Acute Kidney Injury, Burn Resuscitation, and a Novel, Visualization Approach to Resuscitation Review at University of Louisville Hospital

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Disclosure Information	Authors and Co-authors have no relevant financial relationships to declare.

Abstract

Background: A review of patients who sustained 20% or greater total body surface area (TBSA) burns from the 2019 University of Louisville Hospital (ULH), burn-patient census (n=33) found ≈ 58% of the patients to have sustained a stage-I (n = 5; ≈ 15%), stage-II (n = 4; ≈ 12%), or stage-III (n = 10; ≈ 30%) acute kidney injury (AKI). Of those patients who sustained an AKI (n = 19), 63% did not survive their burn injuries (n = 2 stage-I; n = 2 stage-II; n = 8 stage-III). A cursory review of the literature shows ranges from 30% to 40% of qualifying, burn patients to have sustained an AKI (Clark, Neyra, Madni et. al., 2017; Folkestad, Bruberg, Nordhuus et. al., 2020). These findings prompted an investigation into the current resuscitation measures used for patients who sustained a burn injury of 20% or greater TBSA at ULH. The Parkland Formula and the Rule of 9's (Baxter & Shires, 1968; Mehta & Tudor, 2019) were used to determine the resuscitation needs of the patients in this investigation.

Methods: Information about net-totals of inputs and outputs (I&O) is readily available for each patient, and with some effort hourly values of I&Os is also obtainable. Presenting these numbers in table-form, however, was both cumbersome to create and difficult to quickly communicate to various disciplines (i.e. physicians, nursing, pharmacy, and non-clinical staff). Therefore, a visual approach was chosen to better understand how each patient was resuscitated in the first 24 hours of the burn injury. To accomplish this, the software package R (R Core Team, 2020) was used to clean data and create a graphical representation of the following variables:

a.) Urine output (UOP)
b.) Nurse charting for inputs (e.g. fluid boluses, liquid medications, resuscitation fluid etc.)
c.) Orders by the M.D. for resuscitation fluids
d.) Pre-hospital fluids
e.) Lab values (e.g. serum creatinine, blood gasses, alcohol levels etc.)
f.) Vital signs (e.g. blood pressure, temp, heart rate etc.).

Using this software an interactive dashboard was created to allow users to interact with the graphs and visualize not only the numerical values associated with resuscitation, but to also see how each of these numbers relate to each other in an hourly timeline (e.g. when resuscitation fluids are reduced UOP also decreases, creatinine elevates, blood pressure decrease etc.).

Results: After presenting the interactive dashboard to key members of the burn program, it was determined that while many patients have an excess of resuscitation fluid administered in the first 24 hours of burn injury, as compared to the calculated Parkland Formula requirements, inconsistencies of hourly administration of fluids were frequently observed. For example, when fluids are reduced by half, as is the practice using the Parkland Formula (Baxter & Shires, 1968; Mehta & Tudor, 2019), some patients would receive multiple boluses in response to drops in UOP or blood pressure, whereas others would not receive more fluid until a need for a vasopressor to maintain adequate blood pressure was evident.

1. Therefore, the decision was made to align resuscitation practices with the American Burn Association's (2018) consensus for burn resuscitation in order to respond to changing fluid statuses and resuscitation needs in a more proactive and timely manner.
2. Additionally, the charting standards for nursing as they relate to I&Os was found to be problematic in recounting exactly how much fluid a patient received each hour, thus charting practices were adjusted to more accurately capture this information.
3. Finally, the dashboard is being used to discuss the resuscitation efforts in a timely manner. The dashboard has been used during burn rounds, as well as, at the bedside during the resuscitation window, as opposed to reviewing information weeks or months later.

Conclusion: While the dashboard used for assessing burn resuscitation is a relatively new tool and approach at ULH, the ability to visually recount the resuscitation efforts of each patient has opened the conversation about best practices. Additionally, it has allowed more disciplines to participate in the conversations due to the ease with which the presented information can be disseminated and explained to the layperson. This has allowed for more people to become stakeholders in the burn program. Finally, while the front-end effort to create the dashboard was extensive, the reproducibility of graphic visualizations for new patients is now quick and accurate. As such further uses and applications of dashboards are being explored for other aspects of burn care management at ULH.

Learning Objectives
1. Participants will see alternative strategies for evaluating resuscitation and AKI in burn patients.
2. Participants will gain a conceptual idea of what visual representation of resuscitation can look like.
3. Participants will see the value of visual representation as a means of communicating large amounts of data.

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