

Cystatin C: A Reliable Biomarker for Renal Function Damage in Severely Burned Patients

Jingyao Lia^{1*}, Xiangyun Lib² and Jing Haoc³

¹Hepatology Department of Hebei Traditional Chinese Medicine Hospital, China

²Department of Hepatobiliary surgery, Xingtai People's Hospital, China

³Department of Hepatobiliary surgery, Xingtai People's Hospital, China

***Corresponding author:** Jingyao Li, Hepatology Department of Hebei Traditional Chinese Medicine Hospital, No. 389 Zhongshan East Road, Chang'an District, Shijiazhuang City, Hebei Province, China

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ABSTRACT

Objective: To explore the significance of serum cystatin C in the diagnosis of early renal function damage in severely burned patients.

Method: Serum Cys C, BUN, and Scr values were monitored in 36 severe burn patients at 12 hours, 1 day, 2 days, and 3 days after burn, and statistically analyzed with the serum Cys C, BUN, and Scr values of mild burn patients at the same time.

Result: The serum Cys C, BUN, and Scr values of severe burn patients were higher than those of mild burn patients during the same period ($p < 0.01$), with significant statistical significance; The positive detection rate of serum Scr reached 52% 2 days after injury, reaching 69% at 3 days, with the highest positive rate; The positive detection rate of serum BUN also reached 52% 3 days after injury; The positive detection rate of serum Cys C reached 16% 12 hours after injury, which was significantly higher than the other two indicators ($p < 0.01$). The positive detection rate reached 36% on the first day after injury, and the difference was statistically significant. The positive detection rate on the second and third days after injury was basically the same as the change in Scr; As the injury time of severely burned patients prolongs, the detected indicators of renal function gradually increase.

Conclusion: The changes in serum Cys C values can better detect renal injury in the early stage and provide a basis for clinical early treatment.

Keywords: Urea; Nitrogen; Creatinine Cystatin C; Severe Burns; Renal Function

Abbreviations: GFR: Glomerular Filtration Rate; BUN: Urea Nitrogen; NGAL: Neutrophil Gelatinase Associated Lipid Transport Protein; CPI: Cysteine Protease Inhibitor; MSA: Multiple System Atrophy; ACS: Acute Coronary Syndrome

Introduction

Severe burn patients often experience multiple organ failure, and renal function damage is also one of the earliest complications. In severe cases, it often poses a threat to life, especially for patients with unstable burn shock, the chances of renal function damage are greater and the consequences are more severe. Cystatin C (Cys C) is a new

indicator of glomerular filtration rate (GFR) discovered by Grubb et al. in Sweden in the 1980s, which has high specificity, good accuracy, and is more sensitive than creatinine clearance rate [1]. The author investigated the clinical value of serum cystatin C (Cys C), urea nitrogen (BUN), and creatinine (Scr) levels in severe burn patients (TBSA $\geq 50\%$ burn area) by monitoring their levels.

Materials and Methods

General Information

From January 2015 to December 2022, there were 36 adult patients with severe burns admitted to Xingtai People's Hospital, including 31 males and 5 females, serving as the observation group; Forty adult patients with mild burns (TBSA \leq 10% burn area) in the same period were selected as the control group, including 23 males and 7 females; All patients were admitted to the hospital within 6 hours after injury, and there were unequal amounts of crystals, colloids, or water input in the local area before admission. Exclusion criteria: [1] Individuals with a history of chronic kidney disease; [2] Those who have no history of kidney disease but are found to have abnormal renal function during hospitalization physical examination; [3] Have a history of diabetes, lupus erythematosus and renal tumor; [4] There were no obvious burn shock symptoms before admission.

Method

On the morning of admission at 6:30 am, 3 ml of fasting venous blood was collected to measure the serum Cys C, BUN, and Scr values at 12 hours, 1 day, 2 days, and 3 days after injury. Author unit reference values, Cys C 0.54-1.51mg/L, BUN 2.5-7.5mmol/L, Scr 45-84umol/L.

Instrument

Hitachi 7600 fully automatic biochemical analyzer.

Reagent

Urea nitrogen (BUN) detection kit (urease UV, ammonia removal method) creatinine detection kit (enzyme method) are all provided by Union Medical Corporation; The Cys C assay kit (immunoturbidi-

metry) is provided by Shenzhen Mindray Biomedical Electronics Co., Ltd.

Statistical Method

The test results are presented in table form, and data analysis is completed using SPSS 13.0 software.

Result

From (Table 1), it can be seen that the serum Cys C, BUN, and Scr values of severe burn patients are higher than those of mild burn patients in the same period ($p < 0.01$), with significant statistical significance. From (Table 2), it can be seen that by monitoring the serum Cys C, BUN, and Scr values of severely burned patients within 3 days after injury, it was found that their positive detection rates (i.e. the rate at which the detection values were higher than the normal range) were significantly different at different time periods. Among them, the Scr change was the most significant, with a positive detection rate of 52% on the 2nd day after injury and 69% on the 3rd day, indicating the highest positive rate; The positive detection rate of serum BUN also reached 52% 3 days after injury; The positive detection rate of serum Cys C reached 16% 12 hours after injury, which was significantly higher than the other two indicators ($p < 0.01$). The positive detection rate reached 36% on the first day after injury, and the difference was statistically significant. The positive detection rate on the second and third days after injury was basically the same as the change in Scr. From (Table 3), it can be seen that as the injury time of severely burned patients prolongs, the detected indicators of renal function gradually increase, and the damage to renal function will gradually manifest.

Table 1: Comparison of BUN, Scr, Cys C Test Results between Two Groups ($\bar{x} \pm s$).

Group	Number of Cases	BUN (mmol/L)	Scr (umol/L)	Cys C (mg/L)
Observers	36	10.52 \pm 1.20*	87.23 \pm 25.41*	1.52 \pm 4.53*
control group	40	3.27 \pm 1.86	52.18 \pm 9.89	0.65 \pm 0.12

Note: * $P < 0.01$.

Table 2: Positive detection results of serum BUN, Scr, Cys C in severely burned patients at different times (n,%).

Observed Indicator	12 Hours After Injury	1 Day After Injury	2 Days After Injury	3 Days After Injury
BUN	2 (5%)	8 (20%)	16 (40%)	19 (52%)
Scr	1 (2.5%)	10 (27%)	19 (52%)	25(69%)
Cys C	6(16%)*	13(36%)* *	20(54%)	23(64%)

Note: * $p < 0.01$ ** $p < 0.05$.

Table 3: Monitoring Results of Serum BUN, Scr, Cys C in Severe Burn Patients ($\bar{x} \pm s$).

Observed Indicator	12 Hours After Injury	1 Day After Injury	2 Days After Injury	3 Days After Injury
BUN	4.60 \pm 1.81	7.89 \pm 2.46	9.23 \pm 3.56	12.20 \pm 4.31
Scr	51.23 \pm 17.22	60.38 \pm 21.65	74.11 \pm 23.10	113.86 \pm 35.14
Cys C	1.13 \pm 0.59	1.46 \pm 0.73	1.59 \pm 0.97	1.63 \pm 0.52

Discussion

Urea nitrogen (BUN), blood creatinine (Scr), endogenous creatinine clearance rate (Cer), and neutrophil gelatinase associated lipid transport protein (NGAL) are commonly used indicators in clinical evaluation of glomerular function, but all have their limitations [2,3]. In recent years, cystatin C (CysC) has received widespread attention and application as a new sensitive biomarker of renal function [4]. Serum cystatin C is the first high-purity cysteine protease inhibitor (CPI) isolated and purified by Anastasi et al. in egg white, and later named cystatin C. It is widely present in various bodily fluids, such as cerebrospinal fluid, saliva, urine, semen, etc. The concentration is highest in semen and cerebrospinal fluid, and lowest in urine. Cystatin C can be expressed in all nucleated cells and its production rate is very stable, unaffected by infections, tumors, diet, body mass, and liver function changes [5]. Easy to pass through the glomerular filtration barrier, its only metabolic pathway in the body is through renal excretion, and it is completely degraded in renal tubular epithelial cells, no longer returning to the bloodstream, and the renal tubules do not secrete cystatin C. Therefore, Cys C can be considered as a very good indicator of glomerular filtration rate GFR [6]. There are literature reports that cystatin C levels are associated with acute coronary syndrome (ACS), multiple system atrophy (MSA), and dominant cerebellar ataxia (MSA-C) [7,8]. Severe burns are often accompanied by burn shock, with multiple organs throughout the body experiencing ischemia and hypoxia.

The larger the burn area, the more severe the burn, the longer the recovery time from burn shock, and the more severe the kidney damage. A series of serious pathological changes occur in the glomerulus and renal tubules, including swelling of endothelial cells in the glomerular capillaries, narrowing of the lumen, and varying degrees of ischemia. Many glomerular capillaries are compressed, and even the lumen disappears. Edema and lipidosis of the renal tubular epithelium can occur, and in severe cases of renal tubular lesions, the basement membrane can also be damaged, causing glomerular filtrate to

leak into the interstitium, further increasing renal pressure, exacerbating renal ischemia, and causing renal failure. This experiment observed that as the burn time continued to extend, the serum Cys C, BUN, and Scr values would continue to increase, indicating further damage to renal function. The earliest increase in serum Cys C value was observed, and it changed within 12 hours after injury. There was no significant difference in the positive detection rate of serum BUN and Scr values after 2 and 3 days of injury. Therefore, checking the changes in serum Cys C values can better detect kidney damage in the early stage and provide a warning basis for clinical treatment.

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Jingyao Li. Biomed J Sci & Tech Res



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