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Stratification of venous thromboembolism risk in burn patients by Caprini score

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ABSTRACT

Background: The purpose of the research was to determine the efficacy of the Caprini risk assessment model for the guidance of prophylactic treatments for a 3-year period in the burn center of the Inner Mongolia region.

Methods: From July 2014 to August 2017, the Caprini score for every admitted patient was calculated to evaluate venous thromboembolism (VTE) risk. Subjects with a Caprini score between 0 and 2 were not administered a chemical VTE prophylaxis, and subjects with a score of 3 and above were administered low-molecular-weight heparin (LMWH). Demographic information, abbreviated burn severity index (ABSI) score, body mass index (BMI), Caprini score, full-thickness total body surface area (TBSA), overall TBSA, day of ambulation, hospital stay, inhalation injury, electrical burn, central venous catheters, and operations were noted for analysis.

Results: Of 1939 inpatients during the study period, 13 patients (0.67%) had VTE complications. The interval from injury to VTE diagnosis was 13.9±8.7 days. Among patients (n=1131) with a Caprini score between 0 and 2, two patients (0.18%) had VTE. A total of 792 patients received LMWH thromboprophylaxis; 11 patients had VTE complications, and among them, one patient (0.13%) developed heparin-induced thrombocytopenia and two patients (0.25%) developed major bleeding. VTE (8.82%) occurred most commonly in the Caprini score >8 group. Age, Caprini score, ABSI score, overall and full-thickness TBSA, central venous catheters, day of ambulation, and hospital stay in patients with VTE (n=11) were significantly higher than those (n=781) without VTE ($p<0.05$).

Conclusions: Caprini score allows for informed decision-making regarding prophylaxis strategies. Early ambulation and mechanical prophylaxis are recommended for patients predisposed to VTE.

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1. Introduction

Venous thromboembolism (VTE) consists of deep vein thrombosis (DVT) and pulmonary embolism (PE), and it is the number one preventable complication of death among patients during their hospital stay [1–3]. VTE is often caused by venous stasis, hypercoagulability, and endothelial injury, or the triad of Virchow [4]. Owing to burn victims' immobility, repeated operations, and recurrent use of indwelling venous catheters, they have a high risk of VTE complications. The lowest frequency of thromboembolic complications has been reported as 0.25% through routine administration of prophylactic heparin [5]; however, the argument against routine use of chemical prophylaxis is that it can cause bleeding and heparin-induced thrombocytopenia (HIT). Most burn surgeons suggest selective use of chemical VTE prophylaxis in burn victims; however, these patients are poorly categorized [6,7].

There are currently no guidelines for thromboprophylaxis in burn victims [7], although identifying burn victims at VTE risk is a clinically important feature during treatment. Although several risk assessment models (RAMs) have been proposed to predict the risk of VTE, none have been extensively validated among burn patients. The Caprini RAM is the most widely recognized and validated model among VTE assessment tools [1,8], which has been proved to be effective in plastic, urologic, vascular, and general surgery patients in retrospective studies [1,9]. In our burn unit, we have been using the Caprini score to stratify our patients' VTE risk prospectively after admission and to assign prophylactic modalities since 2014; at-risk VTE groups were administered with chemical prophylaxis. The aim of the research was to determine the efficacy of the Caprini RAM in the guidance of prophylactic treatments for a 3 year period at our burn unit.

2. Methods

From July 2014 to August 2017, a Caprini score was calculated within 48 h for every inpatient to evaluate VTE risk [1]. A score between 0 and 2 indicated a low risk, and no chemical prophylaxis was administered in these patients. A score of 3 and above is considered to represent a moderate-to-high VTE risk, and these patients received prophylactic anti-coagulation with low-molecular-weight heparin (LMWH) starting on the day of admission at a 0.5 mg/kg q12h dose subcutaneously, thereby reaching a maximum of 40 mg q12h, until they started to mobilize or lower extremity burns had healed. Heparin contraindications include (1) allergic reaction to heparin; (2) a history of heparin treatment-induced reduced platelet count; and (3) bleeding tendency or active peptic ulcer. Mechanical prophylaxis is recommended in addition to pharmacologic prophylaxis, which includes the wearing of compression stockings, early ambulation, and the application of intermittent pneumatic compression system. If pharmacological methods are contraindicated because of bleeding risk, mechanical prophylaxis should be administered as a single therapy.

The patients admitted to the burn unit who received chemical prophylactic anticoagulation were included in this research. Patients without medical profiles were excluded from this study. The body mass index (BMI) was determined for each patient. The abbreviated burn severity index (ABSI) was noted to assess the injury severity for each burn patient [10]. The medical profiles of the admitted patients with chemical thromboprophylaxis were noted, which included demographic information, Caprini score, ABSI score, full-thickness total body surface area (TBSA), overall TBSA, inhalation injury, day of ambulation, electrical burn, hospital stay, and the central venous catheters. The number of operations, defined here as procedures involving excision, grafting, and flap, was also counted. The medical profiles of the admitted patients diagnosed with VTE were followed up within at least 90 days. For patients with proximal DVT or PE, chemical anticoagulant treatments were administered for at least 3 months. Information about treatment, position of VTE, predisposed factors, and the interval from burn injury to VTE diagnosis was recorded. All analyses were performed with the expressed approval of the Third Affiliated Hospital of the Inner Mongolia Medical University.

The diagnosis of VTE was on the basis of ultrasound imaging test results and computer tomography (CT) pulmonary angiography results, which were obtained on each clinical suspicion. Ultrasound and CT scans were performed by trained technicians, and all abnormal results were confirmed by imaging experts. A therapeutic dose of LMWH was administered to the patients who were diagnosed with VTE if their prothrombin time and platelet count were within the normal ranges. Warfarin was administered orally until the International Normalized Ratio between 2 and 3 for more than 24 h was reached and continued until 3 months depending on the resolution of the thrombus diagnosed by ultrasound. Rivaroxaban was administered orally without monitoring the blood function of coagulation.

Statistical analyses were carried out using the Statistical Package for Social Sciences (SPSS, version 19.0, Chicago, USA). Data are presented as rate and frequency values or mean ± standard deviation where appropriate. Independent sample t-test was applied for quantitative continuous variables. Chi-square or Fisher exact tests were used for categorical variables. Statistical significance was defined as a p value < 0.05.

3. Results

From July 2014 to August 2017, 1939 patients were admitted to the burn department. There were 187 female and 1752 male patients. The patients were stratified by Caprini scores of 0 to 2, 3 to 4, 5 to 6, 7 to 8, and >8. The distributions of patients according to the Caprini score are presented in Fig. 1. The predominant stratified group had a Caprini score of 0 to 2 (n=1131, two patients with VTE), followed by the score 3 to 4 group (n=435, three patients with VTE), and the score 5 to 6 group (n=257, two patients with VTE) (Fig. 1). For VTE risk analysis, the incidence of VTE according to the Caprini score is presented in Fig. 2. VTE complication (8.82%) occurred most commonly in the Caprini score >8 group, followed by the Caprini score of 7 to 8 group (3.66%), and the lowest incidence of VTE among the 1131 inpatients (Caprini score of 0 to 2) was only 0.18% (Fig. 2).

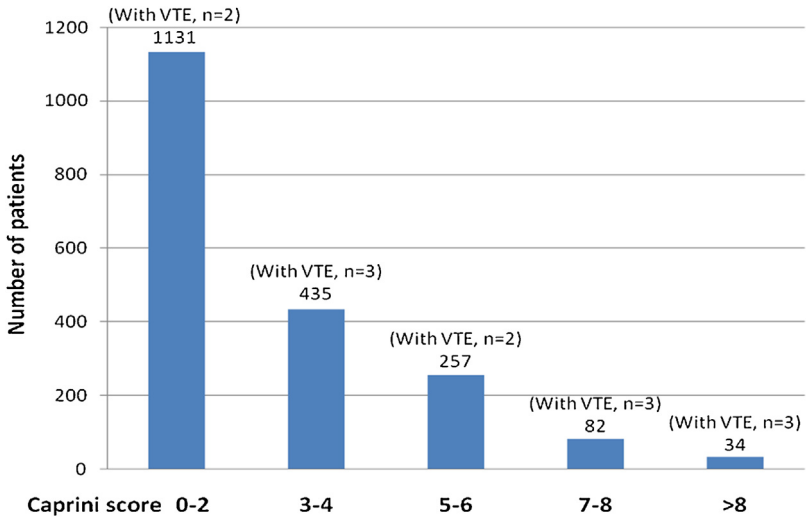

Fig. 1 – Distributions of patients according to the Caprini score, n=1939.

Of all 1939 patients, 13 patients had VTE complications (Table 1), thus accounting for an incidence of 0.67%. A total of 62 deaths were recorded, with an overall mortality of 3.2%. Characteristics of patients, predisposed factors, treatment results, and 3-month follow-up of patients with VTE are listed in Table 1. The patients diagnosed with VTE included 12 males (92.3%) and 1 female, with an average age of 49.1±13.9 years (range 25–69 years). Acute VTEs consisted of calf DVT, popliteal, iliofemoral, and femoral vein thrombosis, and three patients were diagnosed with PE and DVT. The interval from burn injury to VTE diagnosis was 13.9±8.7 days (range 6–35 days). Six patients with VTE complications showed complete patency with at least 90 days of follow-up. Complications such as swelling, pain, discoloration, and scaling in the affected limb resulting from post-thrombotic syndrome occurred in four patients. One patient died among the 13 patients with VTE (Table 1).

As specified by the Caprini RAM, a patient with a score of 3 and above is deemed to be at moderate-to-high VTE risk [1,8]. A total of 792 patients without heparin contraindications received LMWH thromboprophylaxis. Among them, 95 patients had delay in starting LMWH subcutaneously, and one of them developed VTE during hospitalization. Three patients developed VTE after cessation of LMWH thromboprophylaxis with ambulation. Sixteen patients who could not receive prophylactic anticoagulation owing to their bleeding risk received mechanical prophylaxis instead. Among the 792 patients who received chemical prophylaxis, one patient (0.13%) developed HIT complication and two patients (0.25%) developed major bleeding.

Comparisons between patients with VTE and those without VTE in the chemical thromboprophylaxis group are presented in Table 2. Patients with VTE (n=11) with an average age of 49.6 ±14.7 years were found to have significantly higher values than patients (n=781) without VTE (37.0±17.9 years, $p<0.05$). The full-thickness and overall TBSAs in patients with VTE were found to be significantly higher than those in patients without VTE ($p<0.05$). The Caprini score in patients with VTE was significantly higher than that in the other group (7.2±2.8 vs. 4.7±2.1, respectively, $p<0.01$). The ABSI score was also found to be significantly higher in the group of patients with VTE (6.5 ±2.3 vs. 4.3±2.6, respectively, $p<0.05$) than in the other group. The day of ambulation in patients without VTE (7.2±13.1) was significantly earlier than that in patients with VTE (30.4±24.1,

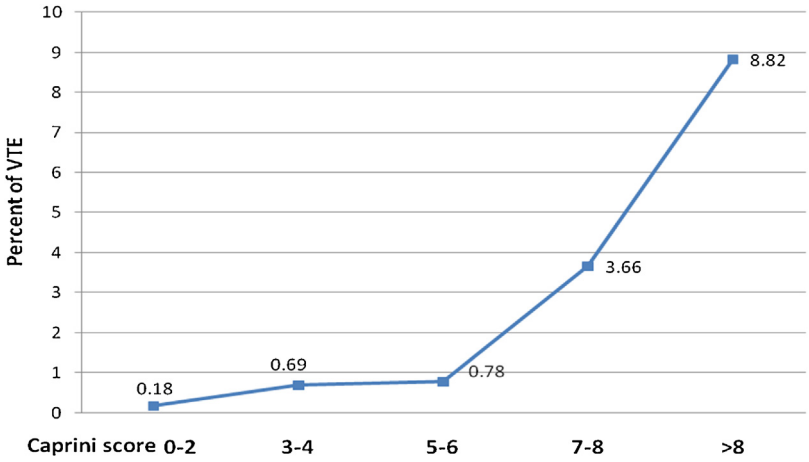

Fig. 2 – Incidence of VTE according to the Caprini score.

Table 1 – Characteristics and treatment results of patients with VTE.

No.	Age/sex	Caprini score	ABSI score	Overall TBSA (%)	Positions	Interval (days)	Predisposed factors	Treatment	Follow-up
1[a]	37/M	1	3	15	Calf DVT	8	Obesity	Rivaroxaban	Complete patency
2[a]	55/M	2	4	18	Femoral vein	6	Diabetes mellitus	VKA	Complete patency
3	68/M	4	6	20	Popliteal vein	9	Confined to bed	LMWH	PTS
4	35/M	4	7	57	Popliteal vein	19	Infection, operation, obesity	LMWH	Complete patency
5	42/M	4	4	22	Calf DVT	6	Obesity, confined to bed	VKA	PTS
6	25/M	6	11	85	Femoral vein	35	Central venous access, operation	LMWH	Partial patency
7	48/M	6	5	25	PE, calf DVT	8	Family history of VTE	Rivaroxaban	Recurrent
8	63/M	7	6	14	Popliteal vein	12	Head injury, confined to bed	LMWH	Complete patency
9	47/M	8	4	38	Popliteal vein	9	Leg fracture, operation	LMWH	Complete patency
10	69/F	8	5	16	Calf DVT	15	Obesity, cast immobilization	Rivaroxaban	PTS
11	39/M	9	5	25	Femoral vein	11	Leg fracture, confined to bed	LMWH	Complete patency
12	65/M	10	10	63	PE, femoral vein,	27	COPD, heart failure, respiratory failure, sepsis, operation	LMWH	Died
13	45/M	13	8	52	PE, iliofemoral, popliteal vein	16	Hypertension, diabetes mellitus, obesity, hip and leg fracture	LMWH, IVC filter, CDT, Urokinase	Partial patency, PTS, recurrent

[a] Patients without chemical thromboprophylaxis; VTE, venous thromboembolism; ABSI, abbreviated burn severity index; TBSA, total body surface area; DVT, deep vein thrombosis; PE, pulmonary embolism; COPD, chronic obstructive pulmonary disease; LMWH, low-molecular-weight heparin; VKA, vitamin K antagonist; IVC, inferior vena cava; CDT, catheter-directed thrombolysis; PTS, post-thrombotic syndrome.

Table 2 – Comparisons between patients with VTE and those without VTE in chemical thromboprophylaxis patient group (n=792).

	Patients with VTE (n=11)	Patients without VTE (n=781)	*p* value
Age (years)	49.6±14.7	37.0±17.9	0.028
BMI >25, n (%)	4 (36.4%)	128 (16.4%)	0.094
Overall TBSA (%)	37.9±23.2	19.8±15.8	0.027
Full-thickness TBSA (%)	18.1±19.8	9.5±12.1	0.033
Electrical burn, n (%)	3 (27.3%)	71 (9.1%)	0.075
Inhalation injury, n (%)	2 (18.2%)	47 (6.0%)	0.144
Day of ambulation (days)	30.4±24.1	7.2±13.1	0.009
Mean hospital stay (days)	45.5±34.3	15.1±18.8	0.015
ABSI score	6.5±2.3	4.3±2.6	0.012
Caprini score	7.2±2.8	4.7±2.1	0.001
Central venous catheters, n (%)	4 (36.4%)	89 (11.4%)	0.031
Number of operations	2.8±2.4	1.6±2.1	0.076

VTE, venous thromboembolism; BMI, body mass index; TBSA, total body surface area; ABSI, abbreviated burn severity index. Data are expressed as mean±standard deviation except BMI, inhalation injury, electrical burn, and central venous catheters.

$p<0.01$). The mean hospital stay and the central line venous catheters in patients with VTE were significantly higher than those in patients without VTE ($p<0.05$). No significant differences were found between the groups when comparing BMI, electrical burn, inhalation injury, and the number of operations ($p>0.05$) (Table 2).

4. Discussion

To the best of our knowledge, there is substantial evidence that primary thromboprophylaxis protects at-risk patients from VTE [1], but there is no agreement regarding the administration of VTE prophylaxis in burn victims [5,7,11,12]. Identifying patients with VTE risk and early initiation of proper prophylaxis is therefore a key factor in improving prognosis [3,13]. With the aim of stratifying patients to guide subsequent VTE monitoring and prophylaxis shortly after admission, Caprini developed a risk assessment tool to evaluate DVT risk in the general surgical population [1], which is referred to as venous stasis (age, obesity, and bed confinement), vascular injury (central venous access), and hypercoagulability (static and operation). In burn patients, increased TBSA, immobilization, hypercoagulability, destruction of vascular integrity, the number of surgeries, and central venous catheter insertion were also found to be independent predictors of VTE [1,6,7,14–18]. This may be the reason why the Caprini risk assessment score can be used in stratifying burn patients theoretically.

In our 3 year study period, 13 patients out of 1939 inpatients presented with clinically relevant thrombotic complications by selective administration of prophylactic interventions in at-risk patients, with an acceptable incidence of 0.67%. The incidence in our study is lower than that reported in the largest study of 22,618 adult burn patients by Pannucci, who reported a VTE incidence of 0.97% [18]. This study found that 92.3% of VTE occurred in males, which is supported by previous findings where men had more VTEs than women [11]. In this study, one burn patient developed iliofemoral, popliteal VTE and subsegmental PE complications. To lessen the risk of fatal PE, an inferior vena cava (IVC) filter was placed after recurrent DVT despite adequate anticoagulation treatment (Table 1). The placement of an IVC filter in trauma patients is currently the subject of some debate [13]; the American College of Chest Physicians recommends against the use of a IVC filters in patients with PE or acute DVT receiving treatment with anticoagulants [19]. However, IVC filters are not used for primary prophylaxis. The filters should be considered only in those patients who would derive the most benefit from their use.

Various other studies have identified that LMWH is superior in reducing the incidence of embolism events and mortality in trauma patients [7,13,20,21]. A research by Busche et al. reported that among the 21 hospitals in Europe, the burn departments using LMWH as chemical thromboprophylaxis for all inpatients had considerably lower rates of HIT (0.2%) and a low rate of DVT (0.9%) than all other centers [22]. In this study, 792 patients received VTE prophylaxis by using LMWH subcutaneously; one patient (0.13%) developed HIT complication and two patients (0.25%) developed major bleeding. However, the use of any anticoagulant has its risks [23]; therefore, it is important to identify subset populations that would benefit from VTE prophylaxis despite the associated risks. In clinical practice, the manifestation of limb DVT should be differentiated from the limb swelling caused by burn. If the exudation period of the burn is complete, the swelling and pain occur on lower extremity again, or unexplained redness and swelling are manifested around the deep vein puncture point, and the formation of VTE should be highly suspected.

During our 3 year study, 3 of the 34 patients (8.82%) with a Caprini score of >8 had thrombosis complications even under chemoprophylaxis immediately after admission (Fig. 2). The Caprini RAM recognizes patients with a Caprini score of >8 as a distinct "super-high-risk" group; therefore, extended-duration (30 days) chemical prophylaxis should be used and mechanical prophylaxis is recommended in addition to chemical prophylaxis for this group [3,8,9]. Our study found that with a Caprini score between 0 and 2, two patients (0.18%) developed VTE without any chemical prophylaxis administered. For patients with a Caprini score between 0 and 2, early ambulation and mechanical prophylaxis should be emphasized on those patients with predisposed factors (such as diabetes mellitus, obesity, or hypertension) [3,8]. However, extensive use of chemical anticoagulants in all patients may be problematic, with potential bleeding risks, arterial thrombosis, and thrombocytopenia [6].

In our study, particularly among patients with VTE complication, the overall TBSA, full -thickness TBSA, day of ambulation, mean of hospital stay, and ABSI score were found to be significantly higher ($p<0.05$) than those without VTE complication (Table 2). Pannucci et al. reported that the weighted score for VTE risks is associated with inhalation injury and TBSA burned by analyzing the National Repository of the American Burn Association [18]. Ahuja et al. argued that TBSA burned ought to be included in the Caprini risk calculation for burn patients [7]. In burn patients, increased TBSA burned, the number of operations, and the length of the intensive care unit (ICU) stay were independently associated with significantly increased risk of VTE [14,17]. A retrospective study of burn data from 1980 to 2012 conducted by Sikora et al. reported that burn severity predisposes patients to thromboembolic complications [11]. Actually, in a clinical setting, increased TBSA burned prognosticates to a corresponding increased hospital stay, ICU stay, ABSI score, and the number of operations, and ideally, TBSA analysis must be completed within the first 24 h. As such, TBSA, which could be calculated shortly after admission, is clinically useful as a parameter to be incorporated into the Caprini model to predict VTE risk in burn patients.

This study had some limitations, which need to be mentioned. For instance, it was performed at a single center. In addition, ultrasound imaging tests were applied every time there was a clinical suspicion; therefore, we did not check for asymptomatic VTE in burn patients. As a result, this study possibly under-represents the real incidence of VTE.

5. Conclusions

The Caprini score could allow for informed decision-making regarding prophylaxis strategies for burn patients. Mechanical

prophylaxis and early ambulation are recommended for patients with chemical prophylactic contraindications and predisposed factors.

Conflict of interest

None.

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