**HDEF manuscript**

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**Introduction:**

Hyperdynamic left ventricular ejection fraction (HDEF) on transthoracic echocardiography (TTE) is not an uncommon finding in the intensive care unit (ICU). In spite of growing use of echocardiography in the critical care setting, limited information exists on the etiology, prevalence, and significance of HDEF in the ICU. HDEF is seen in the settings of low afterload, inadequate preload, and/or increased contractility.

In prior studies, certain baseline patient characteristics correlated with a higher incidence of HDEF [23,5,3]. For instance, acute illness has also been associated with HDEF. TTE performed on non-traumatic patients in undifferentiated shock, suggested that HDEF was highly specific for sepsis, but had poor sensitivity [2].

Using a large public, de-identified clinical observational cohort, we aimed to evaluate the prevalence, characteristics, and outcomes of HDEF in an ICU setting. When comparing HDEF and normal EF in ICU patients, our primary outcome was 28-day mortality.

**Methods:**

We conducted a longitudinal, single center, retrospective cohort study of adult patients who underwent TTE during an ICU admission at the Beth Israel Deaconess Medical Center between 2001 to 2008. Patient information was extracted from the Multiparameter Intelligent Monitoring in Intensive Care II (MIMIC II) database. MIMIC II is a freely available in the public domain and contains information from electronic medical records of 32,425 patients admitted to the ICUs at Beth Israel DeaconessMedical Center between 2001 and 2008. 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 in the database were screened for purposes of inclusion, with. Data regarding each patient’s age, sex, SAPS, laboratory values, vital signs, International Classification of Diseases-Ninth Revision (ICD-9) diagnoses were extracted from the database. Medical comorbidities were represented by the Elixhauser scores for 30 comorbidities, as calculated from the ICD-9

codes. The first values of common pertinent laboratory results were also extracted, including white blood cell count (WBC), lactate, and creatinine.

Our patients were treated across a variety of ICUs with distribution shown between the medical ICU (MICU), surgical ICU (SICU), cardiac ICU (CCU), and cardiac surgery ICU (CSRU). Patients with at least one HDEF on TTE and those with normal EF were included in the cohort. HDEF was defined as ejection fraction greater than 70%. Normal EF was defined as an EF between 55-70%. Those with EF less than 55% were excluded from the analysis. Furthermore, patients with known chronic HDEF were excluded from the analysis. Chronic HDEF was defined as having more than one HDEF on TTE from different ICU stays. Baseline comparisons were performed using Fisher’s Exact Test for count data with results reported as numbers and percentages. Continuous variables were compared using two-sample Wilcoxon Rank Sum Test (also known as the Mann-Whitney test) and reported as medians and inter-quartile range. Significance levels are shown with an asterisk for *P*-values less than 0.05.

Subgroup analysis was performed on patients with documented acute HDEF. Acute HDEF was defined as having normal EF from a different TTE in MIMIC II. A multivariate logistic regression model was used to predict 28-day mortality using the variables: age, gender, SAPS-I score, Elixhauser score of comorbidities, vasopressor use and the presence of HDEF. The results are shown as odds ratios with 95% confidence interval. *P-*values are shown with significant values defined as less than 0.05.

**Results:**

*Validation of Inclusion Criteria*

Of the 3,114 ICU admissions with echo reports, 2,481 patients met criteria after exclusion of 635 patients for depressed EF and 28 patients for known chronic HDEF**.** With respect to baseline characteristics, our study found that patients with HDEF are more likely to be female. Those with HDEF also were more likely to have associated ICD9 codes for CHF, hypertension, and cancer. HDEF patients as a cohort were slightly more acutely ill based on SAPS-I score, white blood cell count, and lactate measurements, although the lab values were of similar clinical significance (Table 1**).** HDEF patients more frequently required intravenous fluids, vasopressors and mechanical ventilation (Table 1).

*Study Outcome Analysis*

Our primary outcome was 28-day mortality for patients who presented with HDEF versus patients with normal EF. When looking at the unadjusted data, it was apparent that patients with HDEF had a statistically significant increased 28-day mortality when compared to patients with normal EF. These patients also had increased mortality in-hospital and at one year. In order to minimize confounding variables we performed a multivariate analysis, which supported our finding of an increased 28-day mortality in patients with HDEF after controlling for age, gender, disease severity (by SAPS-I score), comorbidities (by Elixhauser score), and vasopressor use (OR 1.4743; 95% CI 1.0642-2.0240; *P* = 0.0178)

*Subgroup Examination of Study Outcome*

On subgroup analysis, patients with sepsis had a higher incidence of acute HDEF when compared to non-septic patients (11.2% vs. 8.7%, *P* < 0.05 in Table 4).

When looking at subgroup analysis of acute HDEF, we did not show increase in mortality, but may be underpowered given decreased sample size of confirmed acute HDEF (N = 69). Unpublished data analysis of documented acute HDEF also had increased association with hypertension and CHF in addition to valvular disease and arrhythmias. The sample size was too small to show the association with cancer, although the trend was very suggestive with 7.25% of acute HDEF having cancer diagnosis compared to 4.4% in the normal EF group**.**

A histogram of vasopressor use was constructed for all patients on vasopressors within 24 hours prior to the TTE. Overall, the distributions of eight different vasopressor types were similar. Norepinephrine, phenylephrine and dopamine were the most commonly used vasopressors respectively in each group. The only statistically significant difference noted was an increase in epinephrine and milrinone use in the HDEF group. This cumulative difference was clinically small with only 6.0% in the HDEF group receiving one of these two uncommon agents compared to 1.2% in the normal EF group. Overall, similar types of vasopressors were administered. The HDEF group was more likely to receive vasopressors, which was adjusted for in our multivariate analysis as above.

**Discussion:**

This study, to our knowledge, is the only large scale description of HDEF in the ICU setting. We found that HDEF was present in 7.8% of ICU patients who had a TTE during their ICU stay. The finding of HDEF was associated with female gender, prior diagnosis of CHF, hypertension, and in patients who were septic. Patients with HDEF had increased 28-day mortality compared to those with normal EF as seen on our multivariate regression analysis.

The exact cause of HDEF in the ICU is not well understood. Cardiac function is extremely variable in the setting of critical illness and depends on multiple physiologic determinants. Cardiac systolic function is the product of heart rate, preload, afterload, and contractility. A patient’s EF may be hyperdynamic in the setting of many types of critical illness due to changes in these basic physiologic parameters. In early trauma, HDEF may be present due to low systemic vascular resistance (SVR) from blood loss and elevated adrenergic tone leading to increased heart rate and contractility.

Per prior data, cardiovascular fitness does not appear to cause HDEF when echocardiograms were performed on professional football players [5]. Another study suggested that obese patients have a higher chance of increased ejection fraction compared to normal weight patients, although BMI was not included in our analysis [3].

In our study, an increased proportion of patients with HDEF were, female which has been previously seen although there is no data to explain why gender may play a role in having HDEF [23].

One of the most surprising associations was the increased presence of ICD9 code for CHF in the HDEF group. This association was also seen in the subgroup analysis of the acute HDEF group. It is unclear why these patients with increased ejection fraction have a prior diagnosis of CHF. Diastolic dysfunction could be playing a role that would be supported by the more likely finding of hypertension in the HDEF patients. Cancer was also found to be more commonly associated with HDEF.

Our patients with HDEF required a significant increased amount of fluids. One study suggested that hypotensive patients with HDEF tended to have a faster pace of weaning from vasopressors and an increase in the amount of fluid given suggesting hypovolemia as the etiology of HDEF [21]. However a small study showed that 3 of 4 patients with HDEF on TEE had PCWPs greater than 20 mmHg, which would speak against hypovolemia as the cause of hemodynamic instability [22].

Of note, it has been proposed that HDEF may lead to transient development of angina-like chest pain of unclear etiology [14]. This may suggest some ischemic component to the mechanics of having HDEF, but this was not able to be determined from our study.

We found that HDEF was more common than normal EF in septic patients. In sepsis, cardiovascular dysfunction is frequently present. Sepsis is commonly a state of reduced systemic vascular resistance (SVR), marked tachycardia, and increased adrenergic tone. Adequately resuscitated patients with severe sepsis can display a hyperdynamic circulation with warm peripheries, high cardiac output, and HDEF (A.). One study demonstrated that in 34 patients with septic shock, EF was more hyperdynamic in the subset of 14 patients with concurrent cirrhosis [30]. A separate study of TTE performed on non-traumatic patients in undifferentiated shock, suggested that HDEF was highly specific for sepsis, but had poor sensitivity [2]. Our study showed that HDEF was actually seen frequently outside the diagnosis of sepsis, which would speak against HDEF having a high specificity for the presence of sepsis. It is also important to note that EF may also be depressed in sepsis as has been demonstrated in multiple prior studies [6] [4] [7] [26]. For patients with sepsis, much of the literature has been mixed with regards to ejection fraction and prognosis.

*Implications*:

 This study, to our knowledge, is the only large scale description of HDEF in the ICU setting. It is difficult to determine exactly why HDEF has a worse prognosis when associated with an ICU admission. The etiology of increased mortality in the HDEF group may be related to the myocardial mechanics of HDEF or could be a marker of a pathophysiologic process not captured by SAPS-I or Elixhauser scores.

*Limitations*:

Our study is inherently limited by the retrospective approach. TTEs were not obtained immediately on presentation. Our TTEs were performed on average near the 24-hr mark after arrival to the ICU, and were similar between the normal EF and HDEF groups. With the delay, the value of triage and prognostication may be limited. We likely did not capture all of the patients who initially presented with HDEF. The effect of our interventions on HDEF is difficult to capture without pre and post TTEs for each patient.

*Further research*:

If HDEF mechanics are the etiology of worsened prognosis, then further studies might be considered to investigate if modulating HDEF with pharmacotherapy would improve outcomes. A recent randomized control trial showed use of esmolol in septic shock improved mortality [32]. It is unknown if the findings of decreased mortality using betablockade in septic shock has any relevance to HDEF.

The use of HDEF for triage or prognostication could also be another area of future research.

**Conclusion:**

HDEF is not uncommonly seen on TTE in critically ill patients in the ICU. Patients with HDEF were more likely to be female, have a prior diagnosis of CHF or hypertension, or present with sepsis. The finding of HDEF was associated with an increased 28-day mortality in comparison to patients with normal EF even after adjustment for age, gender, disease severity (by SAPS-I score), comorbidities (by Elixhauser score), and vasopressor use (OR 1.4743; 95% CI 1.0642-2.0240; *P* = 0.0178\*)

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**References:**

(A) Vieillard-Baron A, Prin S, Chergui K, Dubourg O, Jardin F: Hemodynamic instability in sepsis. Bedside assessment by Doppler echocardiography. Am J Respir Crit Care Med 2003, 168: 1270-1276.

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| |  | | --- | | LITERATURE REVIEW:    --PUBMED SEARCH: 78 results "hyperdynamic ejection fraction"    1) Sepsis-induced cardiomyopathy: a review of pathophysiologic mechanisms.  -Traditionally, the physiologic disturbances have classically been described in a biphasic spectrum: early hyperdynamic shock characterized by increased cardiac output, decreased systemic vascular resistance (SVR) and warm, perfused skin, followed by cold hypodynamic shock, during which SVR increases to compensate for worsened cardiac output, resulting in tissue hypoperfusion, cool skin and eventual organ failure (link). However, recent research suggests that hypodynamic shock is a mere manifestation of inadequate volume resuscitation and may be prevented by appropriate volume loading  Experimental evidence indicates that even patients with so-called hyperdynamic shock exhibit myocardial dysfunction relative to non-septic controls [3]. These patients have lower stroke work indices (stroke volume x mean arterial blood pressure, standardized for body surface area) as a function of end-diastolic volume, marking a downward and rightward shift of the Frank-Starling mechanism [4]. In fact, dilatation of the left ventricle in this setting is seen as an adaptive response that preserves cardiac output via the Starling mechanism, and it has been associated with lower mortality and improved prognosis in patients with sepsis [5]. Earlier studies [6] note survivors of septic cardiomyopathy have significantly more dilated left ventricles (LV) and decreased ejection fractions (EF) relative to non-survivors [6]. However, newer literature has shown that lower ejection fractions translate into poorer prognoses [2].    2) Diagnostic accuracy of left ventricular function for identifying sepsis among emergency department patients with nontraumatic symptomatic undifferentiated hypotension.  Jones AE, Craddock PA, Tayal VS, Kline JA.  Source  The sensitivity and specificity of hyperdynamic LVF for predicting sepsis were 33% (95% CI 19%-50%) and 94% (85%-98%), respectively. Hyperdynamic LVF had a positive likelihood ratio of 5.3 for the diagnosis of sepsis and was a strong independent predictor of sepsis as the final diagnosis with an odds ratio of 5.5 (95% CI 1.1-45). Among ED patients with non-traumatic undifferentiated symptomatic hypotension, the presence of hyperdynamic LVF on focused echo is highly specific for sepsis as the etiology of shock.    3) Obes Res. 2004 Oct;12(10):1616-21.  Adapted changes in left ventricular structure and function in severe uncomplicated obesity.  Iacobellis G, Ribaudo MC, Zappaterreno A, Iannucci CV, Di Mario U, Leonetti F.  Obese subjects also showed higher ejection fraction and midwall shortening than normal-weight subjects (p = 0.05 and p < 0.01, respectively), suggesting a hyperdynamic systolic function. No significant difference in systolic performance between obese subjects with BMI > or = 50 kg/m(2) and those with BMI < or = 50 kg/m(2) was seen.    4) Chest. 2004 Sep;126(3):860-7.  Experimental human endotoxemia is associated with depression of load-independent contractility indices: prevention by the lipid a analogue E5531.  Kumar A, Bunnell E, Lynn M, Anel R, Habet K, Neumann A, Parrillo JE.  Endotoxin generates significant myocardial depression when measured using highly load-independent indices of cardiac contractility. E5531 is a potent inhibitor of the early hyperdynamic cardiovascular and later myocardial depression response seen in experimental human endotoxemia    5) J Am Coll Cardiol. 2003 Jan 15;41(2):280-4.  Echocardiographic characteristics of professional football players.  Abernethy WB, Choo JK, Hutter AM Jr.  Source: Cardiac Unit, Massachusetts General Hospital, Boston, USA.  Both wall thickness and LVID of elite American football players are increased and correlate with body size. There is a high RWT, reflecting an emphasis on strength training. The LV EF was normal and not supranormal, as is sometimes believed. Regardless of the resting EF, all players had hyperdynamic cardiac responses with exercise.    6)  Crit Care. 2002 Dec;6(6):500-8. Epub 2002 Sep 12.  Clinical review: Myocardial depression in sepsis and septic shock.  Court O, Kumar A, Parrillo JE, Kumar A.  Source : Section of Critical Care Medicine, Health Sciences Center, University of Manitoba, Winnipeg, Canada.  Figure 2  The mean (± SEM) left ventricular ejection fraction (LVEF) plotted versus time for all patients, survivors, and nonsurvivors. Overall, septic shock patients showed a decreased LVEF at the time of initial assessment. This effect was due to marked early depression of LVEF among survivors that persisted for up to 4 days and returned to normal within 7–10 days. Nonsurvivors maintained LVEF in the normal range. The hatched area represents the normal range. Reproduced with permission from [16].    7) Curr Opin Crit Care. 2002 Oct;8(5):376-88.  Myocardial dysfunction in the patient with sepsis.  Krishnagopalan S, Kumar A, Parrillo JE, Kumar A.  Source: Section of Critical Care Medicine, Rush-Presbyterian-St. Luke's Medical Center, Chicago, Illinois, USA.  Current data suggest, contrary to older literature, that patients with septic shock develop a hyperdynamic circulatory state after fluid resuscitation and maintain this hyperdynamic circulatory state until death or recovery. Overt myocardial depression, as manifested by decreased cardiac output, is decidedly uncommon, even in the preterminal phase. Nonetheless, myocardial depression, as evidenced by biventricular dilation and depression of the ejection fraction, can be demonstrated in most patients with septic shock by using either radionuclide cineangiography or echocardiography. Depression is reversible over the course of 7 to 10 days in survivors. Available evidence suggests that myocardial hypoperfusion is not responsible for septic myocardial depression, because examination of humans with septic shock demonstrates increased myocardial perfusion, and animal models of septic shock appear to maintain myocardial high-energy phosphates. A circulating factor or factors, including the cytokines tumor necrosis factor alpha and interleukin-1beta, appear to have a significant role in the phenomenon. In addition, septic myocardial depression appears to be mediated in part through combinations of nitric oxide-dependent and -independent alterations of basal and catecholamine-stimulated cardiac myocyte contractility.    8) Crit Care Clin. 2000 Apr;16(2):251-87.  Myocardial dysfunction in septic shock.  Kumar A, Haery C, Parrillo JE.  Source Section of Critical Care Medicine, Rush-Presbyterian-St. Luke's Medical Center, Chicago, Illinois, USA. akumar@rush.edu  Over the last decade, it has become clear that myocardial depression, like vascular dysfunction, is typical of human septic shock. Human septic myocardial depression is characterized by reversible biventricular dilatation, decreased ejection fraction, and decreased response to fluid resuscitation and catecholamine stimulation (in the presence of overall hyperdynamic circulation). A circulating myocardial depressant substance, not myocardial hypoperfusion, is responsible for this phenomenon. This substance has been shown to represent low concentrations of TNF-alpha and IL-1 beta acting in synergy on the myocardium through mechanisms that include NO and cGMP generation.    9) J Appl Physiol. 1994 Mar;76(3):1060-7.  Decrease in left ventricular contractility after tumor necrosis factor-alpha infusion in dogs.  Walley KR, Hebert PC, Wakai Y, Wilcox PG, Road JD, Cooper DJ.  Source  Pulmonary Research Laboratory, St. Paul's Hospital, Vancouver, British Columbia, Canada.  We conclude that TNF-alpha is important in causing the hypotensive, hyperdynamic circulation of sepsis. The new finding that left ventricular contractility is decreased shortly after TNF-alpha infusion suggests that TNF-alpha, or another mediator released very soon after TNF-alpha, is an important myocardial depressant factor.    10) J Appl Physiol. 1992 Sep;73(3):925-31.  Effects of ibuprofen and pentoxifylline on the cardiovascular response of normal humans to endotoxin.  Martich GD, Parker MM, Cunnion RE, Suffredini AF.  Sourc: Critical Care Medicine Department, National Institutes of Health, Bethesda, Maryland 20892.  After volume loading, the left ventricular ejection fraction and left ventricular end-diastolic and end-systolic volume indexes did not differ among the groups. The hyperdynamic cardiovascular response to endotoxin in humans occurs in the absence of fever and is not significantly ameliorated by oral cyclooxygenase or phosphodiesterase inhibition.    11) Circ Shock. 1991 Sep;35(1):31-6.  Cardiac function in an ovine model of endotoxemia.  Redl G, Newald J, Schlag G, Traber LD, Traber DL.  Source Department of Anesthesiology, University of Texas Medical Branch, Galveston.  Eight hours post LPS a hyperdynamic phase (phase III) was distinguished, with a high cardiac output and a low systemic vascular resistance. During this time there was evidence of probable reduced myocardial contractility.    12)  Am J Physiol. 1991 May;260(5 Pt 2):H1474-81.  Cardiac dysfunction after acute endotoxin administration in conscious sheep.  Sugi K, Newald J, Traber LD, Maguire JP, Herndon DN, Schlag G, Traber DL.  Source: Department of Anesthesiology and Physiology, University of Texas Medical Branch, Galveston.  Other indexes of the LV contractility (maximum pressure development and ejection fraction) were also reduced. There was a simultaneous increase in the LV end-systolic and diastolic volumes. These findings confirm the hypothesis that there is a myocardial depression during LPS in the ovine model    13)  Int J Rad Appl Instrum B. 1989;16(7):705-7.  Nuclear medicine studies of aging--IX. Resting left ventricular ejection fraction-diastolic area relationship in the "oldest old".  Spencer RP, Haddon MJ, Rosenberg RJ, Dey HM, Sziklas JJ.  Source Department of Nuclear Medicine, University of Connecticut Health Center, Farmington 06032.  We retrospectively investigated the relationship between left ventricular ejection fraction (EF) and end diastolic cross sectional area (DCS), by means of gated cardiac blood pool studies, in 62 individuals (68 studies) who were of age 85 y or older. In these "oldest old", a plot of log ejection fraction as a function of log cross sectional area revealed good correlation (r = 0.66). The graph demonstrated the increase in heart size with a falling ejection fraction. Of the "oldest old", 38% had EF values at or above 55%. By comparison, in a group of 100 patients of ages 55-75 y, 32% had EF values of or above 55%. In the "oldest old" 13/68 (19%) had "hyperdynamic" EF values over 65%; in the 55-75 y old group, this value was 16%. The log-log plot was divided into four quadrants by two lines (one at a DCS of 26 cm2 and the other at EF of 55%). Possible prognostic significance of each of these four categories will have to be determined by following the patients and sorting out the contributions of such factors as hypertension, coronary artery disease and medications.    14)  Cathet Cardiovasc Diagn. 1978;4(3):249-63.  Elevated ejection fractions in patients with the anginal syndrome and normal coronary arteriograms.  Boden WE, Smulyan H, Potts J, Johnson LW, Obeid AI, Eich RH.  These elevated values for ejection fraction, and reduced measurements of ventricular volumes, indicate that some patients with chest pain and normal coronary arteriograms may have small hearts with hyperdynamic ventricular contraction. These findings suggest that hyperdynamic ventricular contraction may play a causative role in the development of transient, angina-like chest pain in these patients. The etiology of the proposed hyperdynamic ventricle is unknown, but it may be attributable to increased beta-sympathetic stimulation of the myocardium.    --------------------  SEARCHED  "hyperdynamic ventricle" on GOOGLE SCHOLAR  (x first 10 pages results)    21)  Transesophageal Echocardiographyin the Intensive Care Unit: Impact on Diagnosis and Decision-Making  ADRIANCHFNZBRAUN,M.D., FAUSTOJ.PLNTO,M.D., INCELSACHiWTGER,M.D.  Division of Cardiovascular Medicine, Stanford University School of Medicine, Stanford, California, USA  Clin. Cardiology 17  438-444  (1994).  hyperdynamic left ventricle was seen suggesting hypovolemia.  However, in a patient with hypotensionand hyperdynamicventricle on TEE, what often happened was a faster pace of weaning from in- otropic support and an increase in the amount of fluid given. Therefore, it is possible that we underestimatethe real impact of TEE on patient management in the intensive care unit.    22)  Bedside Ultrasonography in the ICU\*:Part 1  Chest  August 2005, Vol 128, No. 2  Yanick Beaulieu, MD; Paul E. Marik, MD, FCCP  ICU patients, four patients with hemodynamic instability were found to have a small hyperdynamic ventricle on TEE. Of these four patients, three had PCWPs > 20 mm Hg.    23) Left ventricular function in men and women. Another difference between sexes  C. BUONANNO, E. ARBUSTINI, L. ROSSI, B. DANDER, C. VASSANELLI, B. PARIS and A. POPPI  Department of Cardiology, University Hospital of Verona Italy  European Society of Cardiology  Requests for reprints to: Dr C. Buonanno, Department of Cardiology, University Hospital of Verona, Piazzale A. Stefani 37126 Verona, Italy.  In a group of 70 patients, 29 women and 41 men, with atypical chest pain and normal findings at coronary arteriography, some hemodynamic and angiographic parameters of left ventricular function were measured  The physiological diversity between the sexes, with women showing a constant hyperdynamic condition in comparison to men, with smaller ventricular volumes and increased contraction, seems to offer a possible explanation for some intriguing aspects of the diagnosis of ischemic heart disease in the female sex.    --------------------  OTHER REFERENCES:    24)  Is early ventricular dysfunction or dilatation associated with lower mortality rate in adult severe sepsis and septic shock? A meta-analysis.  May 2013  Critical Care      25)  Crit Care. 2012; 16(3): 132.  Published online 2012 June 27. doi:  10.1186/cc11367  PMCID: PMC3580648  Down but not out: myocardial depression in sepsis    26) Heart Fail Rev. 2010 Nov;15(6):605-11. doi: 10.1007/s10741-010-9176-4.  Sepsis-induced cardiomyopathy: a review of pathophysiologic mechanisms.  Flynn A, Chokkalingam Mani B, Mather PJ.  Source  Cardiology, St. Louis University Hospital, 3635 Vista Ave. 13th Floor, St. Louis, MO 63110, USA.    -Complement molecules, nitric oxide, cellular adhesion molecules, disordered intracellular energetics, and abnormalities in intracellular calcium fluxes are some of the more recently postulated causes.    ---------------------  MeSH TERMS: "stroke volume" + "intensive care unit" = 109 results    30) Acta Anaesthesiol Scand. 2008 Jan;52(1):45-51. Epub 2007 Nov 8.  Echocardiographic features, mortality, and adrenal function in patients with cirrhosis and septic shock.  Thierry S, Giroux Leprieur E, Lecuyer L, Brocas E, Van de Louw A.  SourceRéanimation Chirurgicale, Centre Cardiologique du Nord, Saint Denis, Paris, France. s.thierry@ccn.fr; thierry.stephane@free.fr    "Thirty-four patients admitted to the intensive care unit (ICU) for septic shocks were included, 14 with and 20 without liver cirrhosis. Echocardiography was performed within the first 24 h to measure the cardiac index (CI), systolic index (SI), and left ventricular ejection fraction (LVEF). In a population with septic shock, left ventricular function was more hyperdynamic in the subset with cirrhosis. Relative adrenal insufficiency occurred in similar proportions of patients with and without cirrhosis. Serum cortisol levels under basal conditions (H0) and after stimulation (H1) showed no significant differences between patients with and without cirrhosis. "    31)  Chest. 1999 Nov;116(5):1354-9.  Persistent preload defect in severe sepsis despite fluid loading: A longitudinal echocardiographic study in patients with septic shock.  Jardin F, Fourme T, Page B, Loubières Y, Vieillard-Baron A, Beauchet A, Bourdarias JP.  SourceMedical Intensive Care Unit, University Hôpital Ambroise Paré, Assistance Publique Hôpitaux de Paris, Boulogne, France.    "2D-ECHO changes during hemodynamic support in 90 septic patients confirmed defective LV preload with a propensity to worsen despite fluid loading in nonsurvivors (62% in the present study). Our results are also in agreement with previous studies reporting depressed LV systolic function at the initial phase of septic shock. Since LV dysfunction was more marked in patients who recovered, we suggest that the exact significance of this finding should be reevaluated."    ----  (32) Effect of Heart Rate Control With Esmolol on Hemodynamic  and Clinical Outcomes in Patients With Septic Shock  A Randomized Clinical Trial  Andrea Morelli, MD; Christian Ertmer, MD; MartinWestphal, MD; Sebastian Rehberg, MD; TimKampmeier, MD; Sandra Ligges, PhD;  Alessandra Orecchioni, MD; Annalia D’Egidio, MD; Fiorella D’Ippoliti, MD; Cristina Raffone, MD; Mario Venditti, MD;  JAMA 2013 | |

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