Accuracy of urine dipstick in the detection of patients at risk for crush-induced rhabdomyolysis and acute kidney injury

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Objectives **To evaluate the utility of urine dipstick test (UDT) for detecting rhabdomyolysis and acute kidney injury (AKI) due to crush injury.**

Methods **All the rescued victims of the Bam earthquake who had a documented urine analysis and serum creatine phosphokinase and creatinine levels during their hospitalization period were eligible to enter the study. The sensitivity and the specificity, along with the positive and negative likelihood ratios, of UDT in detecting at-risk patients for rhabdomyolysis and crush-related AKI were calculated.**

Results **Urine red blood cell count of 5 or less in blood-positive UDT, as a surrogate marker for myoglobinuria, was reported in 210 (31.7%) of the total 1821 urine analyses. Blood-positive UDTs (without considering the urine red blood cell count) had a 92.5% (95% confidence interval: 79.6–98.4) sensitivity in creatine phosphokinase, with a cut-off of 15 000 (IU/l). Comparing the results of the serum creatinine level and the urine blood, analysis showed that UDT had a sensitivity and a specificity of as high as 83.3 and 56.6% in detecting high-risk patients for AKI, respectively.**

Conclusion **UDT can be considered as an early screening tool for the detection and triage of patients at risk of developing AKI because of traumatic rhabdomyolysis after mass disasters.** ***European Journal of Emergency Medicine*** **19:329–332 © 2012 Wolters Kluwer Health | Lippincott Williams & Wilkins.**

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Introduction

Crush-induced rhabdomyolysis and its complications are the most frequent cause of morbidity and mortality during natural disasters [1,2]. Many clinical features of traumatic rhabdomyolysis are nonspecific, and the course of the syndrome varies depending on the underlying condition [3]. A wide spectrum of muscle trauma ranging from transient and mild hyperkalemia, hypocalcemia, myoglobinemia, and increased serum levels of creatine phosphokinase (CPK) to more serious systemic complications of a crush syndrome such as acute kidney injury (AKI) are reported in these cases [4,5]. Early detection of patients at risk for rhabdomyolysis and AKI, and the initiation of prompt prophylactic therapy, can prevent the extent of life-threatening complications [6–8]. Therefore, an easy and applicable test such as using a urine dipstick test (UDT) for detecting myoglobinuria, and screening high-risk victims at the scene of disaster is needed [9]. Despite the pathogenic impact of myoglobin in rhabdomyolysis-induced AKI, the compound is seldom measured directly in the urine or the serum. UDT is unable to distinguish between myoglobin and hemoglobin. In the absence of red blood cells (RBCs) in a fresh spun sediment of urine, positive UDT for 'blood' can be used as a surrogate marker for myoglobin [3]. UDT had long been used for detecting rhabdomyolysis induced by certain conditions including heat injury, general convulsions, immersion, and near-drowning and extreme exercise [10–14]. In the present study, we evaluated the accuracy of UDT, with and without urine RBCs, in detecting patients at risk of developing crush-induced AKI among the victims of the Bam earthquake.

Materials and methods

This is a retrospective cohort study, examining patients admitted to the hospital after the Bam earthquake. A questionnaire consisting of information on the clinical, biochemical, and demographic data was completed for patients who had been admitted to hospitals, during the Bam earthquake (15 centers in seven cities; Bandarabbas, Bushehr, Esfahan, Kerman, Shiraz, Tehran, and Zahedan). All victims with a documented urine analysis and CPK and creatinine levels were included in the analyses. Patients with a history of chronic renal failure and AKI due to causes other than crush were excluded. UDT (Uriyab-8 tapes; Bakhtar Chimie company, Tehran, Iran) was performed by the treating physician or laboratory personnel, using voiding or catheterization samples, during the 12–36 h after extrication. The reactions, considered as either positive (from 1+ to 4+) or negative, were evaluated by comparing the strip test areas with the color chart printed on the bottle. AKI was

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defined as an acute loss of renal function with a persistent (at least two times in two different days) elevation in creatinine levels ($\geq$ 1.6 mg/dl or $\geq$ 141 μmol/l).

CPK and creatinine levels were considered as the gold standard test for rhabdomyolysis and AKI, respectively.

Statistical analysis

Analyses were performed utilizing the STATA (8.0) statistical software (StataCorp. LP, Texas, USA). Data were expressed as mean ± SD or as the number of patients. The sensitivity and specificity along with the positive and negative likelihood ratios of UDT (without considering the RBC count) in detecting the patients at risk of developing rhabdomyolysis and crush-induced AKI were calculated.

Results

Demographic

Clinical and laboratory data of 2962 hospitalized victims, with a mean age of 28.4 years (SD: 14.2, ranging from 1 to 90 years) were analyzed. About 40% of the hospitalized patients were females. Documented results of UDT were present in 1821 cases and that of CPK level in 1269 cases. The mean of CPK was 3608 ± 8868 IU/l (minimum: 200; maximum: 140 000). Nearly 611 (20%) patients were affected with moderate rhabdomyolysis (CPK > 1000 IU/l), whereas 200 (6.7%) developed AKI and 154 (5%) needed hemodialysis. Table 1 outlines the urine analysis in the 1821 cases studied. About 50.8% (926) of the UDTs were positive for blood, 19% (346) for protein, 10.9% (197) for ketones, and 6% (108) for casts.

Table 1 Results of 1821 urine analyses of the hospitalized Bam earthquake victims

Urine analysis	Value	Number (%)
Protein	Negative	1475 (81)
–	≥ 1+	346 (19)
Cast	Negative	1713 (94)
–	≥ 1+	108 (6)
Keton	Negative	1624 (89.1)
–	≥ 1+	197 (10.9)
Blood	Negative	895 (49.1)
–	1+	276 (15.1)
–	2+	186 (10.2)
–	3+	282 (15.4)
–	≥ 4+	162 (7.6)
RBC	Negative	441 (24.2)
–	≤ 5	662 (36.3)
–	5–50	711 (39.0)
–	>50	7 (0.03)

RBC, red blood cell.

Urine dipstick test and creatine phosphokinase (considering the urine red blood cell count)

A urine RBC of less than 5 and blood-positive UDT, as a surrogate marker for myoglobinuria, were reported in 210 (31.7%) of the urine analyses. The sensitivity and the specificity of myoglobinuria for a serum CPK cut-off of 1000 IU/l were 56.6% [95% confidence interval (CI): 37.1–62.5] and 67.5% (95% CI: 58.2–73.4), respectively.

Urine dipstick test and creatine phosphokinase (without considering the urine red blood cell count)

A total of 862 cases had documented results of UDT and CPK simultaneously. Table 2 shows the sensitivity, the specificity, and the positive and negative likelihood ratios of UDT for detecting rhabdomyolysis in different cut-offs of serum CPK. Blood-positive UDTs (without considering the urine RBC count) had a 92.5% (95% CI: 79.6–98.4) sensitivity for a CPK cut-off of 15 000 (IU/l).

Urine dipstick test and creatinine (without considering the urine red blood cell count)

A total of 1710 cases had documented results of UDT and creatinine at the same time. Comparing the results of the serum creatinine level and the urine blood, analysis showed that UDT had a sensitivity and a specificity of as high as 83.3 and 56.6% in detecting high-risk patients for AKI ($\geq$ 1.6 mg/dl or $\geq$ 141 μmol/l), respectively.

Discussion

The results showed that blood-positive UDTs (without considering the RBC count) had a sensitivity of 92.5 (95% CI: 79.6–98.4) for a CPK cut-off of 15 000 (IU/l). In mass disasters, early detection of patients at risk for traumatic rhabdomyolysis and prompt initiation of prophylactic fluid therapy has been extensively emphasized [7,15,16]. CPK is the quickest and least expensive screening test for rhabdomyolysis in the hospital settings [17]. Considering the insufficiency of medical equipment resources and personnel at the early postextrication period of disaster, the use of CPK as an effective screening tool is often impossible. A positive urine myoglobin test, however, is capable of providing supportive evidence of rhabdomyolysis [3]. Myoglobinuria can be inferred when UDT is reported to be positive for blood in the absence of RBCs ($\leq$ 5) in the microscopic evaluation of urine sediment. Previously, it had been suggested that urinary myoglobin levels can indicate the risk of AKI development; nevertheless, later it was noted that AKI does not necessarily develop in the presence of significant myoglobinuria [18,19]. Utilization of UDT is associated with the potential risk of misdiagnosis in patients with serum myoglobin concentrations lower than 60 000 μg/l [20]. A negative result of myoglobinuria in UDT, however, does not rule out rhabdomyolysis [21]. In a review conducted by Melli G and colleges, 19% of the patients with rhabdomyolysis had myoglobin-positive UDTs [21]. In our study, similarly, 10.9% (47/429) of patients with a CPK of more than 1000 IU/l had blood-positive UDT and a urine RBC count of 5 or less, as a surrogate marker for myoglobin. Lack of facilities such as light microscopes, centrifuges, and even electricity for standard urine analysis and detection of RBCs is a critical and practical concern at the early postextrication period after disasters. As a result, we decided to assess the efficacy of UDT in

Table 2 Sensitivity, specificity, positive likelihood ratio, and negative likelihood ratio of blood-positive urine dipstick test (without considering the red blood cell count) for the detection of rhabdomyolysis at different serum creatine phosphokinase cut-offs

Serum CPK (IU/l)	Number (%[a])	Sensitivity (95% CI)	Specificity (95% CI)	PLR	NLR
≥ 500	571 (66.2)	51.8 (47.6–56)	61.8 (58.2–64)	1.35	0.77
≥ 1000	445 (51.6)	55.9 (51.2–60.6)	62.1 (59.3–66.1)	1.47	0.71
≥ 5000	157 (18.2)	72.6 (64.9–79.4)	58.4 (54.9–61.7)	1.75	0.46
≥ 10 000	73 (8.4)	82.1 (71.4–90.1)	56.0 (52.3–61.2)	1.86	0.31
≥ 15 000	40 (4.6)	92.5 (79.6–98.4)	54.9 (49.9–58.7)	2.05	0.13
≥ 20 000	35 (4)	93.1 (77.2–99.1)	54.3 (50.1–59)	2.03	0.12

CI, confidence interval; CPK, creatine phosphokinase; NLR, negative likelihood ratio; PLR, positive likelihood ratio.
[a]Number/862.

detecting rhabdomyolysis in such cases. The results revealed that blood-positive UDTs (without considering the urine RBC count) have a sensitivity of 55.9% (51.2–60.6) and a specificity of 62.1% (59.3–66.1) at a serum CPK cut-off of 1000 IU/l. As shown in Table 2, any increase in serum CPK cut-offs from 500 to 20 000 is associated with an increase from 51.8 to 93.1% in the sensitivity. There is, however, no defined threshold value for serum CPK levels, above which the risk of AKI would increase markedly [22]. It should, however, be noted that the risk of AKI is usually low when serum CPK levels at the admission time are less than 15 000 – 20 000 IU/l [23–25]. Among the patients admitted with crush injury, those presenting with the complete feature of crush syndrome and AKI had significantly higher serum levels of CPK [4348 ± 5978 (IU/l) vs. 25 561 ± 28 569] [4]. It could be, therefore, concluded that UDT (without considering the urine RBC count) can be considered as a fast and applicable screening test for detecting high-risk patients with severe rhabdomyolysis at the chaotic early postextrication period. Comparing the results of serum creatinine levels and urine blood in AKI-positive patients showed that UDT (without considering the RBC count) has a sensitivity and a specificity of 83.3 and 56.6%, respectively, in detecting high-risk patients.

Limitations

The chaotic aftermath of an earthquake, missing data, multicenter management of patients using different protocols, lack of instrument, and lack of evidence regarding the type and severity of trauma were some of the limitations of the present study. The presence of blood in urine causes false-positive readings, which may negatively influence the sensitivity, the specificity, and the accuracy of UDT. In addition, in some of our cases, there was a 36-h gap between the earthquake and the performance of UDT. Thus, it is possible that this gap and therapeutic efforts in this time interval influence the final results.

Conclusion

UDT can be considered as an early screening tool for the detection and triage of patients at a high risk of developing AKI because of traumatic rhabdomyolysis at the postextrication period of mass disasters.

Acknowledgments

Conflicts of interest

There are no conflicts of interest.

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