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) [1] 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].

2. Materials and Methods

The cohort used in this study is shown in Figure 1. The consisted of all adults admitted to the ICU with echo reports. A subset anlysis considers the patients who satisfy for the Angus crietria [3]. All statistical analysis was performed using Matlab version 2013a (Mathworks). Baseline comparisons were performed using chi^2 tests for equal proportion with results reported as numbers, percentages, and 95% confidence intervals. Continuously normally distributed variables were compared using t-tests and reported as means with 95% confidence intervals, while non-normally distributed data were compared using Wilcoxon rank sum tests and reported as medians and interquartile range (IQR).

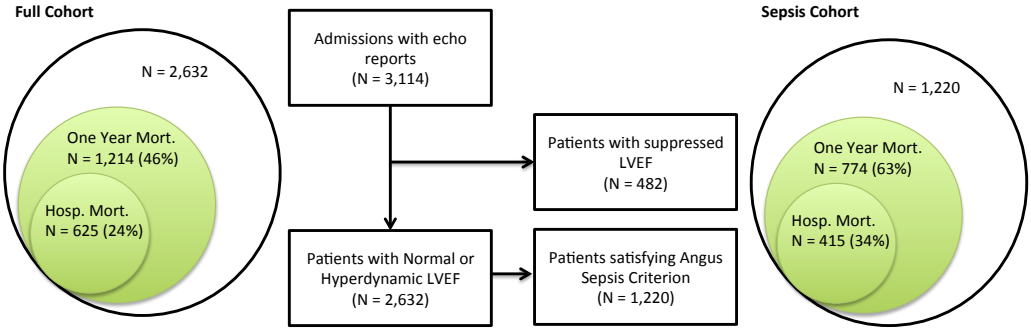

Figure 1: Patient record selection. Using the MIMIC II database we identified 2,632 patients that had a echo report.

3. Results

Table 1 highlights the results of the univariate analysis for all patients with echo reports. 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 3 looks at potential confounders for the cohort: hyperdynamic patients are more liekly to have congestive heart failure, hypertension and cancer.

Table 11 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 12 is inconclusive.

References

[1] S. J. Huang, M. Nalos, A. S. McLean, Is early ventricular dysfunction or dilatation associated with lower mortality rate in adult severe sepsis and septic shock? a meta-analysis, Critical Care 17 (2013) R96.

[2] M. Saeed, M. Villarroel, A. T. Reisner, G. Clifford, L. Lehman, G. M. ody, T. Heldt, T. H. Kyaw, B. Moody, R. G. Mark, Multiparameter intelligent monitoring in intensive care II (MIMIC-II): A public-access intensive care unit database, Crit Care Med 39 (2011) 952–960.

Table 1: Proportional characteristics of all patients (n = 2632).

	Normal (n=2373 , 90%)		Hyperdynamic (n=259, 10%)		P value
Male	1159	(49)	98	(38)	$<$ **0.001**
Service type:					
MICU	1234	(52)	138	(53)	0.695
CCU	364	(15)	28	(11)	0.052
SICU	572	(24)	69	(27)	0.367
CSRU	188	(8)	23	(9)	0.590
Primary outcomes:					
Twenty-eight day mortality	458	(19)	79	(31)	$<$ **0.001**
One-year mortality	892	(38)	129	(50)	$<$ **0.001**
ICU Mortality	296	(12)	60	(23)	$<$ **0.001**
Hospital Mortality	433	(18)	80	(31)	$<$ **0.001**
Treatments:					
RRT	363	(15)	55	(21)	**0.013**
Vasopressor	1063	(45)	139	(54)	**0.006**
Ventilated	1453	(61)	186	(72)	$<$ **0.001**

[3] D. C. Angus, W. T. Linde-Zwirble, J. Lidicker, G. Clermont, J. Carcillo, M. R. Pinsky, Epidemiology of severe sepsis in the united states: analysis of incidence, outcome, and associated costs of care, Critical care medicine 29 (2001) 1303–1310.

Table 2: Continuous characteristics of all patients (n = 2632).

	Normal (n=2373, 90%)		Hyperdynamic (n=259, 10%)		P value
Age	65.2	(26.4-91.5)	69.0	(29.2-92.3)	**0.046**
Secondary outcomes:					
ICU Length of Stay	5.0	(0.9-44.1)	6.1	(1.0-39.8)	**< 0.001**
Hosp. Length of Stay	12.0	(2.0-63.9)	15.0	(3.0-81.0)	**0.003**
SOFA Scores:					
First	6.0	(0.0-16.0)	8.0	(1.0-18.0)	**< 0.001**
Day 1	7.0	(1.0-16.0)	8.0	(1.0-16.2)	**0.003**
Day 2	7.0	(0.0-16.0)	8.0	(0.0-16.0)	**0.018**
Day 3	6.0	(0.0-16.0)	7.0	(1.0-18.0)	**0.012**
SAPS-I Scores:					
First	15.0	(5.0-26.0)	17.0	(7.0-28.5)	**< 0.001**
Day 1	16.0	(6.0-26.0)	17.0	(8.0-26.0)	**< 0.001**
Day 2	14.0	(6.0-23.0)	15.0	(6.0-24.2)	**0.008**
Day 3	13.0	(5.0-22.0)	15.0	(5.9-24.2)	**0.004**
Lab Tests (first 3 days):					
Max lactate	2.2	(0.8-12.8)	2.5	(0.8-15.5)	**0.017**
Max wbc	13.8	(4.4-38.3)	15.3	(5.4-49.9)	**< 0.001**
Max createnin	1.1	(0.4-8.3)	1.3	(0.4-8.8)	**0.031**
Avg lactate	1.8	(0.8-7.3)	1.8	(0.8-9.7)	0.067
Avg wbc	11.1	(3.6-27.7)	11.8	(4.2-34.1)	**0.005**
Avg createnin	1.0	(0.4-6.8)	1.1	(0.3-7.4)	0.102
Elixhauser Points:					
Twenty-eight day mortality	4.0	(-6.0-18.0)	5.0	(-5.2-21.2)	0.093
One-year mortality	4.0	(-3.0-18.0)	6.0	(-3.0-23.0)	**0.039**
Two-year mortality	11.0	(-5.0-41.0)	14.0	(-3.1-50.0)	**0.027**
Treatments (first 3 days):					
Fluids in	41625.8	(1118.1-208541.4)	51984.2	(3264.9-201147.0)	**< 0.001**
Fluids out	5950.5	(371.8-21210.7)	6562.5	(420.4-23471.4)	0.079
Max pressor dose	2.5	(0.1-43.9)	3.0	(0.0-80.8)	0.198
Max pressor duration	2640.0	(30.0-46173.8)	5040.0	(203.5-40469.0)	**0.002**

Table 3: ICD9 Group and Elixhauser comorbidities of all patients (n = 2632).

	Normal (n=2373 , 90%)		Hyperdynamic (n=259, 10%)		P value
ICD9 Group:					
Cardiovascular	736	(31)	73	(28)	0.349
Respiratory	362	(15)	39	(15)	0.933
Cancer	433	(18)	57	(22)	0.140
Endocrine metabolic	42	(2)	3	(1)	0.471
Gastrointestinal	212	(9)	33	(13)	**0.045**
Genitourinary	65	(3)	7	(3)	0.973
Trauma	362	(15)	36	(14)	0.563
Treatment	0	(0)	0	(0)	NA
Elixhauser Comorbidity:					
Diabetes	626	(26)	70	(27)	0.823
CHF	813	(34)	111	(43)	**0.006**
Alcohol abuse	127	(5)	12	(5)	0.623
Arrhythmias	703	(30)	61	(24)	**0.041**
Valvular disease	331	(14)	42	(16)	0.320
Hypertension	826	(35)	116	(45)	**0.001**
Renal failure	278	(12)	31	(12)	0.904
Chronic pulmonary	569	(24)	60	(23)	0.771
Liver disease	179	(8)	24	(9)	0.324
Cancer	97	(4)	25	(10)	$<$ **0.001**
Psychosis	82	(3)	10	(4)	0.736
Depression	125	(5)	16	(6)	0.537

Table 4: Proportional characteristics of sepsis patients (n = 1220).

	Normal (n=1083 , 89%)		Hyperdynamic (n=137, 11%)		P value
Male	547	(51)	57	(42)	**0.050**
Service type:					
MICU	724	(67)	81	(59)	0.072
CCU	106	(10)	9	(7)	0.225
SICU	185	(17)	35	(26)	**0.015**
CSRU	63	(6)	12	(9)	0.177
Primary outcomes:					
Twenty-eight day mortality	271	(25)	50	(36)	**0.004**
One-year mortality	530	(49)	83	(61)	**0.010**
ICU Mortality	193	(18)	45	(33)	$<$ **0.001**
Hospital Mortality	272	(25)	54	(39)	$<$ **0.001**
Treatments:					
RRT	276	(25)	47	(34)	**0.027**
Vasopressor	614	(57)	92	(67)	**0.019**
Ventilated	749	(69)	106	(77)	**0.048**

Table 5: Continuous characteristics of sepsis patients (n = 1220).

	Normal (n=1083, 89%)		Hyperdynamic (n=137, 11%)		P value
Age	65.9	(31.7-92.3)	66.7	(29.0-90.0)	0.979
Secondary outcomes:					
ICU Length of Stay	7.4	(1.1-52.3)	8.9	(1.5-46.5)	0.058
Hosp. Length of Stay	17.0	(3.0-71.8)	18.0	(3.0-106.2)	0.221
SOFA Scores:					
First	8.0	(1.0-17.0)	9.0	(2.0-19.0)	$<$ **0.001**
Day 1	8.0	(1.0-17.0)	9.0	(2.9-17.1)	0.105
Day 2	8.0	(1.0-17.0)	9.0	(1.0-19.1)	**0.045**
Day 3	7.0	(1.0-18.0)	9.0	(1.0-18.1)	**0.010**
SAPS-I Scores:					
First	16.0	(7.0-27.0)	18.0	(10.0-31.0)	$<$ **0.001**
Day 1	16.0	(7.0-27.0)	18.0	(10.0-26.1)	**0.049**
Day 2	15.0	(7.0-24.0)	16.0	(7.8-26.0)	**0.025**
Day 3	14.0	(6.0-22.1)	16.0	(7.9-25.0)	**0.013**
Lab Tests (first 3 days):					
Max lactate	2.4	(0.8-14.1)	2.8	(1.0-20.2)	**0.002**
Max wbc	15.1	(3.7-41.1)	17.1	(5.7-71.6)	**0.002**
Max createnin	1.7	(0.5-9.0)	1.8	(0.5-11.4)	0.332
Avg lactate	1.8	(0.8-7.9)	2.1	(0.9-10.8)	**0.004**
Avg wbc	11.8	(2.7-29.7)	13.6	(5.0-37.6)	**0.004**
Avg createnin	1.4	(0.4-7.6)	1.4	(0.4-9.6)	0.649
Elixhauser Points:					
Twenty-eight day mortality	6.0	(-4.0-19.0)	7.0	(-3.2-21.3)	0.325
One-year mortality	7.0	(-1.5-20.0)	8.0	(-1.0-24.1)	0.175
Two-year mortality	16.0	(-2.0-43.0)	17.0	(-1.1-53.1)	0.156
Treatments (first 3 days):					
Fluids in	50872.8	(2530.0-232765.7)	63560.9	(4924.9-204467.6)	**0.003**
Fluids out	6025.5	(405.0-23849.5)	6698.5	(512.3-22430.1)	0.186
Max pressor dose	3.0	(0.1-83.0)	4.4	(0.1-38.7)	0.100
Max pressor duration	3772.5	(30.0-57238.5)	5977.5	(241.0-43402.0)	0.093

Table 6: ICD9 Group and Elixhauser comorbidities of sepsis patients (n = 1220).

	Normal (n=1083 , 89%)		Hyperdynamic (n=137, 11%)		P value
ICD9 Group:					
Cardiovascular	198	(18)	23	(17)	0.669
Respiratory	198	(18)	18	(13)	0.137
Cancer	300	(28)	44	(32)	0.279
Endocrine metabolic	21	(2)	2	(1)	0.698
Gastrointestinal	109	(10)	23	(17)	**0.017**
Genitourinary	54	(5)	5	(4)	0.492
Trauma	146	(13)	18	(13)	0.912
Treatment	0	(0)	0	(0)	NA
Elixhauser Comorbidity:					
Diabetes	349	(32)	44	(32)	0.980
CHF	513	(47)	69	(50)	0.508
Alcohol abuse	65	(6)	6	(4)	0.445
Arrhythmias	380	(35)	45	(33)	0.604
Valvular disease	182	(17)	18	(13)	0.275
Hypertension	352	(33)	57	(42)	**0.033**
Renal failure	204	(19)	25	(18)	0.868
Chronic pulmonary	287	(27)	35	(26)	0.812
Liver disease	133	(12)	22	(16)	0.211
Cancer	52	(5)	15	(11)	**0.003**
Psychosis	35	(3)	6	(4)	0.482
Depression	62	(6)	8	(6)	0.957

Table 7: Proportional characteristics of hospital survivors patients (n = 2119).

	Normal (n=1940 , 92%)		Hyperdynamic (n=179, 8%)		P value
Male	940	(48)	65	(36)	**0.002**
Service type:					
MICU	969	(50)	89	(50)	0.953
CCU	335	(17)	23	(13)	0.131
SICU	460	(24)	46	(26)	0.551
CSRU	163	(8)	20	(11)	0.207
Primary outcomes:					
Twenty-eight day mortality	75	(4)	6	(3)	0.731
One-year mortality	460	(24)	49	(27)	0.272
ICU Mortality	0	(0)	0	(0)	NaN
Hospital Mortality	0	(0)	0	(0)	NaN
Treatments:					
RRT	246	(13)	24	(13)	0.780
Vasopressor	759	(39)	78	(44)	0.244
Ventilated	1092	(56)	116	(65)	**0.028**

Table 8: Continuous characteristics of hospital survivors patients (n = 2119).

	Normal (n=1940, 92%)		Hyperdynamic (n=179, 8%)		P value
Age	64.6	(26.5-90.7)	68.8	(33.0-91.8)	**0.039**
Secondary outcomes:					
ICU Length of Stay	4.5	(0.9-44.2)	6.0	(1.0-42.8)	**< 0.001**
Hosp. Length of Stay	11.0	(2.0-63.0)	16.5	(3.0-81.0)	**< 0.001**
SOFA Scores:					
First	6.0	(0.0-15.0)	7.0	(1.0-15.1)	**< 0.001**
Day 1	7.0	(1.0-15.0)	8.0	(1.0-15.0)	**0.018**
Day 2	6.0	(0.0-14.0)	6.0	(0.0-14.5)	0.212
Day 3	5.0	(0.0-14.0)	6.0	(1.0-14.4)	0.381
SAPS-I Scores:					
First	14.0	(5.0-25.0)	16.0	(7.0-26.6)	**< 0.001**
Day 1	15.0	(6.0-25.0)	16.0	(8.0-26.0)	**0.018**
Day 2	13.0	(5.2-22.0)	14.0	(5.5-23.5)	0.236
Day 3	13.0	(5.0-21.0)	13.0	(4.5-21.5)	0.326
Lab Tests (first 3 days):					
Max lactate	2.1	(0.8-10.3)	2.3	(0.8-9.8)	0.230
Max wbc	13.5	(4.4-36.6)	14.7	(5.7-43.4)	**0.019**
Max createnin	1.1	(0.4-8.4)	1.2	(0.4-10.4)	0.116
Avg lactate	1.7	(0.7-6.3)	1.8	(0.8-6.7)	0.588
Avg wbc	10.9	(3.7-26.4)	11.4	(4.2-33.0)	0.097
Avg createnin	0.9	(0.4-6.9)	1.0	(0.3-8.7)	0.253
Elixhauser Points:					
Twenty-eight day mortality	4.0	(-6.0-17.0)	4.0	(-5.2-21.0)	0.134
One-year mortality	4.0	(-3.0-18.0)	5.0	(-3.0-22.1)	0.056
Two-year mortality	9.0	(-5.0-39.0)	12.5	(-3.0-48.1)	**0.045**
Treatments (first 3 days):					
Fluids in	36902.5	(902.4-191071.7)	46901.6	(2587.3-204064.7)	**< 0.001**
Fluids out	5975.0	(373.1-20830.0)	6827.0	(460.1-25713.1)	**0.017**
Max pressor dose	2.4	(0.0-28.1)	3.0	(0.1-56.7)	0.248
Max pressor duration	2100.0	(12.4-41363.2)	3360.0	(65.2-46555.5)	**0.016**

Table 9: ICD9 Group and Elixhauser comorbidities of hospital survivors patients (n = 2119).

	Normal (n=1940 , 92%)		Hyperdynamic (n=179, 8%)		P value
ICD9 Group:					
Cardiovascular	648	(33)	54	(30)	0.379
Respiratory	282	(15)	28	(16)	0.689
Cancer	318	(16)	35	(20)	0.277
Endocrine metabolic	40	(2)	3	(2)	0.726
Gastrointestinal	156	(8)	19	(11)	0.231
Genitourinary	54	(3)	6	(3)	0.661
Trauma	301	(16)	25	(14)	0.583
Treatment	0	(0)	0	(0)	NA
Elixhauser Comorbidity:					
Diabetes	538	(28)	54	(30)	0.487
CHF	653	(34)	79	(44)	**0.005**
Alcohol abuse	100	(5)	7	(4)	0.467
Arrhythmias	556	(29)	39	(22)	0.050
Valvular disease	291	(15)	33	(18)	0.222
Hypertension	717	(37)	80	(45)	**0.041**
Renal failure	229	(12)	23	(13)	0.679
Chronic pulmonary	488	(25)	47	(26)	0.745
Liver disease	125	(6)	10	(6)	0.653
Cancer	55	(3)	18	(10)	$<$ **0.001**
Psychosis	73	(4)	9	(5)	0.401
Depression	110	(6)	12	(7)	0.570

Table 10: Sensitivity anlysis showing p-values of proportional characteristics with and without chronic hyperdynamic patients.

	All Patients (n=2632)	Without Chronic Hyperdynamic (n=2562)
Male	0.050	0.021
Service type:		
MICU	0.072	0.422
CCU	0.225	0.114
SICU	0.015	0.403
CSRU	0.177	0.528
Primary outcomes:		
Twenty-eight day mortality	0.004	0.000
One-year mortality	0.010	0.000
ICU Mortality	0.000	0.000
Hospital Mortality	0.000	0.000
Treatments:		
RRT	0.027	0.048
Vasopressor	0.019	0.028
Ventilated	0.048	0.024

Table 11: Sensitivity analysis showing p-value of continuous characteristics with and without patients.

	All Patients (n=2632)	Without Chronic Hyperdynamic (n=2562)
Secondary outcomes:		
ICU Length of Stay	0.058	0.018
Hosp. Length of Stay	0.221	0.251
SOFA Scores:		
First	0.000	0.000
Day 1	0.105	0.020
Day 2	0.045	0.052
Day 3	0.010	0.128
SAPS-I Scores:		
First	0.000	0.000
Day 1	0.049	0.004
Day 2	0.025	0.046
Day 3	0.013	0.039
Lab Tests (first 3 days):		
Max lactate	0.002	0.005
Max wbc	0.002	0.001
Max createnin	0.332	0.029
Avg lactate	0.004	0.036
Avg wbc	0.004	0.007
Avg createnin	0.649	0.053
Elixhauser Points:		
Twenty-eight day mortality	0.325	0.210
One-year mortality	0.175	0.126
Two-year mortality	0.156	0.097
Treatments (first 3 days):		
Fluids in	0.003	0.002
Fluids out	0.186	0.487
Max pressor dose	0.100	0.146
Max pressor duration	0.093	0.035

Table 12: Sensitivity analysis showing P-values for ICD9 Group and Elixhauser comorbidities with and without chronic hyperdynamic patients.

	All Patients (n=2632)	Without Chronic Hyperdynamic (n=2562)
ICD9 Group:		
Cardiovascular	0.669	0.407
Respiratory	0.137	0.854
Cancer	0.279	0.223
Endocrine metabolic	0.698	0.365
Gastrointestinal	0.017	0.231
Genitourinary	0.492	0.948
Trauma	0.912	0.968
Treatment	NaN	NaN
Elixhauser Comorbidity:		
Diabetes	0.980	0.982
CHF	0.508	0.038
Alcohol abuse	0.445	0.766
Arrhythmias	0.604	0.031
Valvular disease	0.275	0.187
Hypertension	0.033	0.005
Renal failure	0.868	0.923
Chronic pulmonary	0.812	0.658
Liver disease	0.211	0.561
Cancer	0.003	0.000
Psychosis	0.482	0.596
Depression	0.957	0.329