Decision Support System for Burn Resuscitation Improved Patient Outcomes

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The use of Army medical and/or other Army records in the preparation of this material is acknowledged, but is not to be construed as implying official Department of the Army approval of the conclusions presented.

Abstract

Introduction. Over and under resuscitation of burn patients is not uncommon. Urinary outputs (UOP) outside the standard of care (30 – 50 ml/hr) may lead to higher complication rates and increased morbidity and mortality. We have developed a computerized decision support system (CDSS) in our institute that provider users with recommendations for crystalloid infusions in burn patients with greater than 20% TBSA. The objective of this study was to determine if this improved patients fluid management and outcomes in our patient population.

Methods. The CDSS system provides a network deployable solution that can be extended to all ICU beds. Users are provided with an initial fluid recommendation based on the patient history and available data. Hourly or ½ hour fluid infusion recommendation rates are displayed to the care provider who then chooses to accept or reject rates. Recommendations are based on a fluid response algorithm and model that was derived empirically by analyzing the response curves of 30 burn patients in our institution. System was deployed as standard of care for patients with greater than 20% TBSA. Data from admissions from November 2007 to January 2009 that used the CDSS system were compared against 40 control patients resuscitated before CDSS deployment.

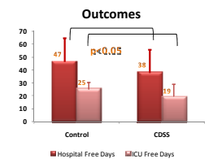
Results. There was no significant difference between the model set and CDSS groups for TBSA, full thickness burn, inhalation injury, age, or admission weight. Patients on the DSS system had a significant lower overall mortality rate. Total crystalloid volume over resuscitation period, total crystalloid icu volume, and initial 24 hour crystalloid icu volumes were all significantly lower in the CDSS groups. Additionally ratios of ml/kg and ml/kg/TBSA were also significantly lower on DSS patients. Patients on the CDSS system met target UOP values a significantly higher percentage of the time. Hospital free days and icu free days were significantly lower in the CDSS group. Ventilator days were not significantly different. Military admissions did not show improvement in any measured outcomes during the same period.

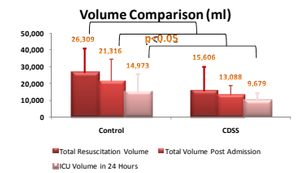
Conclusions. A network deployable decision support system for burn ICUs was developed for use in our institutes. The system is based on a standardized flowchart concept which provides a graphical representation of the resuscitation algorithm and recommendations in addition to providing intuitive fluid balance graphics and tools. CDSS use for burn resuscitation in the ICU resulted in better outcomes for mortality and fluid administration during the initial 48 hours post-burn for patients with > 20% TBSA. All measures of crystalloid fluid volume were reduced while maintaining patients within clinical targets a higher percentage of time.

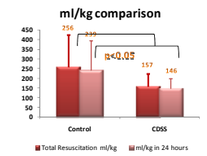
Introduction

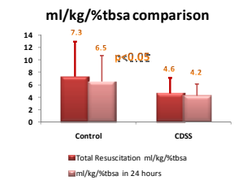
Because acute burn care is particularly labor intensive and can quickly overwhelm even the best hospitals and burn centers. Critical to survival are the initial 48 hours of post-burn resuscitation. During this phase, patients require prompt initiation of fluid therapy, and around-the-clock care by experienced care providers which is not found in most hospitals.

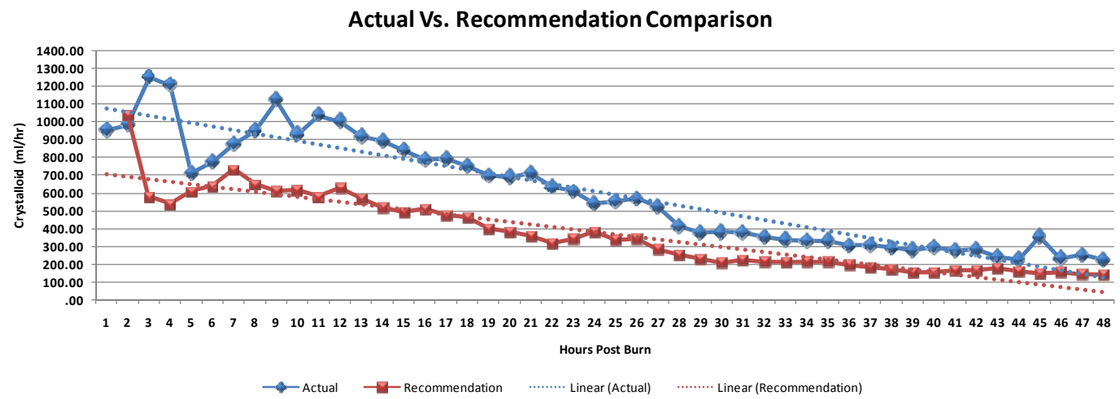
Delayed or inadequate fluid resuscitation is associated with increased morbidity and mortality. Initial treatment currently consists of isotonic crystalloid infusion based on a regimen that is directed towards volume replenishment to obtain cardiovascular stabilization and maintain adequate renal function. Using information technology and closed loop techniques, systems can be developed that provide personnel with guidance during acute burn resuscitation. These decision support systems (DSS) attempt to incorporate the expertise of experienced care providers into a automated system that can be used to assist personnel during acute resuscitation.

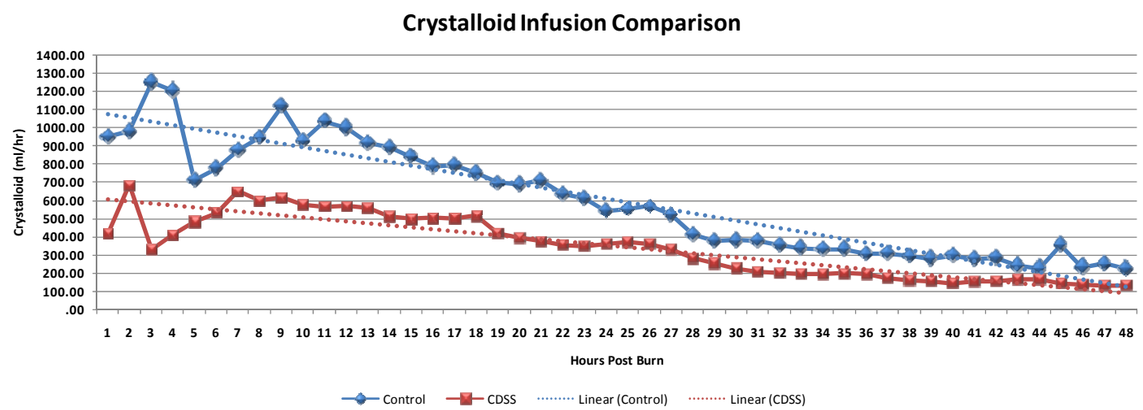


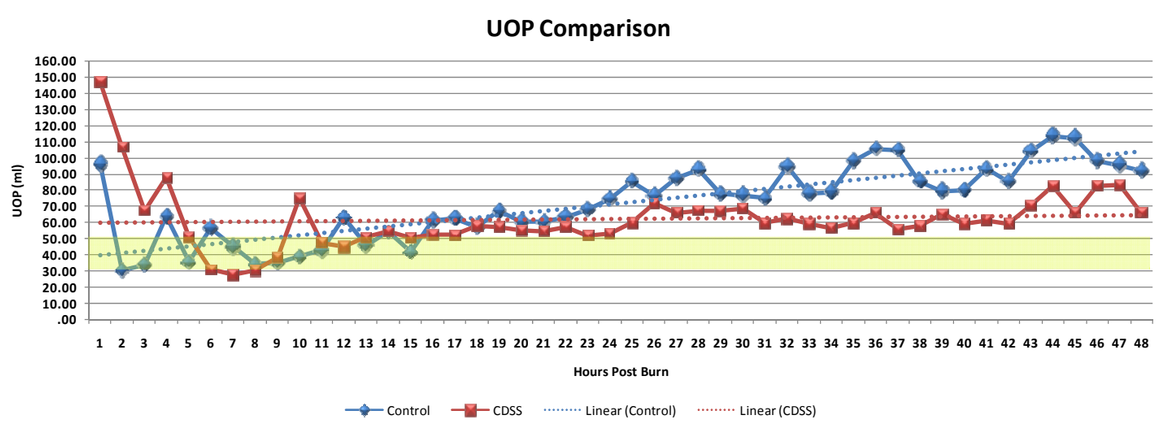












Methods

CDSS system was implemented as the standard of care for all admissions to our burn unit in November 2007. Historical control data from 40 patients captured during model development was compared against patients on CDSS system admitted from November 2007 to January 2008 and analyzed for improvements in crystalloid fluid management, hospital outcomes, rates of complications, and mortality. 66 patients were resuscitated using the CDSS for at least 1 hour during the ICU stay. Analysis included patients on CDSS system that had at least 24 hours of recommendations from the software. Patients that did not have 24 hours of recommendations due to clinical complications, mortality, or other factors were excluded from analysis. Control cohort included only patients that survived for the initial 24 hours post admission and had at least 24 hours of fluid resuscitation. This resulted in 32 patients for analysis in the CDSS group and 38 patients in the historical control cohort. Mann-Whitney and Chi-Square tests were used for comparison of variables using the SPSS (SPSS Inc, Chicago, IL) analysis system. Analysis variables included mortality, 24 hour crystalloid volume, overall crystalloid volume, prehospital volume, ml/kg rate, ml/kg/tbsa rate, percentage of time within target. Hospital free days, icu free days, and ventilator free days were used to analyze differences in outcomes between the two groups.

Results

58 patients were resuscitated with the CDSS system from November 2007 to January 2009 with at least 20% TBSA. There were 32 patients resuscitated with the CDSS that had at least 24 hours of recommendations during the initial 48 hours post burn. 38 historical control patients met criteria for inclusion in analysis. Both DSS and control patient cohorts had statistically similar values for %TBSA, age, weight, and rate of inhalation injury. DSS patients had statistically lower total volume over 48 hours ($p<0.05$) , total volume over 24 hours ($p<0.05$), and total icu volume over 24 hours (does not include prehospital fluids). Additionally, DSS patients had lower ml/kg values ($p<0.05$) and ml/kg/%tbsa values ($p<0.05$). Also DSS patients had statistically better UOP values within target ($p<0.05$). Prehospital fluids was significantly lower in the CDSS group.

Mortality in the CDSS group was reduced from 44.1% to 29% ($p<0.05$). CDSS patients had lower hospital free days and icu free days ($p<0.05$). Ventilator free days was not different between groups.

Conclusion

Using an automated DSS system for initial burn resuscitation resulted in lower fluid delivered compared to our control cohort. Patients on the DSS system had statistically lower ml/kg and ml/kg/%tbsa than controls as well as overall fluid requirements at both 24 and 48 hours post burn. CDSS system achieved the target UOP a statistically larger percentage of the time. Patient mortality, hospital free days, and icu free days were also reduced in CDSS patients. The CDSS system provides an example of patient care improvement using information technology.