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Goal directed fluid resuscitation decreases time for lactate clearance and facilitates early fascial closure in damage control surgery

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Abstract

BACKGROUND: Damage-control surgery frequently results in open abdomen. The objective of this study was to determine whether resuscitation with goal-directed fluid therapy (GDT) using "dynamic" hemodynamic indices via modern pulse contour analysis devices such as the FloTrac Vigileo monitor leads to lower fluid requirements, subsequent quicker abdominal closure, and overall improved outcomes in these patients.

METHODS: Patients admitted to the surgical intensive care unit with open abdomen were retrospectively reviewed. Those resuscitated with Vigileo-guided GDT were matched to those resuscitated by static clinical parameters.

RESULTS: Total fluid intake and vasopressor requirements were similar in both groups. GDT with the Vigileo allowed earlier lactate clearance and reduced the number of days until abdominal wall closure by an average of .99 days.

CONCLUSIONS: Vigileo-mediated GDT did not affect fluid volume or vasopressor use in open abdomen patients, but facilitated more effective resuscitation and decreased the number of days to fascial closure, leading to shorter hospital stays. Vigileo-mediated GDT, therefore, may improve overall outcomes in open abdomen patients.

The open abdomen (OA) is now a widely accepted therapeutic option for myriad abdominal disease processes. It was initially advocated in damage-control surgery involving trauma patients with the triad of death[1,2] but now is readily applied to a host of surgical diseases, vascular catastrophes, septic abdomen, necrotizing pancreatitis,[3] and abdominal compartment syndrome.[4] Once committed to this pathway, the next major therapeutic intervention is attaining fascial closure.

DuBose et al[5] recently published a prospective multi-institutional study in trauma patients with OA. Their research determined that fascial closure was influenced by the number of repeat explorations, the presence of intra-abdominal abscess or sepsis, any bacteremia, acute renal failure, enteric fistulas, and Injury Severity Score >15.

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In addition, closure is limited by lateral visceral adhesions, increased visceral and abdominal wall edema, positive fluid balance, and worse initial base deficit.[6–8] However, paramount to successful closure is compliance of the abdominal wall and minimization of intra-abdominal edema.

Optimizing fluid resuscitation in OA patients remains a challenge. The resuscitative goal should balance optimized cardiac function and end-organ perfusion without generating marked visceral, retroperitoneal, and abdominal wall edema. Assessment of intravascular volume is the key effector. Recent perioperative studies have confirmed the higher accuracy of "dynamic" hemodynamic indices specifically pulse pressure variation and stroke volume variation (SVV), as compared to traditional "static" indices such as central venous pressure or pulmonary artery occlusion pressure, in determining fluid responsiveness in patients.[9–12]

Dynamic indices allow more accurate volume resuscitation with improved markers of perfusion, specifically lower base deficits and lactate.[9] In addition, previous studies have suggested that limited crystalloid resuscitation, as opposed to over-resuscitation, improves patient outcomes in abdominal surgery.[13] On the basis of this evidence, we hypothesized that using dynamic indices would allow us to increase the accuracy of our resuscitation, resulting in earlier fascial closure and correction of under-resuscitation leading to a decrease in long-term complications.

Methods

This was a retrospective, single-institution study of the OA surgical cohort from Scott & White Memorial Hospital, a level I trauma center in Temple, Texas, from 2008 to 2012. Approval was obtained from the Scott & White institutional review board. Electronic medical records for all patients with OA after damage-control surgery admitted to the surgical trauma intensive care unit (STICU) during this time period were reviewed. The inclusion criterion was nonclosure of the abdominal fascia after initial celiotomy. OA patients were stratified on the basis of etiology: abdominal compartment syndrome (n = 4), abdominal sepsis (n = 54), vascular compromise (n = 2), trauma (n = 4), and other (n = 6). Patients aged <18 years, those who were pregnant, and those who died before STICU discharge were excluded. Demographic data, hospital course, operative findings, and outcomes were reviewed.

In 2010, the STICU began utilizing the Vigileo monitor with the 3rd-generarion FloTrac sensor (Edwards Lifesciences, Irvine, CA) for resuscitation of critically ill patients. Before, static indices, cardiac echocardiography, or lactate was used to assess adequate resuscitation. The algorithm for resuscitation with the Vigileo and FloTrac in the OA population uses the SVV, with a goal of <12% to optimize the cardiac function of hypotensive patients with low cardiac and stroke volume indices. If SVV is >12%, the patient receives 500 mL of crystalloid until the SVV is <12%. If the patient remains hypotensive at that point, vasopressor therapy is initiated.

STICU fluid resuscitation volumes of crystalloid, colloid, and blood products in the first 48 hours were recorded individually and as a total volume. The number and type of inotropic agents or vasopressors and Vigileo-derived SVV trends for the first 48 hours in the STICU were reviewed and recorded.

Primary outcome measures included days to abdominal wall closure and type of closure (primary vs mesh vs separation of components). Secondary outcome measures included hospital length of stay (LOS), intensive care unit (ICU) LOS, number of ventilator-dependent days, number of days to correction of lactic acid (lactate clearance), and complications (fascial dehiscence, acute kidney injury, deep space infection, or superficial infection).

Statistical analysis

We matched patients in the two groups (Vigileo vs control) for age, Acute Physiology and Chronic Health Evaluation (APACHE) II score or Injury Severity Score, and etiology of OA. Age was coarsened into 3 groups: 18 to 40, 41 to 65, and >65 years. APACHE II was divided into 3 groups: 0 to 14, 15 to 30, and ≥31. Each age, APACHE II score, and etiologic stratum in the Vigileo group was randomly matched to the control population in a 1:1 manner. General admission demographics, laboratory values, STICU flow-sheet data, and outcomes were summarized using means and standard deviations or percentages as appropriate.

Gender, age, APACHE II score, number of reoperations, OA etiology, total and net fluid volume, and number of vasopressors were compared between the control group and the Vigileo group as well as between those with and without primary fascial closure, using Fisher's exact, chi-square, or *t*-tests. A multivariate logistic regression model for primary closure was built which included as covariates Vigileo, and those variables which had a *P* value of less than .2 in comparison between those with and without closure. The bivariate relationships between days to closure and the above covariates was assessed using linear regression. A multivariate linear regression model for days until closure was built including the covariates of Vigileo use and any of the covariates which had a *P* values less than .2 in the above statistical analyses. Ventilator days, ICU LOS, hospital LOS, presence of any complication, days to lactic acid clearance, days to closure, and type of closure were compared between those with and without Vigileo-directed fluid resuscitation. These outcome variables were compared using Fisher's exact, chi-square, or *t*-tests as appropriate. Finally, we used a linear regression model of time to lactate clearance with covariates. Vigileo use, total and net fluid volume in the ICU, and number of vasopressors to determine significance.

Results

Our patient population consisted of 70 patients (47.2% men). Patient demographics showed a well-matched