



# Implementation of a Nurse-Driven Burn Resuscitation Protocol: A Quality Improvement Project

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**BACKGROUND** Burn resuscitation, including titration of fluids and administration of colloids, is often driven by physicians' orders. Inconsistencies in burn resuscitation cause overresuscitation, which has adverse consequences.

**METHODS** Retrospective chart reviews were completed to evaluate fluid resuscitation and complications for 12 months before and after development and implementation of a nurse-driven burn resuscitation protocol.

**RESULTS** Before implementation of the protocol, results at 24 hours after injury indicated that 58% of patients were overresuscitated, had a serum level of lactate of at least 2 mmol/L (100%), and had complications (pulmonary edema 20%, abdominal compartment syndrome 7%, acute lung injury/acute respiratory distress syndrome 30%) within the first 5 days. Two outcomes differed from before to after implementation of the protocol: serum level of lactate at 24 hours ( $t_{37.8} = 2.38, P = .007$ ) and central venous pressure at 48 hours ( $t_{31} = 2.27, P = .03$ ). After implementation of the protocol, no patients had abdominal compartment syndrome develop.

**CONCLUSIONS** Implementation of the nurse-driven burn resuscitation protocol improved nurses' awareness and assessment of fluid status during resuscitation and improved patients' outcomes. (*Critical Care Nurse*. 2013;33[1]:25-36)

to be from 1.7% to 61.4% for patients age 20 to 80 years or older with a TBSA exceeding 20%.<sup>1</sup> The challenges with burn resuscitation lie in the need to administer large amounts of fluids to provide effective tissue perfusion without causing complications<sup>2</sup> of overresuscitation such as abdominal hypertension, abdominal compartment syndrome, acute lung injury, pulmonary edema, and acute respiratory distress syndrome (ARDS).

Many burn centers use formulas to estimate fluid resuscitation needs. The Parkland formula is commonly used, along with the Brooke, Modified Brooke, and US Army's Institute of Surgical Research and Joint Theater Trauma System resuscitation formulas.<sup>2,3</sup> Few protocols were found in publications describing comprehensive burn resuscitation algorithms.<sup>4-6</sup>

A quality improvement project was initiated in a burn intensive care unit (ICU) at University of Colorado Hospital, University of Colorado Health, to develop and implement a protocol for burn resuscitation that was driven by nurses rather than the previous standard, which required

## CNE Continuing Nursing Education

This article has been designated for CNE credit. A closed-book, multiple-choice examination follows this article, which tests your knowledge of the following objectives:

1. Identify the purpose and methods of fluid resuscitation in burn patients
2. Describe the process and practice changes involved in the nurse-driven burn resuscitation protocol quality improvement project
3. Discuss how the nurse-driven burn resuscitation quality improvement project improved the care of burn patients

**E**ffective burn resuscitation continues to evolve with efforts to provide optimal fluid resuscitation to patients with significant total body surface area (TBSA) injury. The National Burn Repository<sup>1</sup> has reported a direct correlation between higher mortality rates in patients and advanced age, TBSA burn exceeding 20%, and the presence of inhalation injury. The current mortality rate is estimated

the nurse to contact the physician for each adjustment in administration of fluids. The change in process was to create a unit-based practice protocol that streamlined the process of burn resuscitation, enabling more efficient and timely fluid adjustments.

The nurse-driven burn resuscitation protocol (NDBRP) was created collaboratively by the interprofessional team of the burn ICU. The NDBRP is similar to other critical care practice protocols in which the prescribing provider provides standing orders for treatment of set parameters related to the patient (eg, glucose levels). This burn resuscitation practice protocol requires the nurse to incorporate several parameters that reflect the patient's current response to fluid resuscitation and determine fluid adjustments by incorporating the nurse's clinical assessment (eg, blood pressure, central venous pressure, urine output, current laboratory values) and protocol orders. This article describes a quality improvement process that examined patients' outcomes before and after implementation of the NDBRP.

## Background

Despite much research on the topic of burn resuscitation in the past 30 years, the practice has not changed

significantly.<sup>2,7</sup> Many formulas exist to guide fluid resuscitation in burn patients; however, a definitive consensus on best practice has not been achieved.<sup>2,6-10</sup> Best practice in burn resuscitation is imperative because effective fluid resuscitation will decrease burn shock, tissue loss, and organ damage and will reduce morbidity and mortality.

The primary goal of fluid resuscitation is to restore the circulating blood volume and maintain perfusion to all tissues during the period of increased capillary permeability.<sup>11</sup> When a patient has burns involving more than 20% TBSA, the sympathetic nervous system (fight or flight) responds by increasing circulating levels of catecholamines, initially producing a hyperdynamic state.<sup>10,12</sup> The inflammatory process that ensues increases circulating levels of inflammatory mediators, which increase capillary permeability, leading to global edema. Major fluid and electrolyte losses occur as a result of the capillary leak and loss of skin. Hypovolemia is the result. Resuscitation is often guided by urine output, hemodynamic parameters, and laboratory values.<sup>11</sup> Delayed or inadequate fluid volume restoration results in suboptimal tissue perfusion with end-organ failure and death.<sup>8</sup>

Charles Baxter was instrumental in developing the Parkland formula, which is, today, the most frequently used burn resuscitation formula.<sup>11</sup> The Parkland formula itself has been modified in various ways, including the "consensus formula," which uses only lactated Ringer solution as a resuscitation fluid. The Parkland formula has been renamed the consensus formula because it is the most widely used resuscitation guideline.<sup>10,13</sup> Baxter's original formula included the use of colloid infusion at 24 hours to complete restoration of intravascular volume.<sup>14</sup> One of the arguments for using fresh frozen plasma as a colloid during burn resuscitation is that the molecule size of fresh frozen plasma is greater than that of albumin, and albumin has a larger molecule size than does crystalloid solution (eg, lactated Ringer solution). Plasma proteins are needed to maintain the oncotic force to counteract the hydrostatic forces experienced with burn shock.<sup>13</sup> Currently the debate about whether to use fresh frozen plasma, albumin, or crystalloid continues.<sup>15</sup>

Recently, a trend in overresuscitation has been reported.<sup>7,16-18</sup> "Fluid creep" is an adverse consequence of overresuscitation, a term originally coined by Pruitt.<sup>16</sup> Fluid creep is described as clinical practice in which more resuscitation fluid is administered than is recommended by the Parkland formula.<sup>7,19</sup> This phenomenon has also been termed "supra-Baxter resuscitation."<sup>20</sup> Complications associated with overresuscitation include pulmonary edema, ARDS, acute lung injury, abdominal hypertension, abdominal compartment syndrome, longer duration of mechanical ventilation, and longer ICU stays.<sup>13</sup>

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### *Local Problem*

Staff from the Regions Hospital burn unit spoke at the American Burn Association conference about a novel approach to burn resuscitation driven by nurses.<sup>21</sup> In a presentation on burn resuscitation, they identified 3 obstacles that lead to fluid creep and excessive infusion of crystalloid solution: (1) inconsistent reduction of intravenous rates when urine output is adequate, (2) frequent use of intravenous boluses, and (3) the practice of waiting 24 hours after burn injury to use colloids.<sup>21</sup> The preliminary data from Regions Hospital's resuscitation protocol indicate that use of the protocol resulted in no incidence of abdominal compartment syndrome and resuscitation volume totals that were 40% less than the Parkland formula estimation. The authors concluded that the number of episodes of overresuscitation decreased, resulting in fewer complications for patients.<sup>21</sup>

The trend in overresuscitation was similar to the experience in our burn ICU, which was discussed with our quality improvement team. Within our burn ICU, all patients with burns involving 20% TBSA or more had initial fluid requirements calculated by using the Parkland formula. Lactated Ringer solution is the fluid used for resuscitation. Colloid resuscitation was not typically initiated until 24 hours after injury unless the patient's international normalized ratio was 1.5 or greater.

The nurse caring for the patient had to identify increased or decreased urine output, hemodynamic instability, or trends in laboratory results before notifying the physician and requesting a fluid titration order. Depending on the experience and comfort level of the medical intern

or resident, an order to increase or decrease the rates of intravenous infusions by 20% was provided. Occasionally, an attending physician was consulted before the medical intern or resident had written a fluid titration order.

At times, this process to obtain changes in fluid orders delayed fluid titration. The nurse may have waited for the result of a laboratory test before making a phone call to the physician. Medical interns and residents rotate on a monthly basis in our burn ICU; thus their experience and comfort with burn resuscitation varied. During the project time frame, the burn ICU did not have a burn fellow; the unit's attending physician was the burn expert. The characteristics of the nursing staff were equally varied, with graduate resident nurses as well as several expert burn ICU nurses.

Nurses were more comfortable with increasing than decreasing the rates of infusion of intravenous fluids, despite adequate urine output (ie, 0.5 mL/kg per hour). This hesitation to decrease rates of fluid resuscitation was reported in other studies<sup>17,22,23</sup> exploring factors associated with overresuscitation and fluid creep in burn patients. The sense of urgency or the need to decrease fluids was not perceived as being as important as the need to increase fluids. This disparity often resulted in unnecessary infusion of resuscitation fluids for multiple hours before a decrease in infusion rates was addressed.

### *Intended Improvement and Goal of the Quality Improvement Project*

In an effort to improve burn resuscitation practices in this burn

ICU and reduce overresuscitation, the quest to develop a NDBRP was implemented. The specific aims of this quality improvement project were (1) to develop and critically evaluate the implementation of an NDBRP in the management of burn patients with burns involving 20% TBSA or more and (2) to explore clinical outcome measures that looked at resuscitation volumes and patients' complications compared with the previous standard of practice of physician-driven resuscitation.

### *Methods*

The burn ICU quality improvement team is composed of interdisciplinary members (eg, physicians, nurses, physical therapists). The quality improvement team developed the NDBRP and the criteria for implementation of the protocol. A process for chart review, patients' outcome variables to be tracked, and time frames (eg, at 24 hours and 5 days after resuscitation) to be examined before and after implementation of the NDBRP were developed for this project.

### *Ethical Issues*

This quality improvement project did not remove or limit the standard of care in burn resuscitation. The institutional review board deemed the project to be consistent with research on nonhuman subjects.

### *Setting and Description of the Population*

The 9-bed burn ICU at this American Burn Association–verified center serves adult burn and trauma victims in the Rocky Mountain Region. University of Colorado Hospital, University of Colorado Health,

is a 413-bed quaternary-care academic medical center. The burn ICU admits only adult patients, defined as patients more than 13 years of age and/or weighing more than 40 kg. Annually, the burn ICU admits approximately 250 burn-injured patients. Patients with burn injuries involving at least 20% TBSA were included in this quality improvement project. Patients with electrical burns were excluded because of the difficulty in determining the percentage of cutaneous and internal injury.<sup>24</sup> Patients with only inhalation injury also were excluded, as again it is difficult to estimate fluid volume resuscitation needs with an airway-only thermal injury.<sup>13</sup> However, a patient with an inhalation injury and a 20% TBSA burn was included in the project and resuscitated with the NDBRP.

### *Planning the Intervention*

Effective implementation of a new protocol into the practice environment requires adequate planning and involvement of all persons with a stake in the process. Nurses can be key players in the change process through active clinical inquiry. After attending a presentation on improving patients' outcomes through a nurse-driven resuscitation protocol at a national conference, a nurse from this unit was inspired to achieve similar outcomes for patients on our unit. Mentorship was sought to implement a similar protocol into practice at our burn ICU, and a small task force was formed.

Regions Hospital was contacted for information on their resuscitation protocol, and permission to amend their protocol was obtained. The benefits of Regions Hospital's

nurse-driven resuscitation protocol and findings from the literature were presented to the burn ICU's process improvement committee.<sup>4,5,21</sup> Members of this committee include permanent charge nurses, the nurse manager, the nurse educator, and the medical director from the burn ICU.

The physician medical director of the blood bank was invited to attend this committee meeting to determine criteria for the release of fresh frozen plasma. The new protocol would call for administration of fresh frozen plasma regardless of coagulation factor criteria (eg, international normalized ratio). Involvement of the blood bank director early in the planning process was vital and proved to be beneficial to the success of the protocol. The group decided that implementation of nurse-driven resuscitation would be valuable for our unit and could improve patients' outcomes.

Once the NDBRP (Figure 1) was approved by the members of the burn ICU's process improvement committee and the blood bank's medical director, a plan to provide consistent education to the nursing and physician staff was developed. The team believed that an interactive 1-hour PowerPoint presentation that used a case study approach and required the nurses to apply the protocol would be the most effective teaching strategy. Participants at the educational session were required to read the case study, perform the necessary fluid resuscitation calculations, and as the case study evolved with changing hemodynamics and urine output, adjust the infusion rate for intravenous fluids according to the NDBRP. The interactive case

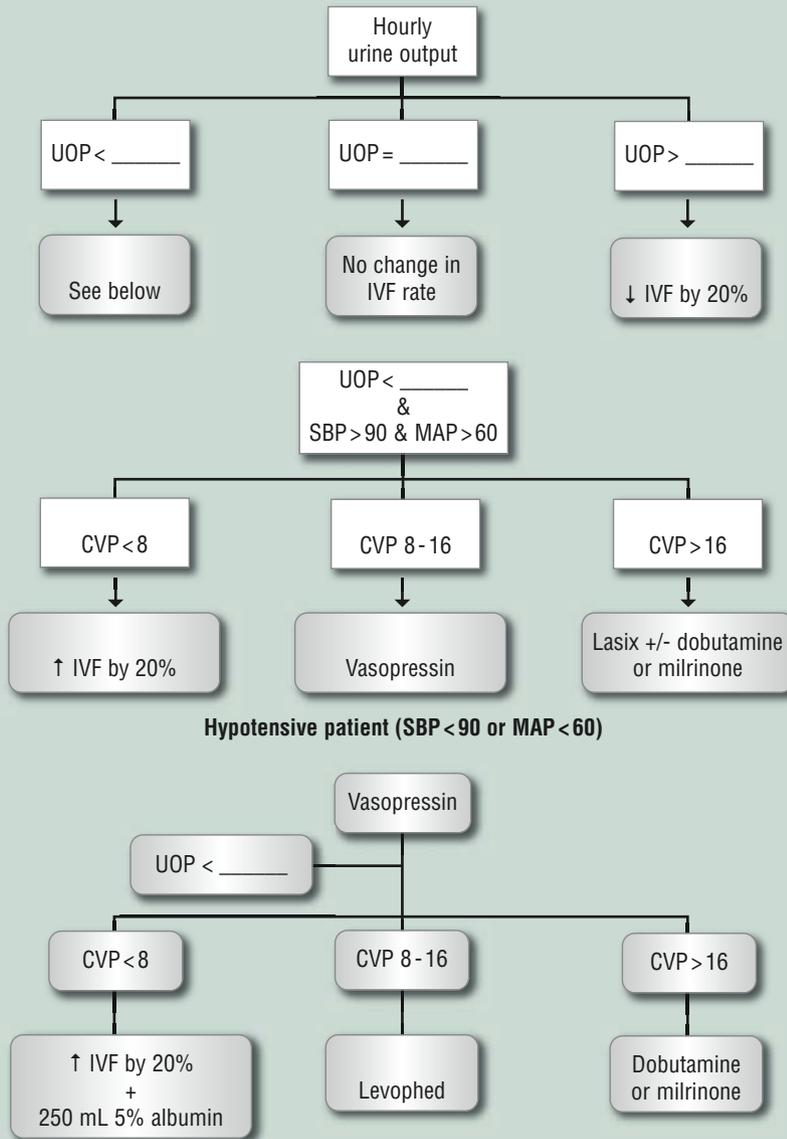
study format provided consistency in education, and familiarity with the protocol was enhanced. The blood bank staff was also educated to release fresh frozen plasma as ordered according to the NDBRP.

A bedside tool (Figure 2) was created to help nurses with their fluid volume calculations and provided prompts for registered nurses to reevaluate the need to implement protocol interventions (eg, fresh frozen plasma, vasopressin). In addition, this tool ensured continuity of care and facilitated handoff if the patient was admitted near change of shift. Once all staff had been trained, the NDBRP was implemented in July 2009.

### *Methods of Evaluation and Analysis*

The goal of this quality improvement project was to develop and critically evaluate the implementation of an NDBRP in the management of patients with burns involving 20% TBSA or more. To evaluate the effectiveness of the change in resuscitation practice, we retrospectively audited medical records of all patients admitted to the burn unit with burns involving at least 20% TBSA between January 1, 2008, and December 31, 2008, for baseline data (before NDBRP). Medical records for review were identified from the burn registry of past admissions. Multiple variables were examined to explore the effectiveness of changing fluid resuscitation practice. Patients' outcomes were measured at 24 hours, 48 hours, and 5 days after admission. The same data were collected after implementation of the NDBRP between July 1, 2009, and June 30, 2010. Table 1 summarizes

Weight, kg	Urine output, range, mL/h		Weight, kg	Urine output, range, mL/h
>100	45-55		55-64	25-30
85-99	40-50		45-54	25
75-84	35-45			
65-74	30-35			



- \*\* Call resident/attending physician:
- Low UOP x 2 hours consecutively
  - Bladder pressure > 15 mm Hg
  - Before starting any pressors, Lasix, FFP, or albumin or when minimum hourly infusion rate is reached
  - CVP > 15 mm Hg

**Figure 1** Nurse-driven burn resuscitation protocol.

University of Colorado Hospital ©July 2009; Revised February 2011. Used with permission.

Abbreviations: CVP, central venous pressure; FFP, fresh frozen plasma; IVF, intravenous fluids; MAP, mean arterial pressure; SBP, systolic blood pressure; UOP, urine output.

patients' outcomes before and after implementation of the NDBRP.

## Results

Baseline data were obtained from medical records of patients admitted between January 1 and December 31, 2008. Initially, all patients with documented burns involving at least 20% TBSA, inhalation injury, and/or electrical injury were included in the baseline data. However, after the data from before and after implementation of the NDBRP were reviewed, it was apparent that postimplementation patients with electrical injuries and patients with inhalation injuries and burns involving less than 18.5% TBSA were not being resuscitated with the NDBRP. Therefore, patients in the preimplementation group that met similar criteria (eg, small electrical and inhalation-only burn injuries) were excluded from the analysis of the project findings.

Additionally, existing disease processes that might have excluded patients from the preimplementation group could not be determined in the retrospective review of medical records. Initially, the medical records of 53 patients who met the criteria for resuscitation via the NDBRP during the baseline data period were reviewed. However, only 30 patients were included in the baseline data because of the exclusion of electrical injuries, inhalation-only injuries, and those patients with inhalation injuries and burn injuries involving less than 18.5% TBSA.

The NDBRP was implemented in July 2009, and analysis of data after the implementation included all patients admitted who met

Patient Name: \_\_\_\_\_ Medical Record Number: \_\_\_\_\_

Admission Time: \_\_\_\_\_

Time of Injury : \_\_\_\_\_ Height (cm): \_\_\_\_\_ Weight: \_\_\_\_\_

Preadmission Fluids: \_\_\_\_\_ % TBSA: \_\_\_\_\_ BSA (m<sup>2</sup>): \_\_\_\_\_

**Calculated maintenance/minimum infusion rate:** \_\_\_\_\_

**PARKLAND:**

Parkland: 4 mL x Weight (kg) x % TBSA = \_\_\_\_\_

½ preadmission fluids = \_\_\_\_\_ mL divided by (8 – hours from time of injury) = \_\_\_\_\_ mL/hour

½ over the next 16 hours = \_\_\_\_\_ mL/h

**FFP:**

Ivy Score (mL/kg): 250 mL/kg = Bladder Pressure 24 mm Hg = ACS

Start FFP at 100 mL/kg: 100 mL x \_\_\_\_\_ weight (kg) = \_\_\_\_\_

\*Preadmission fluids are included in the Ivy Score\*

If fluid rate remains at approximately the same rate, FFP will start at approximately \_\_\_\_\_ (date and time)

Calculation for approximate FFP start date and time (Y):

Weight (kg) x 100 mL = \_\_\_\_\_ Subtract (-) \_\_\_\_\_ (preadmission fluids) = X

X (mL)/Parkland fluid rate (mL/h) = Y (hours after admission)

FFP infusion rate = 0.5 mL/ weight (kg)/ % TBSA over 8 hours

Ex: 85 kg x 100 mL = 8500 mL 8500 mL – 4500 mL (preadmission) = 4000

4000 mL/ 850 mL/hr (Parkland) = 4.7 hours after admission FFP will be started as patient has received 100 mL/kg of crystalloid fluid

FFP rate = 0.5 mL x 85 kg x 40% TBSA / 8 hours = 212 mL

**OTHER RATES:**

25% Albumin @ 10 mL/h x 48 after FFP infusion completed and more colloid is needed

**Maintenance Rate:** (D51/2NS with 20 mEq KCl)

$$\begin{aligned} & \text{Weight (kg) + 40 mL} \\ & + \\ & \text{Insensible loss (mL/hr) = (25+\%TBSA burned) x BSA (in m}^2\text{)} \\ & = \\ & \text{Minimum hourly infusion rate} \end{aligned}$$

\*\* Call resident/attending physician:

- Low UOP x 2 hours consecutively
- Bladder pressure >15 mm Hg
- Prior to initiation of any pressors, Lasix, FFP, or albumin or when minimum infusion rate is reached
- CVP > 15

**When resuscitation complete, please return this tool to the NDBRP inbox.**

**Figure 2** Bedside tool used in nurse-driven burn resuscitation protocol (NDBRP).

University of Colorado Hospital ©July 2009; Revised February 2011. Used with permission.

Abbreviations: ACS, abdominal compartment syndrome; BSA, body surface area; CVP, central venous pressure; D51/2NS, 5% dextrose in 0.45% normal saline; FFP, fresh frozen plasma; TBSA, total body surface area; UOP, urine output.

criteria for use of the NDBRP from July 1, 2009, to June 30, 2010. A total of 21 patients were included in

the data analysis after the NDBRP was implemented. Table 2 provides the patients' demographics and

outcome variables measured both before and after the NDBRP was implemented.

**Table 1** Patients' descriptive information and outcomes examined before and after implementation of the nurse-driven burn resuscitation protocol: end points of fluid resuscitation and complications

Age
Weight, kg
Burn injury
% Total body surface area
Inhalation injury
Electrical injury
Fluid calculation estimated with Parkland formula
Resuscitation fluid volume given at 24 and 48 hours
Central venous pressure at 24 and 48 hours
Bladder pressure
Peak airway pressure
Serum level of lactate and base deficit at 24 hours
Documentation of complications within 5 days of admission:
Pulmonary edema
Adult respiratory distress syndrome
Abdominal compartment syndrome/abdominal hypertension
Total ventilator days
Total days in intensive care unit

The preimplementation and postimplementation groups were similar in the number of patients who met burn injury TBSA criteria, age, and weight; each group had 1 patient with an electrical injury. Two major admission characteristics differed between the 2 groups. The preimplementation group had 9% more patients with inhalation and thermal injuries, and the postimplementation group had a larger mean %TBSA burned. A statistically significant difference was found between the 2 groups on the outcome measures of serum level of lactate ( $t_{37.8}=2.38, P=.007$ ) and central venous pressure at 48 hours ( $t_{31}=2.27, P=.03$ ). Because the homogeneity of variance assumption was violated, corrected  $t$  tests were used in which unequal variances were not assumed.

**Table 2** Demographics and outcome variables before and after implementation of the nurse-driven burn resuscitation protocol (NDBRP)

Patients' outcomes	Before NDBRP <sup>a</sup>	After NDBRP <sup>b</sup>
No. of patients who met NDBRP criteria	30	21
Age, mean (SD), y	49.2 (17.7)	43.9 (21)
%TBSA burned, mean (SD)	37.4 (18.6)	48.4 (25)
Weight, mean (SD), kg	89.1 (27.5)	77.4 (17.7)
Types of burn injury >20% TBSA, No. of patients		
Thermal injury only	15	12
Thermal injury and inhalation injury	14	8
Electrical injury	1	1
Ventilator days, mean (SD)	18.7 (20.9)	35.4 (28.4)
Days in intensive care unit, mean (SD)	28.2 (22.5)	40.3 (26.4)
24-Hour central venous pressure, mean (SD), mm Hg	15 (4.9)	13 (4.6)
48-Hour central venous pressure, <sup>c</sup> mean (SD), mm Hg	17 (3.8)	9 (5.6)
24-Hour lactate, <sup>c</sup> mean (SD), mmol/L	3.3 (1.3)	2.4 (0.7)
24-Hour base deficit, mmol/L	-3.7 (3.8)	-2.8 (1.4)
Abdominal compartment syndrome, No. of patients	2	0
Abdominal hypertension, No. of patients	3	1
Adult respiratory distress syndrome/acute lung injury, No. of patients	9	2
Average 24-hour mL/kg per %TBSA burn	5.2	4.2
Average 48-hour mL/kg per %TBSA burn	8.5	5.6

Abbreviation: TBSA, total body surface area.

<sup>a</sup> January 1, 2008, to December 31, 2008.

<sup>b</sup> July 1, 2009, to June 30, 2010.

<sup>c</sup> Difference between groups was statistically significant at  $P \leq .05$ .

To compare total volume administered and Parkland estimates, total volumes for each patient were recalculated to determine volume by weight and volume by TBSA actually administered at 24 hours and 48 hours. The fluid volume administered was 5.2 mL/kg per %TBSA for the preimplementation group and 4.2 mL/kg per %TBSA for the postimplementation group at 24 hours, indicating that less fluid was administered in the group resuscitated by using the NDBRP. At 48 hours, the preimplementation group received an estimated 8.5 mL/kg per %TBSA compared with 5.6 mL/kg per %TBSA for the postimplementation group, again indicating that less fluid was administered in the group resuscitated by using the NDBRP.

Review of patients' outcomes indicated that before the NDBRP was used, 3 patients had abdominal hypertension and 2 patients had abdominal compartment syndrome develop, whereas after the NDBRP was implemented, only 1 patient had abdominal hypertension develop and no patients had abdominal compartment syndrome develop.

## Discussion

Effective fluid resuscitation that minimizes secondary complications associated with underresuscitation and overresuscitation is essential to survival of burn patients. Achieving optimal resuscitation that maximizes tissue perfusion while limiting complications from overresuscitation in patients with burn injuries is challenging. Changing practice in this burn ICU to a process that implemented a practice guideline for fluid titration in a more dynamic manner did result in less fluids

being administered and improvement in patients' outcomes. Burn patients who were resuscitated by using the NDBRP received less fluid at 24 hours and 48 hours without clinical evidence of underresuscitation. This decrease in fluid volume administered to like patients in the preimplementation group was noteworthy.

No difference was found in the central venous pressure (CVP) measurements between the groups at 24 hours; however CVP at 48 hours differed significantly between the 2 groups, supporting the anticipated effect that use of the NDBRP decreased the volume of fluids administered more rapidly as the resuscitation period completed. Assessment of adequate fluid resuscitation and tissue perfusion was supported by the reduction in serum levels of lactate and base deficit levels in the postimplementation group.

Secondary complications of overresuscitation include abdominal hypertension/abdominal compartment syndrome and acute lung injury/ARDS.<sup>13</sup> Prevention of abdominal compartment syndrome is a primary goal for burn providers, as abdominal compartment syndrome can lead to decreased pulmonary compliance, cardiac dysfunction, multiorgan dysfunction, and/or organ failure.<sup>8</sup> Ivy and colleagues<sup>25</sup> describe a direct relationship between resuscitation volumes delivered per kilogram and the development of abdominal compartment syndrome, validating the importance of well-orchestrated burn resuscitation. Although multiple factors, including mechanism of injury and systemic inflammatory response, affect the patient's risk for secondary complications, overresuscitation

exponentially increases the patient's risk. An important benefit of the NDBRP in this quality improvement process was that less fluid was used to meet the burn patient's needs for tissue perfusion and resuscitation. The NDBRP was successful in this quality-improvement project in the reduced frequency with which patient outcomes of abdominal hypertension and abdominal compartment syndrome were reported.

Lung injury can occur through direct inhalation of chemicals and/or heat.<sup>26</sup> The mechanism by which ARDS occurs after inhalational injury is not completely understood, but it is initiated through activation of the inflammatory cascade following inhalation injury.<sup>26</sup> Nelson and colleagues<sup>26</sup> report that ARDS will develop in as many as 61% of patients sustaining an inhalation injury.

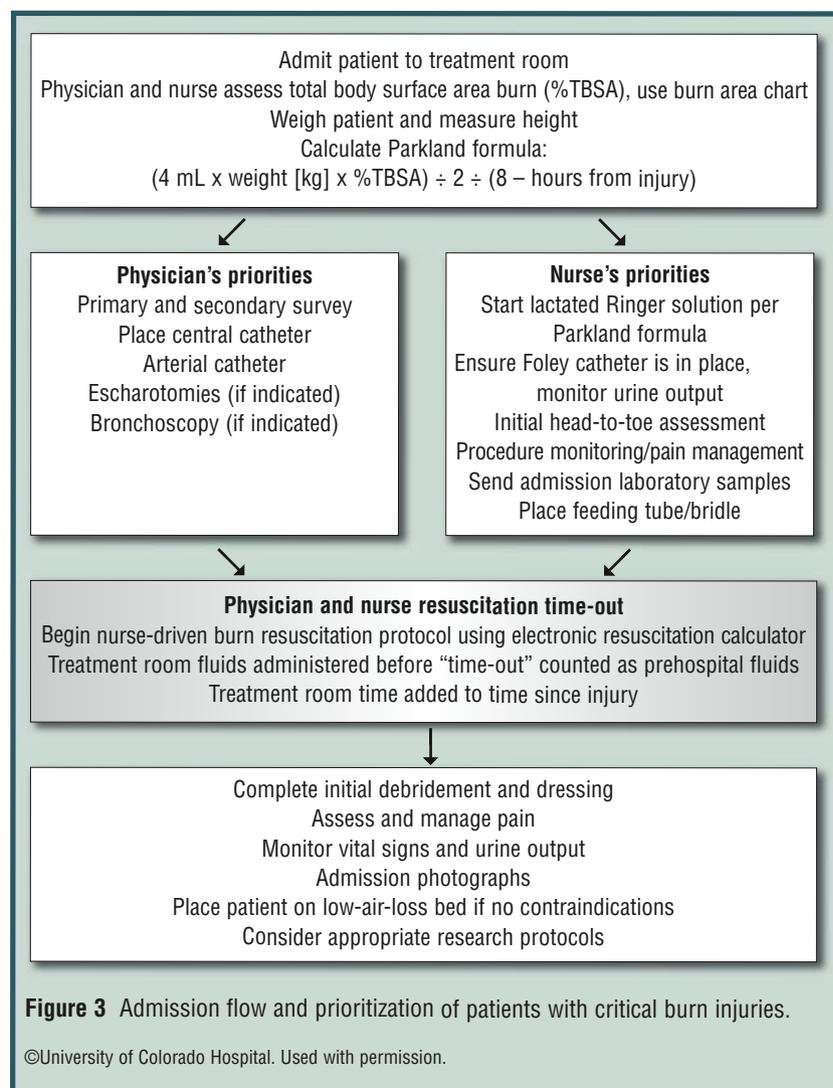
In this quality-improvement project, the total amount of resuscitation fluids administered to the postimplementation group was about 20% less than the total amount administered in the preimplementation group at 24 hours and 30% less at 48 hours, which decreases the risk of pulmonary complications following burn injury and resuscitation.<sup>20,25</sup> In this project, the incidence of ARDS within the first 5 days of admission was 30% in the preimplementation group and was reduced to 10% in the postimplementation group. After review of data, we found that the preimplementation group had more patients with inhalation injuries (47%) than the postimplementation group (38%), which may have contributed to the improved outcomes.

Several factors contribute to the ICU length of stay and duration of

mechanical ventilation, including the number of operating room visits, infections (wound, blood, and respiratory), sepsis, and overall time receiving continuous pain and sedation medications.<sup>27</sup> The longer ICU and ventilator days in the postimplimentation group are most likely due to some of the preceding factors. The clinical complications following burn injury are more profound in patients with burns involving a larger surface area. In a retrospective outcome analysis of 4094 patients, Muller and colleagues<sup>28</sup> reported that burn size was the strongest independent determinant of death following burn injury. The mean %TBSA burned was 11% higher in the postimplimentation group than in the preimplimentation group, which may have been a factor in the longer ICU stays in the postimplimentation group.

Data points for abdominal hypertension/abdominal compartment syndrome and ARDS/acute lung injury were not tracked beyond 5 days after admission in either group. Operating room trips and complications were not factored into ICU length of stay and duration of mechanical ventilation. The ICU length of stay and duration of mechanical ventilation are most likely not a direct result of the change in resuscitation practice, as pulmonary edema, ARDS, and abdominal compartment syndrome within the first 5 days of admission were all reduced with the implementation of the NDBRP.

Although we did have improved outcomes for patients with the NDBRP, ongoing adjustments to continually improve resuscitation practice have occurred in the burn ICU. Hourly resuscitation fluid volumes



were titrated by 20% rather than 10%, resulting in more rapid achievement of clinical fluid goals. An admission flow and prioritization algorithm was developed to assist the nurse and physician in establishing an immediate plan for care: assess the patient, determine %TBSA, and initiate the NDBRP (Figure 3). The use of an admission algorithm brought the burn team together and established a resuscitation “time out” that allowed a consensus on mutual resuscitation goals to be reached. In addition, a resuscitation calculator (Figure 4) was created to ease the process of calculating volumes when

following the protocol. Ongoing education with case study practice has proved to be essential in increasing caregivers’ comfort with and consistency in using the protocol.

### Limitations

The number of patients in whom the practice guideline was used was small; however, it was representative of the mean number of patients with large %TBSA burns admitted annually to this burn ICU, strengthening the clinical impact of the quality improvement practice changes learned from this project. Not all data could be compared from before to

## NDBRP Bedside Tool

**\*\*\*ONLY GRAY FIELDS MUST BE FILLED BY RN FOR CALCULATIONS\*\*\***

Patient Name: \_\_\_\_\_ Medical Record # \_\_\_\_\_

		TIME (00:00)		TOTAL HOURS SINCE INJURY (B - A) in decimal
Time of Injury	A	3:10		_____
Admission Time	B	3:33		

Ht	72.0	(cm)	Pre-Admission Fluids	2100	(ml)
Wt	54.5	(kg)	TBSA	40	%
BSA	_____	(m <sup>2</sup> )	<a href="#">Micromedex BSA Calculator</a>		

### PARKLAND:

4	(ml)	*	54.5	(kg)	*	40	%
= 24 hr fluid total							
= <span style="border: 1px solid black; text-align: center;">8720</span> ml							
1st 8 HRS =		1/2	Pre-admission fluid		(8hrs - x time from injury)		
4360		ml	2100	ml	/	8	
= LR @ <span style="border: 1px solid black; text-align: center;">283</span> ml/hr							
16 HRS =		1/2	=		273 ml/hr		
4360							

FFP:

100	ml	*	54.5	kg	=	Ivy Score 5450	ml
FFP start date and time:							
100ml*kg							
5450		ml	-	pre-admission fluids		Start FFP	
_____		ml	-	2100		12	
				ml		hr	
				/		after admission	
FFP Infusion Rate Calculation							
0.5ml*wt (kg)*%TBSA							
1090		/		8hrs		=	
						FFP Infusion Rate 136	
						ml/hr	

### Maintenance Rate:

(D5 1/2 NS + 20KCl)

54.5 kg + 40 ml

25 + TBSA  
65 % \* 0.0 (m<sup>2</sup>)

**Minimum Hourly Infusion Rate**

95 ml/hr

\*do not go below this rate w/out MD notification

**Figure 4** Bedside tool for the nurse-driven burn resuscitation protocol.

after implementation of the NDBRP, as some patients did not have certain indicators/outcomes measures documented in their medical records. Diagnoses of ARDS/acute lung injury, abdominal compartment syndrome, and so on were not always

documented by the physicians. Evidence of secondary lung complications was obtained only through physicians' notes in patients' charts, not clinical variables such as radiographic reports and ratios of Pao<sub>2</sub> to fraction of inspired oxygen. Data

abstraction was dependent on the charting available (eg, medical record retrieval process) including charting of prehospital fluid administration, creating variability in data elements tracked. Last, this was a quality improvement project;

findings from this project may not be transferable to other burn ICU practices.

Despite the mentioned limitations experienced in this quality improvement project, the high quality of the project and our ability to obtain meaningful data for critically examining the practice change were apparent. The quality improvement process used to examine practice resulted in improved practice and better outcomes for patients.

## Summary

As a result of the NDBRP, nurses appeared to have a heightened awareness of the process of fluid resuscitation, including close assessment of multiple fluid resuscitation end points that required rapid reaction and changes in administration of intravenous fluids. The registered nurses demonstrated an increased comfort with decreasing intravenous fluid volumes while meeting patients' needs for tissue perfusion. This increased comfort was evident in the hourly fluid changes according to the protocol that resulted in an overall decrease in fluid resuscitation volumes found in this project (eg, 4.2 mL/kg per %TBSA). The nurses appreciated more the deleterious effects of both underresuscitation and overresuscitation. Further exploration of fluid resuscitation guidelines or unit protocols such as this NDBRP is encouraged in burn units to continue

efforts to improve practice and outcomes for burn-injured patients.

This quality improvement project demonstrates how changes in practice, specifically implementation of a resuscitation practice protocol, can be effectively implemented into practice to improve patients' outcomes. The NDBRP increased nurses' resuscitation accountability and autonomy. Nurses can implement evidence-based change in their practice areas by using similar quality improvement methods. As a result of this quality improvement project, professional relationships, patients' outcomes, and job satisfaction were strengthened in this burn ICU. **CCN**

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None reported.

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