (15 %)	0.04
Ventilated	1298 (51 %)	198 (61 %)	< 0.01
IVF first 24hr (ml)	2214 [674 - 5248]	2500 [771 - 5702]	0.2
IVF first 72hr (ml)	7393 [3683 - 12799]	8949 [5108 - 14585]	< 0.01

Table 1: Characteristics of normal versus all HDLVEF patients

	TTE (N=2867) N (%) or median [IQR]	No TTE (N=11707) N (%) or median [IQR]	<i>P</i> -value
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)	<i>P</i> -value
Age	1.011 (1.007,1.016)	< 0.001
Gender (Male)	0.997 (0.811,1.226)	1.0
Elixhauser Score	1.054 (1.037,1.072)	< 0.001
SOFA	1.101 (1.066,1.137)	< 0.001
Ventilated	1.232 (0.946,1.605)	0.1
Max Vasopressor Dose	1.676 (1.363,2.067)	< 0.001
HDLVEF	1.371 (1.023,1.823)	0.03

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

	Odds-ratio (95% Confidence Interval)	<i>P</i> -value
Age	1.011 (1.007,1.016)	< 0.001
Gender (Male)	0.972 (0.792,1.192)	0.8
Elixhauser Score	1.054 (1.037,1.071)	< 0.001
SOFA	1.128 (1.091,1.166)	< 0.001
Ventilated	1.177 (0.906,1.530)	0.2
Vasopressor Use	1.210 (0.943,1.549)	0.1
HDLVEF	1.389 (1.039,1.842)	0.02

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

	Odds-ratio (95% Confidence Interval)	<i>P</i> -value
Age	1.011 (1.006,1.016)	< 0.001
Gender (Male)	0.977 (0.796,1.200)	0.8
Elixhauser Score	1.054 (1.038,1.072)	< 0.001
SOFA	1.103 (1.067,1.141)	< 0.001
Ventilated	1.217 (0.936,1.584)	0.1
Vasopressors No.	1.323 (1.149,1.522)	< 0.001
HDLVEF	1.379 (1.031,1.832)	0.03

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

	Odds-ratio (95% Confidence Interval)	<i>P</i> -value
Age	1.011 (1.007,1.016)	< 0.001
Gender (Male)	0.973 (0.793,1.195)	0.8
Elixhauser Score	1.054 (1.037,1.071)	< 0.001
SOFA	1.113 (1.076,1.151)	< 0.001
Ventilated	1.218 (0.935,1.586)	0.1
Vasopressor Duration	1.006 (1.002,1.010)	0.003
HDLVEF	1.393 (1.042,1.848)	0.02

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

	Hazard ratio (95% Confidence Interval)	P-value
Age	1.0068 (1.0044,1.0091)	<0.001
Gender (Male)	1.0396 (0.9558,1.1307)	0.4
Elixhauser Score	1.0347 (1.0260,1.0434)	<0.001
SOFA	1.0209 (1.0059,1.0361)	0.006
Ventilated	0.9457 (0.8502,1.0520)	0.3
Max Adjusted Vasopressor Dose	1.0029 (0.8813,1.1412)	1.0
HDLVEF	1.0939 (0.9525,1.2563)	0.2

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