Infection/Inflammation

Performance of Quick Sequential (Sepsis Related) and Sequential (Sepsis Related) Organ Failure Assessment to Predict Mortality in Patients with Acute Pyelonephritis Associated with Upper Urinary Tract Calculi

Hiroshi Fukushima,* Masaki Kobayashi, Keizo Kawano and Shinji Morimoto

From the Department of Urology, Tsuchiura Kyodo General Hospital, Tsuchiura, Japan

**Abbreviations
and Acronyms**

APN-UTC = acute pyelonephritis associated with upper urinary tract calculi

BMI = body mass index

FiO2 = inspired oxygen fraction

GCS = Glasgow Coma Scale

ICU = intensive care unit

IDI = integrated discrimination improvement

NRI = net reclassification improvement

PaO2 = partial pressure arterial oxygen

qSOFA = quickSOFA

Sepsis-3 = Third International Consensus Definitions for Sepsis and Septic Shock

SIRS = systemic inflammatory response syndrome

SOFA = Sequential (Sepsis-related) Organ Failure Assessment

WBC = white blood count

Purpose: The Third International Consensus Definitions for Sepsis and Septic Shock Task Force proposed a new definition of sepsis based on the SOFA (Sequential [Sepsis-related] Organ Failure Assessment) score and introduced a novel scoring system, quickSOFA, to screen patients at high risk for sepsis. However, the clinical usefulness of these systems is unclear. Therefore, we investigated predictive performance for mortality in patients with acute pyelonephritis associated with upper urinary tract calculi.

Materials and Methods: This retrospective study included 141 consecutive patients who were clinically diagnosed with acute pyelonephritis associated with upper urinary tract calculi outside the intensive care unit. We evaluated the performance of the quickSOFA, SOFA and SIRS (systemic inflammatory response syndrome) scores to predict in-hospital mortality and intensive care unit admission using the AUC of the ROC curve, net reclassification, integrated discrimination improvements and decision curve analysis.

Results: A total of 11 patients (8%) died in the hospital and 26 (18%) were admitted to the intensive care unit. The AUC of quickSOFA to predict in-hospital mortality and intensive care unit admission was significantly greater than that of SIRS (each p <0.001) and comparable to that of SOFA (p = 0.47 and 0.57, respectively). When incorporated into the baseline model consisting of patient age, gender and the Charlson Comorbidity Index, quickSOFA and SOFA provided a greater change in AUC, and in net classification and integrated discrimination improvements than SIRS for each outcome. Decision curve analyses revealed that the quickSOFA and SOFA incorporated models showed a superior net benefit compared to the SIRS incorporated model for most examined probabilities of the 2 outcomes. The in-hospital mortality rate of patients with a quickSOFA score of 2 or greater and a SOFA score of 7 or greater, which were the optimal cutoffs determined by the Youden index, was 18% and 28%, respectively.

Conclusions: SOFA and quickSOFA are more clinically useful scoring systems than SIRS to predict mortality in patients with acute pyelonephritis associated with upper urinary tract calculi.

Key Words: kidney, urinary calculi, sepsis, hospital mortality, decision support techniques

In 1991 sepsis was defined as a combination of SIRS and infection.[1] However, SIRS focuses only on excess inflammation and was found to be too sensitive and not sufficiently specific to identify patients with infection who were at higher risk for mortality.[2,3] Recently the Sepsis-3 Task Force redefined sepsis as "life-threatening organ dysfunction caused by a dysregulated host response to infection," in which organ dysfunction was characterized by SOFA.[4] In addition, the Sepsis-3 Task Force proposed qSOFA as a simpler scoring system for the initial screening of patients at high risk for sepsis.[4] However, the clinical usefulness of qSOFA and SOFA to predict mortality is still unclear. Moreover, given the anatomical, clinical and pathophysiological heterogeneity of infectious diseases, predictive performance may differ depending on the disease.

Urosepsis, which accounts for 20% to 30% of all septic cases, mainly results from obstruction of the urinary tract.[5,6] APN-UTC is a common infectious disease associated with upper urinary tract calculi. In addition to antibiotic administration, it often requires emergent decompression of the urinary tract by percutaneous nephrostomy or an indwelling ureteral stent.[7-9] APN-UTC, which can be lethal, requires an ICU stay if complications arise such as sepsis, septic shock and disseminated intravascular coagulopathy.[10,11] Reportedly the mortality rate of APN-UTC is approximately 2% overall but it can be as high as 10% in patients at high risk who have sepsis and septic shock.[9,10,12]

In the current study we investigated the performance of qSOFA and SOFA to predict in-hospital mortality and ICU admission, and compared it with that of SIRS in patients with APN-UTC.

MATERIALS AND METHODS

Patients

We retrospectively reviewed the medical charts of 144 consecutive Japanese patients who were clinically diagnosed with APN-UTC and treated at our institution between January 2012 and July 2017. In patients who were diagnosed with APN-UTC multiple times the most severe episode was recorded. Three patients were excluded from study due to APN-UTC secondary to surgical interventions for urolithiasis. The remaining 141 patients were included in analysis, of whom 138 presented to the urology outpatient department or the emergency department and 3 experienced onset in the hospital.

Acute pyelonephritis was diagnosed by physicians based on symptoms (fever and flank pain), urinalysis/culture (presence of pyuria and bacteriuria) and blood tests (elevated WBC and C-reactive protein). The presence of calculi was confirmed by computerized tomography in all patients. Patients with nonobstructive calculi were also included in the current study. All patients were treated with antibiotics. The drainage method (percutaneous nephrostomy or indwelling ureteral stent) was determined at physician discretion.

The collected variables were patient age, gender, ECOG PS (Eastern Cooperative Oncology Group Performance Status), BMI, medical history, Charlson Comorbidity Index,[13] body temperature, respiratory rate, heart rate, blood pressure, GCS, urine and blood culture results, calculus location and size, drainage method, time from APN-UTC onset to drainage, WBC, platelet count, PaO2, PaO2/FiO2, creatinine, albumin, bilirubin and C-reactive protein. BMI was calculated using the equation, BMI in kg/m^2 = (weight)/(height)^2. The institutional ethical committee approved the current study protocol (approval No. 582).

Assessment of Quick Sequential (Sepsis Related) Organ Failure Assessment, Sequential (Sepsis Related) Organ Failure Assessment and Systemic Inflammatory Response Syndrome Scores

The qSOFA criteria include systolic blood pressure 100 mm Hg or less, respiratory rate 22 breaths per minute or greater and altered mental status with the latter defined as GCS less than 15.[4] SOFA was determined using PaO2/FiO2, platelet count, bilirubin, mean arterial pressure and the use of vasoactive drugs, GCS, and creatinine and urine output.[4] SIRS criteria included temperature greater than 38C or less than 36C, heart rate greater than 90 beats per minute, respiratory rate greater than 20 breaths per minute or CO_2 partial pressure less than 32 mm Hg, and WBC greater than 12,000 or less than 4,000/μl, or more than 10% immature forms (bands).[1]

To calculate qSOFA, SOFA and SIRS we used the worst physiological and laboratory data measured during the initial 28 hours of hospital admission in patients who presented to the urology outpatient department or the emergency department. In patients with in-hospital onset we used those data during the initial 28 hours of disease onset according to the previous study.[14]

Outcomes

The primary outcome was in-hospital mortality. The secondary outcome was ICU admission.

Statistical Analysis

Differences in the distribution of variables between the groups were evaluated by the chi-square test for categorical variables and the Wilcoxon rank sum test for continuous variables. The predictive accuracy of qSOFA, SOFA and SIRS for in-hospital mortality and ICU admission was