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# Abdominal Complications after Severe Burns

Katharine W Markell, MD, Evan M Renz, MD, FACS, Christopher E White, MD, FACS, Michael E Albrecht, MD, FACS, Lorne H Blackbourne, MD, FACS, Myung S Park, MD, FACS, David A Barillo, MD, FACS, Kevin K Chung, MD, Rosemary A Kozar, MD, FACS, Joseph P Minei, MD, FACS, Stephen M Cohn, MD, FACS, David N Herndon, MD, FACS, Leopoldo C Cancio, MD, FACS, John B Holcomb, MD, FACS, Steven E Wolf, MD, FACS

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- BACKGROUND:** Abdominal catastrophe in the severely burned patient without abdominal injury has been described. We perceived an alarming recent incidence of this complication in our burn center, both during acute resuscitation and later in the hospital course. We sought to define incidence, outcomes, and associated factors, such as excessive resuscitation volume and treatment issues.
- STUDY DESIGN:** We examined all severely burned military and civilian patients with abdominal pathology between March 2003 and February 2008. Data included age, gender, total body surface area burn, inhalation injury, Injury Severity Score, disposition, resuscitation volume, time from injury to diagnosis, use of recombinant factor VIIa, vasopressors, and early tube feedings. We assembled a Delphi panel of surgeons experienced in abdominal catastrophes to review these data.
- RESULTS:** Among 1,825 patients admitted to the US Army Institute of Surgical Research Burn Center, 120 (6.6%) were diagnosed with abdominal pathology (burn size 48%  $\pm$  19%), of which 51 (2.8%) had abdominal catastrophe. The majority of these occurred in the first days after injury with associated abdominal compartment syndrome (32 of 51) and increased linearly to burn size. We noted another group of patients who presented primarily with ischemic bowel later in the course, with the same clinical presentation. Resuscitation volume was 6.02 mL/kg/percent total body surface area burned. Vasopressors were used in 71% of patients and tube feedings in 57% before diagnosis.
- CONCLUSIONS:** Abdominal catastrophe without abdominal trauma occurs in 2.8% of our population. Associated mortality was 78% without obvious cause. Delphi panel experts recommended more aggressive monitoring of abdominal compartment pressures and earlier operative management to improve outcomes. (J Am Coll Surg 2009;208:940–949. © 2009 by the American College of Surgeons)
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Abdominal complications are not unknown in the severely burned patient. In 1968, Kirksey and colleagues<sup>1</sup> reported the incidence and types of gastrointestinal complications in burn patients from the US Army Institute of Surgical Re-

search Burn Center (USAISR). They found the overall incidence of abdominal complications was 25%, with Curling's ulcer the most common malady (54% of the total), followed by esophageal lesions (17%), hemorrhagic gastritis (11%), and a condition termed *acute necrotizing enterocolitis* (10%). They concluded that this condition was not a critical clinical problem because it was almost uniformly associated with serious lethal burns. This was in the period before effective gastric acid control, explaining the high incidence of gastric and esophageal complications. It was also before early excision and grafting were uniformly accepted; mortality in the massively burned patient was almost universal in this period, which is no longer the case,<sup>2</sup> thereby invalidating those conclusions. The finding of ischemic bowel complications, particularly in those patients with massive burns, is of interest to improve outcomes.

In 1991, Desai and colleagues<sup>3</sup> from the University of Texas Medical Branch, reported on a series of severely

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From the United States Army Institute of Surgical Research, Fort Sam Houston (Markell, Renz, White, Albrecht, Blackbourne, Park, Barillo, Chung, Cancio, Wolf); Department of Surgery, University of Texas Health Science Center-San Antonio, San Antonio (Blackbourne, Cohn, Cancio, Wolf); Department of Surgery, University of Texas Health Science Center-Houston, Houston (Kozar, Holcomb); Department of Surgery, University of Texas Southwestern Medical Center, Dallas (Minei); and the Department of Surgery, University of Texas Medical Branch, Galveston, TX (Herndon).

Correspondence address: Steven E Wolf, MD, Department of Surgery, University of Texas Health Science Center-San Antonio, 7703 Floyd Curl, Mail Code 3340, San Antonio, TX. email: [wolfs@uthscsa.edu](mailto:wolfs@uthscsa.edu)

# Report Documentation Page

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### Abbreviations and Acronyms

ISS	= Injury Severity Score
TBSA	= total body surface area
USAISR	= United States Army Institute of Surgical Research Burn Center

burned patients with ischemic bowel identified clinically and at autopsy. They found that approximately 0.5% of their patients had this complication identified before death, and another 2% of children and 7% of adults who died were identified with necrotic bowel after death. The authors attributed this to splanchnic vasoconstriction and ischemia associated with systemic sepsis. The associated mortality rate in those identified before death was 50%. Kowal-Vern and colleagues<sup>4</sup> reported a similar incidence (0.5%) of ischemic bowel complications associated with increasing burn size. These results indicate that this complication still occurs in massive burns.

At our civilian and combat casualty burn center, we perceived a recent alarming incidence of this complication, both during acute resuscitation and later in the hospital course. We sought to define incidence, outcomes, and associated factors, such as excessive resuscitation volume and transport and treatment issues, in hopes of identifying causative factors and effective treatment strategies.

## METHODS

We performed a retrospective analysis of all patients admitted to the USAISR during a 5-year period from the beginning of hostilities in Southeast Asia in March of 2003 until February of 2008. We searched our clinical databases and included all patients with abdominal operations in additional analyses. We collected data on patient demographics (age, gender, and military or civilian), injury characteristics (date of injury, date of admission, date of diagnosis of complication, Injury Severity Score [ISS], burn size, and inhalation injury), outcomes (abdominal catastrophe that included those with abdominal compartment syndrome, ischemic bowel, or both, and mortality), and treatment characteristics (resuscitation volume, time from excision and grafting, vasopressor use, enteral feeding, recombinant factor VIIa use). The study was approved by the Brooke Army Medical Center Institutional Review Board.

The USAISR serves as the sole referral center for all severely burned active-duty military personnel. Severely burned patients from Southeast Asia are met at Landstuhl Regional Medical Center close to Frankfurt, Germany, where the patient is stabilized and flown to the burn center in San Antonio, TX. All additional care for burned military

personnel, including rehabilitation and reconstruction, take place at the USAISR.

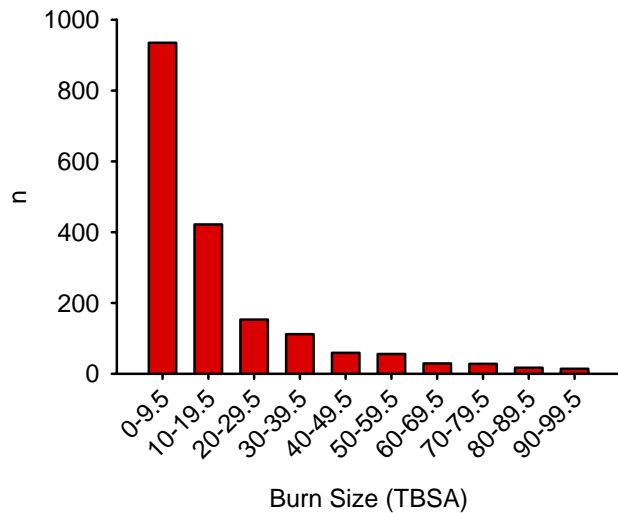
The USAISR also functions as the civilian regional burn center in south Texas, serving an area of 80,000 square miles with 6,800,000 people. Adult patients are brought directly to the USAISR by emergency medical services if burned locally or, if burned outside the immediate metropolitan area, are referred through a centralized referral system for medical emergencies in south Texas. Patients are transported to the USAISR where they receive all of their primary burn care.

Age, gender, military or civilian, date of injury, date of admission, and date of diagnosis was determined from the medical record ISS obtained from the institution's trauma database. Burn size in percent total body surface area (TBSA) was determined from the medical records entered by the attending surgeon. Inhalation injury was defined by probable history with evidence of airway injury on bronchoscopy. Diagnosis of abdominal compartment syndrome was made with the finding of abdominal distention; bladder pressures >30 mmHg; and oliguria, defined as urine output <30 mL/h. Ischemic bowel diagnosis was determined from operative findings. Resuscitation volume was determined by calculating the total crystalloid volume received in the first 24 hours after injury divided by estimated weight and percent TBSA burned. Time from excision and grafting was determined by the length of time from diagnosis to the most proximate preceding excision and grafting procedure. It is our practice to perform excision and grafting of the entire wound regardless of extent, save the face and neck, at the first operation. Vasopressor use was defined as use of a vasopressor agent (vasopressin, norepinephrine, epinephrine, or dobutamine) within 48 hours before laparotomy. Enteral feeding was defined as use of tube feeding, either gastric or small bowel, within the 48 hours before laparotomy. Recombinant factor VIIa use within 48 hours or laparotomy was used for determination of its use.

Statistical analysis was performed with SigmaPlot 11.0 (SPSS, Inc). Student's *t*-test, chi-square, or Fisher's exact tests were used where appropriate, with Bonferroni's correction if required.

## RESULTS

We admitted 1,825 patients between March 2003 and February 2008. Most burns were small (<20% TBSA) in keeping with admissions to most burn centers<sup>5</sup> (Fig. 1). Of these, 770 were military casualties and 1,055 were civilians from south Texas. One hundred twenty were diagnosed and treated for intraabdominal pathology (Table 1). The military group had an ISS of  $35 \pm 13$  and the civilians had



**Figure 1.** Burn size distribution for those admitted to the United States Army Institute of Surgical Research Burn Center from March 2003 to February 2008. TBSA, total body surface area.

an ISS of  $37 \pm 18$ . These complications were more frequent in the military group, and included trauma exploratory laparotomy, abdominal compartment syndrome, ischemic bowel, biliary disease, peptic ulcer disease and gastritis requiring laparotomy, small bowel obstruction, primary fungal infection of the wall of the small bowel, perforated cecum, peritoneal catheter placement, and feeding tube placement. Civilian abdominal complications included trauma exploratory laparotomy, abdominal compartment syndrome, ischemic bowel, biliary disease, peptic ulcer disease and gastritis, large bowel obstruction, cecal bascule, and feeding tube placement. A breakdown of all those with abdominal complications is depicted in Figure 2, including associated mortality rates. Mortality for all

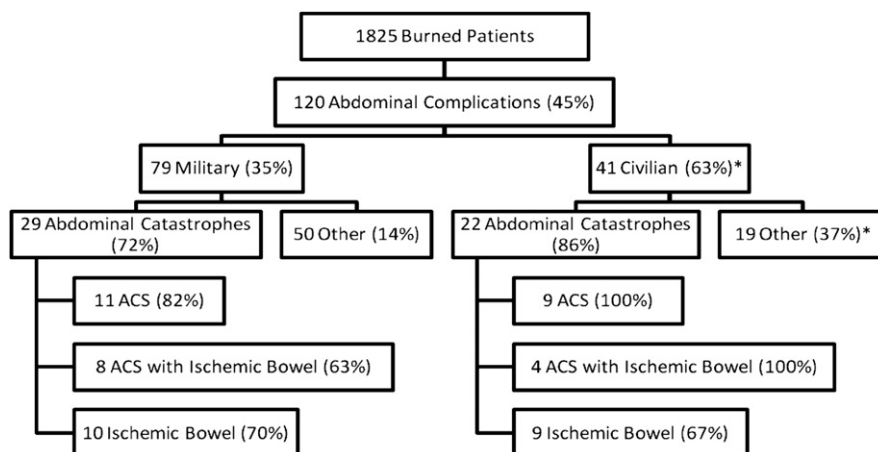
**Table 1.** Incidence of Acute Abdominal Pathology in Burned Patients

	n	Abdominal complications		Abdominal catastrophe	
		n	%	n	%
Military	770	79	10.3	29	3.8
Civilian	1,055	41*	3.5	22*	2.1
Total	1,825	120	6.6	51	2.8

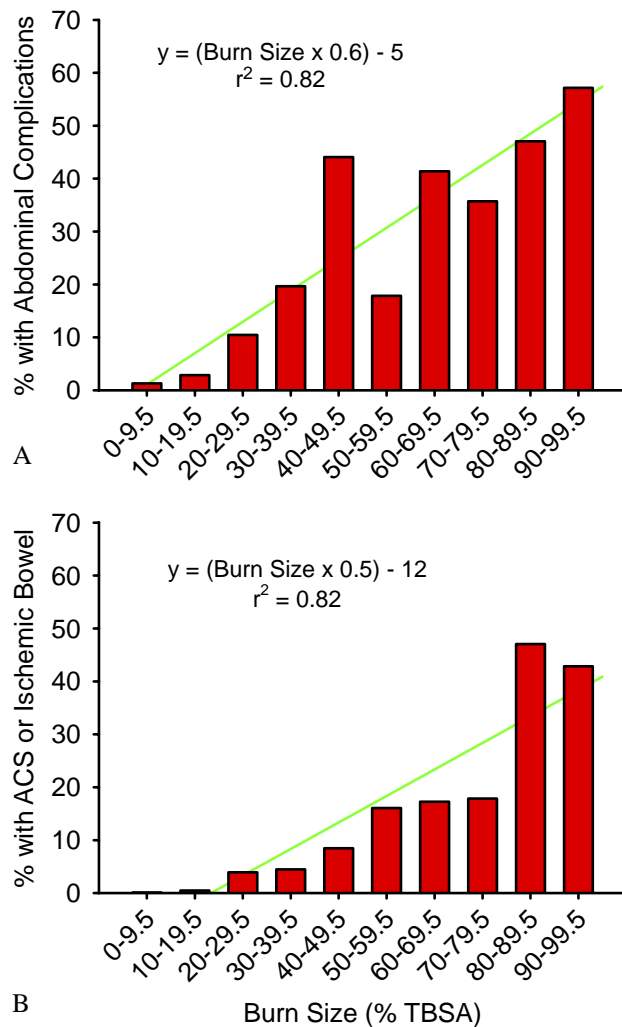
\* $p < 0.05$  between military and civilian patients. Values are  $p < 0.001$  for abdominal complications and  $p = 0.045$  for abdominal compartment syndrome and ischemic bowel.

patients with abdominal complications was 45%. Overall mortality for those with abdominal complications was higher in the civilian group ( $p < 0.05$ ), but when civilians outside the age range for the military group (18 to 51 years) were excluded, no difference was found. A similar finding was discovered when examining only those complications that were not associated with abdominal catastrophe. A frequency distribution of the percentage of abdominal complications by burn size is demonstrated in Figure 3A; abdominal complications increase linearly with increasing burn size ( $r^2 = 0.82$ ).

To focus on those with abdominal catastrophes, we separated those without abdominal catastrophe from those with this complication. We encountered 69 patients with abdominal complication without abdominal catastrophe. In the military patients, this included 35 exploratory laparotomies for traumatic injury (70%); 13 for other complications, such as biliary or perineal conditions (26%); and 4 for feeding access (8%). For the civilians, 2 had trauma laparotomies (10%), 6 had other complications (32%), and 10 were for feeding access (53%). We encountered 51 patients with abdominal catastrophe (43% of abdominal complications) in our 1,825 patients (Table 1). Of these,



**Figure 2.** Abdominal complications in burned military and civilian patients. Percentages are those of mortality. \* $p < 0.05$  between military and civilian. ACS, abdominal compartment syndrome.



**Figure 3.** (A) Frequency distribution of the percent incidence of abdominal complications with burn size. Incidence is positively correlated with burn size in a linear fashion (see inserted regression line) with good correlation ( $r^2 = 0.82$ ). (B) Frequency distribution of the percent incidence of abdominal compartment syndrome (ACS) or ischemic bowel with burn size. Incidence is again positively correlated with burn size in a linear fashion with similar correlation to that of abdominal complications. TBSA, total body surface area.

more were military, who, again, had a higher incidence compared with civilian patients. Mortality for those with abdominal catastrophe was significantly higher than for those with other abdominal complications (78% versus

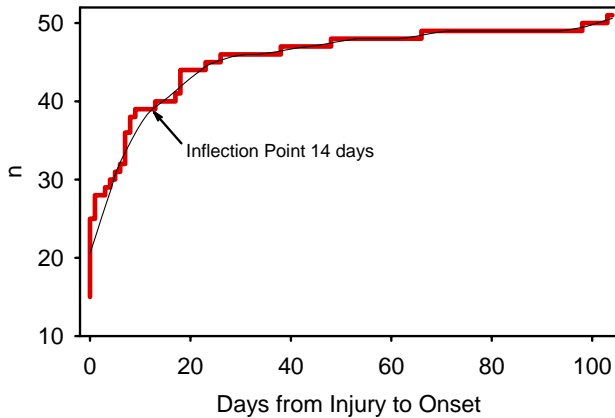
20%;  $p < 0.001$ ). Mortality for those with abdominal catastrophes was not different between the military and civilian populations. For those with burn sizes from 0% to 40% TBSA and abdominal compartment syndrome or ischemic bowel, or both, mortality was 50%. For those with burns from 41% to 60% TBSA, mortality was 73%; for those with burns 61% to 80% TBSA, mortality was 100%; and for burns >80% TBSA, mortality was 93%. Demographics and injury characteristics are listed in Table 2. A frequency distribution of the percentage of abdominal compartment syndrome or ischemic bowel, or both, showed a positive close correlation to burn size ( $r^2 = 0.82$ ), with a slope similar to that of all abdominal complications; the curve was shifted to the right for burn size (Fig. 3B). Twenty-four hour resuscitation volume was 6.2 mL/kg/percent TBSA burned for these patients as a whole, and 5.9 mL/kg/percent TBSA burned for those with complicating ischemic bowel ( $p = \text{NS}$ ), associating increased resuscitation volume with development of these complications (recommended volume 2 to 4 mL/kg/percent TBSA burned). We assessed the time of onset of abdominal catastrophe to days after burn (Fig. 4). This shows that most often this complication occurred within 3 days of injury, by which time 28 of 51 cases occurred (55%). The inflection point for the smoothed data is at 14 days after injury, by which time 80% of cases occurred. These data demonstrate that abdominal catastrophe is most commonly associated with resuscitation and acute burn care, but is not limited to this period only; it can develop later in the hospital course.

Based on these findings, we then sought to discriminate between those with abdominal compartment syndrome from abdominal compartment syndrome with or without ischemic bowel to those with only ischemic bowel. Of the 51 patients with abdominal catastrophe, 20 had only abdominal compartment syndrome without ischemic bowel, 12 had abdominal compartment syndrome with ischemic bowel found at laparotomy, and 19 had only ischemic bowel without elevated abdominal pressures >30 mmHg (Fig. 5). When percent incidence was assessed, it appears that abdominal compartment syndrome increases more with increasing burn size than ischemic bowel (Fig. 6). When the time to onset was considered, abdominal compartment syndrome with and without bowel ischemia ap-

**Table 2.** Demographics and Injury Characteristics of Those with Abdominal Compartment Syndrome or Ischemic Bowel, or Both

	n	Mean age (y) $\pm$ SD	Gender (male/female)	Inhalation injury		Mean ISS $\pm$ SD
				n	%	
Military	29	27 $\pm$ 3	28/1	15	52	35 $\pm$ 13
Civilian	22	42 $\pm$ 5	15/7	16	73	37 $\pm$ 18
Overall	51	34 $\pm$ 5	43/8	31	61	36 $\pm$ 15

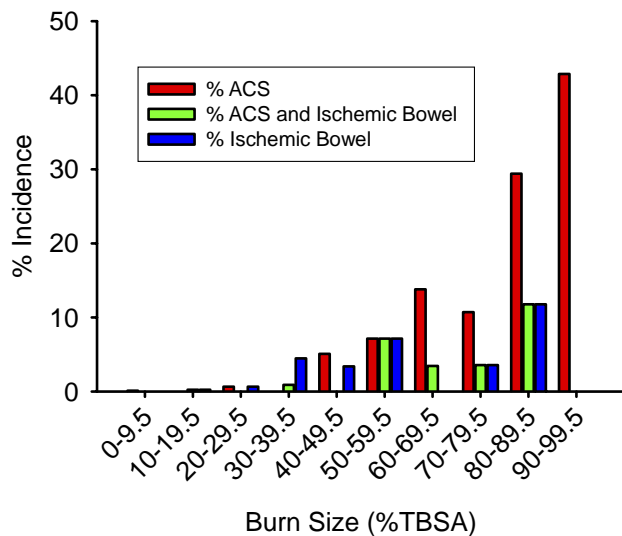
ISS, Injury Severity Score.



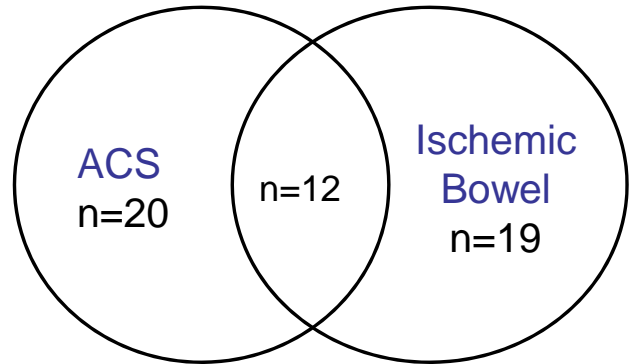
**Figure 4.** Cumulative incidence of abdominal compartment syndrome or ischemic bowel, or both, during the course of hospitalization. More than 50% of cases occurred in the first 3 days after injury, although a substantial number were also seen much later in the course.

pear to parallel one another, although ischemic bowel alone appears later (Fig. 7).

To discern outcomes and potential causes of these conditions, in addition to resuscitation volume, we assessed time from proximate excision and grafting procedure, use of vasopressors, tube feedings, and recombinant factor VIIa within 48 hours before diagnosis (Table 3). We found that mortality was similar between the diagnosis of abdominal compartment syndrome, abdominal compartment syndrome with bowel ischemia, and bowel ischemia alone ( $p = NS$ ). For those with abdominal compartment syn-

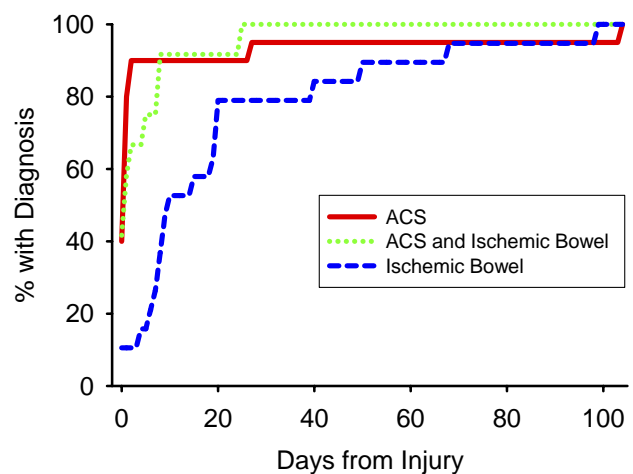


**Figure 6.** Percent incidence among the entire burn population for the diagnosis of abdominal compartment syndrome (ACS), ACS with ischemic bowel, and ischemic bowel alone compared with burn size. TBSA, total body surface area.



**Figure 5.** Patients with abdominal compartment syndrome (ACS) or ischemic bowel. The two conditions are associated but can occur independently.

drome, only 2 of 20 (10%) had an excision and grafting procedure before decompressive laparotomy was done 12 and 14 days after a preceding excision and grafting procedure. For those with abdominal compartment syndrome and ischemic bowel, five had abdominal procedures before excision and grafting (43%), four had laparotomy within 3 days after excision and grafting (33%), and the remaining three were after 5 days (25%). For the 19 with ischemic bowel alone, 3 underwent laparotomy before excision and grafting (16%), 8 had undergone excision and grafting within the previous 3 days (42%), and the remaining 8 underwent excision and grafting more than 5 days before diagnosis (42%). Vasopressor use was prevalent in this population, as was use of enteral tube feedings and factor VIIa often associated with burn wound excision and grafting.



**Figure 7.** Days from injury to diagnosis and treatment of abdominal compartment syndrome (ACS), ACS with ischemic bowel, and ischemic bowel alone. Ischemic bowel diagnosis alone follows a different path of onset than that of ACS.

**Table 3.** Mortality and Potential Factors Associated with Development of Abdominal Compartment Syndrome, Abdominal Compartment Syndrome with Ischemic Bowel, and Ischemic Bowel Alone

	Abdominal compartment syndrome (%)	Abdominal compartment syndrome with ischemic bowel (%)	Ischemic bowel (%)
Mortality	90	75	68
Vasopressor use	75	83	58
Enteral tube feedings	15*†	57†	100
Recombinant factor VIIa	58	57	50

Data represent the percentage of patients in the groups who were treated with vasopressor agents, enteral tube feedings, or recombinant factor VIIa.

\*Significant difference ( $p < 0.05$ ) from abdominal compartment syndrome with ischemic bowel.

†Significant difference from the ischemic bowel group.

Tube feedings and factor VIIa use are common in the severely burned at our institution, with or without abdominal complications. No clear clinical association was established in this analysis. When assessing these criteria between those who lived and died, no substantial differences were found between the two (data not shown).

These data were presented to a Delphi panel of burn and trauma experts to discern potential causes and prevention/treatment strategies. The group questioned whether abdominal catastrophe associated with abdominal compartment syndrome and abdominal catastrophe with primary bowel ischemia are two related but associated conditions; one early and associated with resuscitation and the other later and a primary bowel problem that results in ileus and distention. It stands to reason that in those with abdominal compartment syndrome with ischemic bowel, the ischemia might be largely related to intraabdominal hypertension and loss of venous return and arterial inflow. In the group with ischemia alone, this might not be the case. For the former patients (those with abdominal compartment syndrome and ischemic bowel), the panel was concerned that perhaps the ischemic bowel is associated with a delay in recognition. It was emphasized that even in those with burns  $>40\%$  and the abdomen opened without ischemic bowel, the mortality rate was dismal. All agreed that prevention of the complication was the best treatment. Balancing the thought of dismal results associated with decompression of the patient with abdominal compartment syndrome and severe burns, the notion was proffered that perhaps an abdominal wall component separation without laparotomy might be a solution to decrease pressure without opening the abdomen in those without ischemia.

## DISCUSSION

Intraabdominal complications in injured patients without direct bowel injury are dramatic and often associated with poor outcomes. In this study of the severely burned, we showed that primary abdominal complications occur in roughly 1 in 20 burn patients, and is considerably higher in those injured in military arenas. Abdominal complications were of a wide range, with an associated mortality of 45%. In the analysis, we showed that abdominal complications increase linearly with burn size.

Perhaps the most dramatic primary abdominal complication is abdominal catastrophe associated with abdominal compartment syndrome or ischemic bowel, both of which commonly present identically with abdominal distention and onset of shock during acute hospitalization. We focused on this group of patients and found that in 2.8% of our patients one or both of these complications developed, which was associated with a much higher mortality rate (78%) than for those with abdominal complications not associated with abdominal compartment syndrome or ischemic bowel, or both (20%). Again, the incidence was higher in the military cohort. These complications also increased linearly with burn size, with a slope similar to that of overall abdominal complications with only one survivor in those with  $>60\%$  TBSA burned. Time of onset from injury was early in most patients (within 3 days of injury), but was not limited to the early phase; some cases developed 1 to 2 months after admission. Regardless of the cause, development of abdominal compartment syndrome or ischemic bowel remains a largely fatal complication in the severely burned, as was stated by Kirksey and colleagues<sup>1</sup> as early as 1968, when they reported a mortality rate approaching 100%. It seems that prevention is likely the best solution.

To better define onset of this complication, we sought to discriminate those with abdominal compartment syndrome from those with ischemic bowel. We found that those with abdominal compartment syndrome associated with increased intraabdominal pressures measured by bladder pressure and with oliguria presented earlier in the course (0 to 3 days), which was more highly correlated with increasing burn size, but not indexed resuscitation volume. Those with ischemic bowel alone noted by abdominal distention, sporadic pneumatosis intestinalis, and moderately elevated bladder pressures presented later in the hospital course.

To discern potential associations with these diagnoses, we analyzed resuscitation volumes, time from proximate excision and grafting, vasopressor use, enteral tube feeding, and recombinant factor VIIa use as potential confounders. Recommended resuscitation volume is 2 to 4 mL/kg/

percent TBSA burned; it was 6.2 mL/kg/percent TBSA burned in this population and massive resuscitation volumes are an associated factor. Proximity to excision and grafting was not found universally. For abdominal compartment syndrome, no clinical association was found, as the vast majority (90%) underwent laparotomy before excision of the burn wound and the remaining 10% were approximately 2 weeks removed from wound excision. For abdominal compartment syndrome with ischemic bowel, most (43%) had again undergone laparotomy before wound excision, but a concerning 33% had undergone proximate excision and grafting. This was even more prevalent in those with ischemic bowel alone, when 42% underwent excision and grafting within 3 days before laparotomy. It is conceivable that the stress and effects of massive excision and grafting can predispose to development of ischemic bowel and must be considered in additional research in this area. It should be noted that the clinical association of massive excision and grafting and development of ischemic bowel is somewhat weak because only approximately 40% with ischemic bowel fit these criteria. It appears that massive excision and grafting can be contributory but not causative.

We found that vasopressor use within 48 hours of intervention was also high in this population (76%) with no differences between the subgroups, also identifying this as an associated, but not discriminating, factor. Perhaps early adjuncts to resuscitation that have the potential to decrease volumes, such as use of continuous hemofiltration or plasma exchange, can play a future role in decreasing inflammatory mediators and fluid requirements. Recently, we reported that continuous hemofiltration treatment substantially decreased vasopressor requirements and overall mortality in the severely burned in a retrospective study with historical controls.<sup>6</sup> A prospective study should be considered. We found that enteral tube feeding was more common in those with ischemic bowel, but this treatment is universal in the severely burned in our unit, making discrimination of effect difficult, but the association remains.

Data were presented to a panel of experts in burns, trauma, and emergency general surgery who offered similar conclusions to those mentioned here. This panel comprised leaders in the field who were able to assess the data with supported conclusions. They concluded that the outcomes of the diagnosis are dismal and efforts should be made to find potential causes and this information used to devise prevention strategies. In the interim, the panel recommended efforts at early recognition and treatment. All those involved were pleased with the review process, which should perhaps be imple-

mented for other problems plaguing practitioners in the field of trauma and burns.

Of interest in this study was the finding of a high incidence of primary abdominal complications requiring intervention in this population of 6.6%. This is higher than other more recent studies from other burn centers in Galveston<sup>3</sup> and Chicago.<sup>4</sup> This might be because of vagaries of our population, including military injuries, as discussed later. We found that our incidence of ischemic bowel complications (1.7%) was similar to these studies, intimating that no real substantial changes have occurred in the prevalence of these conditions.

In this study, we found that the incidence of abdominal complications was higher in the military compared with civilian population for overall abdominal complications, but also for abdominal compartment syndrome and ischemic bowel. This can be explained at least partially for overall injuries by the common mechanism of injury in military burns from explosion and penetrating abdominal injuries. In fact, almost half in the military group with an abdominal complication underwent a laparotomy acutely for suspected intraabdominal injury without abdominal catastrophe (44%). ISS was not different, perhaps because the impact of the other injuries was muted in the scores because of the severity of burn. Inherent differences in practice in terms of abdominal compartment syndrome might also be suggested to be associated with transfer of military patients across great distances. A recent publication showed that institution of a military-wide burn resuscitation guideline and documentation was associated with a decrease in abdominal compartment syndrome and mortality in evacuated burn casualties with burns >30% TBSA,<sup>7</sup> showing that perhaps this has improved with time.

We included abdominal compartment syndrome with ischemic bowel for much of this analysis, although the data intimate that these might be different conditions. Abdominal compartment syndrome associated with severe burn has been reported many times in the literature.<sup>8-10</sup> In contrast, ischemic bowel alone occurred later in the course, and was not as highly associated with burn size. Perhaps this is another recognition of the condition referred to as acute necrotizing enterocolitis mentioned by Kirksey and colleagues<sup>1</sup> many years ago. Whether bacteremia and sepsis were secondary to bowel ischemia or preceded diagnosis of ischemic bowel and was causative cannot be determined in this analysis. The authors observed that most often the small bowel constituted the bulk of bowel with full-thickness ischemia and was patchy in distribution most often associated with ischemia just distal to the feeding tube. The colon



was involved at times, but not without small bowel disease, and the stomach was not involved in any patient. The patchy distribution perhaps links this to the complication of necrotizing enterocolitis seen in neonates, and can have similar causes. It is also possible that ischemic bowel without abdominal compartment syndrome identified later in the course might have been unrecognized increased abdominal pressure that resulted in ischemia; it then took some time for realization. This notion cannot be excluded.

In conclusion, we demonstrated that abdominal complications requiring intervention were prevalent in the severely burned and increased with increasing burn size. The most devastating of these complications were abdominal compartment syndrome and ischemic bowel, which were associated with high mortality. Associated conditions were high acute resuscitation volumes, use of vasopressor agents, and enteral tube feedings, although causation cannot be determined. Development of these complications is best treated with prevention through controlled resuscitation, judicious use of hemodynamic agents and nutritional strategies, and close monitoring of abdominal compartment pressures in patients with burns >20% TBSA and consideration for early release of the abdominal compartment.

### Author Contributions

Study conception and design: Markell, Renz, White, Albrecht, Blackbourne, Park, Barillo, Chung, Cancio, Holcomb, Wolf

Acquisition of data: Markell, Renz

Analysis and interpretation of data: Markell, Renz, White, Albrecht, Blackbourne, Park, Barillo, Chung, Kozar, Minei, Cohn, Herndon, Cancio, Holcomb, Wolf

Drafting of manuscript: Wolf

Critical revision: Markell, Renz, White, Albrecht, Blackbourne, Park, Barillo, Chung, Kozar, Minei, Cohn, Herndon, Cancio, Holcomb, Wolf

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## Discussion

**DR MICHAEL F ROTONDO** (West Palm Beach, FL): I would like to thank the Association and the authors for the privilege and honor of commenting on this article.

I would like to compliment the United States Army Institute of Surgical Research on the tremendous contribution that they have made to the injury care literature since the beginning of hostilities in Iraq and Afghanistan over the last five years. To date there are no less than 270 published manuscripts related to the conflict covering a whole host of areas, many of which will change the face of civilian trauma care in the future. Dr Wolf and colleagues have been consistent and significant contributors in the area of burn management. They have taught us through their previous publications that burn victims in the current conflict are younger, more severely burned, have more associated blast injuries and a higher incidence of inhalation injuries than their civilian counterparts. Moreover, they have experimented with innovative resuscitation strategies using closed loop fuzzy logic to achieve optimal resuscitation endpoints since minimizing fluid administration. In the meantime, The Burn Unit at Brooke Army Medical Center, which was under the able leadership of Dr Basil Pruitt for so many years, has consistently reduced burn mortality rates over nearly 40 years. That's an incredible run of accomplishments.

The work that's presented here today is simply a continuation of their outcomes research to date but this time the question is related to abdominal complications in severely burned patients. In this registry-based retrospective review they index the frequency and distribution of abdominal complications in both military and civilian burn victims.