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BỆNH VIỆN BỎNG QUỐC GIA LÊ HỮU TRÁC
Le Huu Trac National Burn Hospital
HỘI BỎNG VIỆT NAM
Vietnam Burn Association
HỘI Y HỌC KHẨN CẤP VÀ THẢM HỌA VIỆT NAM
Vietnam Association of Disaster and Emergency Medicine

6
2024

THỂ LỆ GỬI BÀI ĐĂNG
TẠP CHÍ Y HỌC THẢM HỌA VÀ BỎNG

I. MỤC ĐÍCH VÀ PHẠM VI CỦA TẠP CHÍ

Tạp chí Y học Thảm họa và Bỏng xuất bản 6 kỳ/năm (trong đó có 01 số xuất bản bằng ngôn ngữ tiếng Anh), một số khoảng 70 trang, đăng tải các chuyên đề:

1. Chuyên đề y học thảm họa.

2. Chuyên đề phòng, điều trị bỏng và nghiên cứu khoa học về bỏng và phẫu thuật tạo hình, thẩm mỹ.

3. Các tài liệu lược dịch về bỏng - Phẫu thuật tạo hình, thẩm mỹ và thảm họa.

4. Tin tức vấn đề và sự kiện y tế trong nước và quốc tế.

***Mục đích:** Trao đổi thông tin nghiên cứu khoa học về bỏng và phẫu thuật tạo hình, thẩm mỹ trong mạng lưới điều trị bỏng toàn quốc; nâng cao nhận thức về phòng tránh thảm họa, bỏng cho cộng đồng.*

***Phạm vi phát hành:** Toàn quốc*

II. MỘT SỐ YÊU CẦU VỀ BÀI ĐĂNG CÔNG TRÌNH NGHIÊN CỨU KHOA HỌC

1. Bài gửi đăng công trình nghiên cứu khoa học chưa đăng ở bất kỳ tạp chí quốc gia nào.

2. Các thuật ngữ thống nhất theo Từ điển Bách khoa Việt Nam.

3. Bài gửi đăng phải đánh máy bằng tiếng Việt Nam (thống nhất dùng font - Unicode cả bài), rõ ràng, cách dòng, một bài không quá 7 trang khổ A4, kể cả bảng biểu, ảnh, và tài liệu tham khảo. Các danh từ tiếng Việt nếu dịch từ tiếng nước ngoài viết kèm theo tiếng nước ngoài. Các chữ viết tắt phải có chú thích các từ gốc của các chữ viết tắt.

4. Trình tự các mục trong bài:

a. Đầu đề (ngắn nhưng đầy đủ, dễ hiểu và đầu đề phải dịch ra tiếng Anh)

b. Họ và tên tác giả (không ghi học hàm, học vị và chức danh)

c. Địa chỉ cơ quan đang công tác và Email

*d. Nội dung: **Tóm tắt:** tiếng Việt Nam và tiếng Anh hoặc tiếng Pháp (tối đa 150 từ). Ghi từ khoá tiếng Việt và tiếng Anh). **Đặt vấn đề** bao gồm cả phần mục đích nghiên cứu. **Đối tượng và phương pháp nghiên cứu, kết quả, bàn luận, kết luận*** (chỉ sử dụng những biểu, bảng, ảnh cần thiết và phải có chú thích rõ yêu cầu in vào đoạn nào trong bài).

*e. **Tài liệu tham khảo** nên chọn lọc (không quá 10 tài liệu). Xếp theo thứ tự vần A, B, C... Cần nêu đủ theo thứ tự: tên tác giả, tên bài báo, tập san báo, số, năm, hoặc quyển (tập) nơi xuất bản, trang đối với cả phần tài liệu tham khảo tiếng Việt, tiếng Anh, tiếng Pháp. Phần tài liệu tham khảo đặt ở cuối bài báo.*

5. Mỗi tác giả đứng tên đầu của bài báo chỉ được đăng một bài trong mỗi phần của một số.

6. Không trả lại bản thảo khi không được đăng.

III. ĐỐI VỚI CÁC BÀI TỔNG QUAN THÔNG TIN VÀ BÀI DỊCH

Đối với bài tổng quan cần có đầy đủ các tài liệu tham khảo và nguồn số liệu đã được trích dẫn trong bài. Tác giả bài tổng quan được ghi rõ chức danh, học hàm, học vị, chuyên ngành, cơ quan hoặc hội đồng chuyên khoa ở phần ghi chú cuối trang đầu của bài tổng quan. Bài tổng quan cũng phải đánh máy trên một mặt giấy khổ A4 và không dài quá 7 trang kể cả bảng biểu và tài liệu tham khảo.

Các thông tin và bài dịch cần ghi rõ xuất xứ của nguồn dữ liệu và của thông tin hoặc bài dịch. Đối với bài dịch cần chụp (photo) toàn văn bài báo tiếng nước ngoài gửi kèm theo với bản dịch.

Người viết bài hoàn toàn chịu trách nhiệm trước Ban biên tập, công luận và những Qui định liên quan đến Luật Báo chí.

Rất mong sự cộng tác, đóng góp ý kiến và phê bình của các bạn!

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In 500 cuốn tại NXB Nông nghiệp
in xong và nộp lưu chiểu tháng 12/2024

MỤC LỤC (TABLE OF CONTENT)

SCIENTIFIC RESEARCH

Ảnh bìa 1:

ASSESSMENT OF THE SAFETY STATE IN DISASTER OF SOME STRATEGIC AND CAMPAIGN-LEVEL MILITARY HOSPITALS

Nguyen Nhu Lam, Nguyen Tien Dung, Tran Dinh Hung, Ngo Minh Duc, Tran Quang Phu, Nguyen Thai Ngoc Minh, Nguyen Thanh Chung, Le Quoc Chieu✉

Le Huu Trac National Burn Hospital

ABSTRACT

Aims: *To evaluate the level of safety in disasters of a number of strategic and campaign-level military hospitals.*

Subjects and methods: *The surveys were conducted at 9 strategic and campaign-level military hospitals. The hospitals were instructed to establish their own assessment teams and follow the steps outlined in the toolkit for evaluating safe military hospitals in disasters.*

Results: *The structural and non-structural groups had the highest proportion of criteria fully met (85.78%), while the lowest was the group managing operations in emergencies and disasters (38.00%). Regarding the level of safety in disasters, 4 hospitals (44.44%) achieved a high safety level, 5 hospitals (55.56%) achieved a medium level, and no hospital achieved a low safety level.*

Conclusion: *It is necessary to improve the level of safety in disaster military hospitals, especially the criteria related to the management of activities in emergency and disaster situations.*

Keywords: *Safety in disasters, military hospitals*

1. INTRODUCTION

According to the World Health Organization (WHO), a "safe hospital" is understood as a medical facility that can maintain maximum operational capacity along with the "integrity" of the infrastructure before, during, and after the impact of emergencies and disasters [1]. The Disaster Safety Hospital Assessment Toolkit was issued by the World Health Organization (WHO) in 2008 and revised in 2015 [1], [2].

In Vietnam, based on the criteria of the 2008 version of the toolkit, the WHO, the Ministry of Health issued a toolkit in 2013 for assessing hospital safety in emergency and disaster situations, which has not yet been updated to the 2015 WHO version [3].

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The Disaster Safety Assessment Toolkit for Military Hospitals was developed based on the Ministry of Health's toolkit, updated with the 2015 WHO version and current legal documents. This study evaluated the results of applying the toolkit at a number of military hospitals at the campaign and strategic levels.

2. RESEARCH OBJECTS AND METHODS

The study utilized some surveys conducted at 9 military hospitals operating on the campaign and strategic front lines, including Military Hospital 109/Military Region 2, Military Hospital 4/Military Region 4, Military Hospital 7/ Military Region 3, Military Hospital 121/ Military Region 9, Military Hospital 211/Army Corps 3, Military Hospital 105/General Department of Logistics, Military Hospital 87/General Department of Logistics, Military Hospital 175 - Ministry of National Defense and Le Huu Trac National Burn Hospital - Vietnam Military Medical University.

These institutions were instructed to form their own assessment teams and adhere to a standardized assessment procedure. Each criterion was evaluated based on 3 levels of achievement: achieved (1.0 points), partially achieved (0.5 points), and not achieved (0 points). The overall safety score for each hospital was calculated using the following formula:

Safety score = $(X_1 + X_2 \times 0.5) \times 100/224$

In which: X_1 represents the number of fully met criteria; X_2 represents the number of incompletely met criteria; 224 is the total number of criteria in the toolkit.

Hospital safety is calculated as follows:

- Level I (0 - 50 points): Low safety level, requiring urgent intervention.

- Level II (51 - 75 points): Average safety level, necessitating short-term intervention.

- Level III (76 - 100 points): High safety level, with ongoing measures to maintain and improve emergency and disaster management capacity.

The collected data were processed using statistical algorithms and analyzed with Stata 14.0 software.

3. RESULTS

Table 3.1. Summary of evaluation results of hospitals by group

Group	Fully Achieved		Incomplete		Not achieved	
	n	%	n	%	n	%
A (n = 54)	46.33 ± 5.22	85.78 ± 9.54	2.67 ± 0.68	5 ± 1.1 5	5 ± 1.52	9.22 ± 8.54
B (n=131)	82.44 ± 4.82	63 ± 3.74	27.89 ± 10.55	21.13 ± 8.12	12.77 ± 8.28	9.89 ± 6.15
C (n = 39)	14.77 ± 8.22	38 ± 20.92	10.66 ± 8.9	38 ± 20.92	14.89 ± 8.55	38.11 ± 22.01

Note: Structural and non-structural elements related to architecture; Group B. Construction equipment systems ensuring safety for users; Group C. Management of activities in emergency and disaster situations.

Comment: The highest level of full achievement is observed in Group A (85.78%), while the lowest is in Group C (38.00%). Group C also has the highest percentage of incomplete achievement (27.44%) and the highest percentage of criteria not achieved (38.11%).

Table 3.2. Detailed evaluation results of criteria groups

Group	Fully Achieved		Incomplete		Not achieved	
	n	%	n	%	n	%
A1 (n = 20)	18.44 ± 1.5	92.22 ± 7.54	0.22 ± 0.06	1.11 ± 0.34	1.33 ± 0.5	6.67 ± 0.79
A2 (n = 34)	27.89 ± 3.98	81.78 ± 11.73	2.44 ± 1.58	7.33 ± 1.59	3.66 ± 1.23	10.89 ± 3.14
B1 (n = 76)	54.55 ± 5.1	71.66 ± 6.85	12.67 ± 3.31	16.44 ± 4.27	8.78 ± 4.26	11.55 ± 5.54
B2 (n = 44)	22.11 ± 3.29	50.33 ± 7.5	11 ± 6,12	25 ± 13.96	1.56 ± 1.3	3.55 ± 1.04
B3 (n = 11)	5.78 ± 2.68	52.67 ± 24.62	4.22 ± 3.3	38.33 ± 30.24	1 ± 0.7	9 ± 6.36
C1 (n = 8)	3 ± 0.74	37.78 ± 27.78	0.66 ± 0.44	8.44 ± 5.58	4.33 ± 0.86	54.55 ± 32.58
C2 (n = 5)	1.11 ± 0.3	22.22 ± 18.55	0.77 ± 0.52	15.56 ± 10.42	3.11 ± 0.65	62.22 ± 32.30
C3 (n = 5)	1.11 ± 0.2	22.22 ± 12.08	0.77 ± 0.52	15.56 ± 5.55	3.11 ± 0.65	62.22 ± 25.38
C4 (n = 5)	1.67 ± 0.62	33.33 ± 12.47	1.78 ± 0.36	35.55 ± 21.86	1.56 ± 0.47	31.11 ± 24.48
C5 (n = 3)	2.33 ± 0.23	77.89 ± 23.57	0.11 ± 0.11	3.66 ± 3.16	0.55 ± 0.17	18.33 ± 5.79
C6 (n = 8)	4 ± 0.97	50.22 ± 36.7	3.11 ± 0.79	39.11 ± 29.38	0.89 ± 0.35	11.11 ± 4.39
C7 (n = 5)	1.56 ± 0.47	31.11 ± 28.48	2.11 ± 0.51	40.22 ± 30.73	1.33 ± 0.33	26.67 ± 20

Note: A1. Hospital structure; A2. Architectural structure; B1. Technical systems infrastructure; B2. Medical and laboratory facilities; B3. Safety and security of people and equipment; C1. Coordination of activities in emergency and disaster situations; C2. Emergency and disaster response and recovery plans; C.3. Information and communication management in emergency and disaster situations; C.4. Human resources in emergency and disaster situations; C.5. Emergency and disaster logistics; C.6. Support services, care in emergency and disaster situations; C.7. Evacuation, decontamination, and security in emergency and disaster situations.

Comment: In the structural subgroup (A1), 92.22% of the criteria were assessed as fully achieved. For the non-structural subgroup (A2) were 81.78% of the criteria fully achieved. In Group B, the highest proportion of criteria achieving full

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compliance is found in the Technical Infrastructure System subgroup (B1: 71.66%), while the lowest is in the Safety and Security for People and Equipment subgroup (B3: 50.33%). In Group C, the highest level of achievement is in the Logistics subgroup (C5: 77.89%), whereas the lowest levels are observed in the Communication Management subgroup and the Response and Recovery Plan subgroup during and after emergencies and disasters (C2 and C3: 22.22%). Additionally, the highest failure rate belongs to the Information and Communication Management subgroup (C3: 62.32%).

Table 3.3. Results of total score calculation by criteria group

Group	Mean	Min - Max
Group A (n = 54)	48 ± 4.77	38 - 54
Group B (n = 131)	96.56 ± 5.36	87 - 103
Group C (n = 39)	19.55 ± 7.76	11 - 32
Total (n = 224)	163.88 ± 8.16	156 - 179

Comment: The average score for Group A was 48 out of 54 points. Group B achieved an average score of 96.56 out of 134 points, and Group C scored an average of 19.55 out of 39 points. The overall average score was 163.88 out of 224 points, with a range from 156 to 179 points.

Table 3.4. Results of Hospital Safety Rating

Group	Quantity	Percentage
Level I (76-100 points)	04	44.44
Level II (51 - 75 points)	05	55.56
Level III (0 - 50 points)	0	0

Comment: Of the total 9 hospitals surveyed, 4 hospitals (44.44%) achieved level I, 5 hospitals (55.56%) achieved level II, and no hospital achieved level III.

4. DISCUSSION

The purpose of assessing hospital safety in disasters is to raise awareness among hospital leaders and staff about the risks posed to the hospital by hazards both within the hospital and in the surrounding areas. The assessment aims to identify areas and activities that are particularly vulnerable during emergencies and disasters and to evaluate the hospital's ability to respond effectively to such events. Additionally, the assessment is intended to guide the development and implementation of intervention activities designed to enhance hospital safety during emergencies and disasters.

Disaster Safety Hospital Assessment Toolkit not only assesses the operational capacity of hospitals during and after emergencies or disasters but also provides authorities with the ability to identify the level and priority items to improve the safety and functionality of hospitals in particular and the health system in general. Worldwide, there have been many reports assessing hospital safety in disasters using the 2008 and then 2015 versions of WHO with very different results between countries as well as between hospital

classes within each country. In 2015, a study in Indonesia at 11 primary hospitals in 4 provinces showed that some gaps needed urgent intervention, especially in the two provinces of West Java (achieving 0.601 points) and Yogyakarta (0.602 points) to ensure the structural safety of buildings, water supply systems, fuel storage; Need to organize disaster response committees, training activities, structures to be prepared to respond to disasters [4].

In Tunisia, a study using the 2015 WHO toolkit found that 7 out of 9 university hospitals were classified as moderately safe, with an overall safety index ranging from 0.37 to 0.62. Additionally, 4 out of 9 university hospitals had a safety score below 0.20 for emergency and disaster management [5].

In 2015, a study of 421 hospitals in Iran found that 82 hospitals (19.4%) were classified as unsafe. In terms of resilience to natural disasters, 339 hospitals (80.6%) were classified as moderately safe, and no hospital was classified as highly safe [6].

In Moldova, of the 61 public hospitals evaluated, 24.6% were classified as good, and 67.2% were classified as average [7].

The safety level of hospitals in Vietnam remains quite modest. In 2009, Ha Van Nhu and colleagues conducted an assessment of 51 hospitals across three provinces: Quang Ninh, Da Nang, and Can Tho. The study revealed that most medical facilities are vulnerable to disasters to varying degrees. Provincial hospitals achieved higher safety indexes compared to district hospitals, with the non-structural and functional indexes being the lowest-performing groups [8].

In 2010, the results of the pilot safety assessment of 15 hospitals in three provinces (Thua Thien Hue, Quang Nam, Quang Ngai) revealed that the preparedness for emergency situations in hospitals had many limitations across structural, non-structural, and functional criteria. Specifically, 5 out of 15 hospitals were built in low-lying areas prone to flooding, 8 out of 15 hospitals had at least one asymmetrical building, and 5 out of 15 hospitals did not have wheelchair ramps. Additionally, 13 out of 15 hospitals placed heavy medical equipment on the ground floor, all 15 hospitals failed to properly secure chemical containers, 5 out of 15 hospitals lacked the system of emergency signs, 12 out of 15 hospitals did not have building diagrams, 10 out of 15 hospitals lacked of fire alarms, 13 out of 15 hospitals did not have plans for emergency operations centers, and 14 out of 15 hospitals did not conduct emergency response drills [8].

Do Thi Hanh Trang and Ha Van Nhu reported the results of assessing hospital safety in disasters in 3 provinces: Quang Ngai, Phu Yen, and Bac Lieu. The assessment focused on three groups of non-structural indicators: the electrical systems, the firefighting systems, and the evacuating systems. The results indicated that the number of medical facilities meeting the indicators in these groups was low. Specifically, 11 out of 33 hospitals had backup generators capable of providing sufficient power for the hospital's priority needs; 11 facilities had lights at the exits with backup batteries; 7 facilities had smoke detectors installed in the appropriate locations; 15 facilities met the standard of having a portable fire

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extinguisher in each room; 17 hospitals had staff trained in fire prevention; and 20 hospitals had lighting equipment installed at all exits [9].

Recently, military hospitals have received significant investments for upgrading, constructing new facilities, and purchasing modern equipment to enhance the quality of medical examination and treatment for both soldiers and civilians. This improvement is objectively reflected in the evaluation results in Part A, which focuses on structural and non-structural aspects, with an average score of 48 out of 54 points.

The assessment results indicate that the current limitations that need to be addressed by military hospitals are concentrated in Group C, which deals with the management of activities in emergency and disaster situations. The total score for this group is approximately 50% (19.55 out of 39 points). The primary reason for this is that this is a relatively new field that has not received much attention. Additionally, human resources and specialized forces are not adequately ensured, particularly in the development of procedures, training, and exercises. Nevertheless, some hospitals have achieved 32 out of 39 points, representing a bright spot and serving as a model for other hospitals to emulate.

It should be noted that the results of this assessment are only valid at the time of evaluation and may be subjective for many criteria. Furthermore, the list of criteria in the toolkit is extensive, and the assessment process can be time-consuming, depending on the size of the hospital. Moreover, it requires the assistance of experts beyond medical staff, such as those in structural engineering, technical systems, and management. To ensure success, the assessment should not be a one-time event but rather a continuous process managed by the hospital's Disaster Management or Quality Management and Planning departments.

Limitations of the study: The survey was conducted at only 9 military hospitals, which constitutes nearly one-third of the total number of military hospitals currently in operation. These hospitals self-formed evaluation teams and conducted assessments according to the toolkit's procedures, which could lead to bias or lack of objectivity in the evaluation results. These evaluation results were only valid at the time of assessment and subjective for many criteria. Additionally, the toolkit's criteria lists were quite extensive, and the evaluation process could be time-consuming, depending on the hospital's scale. Moreover, full assistance from experts outside the medical staff, such as those in structural engineering, technical fields, and management, was required. To be successful, the evaluation should not be a one-time activity but a continuous process, with responsibilities assigned to a dedicated department within the hospital to enhance the effectiveness of intervention measures and improve hospital safety.

Recommendations to address limitations: Conduct studies on more hospitals to ensure that the data results represent the safety criteria of all military hospitals during disasters. Establish evaluation teams comprising independent experts who are not hospital employees to ensure the objectivity and accuracy of the evaluation results. Organize intensive training sessions for the evaluation teams

on the assessment procedures and criteria to minimize subjectivity. Mobilize participation from experts outside the medical field, such as structural, technical, and management experts, to ensure comprehensive and accurate evaluations. Hospital safety evaluations should be performed periodically (for instance: Annually) to monitor improvement progress and implement timely intervention measures. Establish an ongoing evaluation process and assign responsibilities to the Disaster Management or Quality Management Department and the Hospital Planning Office to ensure the maintenance of safety and readiness to respond to disasters. Evaluations should not cease at a single point in time but need to be ongoing and monitored, which includes preparing periodic evaluation reports and organizing meetings to reassess intervention measures.

5. CONCLUSION

The Disaster Safety Assessment Toolkit for Military Hospitals was piloted at 9 military hospitals at the strategic and operational levels. The results indicated that the Structural and Non-Structural Groups related to structures had the highest percentage of criteria fully achieved (85.78%), while the Management of Activities in Emergency and Disaster Situations group had the lowest percentage (38.00%). In terms of safety levels during disasters, 4 hospitals (44.44%) achieved a high safety level, 5 hospitals (55.56%) achieved the average level, and no hospital achieved a low safety level.

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EVALUATING EXPERIMENTAL DRILL ON DEPLOYMENT OF MILITARY EMERGENCY MEDICAL TEAM FOR DISASTER RELIEF

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ABSTRACT

Objective: *To evaluate the results of implementing the Military Medical Team model for natural disasters.*

Subjects and methods: *Organizing an experimental drill of simulated earthquake situations with 25 trauma victims and 5 cases of chronic illness. The evaluated content included the implementation of military medical stations and Medical response at military medical stations in terms of admission, triage, emergency care, and transferring.*

Results: *The deployment of the military medical station for disaster relief met the requirements of over 80%. The management of the team leaders, the members' activities, proficiency in using equipment and forms, as well as coordination were sufficient > 95%. The triage results using START met the scenario requirements from 87.5% and over. All contents of operation achieved 90% or more.*

Conclusion: *The drill met the set requirements; some contents were added to complete the model.*

Keywords: *Military medical team disaster relief, drills*

1. INTRODUCTION

In 2003, the World Health Organization (WHO) issued minimum standards for emergency medical teams (EMT) which have been implemented and applied by many countries [1]. However, currently, Vietnam still does not have an EMT built according to the minimum standards of WHO in medical response to disasters.

In Vietnam, the military medical force plays a particularly important role in responding to medical emergencies, especially in overcoming the consequences

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of natural disasters in remote, border, and island areas. Building a military EMT for disaster relief is one of the main contents of the Government's project "Developing and improving the capacity to respond to natural disasters, search and rescue by 2030, with a vision to 2045" [2].

Based on the assessment of the status of the existing medical military units, we built a model of a military EMT for disaster relief that is close to the minimum standard of type 1 fixed EMT, suitable for Vietnam's conditions and general orientation of the health sector, ensuring consistency in domestic and international deployment. This study evaluated the results of the experimental exercise of deploying the military EMT for natural disasters to supplement and complete the built model.

2. OBJECTIVES AND RESEARCH METHODS

2.1. Scenario

A magnitude 7.0 earthquake occurred in H province. Many buildings, houses, and schools collapsed; some residential areas were isolated. According to initial assessments, some people died, injured, and many victims were still trapped in buildings. Commune and district health facilities in the disaster area were also destroyed and no longer able to operate. Rescue forces were deployed to the disaster area to search and rescue victims. EMTs were also dispatched to the affected area.

As assigned by the medical military department, a military EMT for disaster relief was dispatched to the disaster area setting up a medical station and coordinating with local medical forces to triage, provide emergency treatment, and transfer victims to the hospitals as well as care residence health at the affected area.

There was a total of 25 mass casualty victims including 6 requiring immediate emergency care (red), 12 delayed emergency care victims (yellow) and 07 mild victims (green). In addition, there were 5 assumed patients who were residents coming for examination and treatment of chronic diseases.

2.2. Drill setting

- Drill location and time: Le Huu Trac National Burn Hospital, on 27th July 2024.

- Participants: staff from the National Burn Hospital was assigned and trained as members of Military EMTs for disaster relief. Students from Hanoi Nursing College were trained as victims and patients.

An organizing committee was set up and a checklist was issued and performed before starting the drill.

2.3. Drill evaluation

- Evaluation team: 60 medical experts with experience in the fields of disaster medicine, emergency, intensive care, and medical organizations.

- Evaluation method: In order to obtain objective results when conducting the assessment, the evaluator developed a checklist for the assigned assessment contents. Based on the criteria built into the checklist, the performance content of the participants in the drill was evaluated as satisfactory or unsatisfactory. The criteria that need to be quantified were calculated and recorded independently among the assessment teams. The assessment information was aggregated and analyzed.

- Evaluated criteria:

+ Implementation of military medical station: Deployment location, arrangement

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of teams, medication and equipment arrangement, using EMT forms. Command system and standard operation system (SOP) as well as coordination between EMT components.

+ Medical response at military medical station: Patient admission, triage, providing medical care, transferring and outpatient care.

- Data analyzing collected data were analyzed by using Intercool Stata software.

3. RESULTS

The overall model of deploying the military medical station for disaster relief, arranging the deployment locations of the units, designing the classification form, transfer form, medical record form, and the station's signage system were assessed to reach 90% or more. The preparation of paperwork, medication and supplies, and equipment of the teams were also assessed to reach > 95% (Table 3.1).

Table 3.1. Results of model implementation evaluation (n = 60)

Criteria	Satisfactory		Unsatisfactory	
	n	%	n	%
Overall model of military medical station	60	100	0	0
Location of team deployment	60	100	0	0
Medication and consumable material setting	55	91.67	5	8.33
Equipment setting	54	90	6	10
Design of triage tag	60	100	0	0
Referral form	60	100	0	0
Disaster medical record	60	100	0	0
Outpatient prescription	60	100	0	0
Paper works, EMT forms	58	96.67	2	3.33
Direction system	60	100	0	0

Table 3.2 indicates that the team leader's management, the members' performance of their duties, the assessment of the proficiency in using equipment and forms, and the coordination of activities with other departments all meet requirements from 95% and more.

Table 3.2. Evaluation result of operations and activities (satisfactory)

Criteria	Triage		Emergency care		Treatment		Logistic	
	n	%	n	%	n	%	n	%
Team leader's management	60	100	59	98.33	56	93.33	60	100
EMT member works	57	95.00	60	100	100	100	60	100
EMT forms using	58	96.67	58	96.67	58	96.67	-	-
Equipment using	60	100	100	100	100	100	57	95.00
Coordinating	60	100	100	95.00	58	96.67	-	-

As can be seen from Table 3.3, the results of on-scene triage according to the START procedure met the requirements of the scenario in 100% of red victims, 91.6% of yellow victims, and 87.5% of green. The average triage time for 1 victim was 1.6 minutes.

Table 3.3. Victim triage results (n = 25)

Triage tags	Script	Reality	Matching (%)
Red	06	06	100
Yellow	12	11	91.6
Green	07	08	87.5
Average triage time	1.6 ± 0.8 minutes		

All medical interventions including first aid, caring before transferring, ambulance team and medical command operating were assessed as satisfactory (100%). Completing the transfer form and activities of the evacuated team reached 90% (Table 3.4).

Table 3.4. Results of medical treatment assessment at the station (n = 60)

Criteria	Satisfactory		Unsatisfactory	
	n	%	n	%
Performing first aid techniques	10	100	0	0
Caring before transferring	10	100	0	0
Completing the transfer form	9	90	1	10
Activities of the evacuated team	9	90	1	10
Activities of an ambulance team	10	100	0	0
Medical command operating	10	100	0	0

4. DISCUSSION

Drills are considered as the highest and most effective form of training. They are real-time, on-site activities designed to evaluate plans and arrangements for medical response in emergency and disaster situations. Participants in the drills are assigned to positions that they will perform in the medical response plan in emergency and disaster situations. Command and management work as well as plans for handling hypothetical situations, practical skills, use of equipment and techniques applied in specific situations are evaluated and lessons learned to update and supplement the response plan to be more appropriate and closer to reality.

In the world, there are many models of military medical forces operating when participating in disaster response, depending on the conditions of each country. According to the recommendations of the World Health Organization,

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developing countries (including Vietnam) should build EMT type 1 and recommend unifying the medical force model when participating in international relief [1].

According to WHO statistics currently, the military medical forces of some Countries that have built disaster relief medical teams (Vietnamese conventional name) based on the minimum standards of the World Health Organization include: Israel (Type 3), Barbados (fixed type 1), some have registered for WHO assessment including Indonesia, Sri Lanka (type 1 fixed) [3].

Madge SN et al. (2004) investigated the ability of doctors in 11 hospitals in the Wessex region of England to respond to mass casualty situations. The results showed that less than 1/3 of doctors had ever participated in mass casualty management, 11% had participated in disaster medical response drills, and only 45% of doctors felt confident in participating in disaster medical response [4].

In Switzerland, in 2011, the first drill was conducted on the response procedures for fire and explosion disasters that had been developed since 2010 with a hypothetical situation of a dance floor fire with a large number of victims of burns, combined injuries, and respiratory burns. The experience was done and in 2012, the second drill was conducted with the same scenario, showing a clear improvement in the command and control of first aid, emergency care, triage and referral from the scene to the specialized line, reducing errors and overcoming the limitations of the first drill [5]; this result also showed similarities with our study when the command and control results of department heads and team leaders all clearly improved through training activities, drill rounds, and reached over 80% at the end of the drill.

With many patients at the same time after a disaster, triage, first aid and transportation require flexibility, as well as command and control experience are very important. In developing countries, there is no professional rescue team, most of them rescue themselves and rely mainly on the fire department, while the rescue skills of this force are also limited, and insufficient specialized ambulances. This is one of the major limitations for mass victim rescue. Many patients do not receive pain relief, the means of transport are not guaranteed, the transport time is long, resulting in a high rate of patients with serious complications and a high risk of death.

According to a study by Nguyen Nhu Lam and colleagues (2016), in 83 mass burn cases, only 16.5% of patients were cooled with clean water, 1.48% dressing, while 14.8% used inappropriate materials applied to the burned area. Among 241 patients with burns ≥ 10% of body surface area, 15 patients were given Oresol, accounting for 6.22% [6].

Performing well the work of classifying, giving first aid, and transporting victims to treatment facilities is an important condition to minimize the risk of death, reduce complications, and create favorable conditions for treatment. However, due to the accident occurring suddenly, the victim panicked and ran away from the scene and was rescued by people around, then went to the nearest emergency medical facility without being triaged and emergency management.

Schenker JD et al. in 2006, evaluated the triage results according to the START

procedure at the scene in a fire disaster drill with 130 victims, the participating forces had been trained in advance but at the time of the drill were not retrained, the results showed that the rate of meeting the requirements was 78% (correct classification), and 62% if the situation changed on the same victim [7].

In our study, the correct triage rate according to the scenario reached 87.5% or more, but the results when changing the situation were not evaluated.

Through organizing drills and evaluating results from independent experts, positive results have been achieved. Some limitations have also been pointed out by experts, including coordination between forces, especially medical transfer and emergency teams, resource allocation, packaging of medicine and equipment, scientific and easy-to-manage manner, supplementing instruction documents and forms when participating in international activities, etc. These contents have been absorbed and supplemented to perfect the model of the disaster relief medical team.

5. CONCLUSION

The results of the exercise on the deployment of the military EMT model for earthquake disaster relief showed that the deployment of the military medical station and the appropriate arrangement of human resources met the requirements. Some additional contents were noted to complete the model.

Acknowledgments: The research team would like to thank the experts who are military medical officers in units throughout the army who participated, visited, and gave their opinions on the exercise to perfect the model of the Military EMT disaster relief in this study.

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Appendix

VOUCHER EVALUATION OF EXPERIMENTAL REVIEW RESULTS DEPLOYMENT OF DISASTER RELIEF MILITARY MEDICAL TEAM MODEL

I. GENERAL INFORMATION

1. Reviewer's name:
2. Place of work:
3. Evaluation content: Results of the experimental exercise to deploy a model of a military EMT for natural disaster relief.
4. Rehearsal location: Le Huu Trac National Burn Hospital
5. Time: / / 2024

II. EVALUATION CONTENT (MARK X IN THE CORRESPONDING BOX)

STT	Review content	Satisfactory	Unsatisfactory
1.	**Field deployment of the model**		
1.1	Overall model of military medical station		
1.2	Location of deployment of military medical station teams		
1.3	Medicine and consumable material		
1.4	Equipment setting		
1.5	Design of triage tag		
1.6	Referral form		
1.7	Disaster medical record		
1.8	Outpatient prescription		
1.9	Paperwork’s, EMT forms and reports		
1.10	Direction system…		
2.	**Triage team activities**		
2.1	Reasonable deployment layout		
2.2	Level of task mastery		
2.3	Team leader's management		
2.4	Proficient use of triage tag		
2.5	Practical classification skills		
2.6	Coordination of triage and transferring		
3.	**Emergency Team Activities**		
3.1	Reasonable deployment layout		
3.2	Level of task mastery		

3.3	Team leader's operation		
3.4	Use of equipment		
3.5	Emergency management skills		
3.6	Emergency medical record complete skills		
3.7	Completing referral form		
3.8	Coordinate within the organization		
3.9	Coordinate with other groups		
4.	**Activities of care-treatment**		
4.1	Reasonable deployment layout		
4.2	Level of task mastery		
4.3	Team leader's operation		
4.4	Use of equipment		
4.5	Skills of treatment techniques		
4.6	Medical record complete skills		
4.7	Outpatient examination and prescription skills		
4.8	Record the transfer note		
4.9	Coordinate within the organization		
4.10	Coordinate with other departments		
5.	**Activities of the logistic group**		
5.1	Reasonable deployment layout		
5.2	Level of task mastery		
5.3	Team leader's operation		
5.4	Use of material and equipment		
6.	**Activities of the transfer team**		
7.	**Ambulance Team Activities**		
8.	**Team command operations**		

Other comments:

Reviewer

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TO EVALUATE SAFETY OF THE ADSORPTION HEMOFILTRATION TECHNIQUE FOR TREATMENT OF SEPTIC SHOCK IN SEVERE BURN PATIENTS

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ABSTRACT

Objectives: *Evaluating the safety of continuous hemofiltration using an adsorbent membrane to treat septic shock in severe burns patients.*

Subjects and methods: *The study describes 55 episodes of septic shock in 38 severe burn patients (16 - 60 years old) treated at the Intensive Care Unit, Le Huu Trac National Burn Hospital from January 2023 to June 2024.*

Results: *The total number of filters used was 247, of which 8 filters had frozen membranes (3.2%), the average life of the filter was 15.87 hours. There were no cases of systolic blood pressure falling below 90 mmHg when entering the filter. During continuous veno-venous hemodiafiltration (CVVHDF): Body temperature was always within allowable limits; there were no differences in blood potassium levels, blood protein and albumin concentration, and hypocoagulation disorders at all time points ($p > 0.05$); blood sodium concentration decreased significantly to normal limits ($p < 0.01$).*

There was no difference in hypocoagulation status between time points ($p > 0.05$). There was 1 case of bleeding at the dialysis catheter fixation site (1.82%) and 2 cases of bleeding at the skin graft lesion requiring hemostatic treatment (3.62%).

Conclusion: *There were no differences in blood potassium levels, blood protein and albumin concentration, and hypocoagulation disorders at all time points.*

Keywords: *Severe burns, septic shock, CVVHDF*

1. INTRODUCTION

Continuous Renal Replacement Therapy (CRRT) eliminates cytokines and bacterial endotoxins from the body, reduces systemic inflammatory response syndrome and stabilizes hemodynamics. It is a proven effective method to support the treatment of septic shock: improving clinical status, reducing shock recovery time, preventing the progression of organ damage, and improving the mortality rate after 28 days [1], [2], [3], [4], [5]. However, in addition to the above benefits, the CRRT

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technique still has the risk of causing complications. The complications in CRRT can be divided into two large groups: Technical-related complications and clinical-related complications.

All complications have the potential to firstly endanger the patient's life and health, followed by reducing the effectiveness of dialysis, reducing the lifespan of the filter and increasing treatment costs. Clinicians must be able to prevent, recognize, and manage associated complications to ensure optimal dialysis outcomes for patients [6]. The objective of this study was to evaluate the complications of CRRT with adsorbent membranes to support the treatment of septic shock in patients with severe burns patients.

2. SUBJECTS AND RESEARCH METHODS

** Study subjects*

55 episodes of septic shock in 38 severe burn patients (16-60 years old) were treated at the Intensive Care Unit, Le Huu Trac National Burn Hospital from January 2023 to June 2024. There were no comorbidities or co-traumas. Septic shock was diagnosed according to Sepsis-3 [7].

Septic shock patients were treated according to the guidelines of the Surviving Sepsis Campaign (SSC) in 2021 and the guidelines of the International Society for Burn Injuries in 2023 [8], [9]. They received hemofiltration within 6 hours of septic shock diagnosis. Dialysis was terminated when the patient recovered from septic shock for 12 hours or died (requested discharge for death).

** Research methods*

- Prospective, descriptive, longitudinal follow-up

- Uniformly using one method, which is continuous veno-venous hemodiafiltration (CVVHDF) according to the established procedure, oxiris filter, blood flow rate of 180 ml/min, ultrafiltration dose of 25 ml/kg/hour, and dialysis dose of 25 ml/kg/hour.

- Research criteria:

+ Technical-related complications: Problems related to vascular access, hemolysis, air embolism, filter clotting, hypothermia.

+ Clinical-related complications: Hypotension at the start of filtration, electrolyte disturbances, bleeding, loss of protein and albumin.

- Diagnosis of coagulation disorders:

+ Hypocoagulable tendency based on routine coagulation tests based on the risk of bleeding is determined when one of the following four criteria is present: INR > 1.2 and/or aPTT > 1.2 and/or platelet count < 150,000/mm^3 and/or Fibrinogen < 2 g/L.

+ Hypercoagulable tendency based on routine coagulation tests based on the risk of hypercoagulation is determined when one of the following four criteria is present: INR < 0.8 and/or aPTT < 0.8 and/or platelet count > 450,000/mm^3 and/or Fibrinogen > 4 g/L.

+ Mixed hypercoagulable-hypocoagulable tendency based on routine coagulation tests is determined when there is at least one of the criteria for hypocoagulable tendency and at least one of the criteria for hypercoagulable tendency.

- Study time points: At the time of septic shock diagnosis (T1), at the time of CRRT (T2), 6 hours after CRRT (T3), 12 hours after CRRT (T4), 24 hours after CRRT (T5), and 48 hours after CRRT (T6).

- Data were analyzed using Stata 14.0 software, and a p-value < 0.05 was considered statistically significant.

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3. RESULTS

There were 38 severe burn patients with 55 septic shock episodes. The average age of the study patients was 35.11 ± 1.67; males predominated (86.84%). The burn agent was mostly dry heat (84.21%), with 22 patients having respiratory burns (accounting for 57.89%). 23 patients had one episode of shock (60.53%), 13 patients had two episodes of shock (34.21%), and 2 patients had three episodes of shock (5.26%).

The total number of oxiris filters was 247, of which 8 filters were frozen (3.2%). There were no cases of systemic air, catheter kinking, or twisting. There were no cases of systolic blood pressure falling below 90 mmHg when entering the filter.

Table 3.1. Blood filtration parameters

Parameters	Value
Blood flow rate, ml/kg/min	180
Ultrafiltration dose, ml/kg/hour	25
Replacement fluid volume, ml/kg/ hour	25
Dialysis time, hour, median (Q1- Q3)	50 (39.5 - 83.5)
Number of oXiris filters, filter, median (Q1- Q3)	4 (3 - 4)
Life/ 01 oXiris, hour, $\overline{X}$ ± SD	15.87 ± 4.85
Time to start CRRT after septic shock diagnosis, min, $\overline{X}$ ± SD	87.62 ± 41.86

The Median CRRT time was 50 hours, and the number of filters used for each patient was 4. The average filter life was 15.87 hours.

Table 3.2. Coagulation changes before and during CRRT

Parameter	Time (n = 55)				p
	T1	T4	T5	T6	
Coagulation disorders, n (%)	55 (100%)	55 (100%)	55 (100%)	49 (89.09)	0.0004
Hypocoagulation, n (%)	44 (80%)	51 (92.73)	49 (89.09)	46 (83.64)	0.20
Hypercoagulation, n (%)	45 (81.82%)	44 (80)	41 (74.55)	23 (41.82)	0.0001

There was no difference in hypocoagulation status between time points ($p > 0.05$). The number of shock episodes that had coagulation disorders was significantly reduced after 48 hours after CRRT ($p < 0.001$). Along with that, the hypercoagulability also decreased significantly ($p < 0.001$).

Table 3.3. Clinical bleeding status

Parameter	Time (n = 55)			
	T3	T4	T5	T6
Bleeding through catheter fixation site, n (%)	0	0	0	1 (1.82)
Bleeding at superficial burn injury, n (%)	0	0	0	0
Bleeding at granulation tissue requiring hemostasis, n (%)	0	0	0	0
Bleeding at skin graft site requiring hemostasis, n (%)	0	0	1 (1.82)	1 (1.82)

There was no clinical bleeding at 6 hours and 12 hours after CRRT initiation. 24 hours after CRRT initiation, there was one case of bleeding at the skin graft site requiring treatment (1.82%). 48 hours after CRRT initiation, there was one case of bleeding through the catheter fixation site (1.82%) and one case of bleeding at the skin graft site requiring treatment (1.82%).

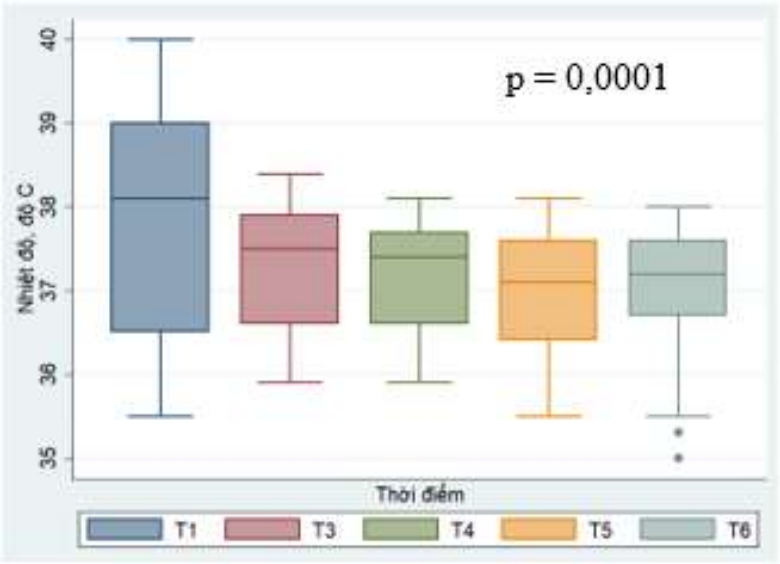

Chart 3.1. Box plots of body temperature changes during CRRT

At the time of septic shock, body temperature fluctuated between 36.5 and 39 degrees Celsius. After CRRT, the patient's body temperature decreased significantly ($p < 0.001$), but was still within the allowable range (36.5 to 38 degrees Celsius).

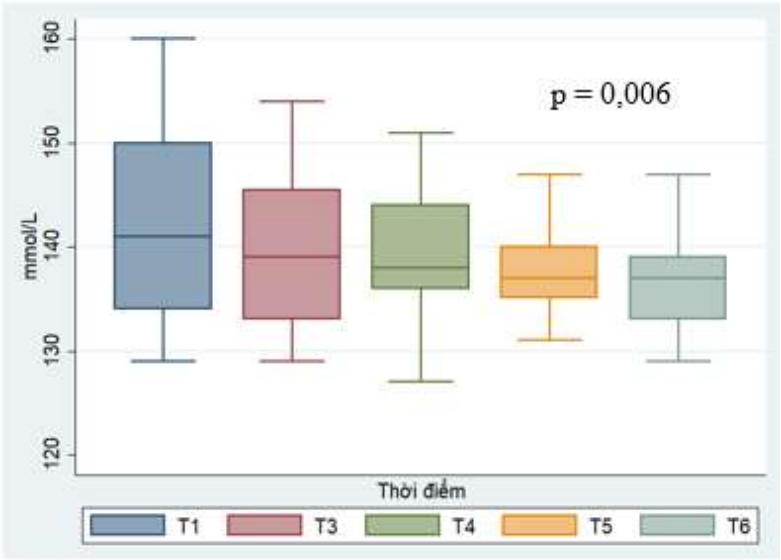

Chart 3.2. Box plot of changes in serum sodium concentration during CRRT

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Before and during CRRT, the median blood sodium concentrations were within limits. Before CRRT, blood sodium concentration was concentrated in the range of 135 to 150 mmol/L. After CRRT, blood sodium concentration decreased significantly and was concentrated in the allowable range (135 - 145 mmol/L) ($p < 0.01$).

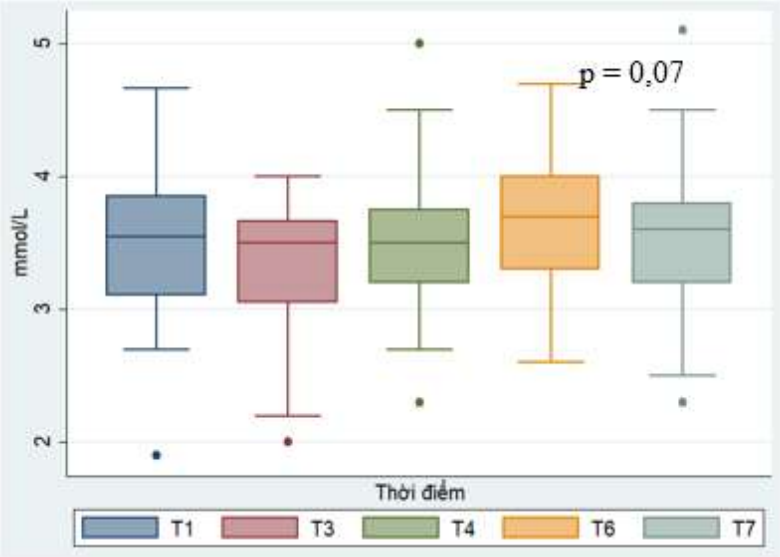

Chart 3.3. Box plot of changes in plasma potassium concentration during CRRT

Before and during CRRT, the median blood potassium level was within normal range and there was no difference between time points ($p > 0.05$).

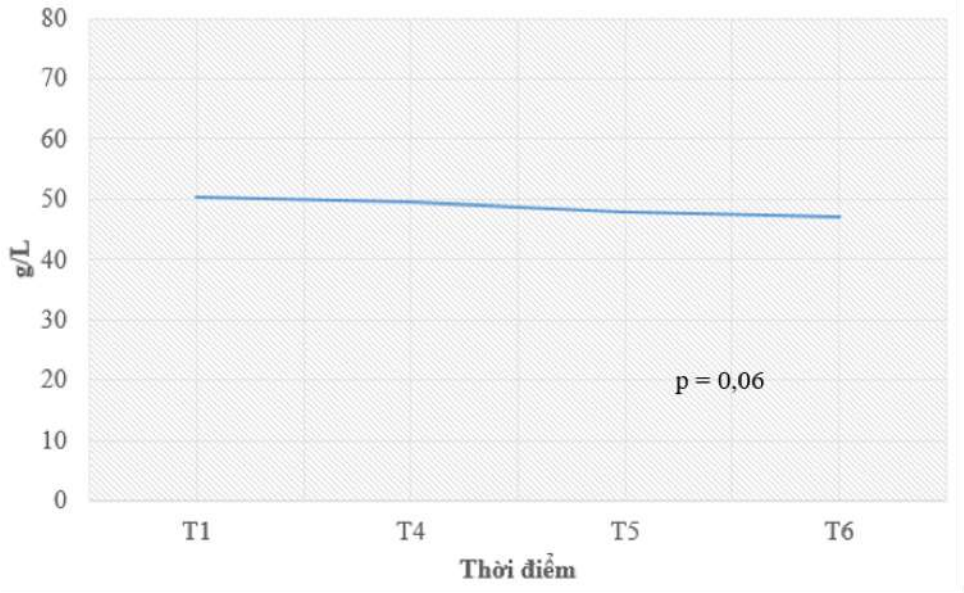

Chart 3.4. Plasma protein changes before and during CRRT

There was no difference in protein concentrations before and during CRRT ($p > 0.05$).

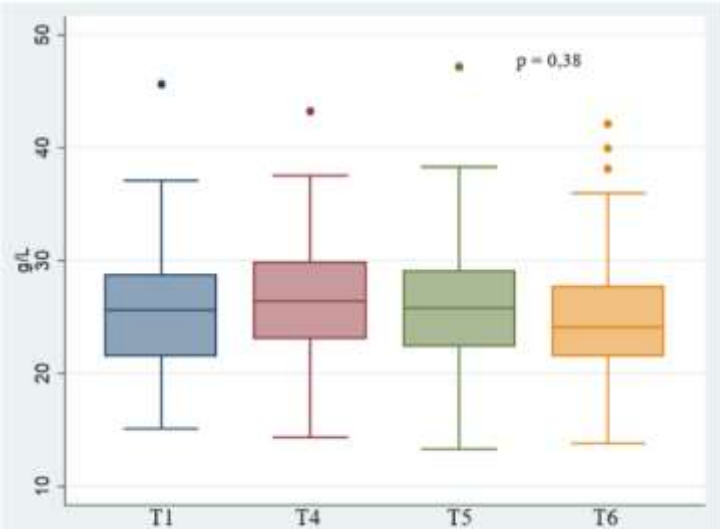

Chart 3.5. Plasma albumin changes before and during CRRT

Blood albumin concentration at all time points ranged from 22 g/L to 30 g/L with some abnormally high points. There was no difference in blood albumin concentration before and during CRRT ($p > 0.05$).

4. DISCUSSION

Technical-related complications include problems related to vascular access, hemolysis, air embolism, and filter clotting. These complications are mainly controlled by prevention, proper implementation of dialysis catheter placement techniques, filter priming, and proper anticoagulation procedures with heparin. Our results show that: in 55 episodes of septic shock in 38 severe burn patients undergoing CRRT with oxiris filter (247 oxiris filters), only 8 filters were frozen (3.2%), and there were no other technical-related complications. 8 filters froze (used for 6 - 8 hours) because the patient had just undergone necrosectomy, skin grafting, or amputation surgery within the previous 48 hours, and we could not use heparin for anticoagulation, accepting a reduction in filter lifespan.

Hypothermia is a common complication of CRRT. 90% of dialysis patients experience hypothermia. In Akhoundy's report, the core temperature before and after CRRT was 36.9^0C and 35.2^0C, respectively [6].

The results of our study show that at the time of septic shock, body temperature fluctuated between 36.5 and 39 degrees Celsius. After CRRT, the patient's body temperature decreased significantly ($p < 0.001$), but remained within the allowed range (36.5 to 38 degrees Celsius).

All of our CRRT patients received:

1) Use of the blood warmer available on the machine (set at 39 - 42 degrees Celsius depending on each patient).

2) Warming the dialysate with an incubator at 38 degrees Celsius before use for the patient.

3) All patient rooms had hot air conditioners turned on at 38 degrees Celsius.

4) Septic shock patients with hypothermia were warmed by a specialized heating lamp for burn patients.

In the study, we followed the correct procedure for blood withdrawal immediately after entering the filter, initially at 100 ml/min, monitoring systolic blood pressure,

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with systolic blood pressure stable above 90 mmHg, after 10 - 15 minutes increasing by 20 ml/min each time, reaching the target of 180 ml/min. As a result, there were no cases of hypotension immediately after entering the filter.

The results of charts 3.2 and 3.3 show that during CRRT, sodium and potassium concentrations were within the allowed limits. Using the correct protocol for adding potassium to the dialysate and adjusting it every 4 - 6 hours allows for better control of the patient's blood potassium levels.

During CRRT, there were no differences in the state of hypercoagulable disorders at various time points ($p > 0.05$). However, the number of shock episodes that had coagulation disorders was significantly reduced after 48 hours after CRRT ($p < 0.001$). Along with that, the hypercoagulability also decreased significantly ($p < 0.001$). This is because we used heparin for anticoagulation during CRRT. Good heparin adjustment during CRRT helps maintain the lifespan of the filter, in addition to correcting hypercoagulable disorders in septic shock patients. There were only 2 cases of clinical bleeding at the lesion that had just undergone necrosectomy and skin grafting within 3 days prior, requiring dressing changes and hemostasis. This highlights the difficulty in controlling coagulation and bleeding during CRRT in severe burn patients who require weekly necrosectomy of deep burns and autologous skin grafting.

5. CONCLUSION

During CRRT, there were no differences in plasma potassium concentration, plasma protein and albumin concentration, and hypocoagulation disorder at any time points ($p > 0.05$). Body temperature always remained within the permissible limits.

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EFFECTS OF POLYHEXAMETHYLENE BIGUANIDE ON INFECTED WOUND BED: HISTOLOGICAL

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ABSTRACT

Objective: *Evaluation of the effect of PBH (PBH) on histopathological and biofilm change at the infected wound bed.*

Subjects and methods: *Fifteen infected wounds of 15 inpatients at the Wound Healing Center - National Burn Hospital, from July to August 2024. The wounds were washed by PBH. Evaluation of histological progression on H&E-stained slides and Biofilm on the wound bed using scanning electron microscopy (SEM), at the time before (T0), after 7 days (T1) and after 14 days (T2) using PBH.*

Results: *The extracellular matrix structure at the wound site showed reduced inflammation, with a statistically significant decrease in the number of inflammatory cells at times T1 and T2. The proportion of wounds with biofilm decreased from 50% at T0 to 20.8% at time T1 and 8.3% at time T2. The biofilm structure was disrupted and eliminated at times T1 and T2 when observed under SEM.*

Conclusion: *PBH effectively eliminates bacteria, disrupts biofilm, and promotes wound healing.*

Keywords: *Infected Wound, Polyhexamethylene Biguanide, Bacteria, Biofilm*

1. INTRODUCTION

Microorganisms can exist harmlessly in wounds, but their growth may lead to infection, localized tissue damage, and impede wound healing. Wound infections can become more severe due to the development of biofilms. The prevalence of chronic wounds associated with biofilms is estimated to be approximately 78% [1]. Biofilms also contribute to the increasing problem of antibiotic resistance. Preventive measures, such as the rational use of antibiotics, infection prevention, and control, are crucial to addressing this threat. Removing biofilms from wound surfaces has been proven to significantly promote wound healing [2].

To effectively remove necrotic tissue and address biofilms at wound sites, a combination of debridement techniques and wound cleaning/irrigation is required [3]. For infected wounds or wounds at high

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risk of infection, wound irrigation solutions containing antimicrobial agents are particularly beneficial. Commonly used agents include hypochlorite, hypochlorous acid (HOCl), povidone-iodine, and Polyhexamethylene biguanide.

Notably, Polyhexamethylene biguanide is a polymer widely used as a disinfectant and antiseptic in various industries, including wound care. It exhibits low toxicity and is effective against a wide range of microorganisms, including bacteria, viruses, and fungi [4]. However, to date, there have been no systematic studies in Vietnam on the effects of Polyhexamethylene biguanide on infected wounds.

Based on this rationale, we conducted this study with the aim of evaluating the histological and biofilm changes at infected wound sites after the application of Polyhexamethylene biguanide.

2. SUBJECTS AND METHODS

2.1. Subject

Fifteen infection wounds from 15 patients aged over 18 years were hospitalized at the Wound Healing Center of the National Burn Hospital from July 2024 to August 2024.

2.1.1. Inclusion criteria

Patients over 18 years old with infection wounds.

2.1.2. Exclusion Criteria

Patients with any of the following conditions were excluded from the study: Patients in critical condition require emergency interventions; Patients with coagulation or bleeding disorders; Patients with infectious diseases such as HCV or HIV.

2.2. Materials and equipment

Including PBH, produced by Biopro Biopharmaceutical Joint Stock Company, Vietnam. JEM 1400 electron microscope by JEOL, manufactured in Japan.

2.3. Methods

2.3.1. Study design

A case-control study, with longitudinal clinical trials comparing pre- and post-treatment outcomes.

2.3.2. Research method using PBH

Patients enrolled in the study underwent wound culture testing, and those with positive culture results were included in the study. During dressing changes, the wounds were treated according to the following protocol: Clean the wound surface with a Natriclorid 0.9% solution to remove all medication and debris. Rinse the wound again with PBH solution. For wounds with biofilm, after rinsing with PBH solution, apply gauze soaked with PBH solution for 15 - 20 minutes until the biofilm softens and dissolves. Rinse the wound once more with PBH solution. Finally, apply iodine-containing dressings and cover the wound. This process was repeated at each subsequent dressing change until the wound healed naturally or surgical intervention was indicated to close the wound.

2.3.3. Study time points

Time T0: Before using PBH; T1: After using PBH for 7 days; T2: After using PBH for 14 days.

2.3.4. Clinical study

All patients were assessed for age; gender; co-mobilities; cause, location, and

duration of the wound. Characteristics of the Biofilm membrane were identified: Observation and description of Biofilm membrane characteristics including color and size (covering the entire or a part of the wound surface).

2.3.6. Morphological study

- Histopathological identification of the wound tissue and inflammatory cell count on H&E-stained slides: Tissue biopsy at the VT site, preparation of H&E-stained slides, and identification of histological images using a Carl Zeiss optical microscope manufactured in Germany, with objective lenses magnified at 100x, 200x, and 400x.

- To determine the number of inflammatory cells per 1 area unit: When observing H&E-stained slides, count the total number of inflammatory cells in a field of view at 400x magnification. Inflammatory cells are counted on six fields of view in six different locations. The total number of inflammatory cells from all six fields was added and divided by six. This provides the average number of inflammatory cells per field of view. This task is carried out at the Department of Anapathology, Military Hospital 103.

- Determination of Biofilm Ultrastructure on the Wound Surface Using Scanning Electron Microscopy (SEM): Samples were prepared and analyzed using the JEM 1400 electron microscope (manufactured by JEOL, Japan). This task was carried out at the Morphology Department, Institute 69, President Ho Chi Minh Mausoleum Protection Command.

2.3.7. Data analysis

Data Analysis: The collected data were compared before and after treatment. At a 95% confidence level, the comparison was considered statistically significant when $p < 0.05$. Data were analyzed by STATA 12.0 software.

3. RESULTS

3.1. Characteristics of study patients

Table 3.1. Characteristics of patients and wounds (n = 15)

Feature	X ± SD	Min - Max
Age (year)	56.4 ± 13.6	28 - 76
Wound size (cm^2)	75.6 ± 49.5	10 - 110
Duration of wound existence (month)	2.37 ± 1.45	0.5 - 4
	N	%
Gender		
Male	9	60
Female	6	40
Wound position (n = 15 wounds)		
Upper extremity	2	13.3
Lower extremity	13	86.7

The study patients had a male-to-female ratio of 1.5, with an average age of 56.4 ± 13.6 years. The wound area was relatively large, averaging 75.6 ± 49.5 cm^2.

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The wounds had an average duration of 2.37 ± 1.45 months. The main causes of the wounds included cellulitis (54%), diabetes (33%), and other causes such as gout and Cushing's syndrome, accounting for 13% (Chart 3.1). Wounds on the lower extremity were the most common, comprising 86.7%, while 13.3% were located on the upper extremity.

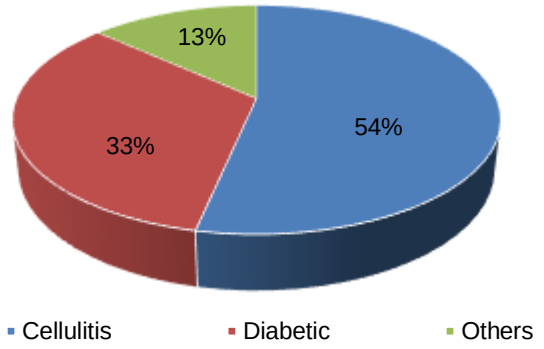

Chart 3.1. Distribution of patients by cause

3.2. Histological changes after using PBH

Table 3.2. Histological Changes after using Latex HB® (n=15)

Time	Histological feature	
T0	Feature	The entire skin layer was damaged. The subcutaneous connective tissue showed inflammatory edema. Intercellular spaces had numerous inflammatory cells (primarily neutrophils and lymphocytes - Figure 3.1A).
	Number of inflammatory cells	16.3 ± 2.7/ area unit
T1	Feature	The wound bed was connective tissue of the dermis layer, with many collagen fibers and fibroblasts. Scattered infiltration of neutrophils and lymphocytes was observed. The spinous cells proliferated from the wound edges to the wound bed center (Figure 3.1B).
	Number of inflammatory cells	8.2 ± 1.6/ area unit
T2	Feature	The proliferation of the extracellular matrix (ECM) was evident as the proliferation of numerous fibroblasts and myofibroblasts. Only a few neutrophils, lymphocytes, and macrophages remained (Figure 3.1C)
	Number of inflammatory cells	4.9 ± 1.5/ area unit
P		$P_{0-1} < 0.05$; $P_{0-2} < 0.001$; $P_{1-2} < 0.05$

After using Latex HB, the wound histology showed significant improvement, and the number of inflammatory cells was statistically reduced compared to before using Latex HB.

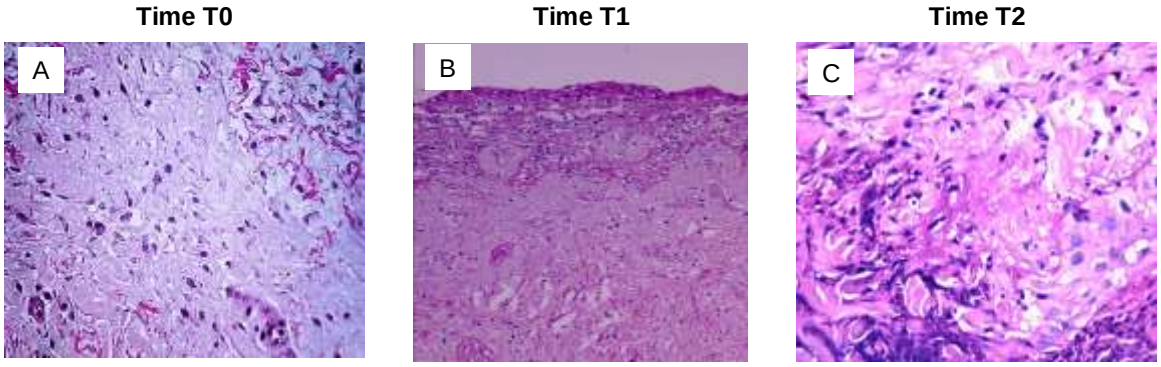

Figure 3.1. Histological characteristics on H&E-stained slides of the wound at different study time points observed under 100x, 200x and 400x magnifications

3.3. Changes in the Biofilm Membrane

Table 3.3. Clinical characteristics of the Biofilm membrane after using PBH (n = 12)

Time / Feature	T0 (n = 12) n (%)	T1 (n = 5) n (%)	T2 (n = 2) n (%)
Color			
- Green	4 (33.3)	1 (20)	1 (50)
- Yellow	7(58.3)	3 (60)	1 (50)
- Yellow + Green	1 (8.3)	1 (20)	
Size			
- Part of the wound surface	4 (33.3)	3 (60)	2 (100)
- Entire wound surface	8 (66.6)	2 (40)	-

At time T0, there were 12 wounds with Biofilm membranes, predominantly yellow, accounting for 58.3%. The second most common color was green (33.3%). 8.3% of the wounds had biofilm membranes with a combination of yellow and green.

Regarding the macroscopic morphology of the Biofilm membranes, at time T0, 66.6% of the wounds had biofilm membranes covering the entire wound surface. At time T1, 33.3% of wounds had biofilm membranes covering only part of the wound surface. At time T2, Biofilm membranes persisted and covered only a portion of the surface in two wounds.

Observing the biofilm membrane under a scanning electron microscope, the biofilm on the wound surface exhibited various morphologies. At time T0, bacteria were densely colonized, covering the wound surface entirely and protected by a polysaccharide membrane. At time T1, the Biofilm structure was destroyed, and the bacterial density on the wound surface significantly decreased compared to T0, with bacteria forming colonies. At time T2, many tissue samples showed no bacteria, or bacteria appeared only sparsely on the wound surface (Figures 3.2 and 3.3).

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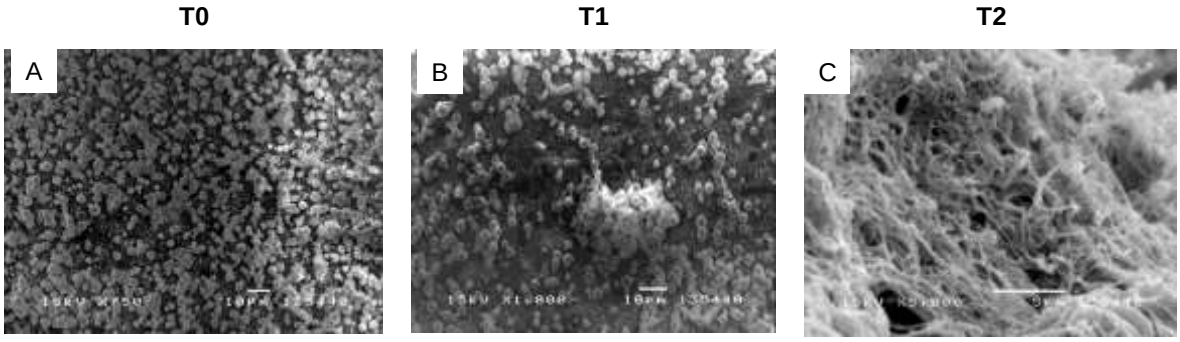

Figure 3.2. Images of the Biofilm Membrane Observed Using Scanning Electron Microscopy (SEM): At time T0, Cocci bacterias were densely distributed, invading the entire wound surface. At time T1, the density of Cocci bacterias decreased compared to time T0, with cocci colonizing and tending to cluster, forming bacterial colonies. By T2, no Biofilm membrane was detected..

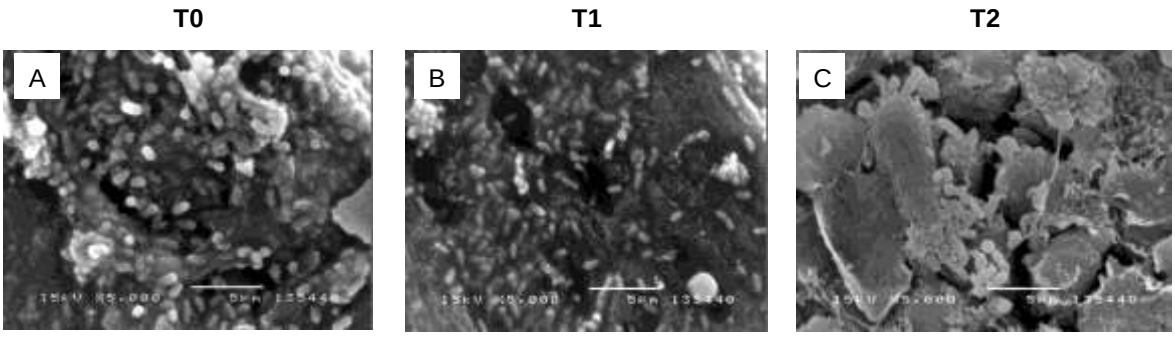

Figure 3.3. Images of the Biofilm Membrane Observed Using Scanning Electron Microscopy (SEM): At time T0, Bacilli were densely distributed and protected by a polysaccharide membrane covering the entire wound surface. At time T1, the Biofilm membrane was disrupted, and the bacilli were aggregated (colony) and still enclosed by the polysaccharide protective membrane, with single bacilli scattered on the outside. At time T2, the wound surface only showed scattered bacilli, with a tendency to cluster together.

4. DISCUSION

In clinical practice, the use of solutions to irrigate wounds aims to reduce infection and remove foreign bodies, cellular debris, or exudates from the wound surface. Sodium chloride 0.9% is recommended for wound irrigation as it is readily available, non-toxic to wound tissue, does not interfere with the wound healing process, and is cost-effective [5].

Additionally, the market currently offers various solutions containing antimicrobial agents that are highly effective in wound care, such as sodium hypochlorite, hypochlorous acid, povidone-iodine, and PBH. PBH is recommended for wound care due to its affordability and availability. Experimental evidence has demonstrated the antimicrobial effects of PBH against a wide range of microorganisms, including

Gram-negative and Gram-positive bacteria, pathogenic fungi, viruses, and protozoa [6].

Several clinical studies have reported that PBH solutions effectively reduce bacterial load in various types of chronic wounds (venous ulcers, diabetic foot ulcers, pressure ulcers) [7] as well as acute wounds (burns, surgical wounds, trauma wounds, skin graft wounds) [8]. Furthermore, when PBH is used in combination with negative pressure wound therapy, it has shown synergistic effects in treating infected wounds [9].

In addition to its antimicrobial properties and ability to eliminate surface bacteria from wounds, some studies suggest that applying dressings impregnated with PBH can improve wound healing [10]. Our research findings align with these observations. When wounds were irrigated and soaked with PBH solution, histological analysis of H&E-stained specimens showed progressive improvements over time, including reduced connective tissue inflammation, increased fibroblast proliferation, and decreased inflammatory cell counts (Table 3.2).

Biofilms are quite common and are one of the primary causes of delayed wound healing. The effectiveness of PBH against biofilms has been demonstrated in several experimental studies. By impregnating dressings with PBH and applying them to wound surfaces, Bazire A et al showed that biofilms were disrupted by betaine which was a surfactant component in PBH [11]. Mueller SW et al reported that PBH effectively eliminates methicillin-resistant Staphylococcus aureus (MRSA) [12].

Chai et al studied the effects of PBH on diabetic foot ulcers infected with drug-resistant Pseudomonas. They observed a significant reduction in bacterial load in the wounds after using PBH [10]. PBH's ability to disrupt biofilms formed by drug-resistant bacteria is achieved by promoting the transfer of antibiotic resistance genes among bacterial species [13].

In this study, we found that PBH was effective well both cocci and bacilli. At T0, bacteria were present in high density and were protected by a polysaccharide membrane covering the entire wound surface. After 7 days of using PBH (T1), the biofilm was disrupted; cocci and bacilli aggregated into colonies and were surrounded by a protective polysaccharide membrane. At time T2, many tissue samples showed no bacteria, or bacteria appeared only sparsely on the wound surface (Figures 3.2 and 3.3).

5. CONCLUSION

PBH effectively eliminates bacteria, disrupts biofilm, and promotes wound healing.

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RESULTS OF WOUND HEALING OF PLATELET RICH PLASMA GEL FROM UMBILICAL CORD BLOOD IN AN EXPERIMENT

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ABSTRACT

Objective: *To evaluate the wound healing effect of PRP gel from human umbilical cord blood in experimental studies.*

Subjects and methods: *The extra-long dorsal skin flaps on 18 white rats were treated for wound healing by injecting PRP gel from human umbilical cord blood and the control was injected with 0.9% NaCl at a dose of 0.5 mL/injection point.*

Research results: *The living area of the skin flaps injected with PRP gel from human umbilical cord blood on days 3; 7 and 14 were 4.1 ± 0.2, 3.9 ± 0.1 and 3.8 ± 0.1 cm^2, respectively, significantly different from the control group ($p < 0.05$). The average number of blood vessels and the average total blood vessel area increased over time when compared with the control group ($p < 0.05$).*

Conclusion: *PRP gel from human umbilical cord blood stimulates angiogenesis and promotes wound healing in experimental studies.*

Keywords: *PRP from human umbilical cord blood, dorsal-long skin flap in white rats*

1. INTRODUCTION

Wound healing is a very complex process, overlapping between inflammation, proliferation and regeneration. The multifactorial nature of the wound environment, systemic and local responses, in addition to the migration, proliferation, interaction and differentiation of many types of cells, many biological molecules, synthesis of matrix components and other signaling networks contribute to the complexity of this process [1].

Autologous platelet-rich plasma (PRP) has been known to contain various biological factors involved in tissue and vascular repair such as specialized granules, alpha granules, platelet-derived growth factor, transforming growth factor-beta, epidermal growth factor and others. Author Jason E et al. (2019) [2]: PRP is effective in tissue regeneration, helping to increase the ability to heal wounds. In clinical practice, there are many elderly patients, chronic diseases, exhaustion... blood collection to produce PRP is difficult and of low quality, human umbilical cord blood (HUCB) has been proven to have

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many outstanding biological characteristics, is easy to collect and produce PRP gel. In order to evaluate the stimulating effect in wound healing treatment, we conducted this study to: Comment on the treatment effectiveness of PRP gel from human umbilical cord blood on the experimental model of extremely long skin flap wound healing.

2. SUBJECTS, MATERIALS AND METHODS OF RESEARCH

2.1. Subjects and materials of research

- Research material: PRP gel from HUCB incubated for 10 minutes in the refrigerator with $CaCl_2$ (10%) and thrombin in a ratio of 4/2/1 (5 ml).

Figure 2.1. PRP gel product from human umbilical cord blood

- The research animals were white Wistar rats, 8 - 10 weeks old, weighing 150 -180g, healthy, modeled with wound healing by creating an extremely long dorsal flap of the mouse and treated with PRP gel injections at the Department of Practical and Experimental Surgery - Military Medical University during the period of 9/2023 - 6/2024

2.2. Research method

- Research design: Cross-sectional, longitudinal, controlled study.

- Sample size: Apply sample size estimation according to one-way ANOVA:

n = DF/k + 1 (DF (Degree of Freedom): degrees of freedom; k: number of groups; n: number of samples per group).

From there, based on the distributed file system (DFs - Depth First Search): $10/k + 1 \leq n \leq 20/k + 1$. Choose n = 6/group.

- Research steps and research criteria

+ Proceed to create PRP gel from HUCB: Umbilical cord blood collected from healthy pregnant women is pumped into 10 ml tubes. Place these tubes in a centrifuge chamber symmetrically, spin at 3000 rpm for 20 minutes and aspirate the dark yellow and light yellow layers. Mix 10% $CaCl_2$ with thrombin (4/2/1) and leave at 4 - 6^0C for 10 minutes.

* Evaluation criteria: Platelet count in PRP gel: Platelet count/ml PRP gel with Model Z3 hematology analyzer and PRP gel quality based on DEPA classification table of Magalon J., et al. (2016) [3]:

Table 2.1. Evaluation of PRP gel quality

Variable	Score			
	1+	2+	3+	4+
Platelet count (µL)	< 1	1 - < 3	3 - < 5	≥ 5
Purity (%)	< 30	30 - < 70	70 - < 90	≥ 90
PRP gel activation process creates an opaque white color	4/1	3/1	2/1	1/1

+ Modeling and PRP treatment: Animals were anesthetized with Ketamine injected into the peritoneum at a dose of 0.001 mg/g body weight. Created an extremely long skin flap model. Treated with PRP gel injection points in a 1cm square on the left and 0.9% NaCl on the right. Ended the experiment with CO_2 asphyxiation, took pathological specimens on days 3 (M1); 7 (M2); 14 (M3).

* Evaluation criteria: Wound area over time (calculated in cm^2 using Image J software) and wound pathology results [4]: Including average vascularity (total number of blood vessels/total number of microscopic fields), percentage of vascular area (total blood vessel area/total flap area)

2.3. Data processing

The collected data will be collected and analyzed using SPSS 20.0 software

3. RESEARCH RESULTS

- Results of PRP gel from HUCB:

Table 3.1. Average platelet count

	Platelets: Mean ± SD (T/L)
HUCB	168 ± 10.5
PRP gel	858.4 ± 13.4

The average platelet count in PRP gel was approximately 5.1 times higher than that in whole blood.

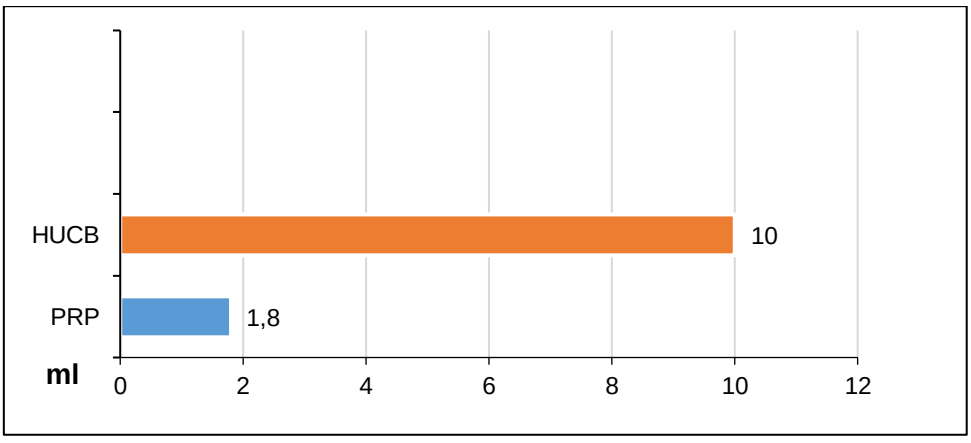

Figure 3.1. PRP volume obtained from 10ml of HUCB

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The volume of PRP obtained was 18% of whole blood and averaged 1.9 ± 1.5ml.

Table 3.2. PRP gel quality

Criteria	Score
Platelet count (µL)	3.8+
Purity percentage (%)	3.9+
PRP gel activation rate (4/2/1)	3.8+

PRP obtained with good quality, high purity, best white opaque activation ratio reached 4/2/1.

- Treatment results of PRP gel on extremely long skin flap model:

+ Survival rate (%): Survival rate reached 100%.

+ Length of living skin flap over time.

Table 3.3. Skin flap length over time

Time	Length of skin flap Mean ± SD (cm)					
	M1		M2		M3	
	gel PRP	NaCl	gel PRP	NaCl	gel PRP	NaCl
After 3 days (n = 6)	4.1±0.2	3.9±0.1	-	-	-	-
After 7 days (n = 6)	4.0±0.2	3.5±0.2	3.9±0.1	3.2± 0.2	-	-
After 14 days (n = 6)	4.0±0.1	3.8±0.5	3.8±0.2	3.0±0.3	3.8±0.1	2.8±0.2

The length of the dorsal skin flap, when injected with PRP gel, was larger than that when injected with NaCl. The distal end of the skin flap had necrosis in the PRP gel injection group more slowly and tended to stabilize during the period from day 7 to 14. Unlike NaCl injection, the necrosis of the skin flap still increased and changed with large SD.

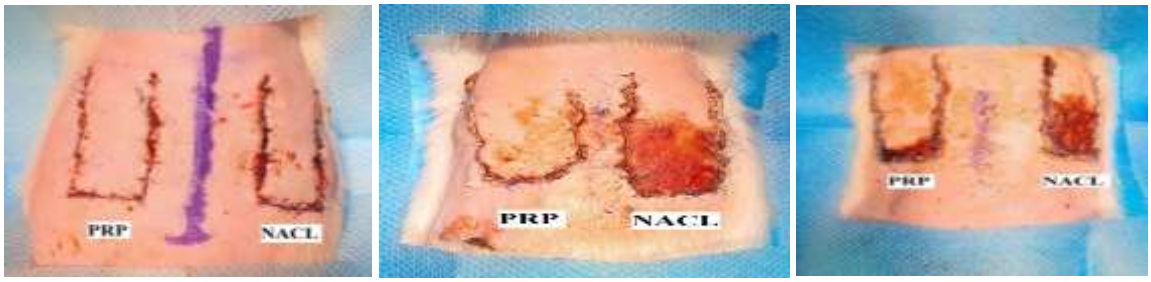

Figure 3.1. Percentage of skin flap survival at days 3, 7 and 14

+ Pathological results and average number of blood vessels:

Table 3.4. Number of blood vessels and average blood vessel area

Variable	M1	M2	M3	p
Average number of blood vessels	6.4 ± 0.6	14.2 ± 1.0	19.8 ± 3.2	p(3,7) < 0.05; p(7,10) < 0.05; p(10,14) < 0.05
Average vascular area (%)	3.3 ± 0.4	6.6 ± 1.2	13.8 ± 2.2	p(3,7) < 0.05; p(7.10) < 0,05; p(10.14) < 0.05

The number of blood vessels and the percentage of blood vessel area in the PRP-injected skin flap increased gradually from day 3 to day 14 and the difference was statistically significant (p < 0.05).

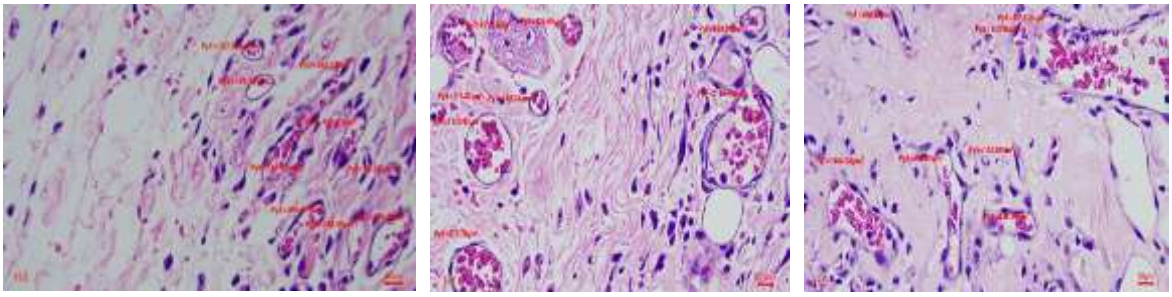

Figure 3.2. Microscopic images of blood vessels on days 3, 7, and 14 after PRP gel treatment

The images show that blood vessels were strongly stimulated to proliferate during the 14 days of the wound.

4. DISCUSSION

According to the research results, the average platelet concentration in PRP is 5.1 times higher than the average platelet concentration in whole blood, lower than the research results of Weiwei et al. (2012) of 5.7 and Chai J. et al. (2019) of 6.2 times [5], [6], however, the average number of platelets obtained is equivalent to other authors and with such quantity and purity, many studies have proven to have high biological activity.

In this study, PRP was activated to form a gel with $CaCl_2$ / thrombin at the tested ratios. These are platelet-activating factors that will release active factors, including a large amount of ADP and thromboxane A2. This activation helps increase the biological effects of platelets because platelets contain many growth factors such as VEGF, IGF, KGF,... which stimulate cell proliferation, encourage the formation of new blood vessels, increase collagen and fibroblast production, and help repair damage. We found that the ratio of 4/2/1 (ml) when incubated for 10 minutes at a temperature of 10 - 20^0C will form a clear white gel.

Unfortunately, in this study, we did not test the growth factors after activating the ratios for comparison. However, in vitro, research on fibroblasts and myofibroblasts by author Schere S.S. et al. 2012 found that platelet activation resulted in poorer wound healing than non-activation [7].

In fact, we found that platelet activation can be used well in wounds without skin loss or skin grafts because platelets will come into direct contact with collagen, which is also a natural activating factor.

Studying the wound healing results of PRP gel from umbilical cord blood on an extremely long skin flap model, it was found that the survival length of the skin flap was much larger than the control with the average length on days 3.7 and 14 being 4.1 ± 0.2, 3.9 ± 0.1 and 3.8 ± 0.1 cm, respectively, compared to the control of 3.9 ± 0.1, 3.2 ± 0.2 and 2.8 ± 0.2. This shows that PRP gel from umbilical cord blood has the ability to stimulate blood vessels to nourish the distal end of the skin flap. This result is similar to the study of Chai J. et al. (2019): The survival rate of the skin flap on the PRP-injected side was much higher than that of the control group from day 7 [5], the study of Weiwei et al in 2012: the skin flap survival rate was 61.2%, the control group was 28% from day 7 onwards [6]. This can be explained by the fact that activated PRP releases many growth factors such as

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PDGF, TGFTGF-β, EGF, VEGF... which play an important role in the process of cell proliferation and tissue regeneration to promote wound healing. The pathological results also demonstrated this with an increase in the number and size of blood vessels in the skin flap injected with PRP gel compared to the control (Figure 4.1), in addition, the control side was also infiltrated with many inflammatory cells.

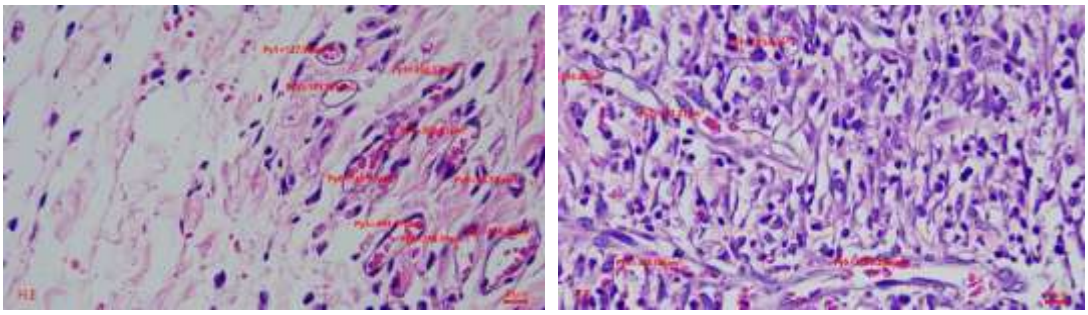

Figure 4.1. Microscopic image of skin flap on day 7

According to Chai J et al. (2019), the PRP activation process releases many growth factors such as PDGF which has been shown to increase the formation of capillaries to help wound healing and VEGF which is known to increase vascular permeability, improve the function of vascular endothelial cells, prolong the life of endothelial cells, and promote angiogenesis [5]. Interestingly, it can be suggested that this can be applied in the process of skin flap harvesting in skin grafting by injecting PRP gel beforehand to increase the survival of the skin flap.

5. CONCLUSION

Human umbilical cord blood PRP gel effectively promotes wound healing by stimulating angiogenesis and reducing inflammatory infiltration in an experimental ultra-long skin flap wound healing model.

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FREESTYLE PEDICLED PERFORATOR FLAPS FOR THE RECONSTRUCTION OF LOWER EXTREMITY DEFECTS

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ABSTRACT

Background: *Lower limb soft tissue defects present unique challenges due to the region's anatomical and functional characteristics. Freestyle pedicled perforator flaps (FPPFs) represent a local skin flap that utilizes adjacent identified perforators, regardless of their source vessel, to cover soft tissue defects. This study evaluated the outcomes of using freestyle perforator flaps to reconstruct lower limb soft tissue defects.*

Subjects and methods: *A prospective study was conducted on 41 patients with 41 lower limb soft tissue defects treated using FPPFs at the Hue University of Medicine and Pharmacy Hospital from March 2022 to September 2024. Data collected included defect characteristics, surgical techniques, and postoperative outcomes. Flap designs included peninsular, advancement/Keystone, and propeller flaps, selected based on defect location and size. Outcomes were evaluated during hospitalization and long-term follow-up.*

Results: *The mean defect size was 27.3 ± 13.2 cm², with infection being the most common cause (73.2%). Among the 41 flaps performed, 87.8% achieved complete survival, and 97.6% maintained optimal outcomes at 6 months, including functional mobility and aesthetic satisfaction. Complications occurred in 12.2% of cases, primarily marginal or distal flap necrosis, but none resulted in total flap loss. Donor site closure was achieved with direct suturing in 90.2% of cases, while skin grafting was needed in 9.8%.*

Conclusion: *FPPFs are reliable for lower limb defect reconstruction with their flexibility and donor site preservation. The modified techniques demonstrated high survival rates, aesthetic compatibility, and improved postoperative quality of life. Further research is needed to minimize venous congestion risks and optimize outcomes.*

Keywords: *Perforator flaps, lower limb, soft tissue defects, Freestyle Pedicled perforator flap.*

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1. INTRODUCTION

With its anatomical structure and weight-bearing function, the lower limb is prone to injury and challenging to restore when soft tissue defects occur. Studies have shown that the lower limb has the highest rate of soft tissue defects requiring coverage and the highest complication rates associated with flap surgery [1]. Axial skin-muscle flaps often require sacrificing underlying muscles and the main arteries supplying the flap, leading to compromised function, aesthetics, and sometimes prolonged donor site pain, reducing reconstruction quality. Moreover, flaps based on fixed axial vascular pedicles have limited rotation angles and movement patterns, reducing flexibility.

In 1987, Taylor and Palmer, building on the anatomical studies of Manchot and Salmon, introduced the concept of angiosomes, identifying that a specific vascular pedicle supplies each area of the body's skin. They found approximately 400 perforating vessels with a diameter >0.5 mm across the body, making any skin area a potential source for perforator flaps [2]. The most significant advantage of perforator flaps (PFs) lies in preserving the functionality of related muscles and minimizing donor site deformities. The muscle is spared even when partially dissected, with maximal preservation of the donor site and reduced postoperative pain. PFs can be designed freely based on defect templates without restrictions on pedicle length, providing sufficient coverage comparable to, or even more extensive than, traditional skin-muscle flaps.

The evolution of perforator flaps began in the 1980s, spearheaded by surgeons such as Koshima and Soeda, who introduced using skin flaps nourished by perforating vessels without including muscle [3]. This approach significantly minimized donor-site morbidity while preserving function and appearance. Building on this foundation, the concept of "freestyle" perforator flaps emerged in the early 2000s, championed by pioneers like Wei and Hallock [4]. The term "freestyle" reflects the freedom to harvest flaps based on the surgeon's intraoperative identification of perforators rather than strict anatomical landmarks. This technique harnessed advancements in Doppler imaging to expand the versatility of flap options, particularly in areas with challenging anatomy or irregular defects [5].

Thus, Freestyle Pedicled Perforator Flaps (FPPFs) for managing lower limb soft-tissue defects is a flexible and effective solution. However, FPPF surgery reduces the need for advanced dissection techniques and is susceptible to venous congestion risks. Improved FPPF designs need further research to enhance flap survival rates and treatment efficacy while minimizing limitations [6-8]. Motivated by these realities, we conducted this study, titled *"Freestyle Pedicled Perforator Flaps for the Reconstruction of Lower Extremity Defects."* aiming to:

- Describe the clinical characteristics of lower extremity soft tissue defects treated with FPPF.
- Evaluate the treatment outcomes of lower extremity soft tissue defects using FPPF.

2. SUBJECTS AND METHODS

2.1. Study subjects

The study included 41 patients with 41 lower limb soft tissue defects (STDs) treated with 41 FPPFs at the Department of Orthopedic and Thoracic Surgery, Hue University of Medicine and Pharmacy Hospital, from March 2022 to September 2024.

Inclusion criteria:

- Patients with lower limb STDs reconstructed using freestyle perforator flaps designed based on adjacent perforators identified preoperatively using a handheld Doppler ultrasound device.
- Soft tissue defects located from the thigh to the foot.

Exclusion criteria:

- Patients whose STDs were treated by other methods, such as primary closure, skin grafting, axial flaps, or free flaps.
- Presence of acute local infection.
- Patients who declined to participate in the study.

2.2. Study methods

This was a prospective longitudinal observational study.

** Study steps included:* Clinical examination, assessment of injuries via clinical and radiographic evaluation, surgical planning, flap selection, surgical procedure, and postoperative follow-up and outcome evaluation.

**** Research characteristics:***

- Demographic characteristics: age and sex.

- Clinical features of STDs: cause, location, size, and wound bed condition.

- Surgical characteristics and outcomes: flap movement technique, donor site coverage method, postoperative flap and donor site condition, and aesthetic evaluation.

** Technical Procedure:*

- Step 1: Clinical examination to evaluate the defect: Identify the cause, local condition, and patient's general health, followed by surgical planning and flap design.

- Step 2: Preoperative Doppler ultrasound was performed using the HADECO BIDOP ES-100V3 handheld Doppler device (Japan) with an 8.0 MHz probe to identify perforator locations. Perforators with strong Doppler signals (3 - 4 in number) were mapped and marked on the skin. The strongest perforator was selected as the main perforator for the flap design (Figure 2.1).

- **Step 3:** Intraoperative debridement and preparation of the recipient site, with re-measurement of the defect. The flap was elevated starting from the anterior border and moving toward the center of the marked perforator area. Dissection was carried out carefully to identify the perforator as preoperatively marked. Intraoperative visual assessment guided the final choice of perforator with the highest viability. Based on the location of the defect, appropriate flap movement techniques were applied (peninsular, advancement/Keystone, or propeller). The donor site was closed primarily or covered with a skin graft as needed.

- **Step 4:** Postoperative care included antibiotics, anti-inflammatory drugs, analgesics, and fluid therapy. Flap viability was monitored closely through clinical indicators such as color, temperature, and capillary refill time. Any complications at the recipient or donor sites were also recorded and managed accordingly.

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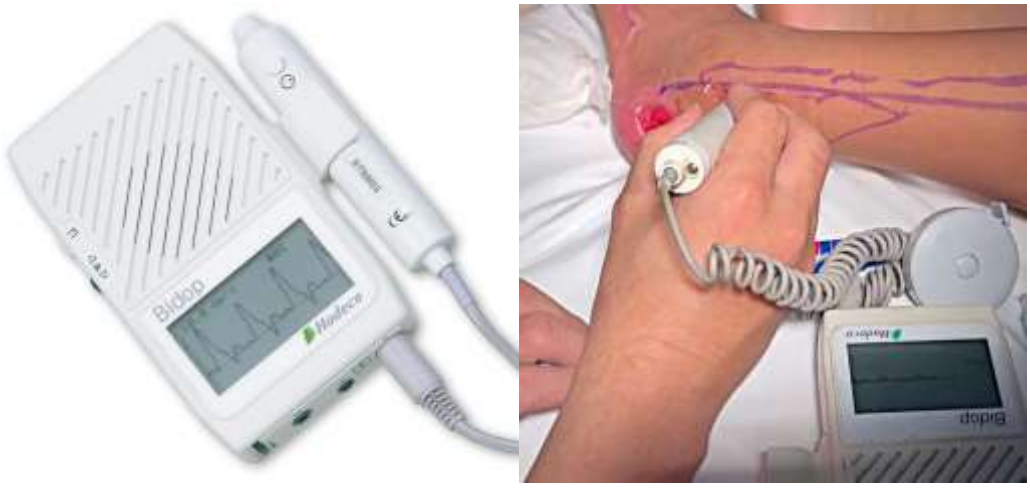

Figure 2.1. Preoperative identification of the perforator using a handheld Doppler ultrasound and FPPF design based on this perforator to cover the soft tissue defect of the heel.

**** Variations of transfer methods for Freestyle Pedicled Perforator Flaps***

- Peninsular rotation-advancement flap: In cases where a perforator is identified near the soft-tissue defect, a peninsular flap can be designed to ensure adequate coverage and enhance flap viability (Figure 2.2).

- V-Y or Keystone advancement flap: For more minor defects, the perforator-based flap can be advanced in a V-Y pattern or Keystone configuration, utilizing the mobility of the perforator pedicle to cover the defect (Figure 3.1).

- Propeller rotation flap: In cases of larger defects or when the identified perforator is not adjacent to the defect, the flap can be rotated around the perforator (propeller-style). The distance from the perforator pedicle to the proximal end of the flap should be 0.5 - 1 cm greater than the distance to the most distal point of the defect (Figure 3.2).

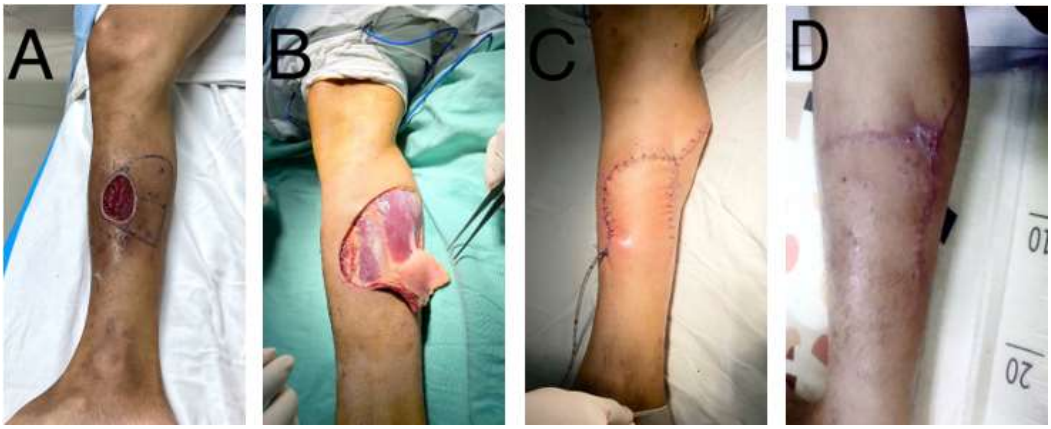

Figure 2.2. (A) Soft tissue defect at the medial aspect of the right lower leg with adjacent perforators marked. (B) Elevation of a peninsular flap. (C) Flap rotation and advancement to cover the defect, immediate postoperative result. (D) Follow-up at 6 months.

2.3. Evaluation of outcomes

The treatment outcomes were evaluated based on flap viability, wound healing at both donor and recipient sites, and functional and aesthetic results. Criteria from Oberlin C and Duparc J were applied to assess both early postoperative outcomes (during hospitalization) and long-term outcomes (at > 6 months postoperatively).

**** Early outcomes:***

- Flap:

- Good: Complete flap survival with primary wound healing.
- Fair: Partial flap compromise, including epidermolysis or marginal necrosis involving < 1/3 of flap area, with or without need for skin grafting; the presence of hematoma or wound infection.
- Poor: Necrosis involving > 1/3 of the flap or total flap loss, requiring excision and alternative reconstruction.

- Donor site:

- Good: Satisfactory wound healing, no infection, viable skin graft (if applicable).
- Complications: Infection, fistula formation, or skin graft necrosis.

**** Long-term outcomes (after 6 months):***

- Flap:

- Good: Full flap survival, soft and mobile tissue, no ulceration, hyperpigmentation, or fistula formation; aesthetically acceptable scarring.
- Fair: Hypertrophy or recurrent fistula formation is manageable with dressing and debridement; there is no need for further coverage surgery.
- Poor: Flap fibrosis, dark discoloration, chronic ulceration, or fistula requiring secondary reconstruction or defect padding procedures.

- Donor site:

- Good: Well-healed, flat, or slightly raised scar.
- Complications: Fistula formation, hypertrophic scarring, or contracture.

** Aesthetic outcome:* The Vancouver scar scale was employed to assess the aesthetic integration of the flap with the recipient site, focusing on color, texture, hair pattern, and contour matching [9].

3. RESULTS

3.1. General characteristics

From March 2022 to September 2024, 41 patients (27 males and 14 females) with 41 lower limb soft tissue defects underwent reconstruction using freestyle pedicled perforator flaps at Hue University of Medicine and Pharmacy Hospital. Patients ranged in age from 11 to 74 years, with a mean age of 47.5 ± 14.2 years.

3.2. Clinical characteristics

** Etiology of defects:*

The most common cause was infection or abscess formation, accounting for 73.2% of cases. Trauma-related defects constituted 19.5%, post-burn contractures 4.9%, and post-tumor excision defects 2.4%.

** Location of defects:*

Most defects were located in the lower leg (25 cases, 61.0%). Ankle and heel defects accounted for 9 cases (22.0%), followed by thigh defects in 4 cases (9.8%) and knee defects in 3 cases (7.2%).

** Characteristics of defects*

Simple defects with no exposure of tendons or bones but requiring soft tissue padding due to depth were observed in 36.6% (15/41). The remaining 63.4% of

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defects involved exposure of critical underlying structures: 19.5% with exposed tendons, 26.8% with exposed bone, and 17.1% with both tendons and bone exposure.

** Defect dimensions*

The average defect measured 7.2 ± 2.4 cm in length (range: 4.0 - 20.0 cm), 4.5 ± 1.1 cm in width (range: 3.0 - 8.0 cm), with a mean surface area of 27.3 ± 13.2 cm^2 (range: 10.5 - 125.0 cm^2).

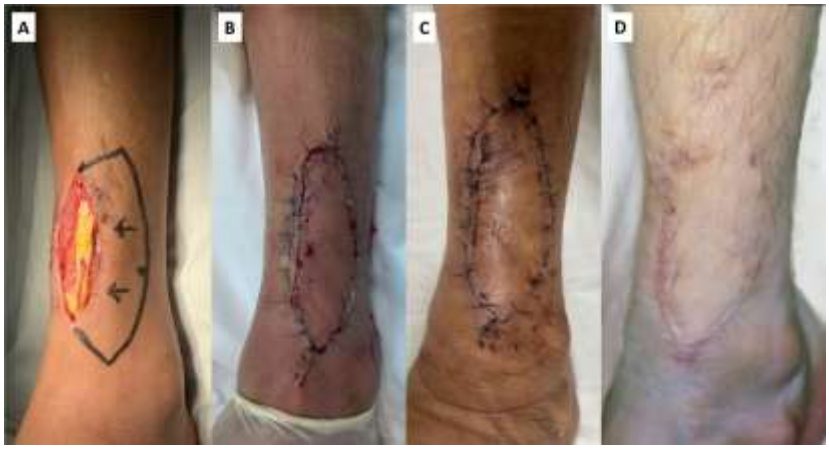

Figure 3.1. Soft tissue defect in the distal third of the anterior-lateral aspect of the lower leg exposing the anterior tibial tendon:
(A) Design of a Keystone perforator-based flap (two arrows indicate the locations of the perforators); (B) Intraoperative coverage of the defect; (C) Dressing change after 5 days; (D) Follow-up at 6 months.

3.3. Treatment outcomes

** Types of flap movement*

Table 3.1. The flaps were categorized based on their transfer method

Perforator Flap	Number (n)	Percentage (%)
Peninsular rotation-advancement flap	7	17.1
Advancement/Keystone perforator-based flap	19	46.3
Propeller perforator flap	15	36.6
Total	41	100.0

** Donor site coverage*

Primary donor site closure was achieved in 90.2% (37/41) of cases, while skin grafting was necessary for the remaining 9.8% (4/41).

** Monitoring flap and donor site conditions in the postoperative period*

- Condition of the flaps in the postoperative period: There were 36 viable, healthy flaps with good color, accounting for a high percentage (87.8%), and five flaps had complications (12.2%). Among

these, 3 cases had partial necrosis at the edge of the flap, and 2 cases had partial necrosis at the distal end of the flap (< 1/3 of the flap area).

- Condition of the donor site in the postoperative period: 40 out of 41 cases (97.6%) had good wound healing, with a 100% survival rate of the skin grafts (4/4). Only 1 case (2.4%) had a superficial infection at the edge of the donor site wound, which was treated with subcutaneous debridement, dressing changes, and antibiotic therapy. The outcome was successful wound healing at the second stage.

** Flap complications and risk factors*

Table 3.2. Analysis of risk factors for complications

Risk Factors		No Complication (n)	Complication (n)	p-value
Gender	Male	23	4	p > 0,05
	Female	13	1	
Age	≥ 60 years	12	3	p > 0,05
	< 60 years	24	2	
Diabetes Mellitus	Yes	3	1	p > 0,05
	No	33	4	
Smoking	Yes	14	3	p > 0,05
	No	22	2	
Flap Area	≥ 60 cm^2	8	2	p > 0,05
	< 60 cm^2	28	3	

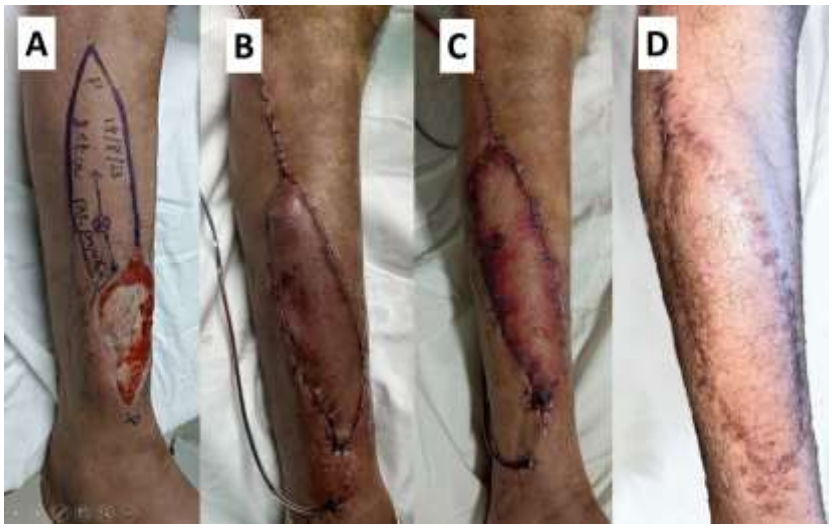

Figure 3.2. Chronic infected wound in the distal third of the anterior aspect of the left lower leg:
(A) Design of a propeller FPPF based on a perforator branch of the peroneal artery; (B) 180^0 rotation of the flap to cover the defect; (C) Postoperative day 5 showing flap congestion and marginal ischemia; (D) Follow-up at 6 months.

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3.4. Evaluation of treatment outcomes

**** Early outcomes (During hospitalization)***

Good outcomes were achieved in 36/41 cases (87.8%), with complete wound healing. While 5 out of 40 cases (12.2%) had complications categorized as moderate outcomes, with no cases having poor results.

**** Long-term outcomes (After 6 Months)***

We followed up with patients 6 months after surgery. 97.6% of the flaps survived well, were soft and mobile, and showed no signs of ulceration, darkening, fistula formation, or well-healed scars. One case (2.4%) had a moderate result due to recurrent ulceration at the pressure point over the lateral malleolus. For the donor site, 100% showed promising results with no ulceration or fistula formation cases.

**** Aesthetic evaluation***

The aesthetic results of the flaps were evaluated using the Vancouver Scar Scale, with an average score of 2.5 ± 1.5, reflecting good integration with the surrounding tissue.

4. DISCUSSION

For lower limb soft tissue defects, the predominant cause in this study was infection (73.2%), which often originated from chronic abscesses, surgical site infections, pressure ulcers, or diabetic foot complications. Similar findings were reported by Usama Abdelfattah et al. [10], where infection accounted for 51.4% of defects, including diabetic foot infections, post-traumatic sequelae, osteomyelitis, and soft tissue infections. Trauma was the second most common cause (17.5%) in this study, consistent with other research by Bekara [11] (55.2%), Phanette Gir [12] (38.8%), and Tripathee [13] (68.9%).

The size of the defects varied widely, with an average area of 27.3 cm^2. This aligns with studies like Lee et al. [14], which reported an average defect size of 24 cm^2.

Advantages of perforator flaps include preserving muscles and their functions, preserving major blood vessels, compatibility between the donor and recipient sites; the donor site is often closed completely; reduced donor site morbidity, and the potential for achieving better aesthetic outcomes. Local perforator-based flaps, such as the propeller flap introduced by Hyakusoku et al., have expanded reconstructive options for the lower extremities. The keystone flap is another type of perforator-based flap, wherein a V-Y advancement flap is utilized for relatively easy closure of defects. Recent advancements in the use of perforator flaps require a paradigm shift in approaching lower extremity defects. Depending on the location of the soft tissue defect, perforator flaps are mobilized in tailored configurations [15, 16].

Small defects (3 - 4 cm wide) can be managed using V-Y advancement flaps, based on perforators, without the need for dissecting the vascular pedicle. Keystone flaps, used to cover elliptical defects, act as advancement flaps supported by underlying perforators and require local tissue laxity. Keystone flaps have higher success rates and lower complexity compared to free or propeller flaps. However, when there is insufficient local tissue laxity for advancement, the keystone flap cannot be applied for reconstruction [17, 18].

The propeller perforator flap allows the donor site to be positioned higher on the lower leg, where the limb circumference is larger, providing more soft tissue for an optimized flap size. This facilitates direct closure of the donor site without the need for skin grafting. Additionally, the broad perforator-based pedicle reduces the need for extensive pedicle dissection and minimizes the risk of injury to the perforating vessels. These flaps can vary in size depending on the defect, and due to their direct vascular supply, relatively large flaps can be harvested when necessary [11, 12, 16].

Perforators from the superficial femoral artery, descending genicular artery, and saphenous artery branches can be used for thigh defects. Perforators from the genicular system are utilized for knee defects, while leg defects can rely on perforators from any of the three major blood vessels [15].

By utilizing perforator-based flaps, reconstruction becomes more flexible and tailored to the defect's requirements, thus sparing donor site tissues and enabling more favorable donor site closure. In this study, 90% of donor sites were primarily closed, aligning with reports by authors such as Bekara (69.7%), Lecours (69.8%), Qian Y (88.8%), and Mendieta (85.7%) [11, 16, 19, 20].

Using 41 flaps in clinical practice, we obtained the following results: 36 out of 41 flaps (87.8%) had complete survival, while five flaps had complications, accounting for 12.2%. Specifically, 3 cases had small necrosis at the flap edge, which did not require surgical intervention, only dressing changes and wound care. 2 cases had necrosis of less than 1/3 of the distal flap, one of which had deep necrosis that required debridement followed by thick skin grafting, and the other only required dressing changes and wound care.

After additional interventions, all defects healed well, ensuring sufficient coverage function. Thus, there were no cases of total flap necrosis in this study. The complication rate in studies by Bekara [11] was 25.2%, while Gir's study [12] showed a complication rate of 25.8%, with 6.45% requiring additional reconstructive surgery. In Sisti's study [1], the complication rate was 31.8%, and 5.2% of patients needed a second surgery. Our study's rate of patients requiring a second surgery was 2.4% (1 case of additional skin grafting).

Evaluation of lower extremity defect management with perforator-based pedicled flaps (FPPF): Both early outcomes at hospital discharge and follow-ups at > 6 months revealed favorable results for both flaps and donor sites. This underscores the indispensable role of FPPF in addressing lower extremity defects, offering advantages such as viability, flexibility, safe preservation of perforators, and aesthetic and functional restoration, ultimately improving patients' postoperative quality of life. Nonetheless, a small percentage of partial flap necrosis due to venous congestion remains a recognized limitation.

5. CONCLUSION

In this study, 41 Freestyle pedicled perforator flaps for lower limb defect reconstruction demonstrated several advantages, including high flexibility, minimal donor site sacrifice, improved aesthetic and functional outcomes, and shorter operative times without requiring

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microvascular techniques. The freestyle pedicled perforator flap is an excellent choice for rapid and effective soft tissue defect coverage, ensuring safety, functional preservation, and enhanced quality of life for patients post-surgery.

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EVALUATION OF SOME CHARACTERISTICS OF PLATELET-RICH PLASMA FROM UMBILICAL CORD BLOOD

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SUMMARY

The study aims to evaluate some characteristics of platelet-rich plasma (PRP) from umbilical cord blood.

Research on 6 umbilical cord blood samples compared with 6 donor venous blood samples, using the GeneWorld kit. The results show that PRP from umbilical cord blood had fewer red blood cells (0.105 (0.07 - 0.17) T/L, 0.32 (0.12 - 0.55), p < 0.01), higher platelet count (701.17 ± 124.75 G/L vs. 457.83 ± 88.95 G/L, p < 0.01) and higher platelet count concentration ratio (2.3 vs. 1.82; p < 0.05). The concentration of EGF in umbilical cord blood plasma was 85.478 ± 28.195 pg/ml, that of healthy donors was 74.973 ± 29.475 (p > 0.05) with VEGF concentrations of 88,090 (67,536 - 135.32) and 10,504 (4,094 - 16,029) pg/ml, respectively, p < 0.05. The EGF concentration in activated PRP from umbilical cord blood and adult blood was 115.72 (50.98 -178.96) pg/mL and 94.91 (50.92 - 159.28) pg/ml (p < 0.05), with VEGF being 281.48 (141.59 - 324.12) pg/mL and 32.6 (11.7 - 53.4) pg/ml, respectively, p < 0.01.

In conclusion, umbilical cord blood had normal hematological indices. PRP from umbilical cord blood had fewer red blood cells, higher platelet counts, platelet aggregation ratio, and VEGF concentration than PRP from adult blood. The VEGF concentration in activated PRP from umbilical cord blood was higher than that in adult blood.

Keywords: *Characteristics, platelet-rich plasma, umbilical cord blood*

1. PROBLEM STATEMENT

Platelet-rich plasma (PRP) is a plasma concentrated with a platelet content many times higher than normal. Activated platelets will produce growth factors that stimulate the wound healing stages. Autologous PRP has been used to treat difficult-to-heal wounds, ensuring many advantages but encountering some difficulties. The source from umbilic al cord blood has a lot of potential, is an abundant blood source, creating a readily available

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PRP product, ensuring economic and medical ethics, especially being able to bring a good quality product for wound treatment, with no safety risks for donors, an easily accessible source, a very low risk of infectious diseases and low immunogenicity [1 - 2].

In the world, stored umbilical cord blood has been applied for autologous transfusion to patients with blood diseases. Umbilical cord blood is applied in the form of allogeneic for cases of patients with neurological diseases, lung diseases, systemic skin diseases, etc. In Vietnam, the application of umbilical cord blood is mainly to store stem cells to treat blood diseases or to store stem cell banks to reserve for autologous treatment in the future. To continue to have stronger evidence in the application of PRP umbilical cord blood in clinical wound treatment, we conducted this study to *evaluate some characteristics of umbilical cord blood and platelet-rich plasma from umbilical cord blood*.

2. RESEARCH OBJECTS AND METHODS

2.1. Research subjects healthy adult donors

Selection criteria: Pregnant women and voluntary blood donors with no accompanying diseases: congenital diseases, tuberculosis, cancer, autoimmune diseases, mental illness, screened for HIV, HBV, HCV with negative results, age 20 - 45; pregnant women have no history of obstetric diseases, no obstetric complications; No fever during labor (< 38^0C). Gestational age from more than 36 weeks; Born within 24 hours from the time the membranes break; Newborn weight ≥ 2800g.

Exclusions: 1) Violation of one or more of the above criteria; 2) Postpartum: Multiple pregnancies (for collection for community cord blood banks); Infants with congenital malformations at birth; Umbilical cords that are too short, severed, crushed, or damaged; Placenta suspected of infection at collection (collection after delivery).

2.2. Raw materials and equipment

New-PRP Pro kit PRP separation kit.

K4500 hematology analyzer with 18 parameters manufactured by Sysmex (Japan). Blood biochemistry analyzer (AU480. Centrifuge. Freezer -80^0C. Sample storage refrigerator: from 2 to 8^0C.

2.3. Research location

Umbilical cord blood was collected at the Department of Obstetrics and Gynecology - Military Hospital 103. Blood was collected from healthy adults, PRP extraction was performed, hematology, biochemistry, and bacterial culture were performed at the Department of Paraclinical Medicine - Le Huu Trac National Burn Hospital.

EGF and VEGF tests were performed at the Military Medical Research Institute/Military Medical Academy. The research period was from May 2023 to September 2024.

2.4. Method of implementation

The umbilical cord was immediately disinfected after birth, using a sterile 10ml syringe to collect blood into a test tube in the kit. Peripheral blood from a volunteer donor was collected using a negative-pressure needle inserted directly into the test tube of the kit. PRP was separated according to the kit's procedure. A portion

of whole blood collected in the same process and a portion of PRP after activation were tested, evaluated and compared.

PRP collection process (according to GeneWorld's instructions):

- Phase 1 (collecting unactivated PRP): Collect venous/umbilical cord blood into a test tube, each tube with a total of 10 ml (including 1.5 ml of available anticoagulant). Centrifuge the first blood tube at 2,000 rpm x 10 minutes to separate plasma, red blood cells and platelets. Gently aspirate the yellow Plasma layer on top into a centrifuge tube labeled PLASMA (total volume recovered from 3 tubes is about 12 - 14 ml). Centrifuge the PLASMA tube a second time at 3,500 rpm x 5 minutes, to obtain a 2-layered solution. Gently aspirate the upper part and discard, leaving 6ml of PRP at the bottom of the tube. This is an unactivated PRP.

- Phase 2 (activate PRP with $CaCl_2$): Continue to draw all remaining 6 ml of PRP into the tube containing the $CaCl_2$ activator, add and mix well for 2 - 5 minutes until a solid mass appears. Use a pipette to gently rotate until the solid mass separates from the tube wall. Wait until the solid mass shrinks completely (5 - 15 minutes), then draw out the solid mass. The final product contains 4 - 5 ml of activated PRP solution with a transparent yellow color.

2.5. Research indicators

Epidemiological and clinical characteristics, blood test indexes of pregnant women and voluntary blood donors; fetal age, infant weight, placental weight, umbilical cord length.

Characteristics and test indexes of EGF, VEGF of PRP from umbilical cord blood and peripheral blood of volunteer donors: Hematological indexes such as red blood cell count, white blood cell count, platelet count, hemoglobin level, hematocrit index; biochemical indexes such as quantification of ALT, AST, Protein, Albumin, Cholesterol; immunohistochemistry: quantification of Epidermal growth factor (EGF) and Vascular Endothelial Growth Factor (VEGF) of plasma and activated platelet-rich plasma; microorganisms.

The data obtained are calculated as the average in the form of X ± SD, compared by the T-test or Q2 (Q1 - Q3) algorithm, compared by the Mann-Whitney U-test. Use SPSS 22.0 software to analyze the data, compare the differences with statistical significance when $p < 0.05$.

3. RESULTS

Table 3.1. Some characteristics of pregnant women and volunteer donors

Characteristic	Maternity (n = 6)	Volunteer (n = 6)
Year Old	31.83 ± 5.38	30.00 ± 5.22
Height (cm)	157.83 ± 7.55	164.00 ± 5.44
Weight (kg)	63.67 ± 10.41	65.15 ± 7.10
Systolic blood pressure (mmHg)	120.00 ± 10.95	114.67 ± 10.17
Diastolic blood pressure (mmHg)	74.50 ± 7.31	67.83 ± 9.81
Body temperature (degrees C)	36.68 ± 0.13	36.65 ± 0.43

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Pregnant women and voluntary blood donors must be healthy, of average physical condition, and free of infectious diseases.

Table 3.2. Some characteristics of the fetus and umbilical cord

Characteristic	Average index
Gestational age (weeks)	38.50 ± 1.22
Child weight (grams)	3155.00 ± 356.41
Placenta weight (grams)	553.17 ± 84.12
Umbilical cord length (cm)	50.00 ± 8.51

Table 3.3. Some characteristics of umbilical cord blood compared with blood from volunteer donors

Characteristic	Umbilical cord (n = 6)	Blood donor (n = 6)	p
Red blood cells (T/L)	4.64 ± 0.31	5.22 ± 0.63	< 0.05
Hemoglobin (g/L)	144.33 ±11.99	154.33 ±15.03	> 0.05
Hematocrit (%)	43.48 ± 2.92	45.63 ± 4.26	> 0.05
White blood cells (G/L)	16.25 ± 7.26	6.98 ± 1.16	0.02
Platelets (G/L)	302.50 ± 60.95	248.50 ± 56.31	> 0.05
Glucose (mmol/L)	4.95 (3.4 - 9.2)	5.5 (4.9 - 5.9)	> 0.05*
Urea (mmol/L)	3.28 ± 0.62	5.30 ± 2.75	> 0.05
Creatinine (µmol/L)	66.67 ± 11.80	79.75 ± 13.59	> 0.05
AST (U/L)	29.40 ± 9.40	20.05 (19.00 - 29.40)	> 0.05*
ALT (U/L)	43.7 (7.1 - 45.3)	25.55 (16.10 - 42.20)	> 0.05*
Protein (g/L)	52.92 ± 3.58	78.40 ± 2.93	< 0.001
Albumin (g/L)	33.78 ± 1.49	45.93 ± 2.32	< 0.001
Cholesterol	1.40 ± 0.45	5.22 ± 0.62	< 0.001

** Mann Whitney U test*

Umbilical cord blood has a high white blood cell count, higher than adults ($p < 0.05$), red blood cell, hemoglobin, platelet within limits, not statistically different from adults ($p > 0.05$). Umbilical cord blood has lower protein, albumin, cholesterol than adults ($p < 0.05$).

Table 3.4. Characteristics of platelet-rich plasma

Characteristic	Cord blood source (n = 6)	Blood from healthy donors (n = 6)	p
Plasma volume (ml) after first centrifugation	14.50 ± 1.18	15.92 ± 0.58	< 0.05
White blood cell count (G/L)	8.40 ± 4.76	5.27 ± 2.80	> 0.05
Red blood cell count (T/L)	0.105 (0.07 - 0.17)	0.32 (0.12 - 0.55)	< 0.05*
Platelet count (G/L)	701.17 ± 124.75	457.83 ± 88.95	< 0.01
PRP Platelet/Whole Blood Ratio	2.3 (1.95 - 2.59)	1.82 (1.7 - 1.94)	< 0.05*
Pre-activation PRP culture (T0)	Negative	Negative	
PRP culture after activation (T1)	Negative	Negative	
Color	100% pure gold	100% pure gold	

** Mann-Whitney U test*

Table 3.5. Concentrations of growth factors EGF and VEGF in blood and PRP after activation from umbilical cord blood compared with adults

EGF, VEGF concentrations	Cord blood (n = 6)	Adults (n = 6)	p
EGF (pg/ml) plasma	85.478 ± 28.195	74.973 ± 29.475	> 0.05
VEGF (pg/ml) plasma	88.090 (67.536 - 135.32)	10.504 (4.094 - 16.029)	< 0.01*
EGF (pg/ml) PRP after activation	115.72 (50.98 - 178.96)	94.91 (50.92 - 159.28)	> 0.05*
VEGF (pg/ml) PRP after activation	281.48 (141.59 - 324.12)	32.6 (11.7 - 53.4)	< 0.01*

** Mann-Whitney U test*

The concentrations of EGF in plasma and activated PRP from umbilical cord blood were higher than those from healthy human blood, with no statistical significance ($p > 0.05$). The concentrations of VEGF in plasma and activated PRP from umbilical cord blood were significantly higher than those from plasma and activated PRP from healthy human blood, with statistical significance ($p < 0.01$).

4. DISCUSSION

4.1. Characteristics of umbilical cord blood

The umbilical cord contains three blood vessels, one vein and two arteries, which coil around the vein in a spiral configuration. The umbilical vein supplies the fetus with oxygen-rich blood and nutrients. The arteries return deoxygenated

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blood to the placenta. The umbilical vein is large and easy to see. When taking umbilical cord blood, blood is taken from the vein, which ensures easy collection and quality blood, rich in nutrients transported from the placenta to the fetus.

The fetus in our study also had the following indicators within the limits: gestational age 38.50 ± 1.22 weeks, weight 3155 ± 356.41 grams, placental mass 553.17 ± 84.12 grams, umbilical cord length 50.00 ± 8.51 cm. This result is similar to the research results of Dang Thi Thu Hang with a gestational age 39.3 ± 0.9 weeks, fetus weight 3.257 ± 394 g, placental weight 505 ± 41.4 g, umbilical cord length 58.1 ± 5.8 cm. The hematological and biochemical indices of umbilical cord blood were similar to those in the study of Dang Thi Thu Hang with blood samples collected from the community with white blood cells 13.5 ± 4.0 G/L, hemoglobin 154.3 ± 14.0 g/L, hematocrit 48.2 ± 4.5 L/L, platelets 303 ± 56.6 G/L [3]. Thus, the report also found that the hematological indices of normal umbilical cord blood, platelets in umbilical cord blood were higher than in pregnant women ($p < 0.05$) and higher than in healthy women ($p > 0.05$), promising better quality PRP.

Studies have shown that autologous PRP has wide clinical applications. However, it may also contain inflammatory cytokines and its quality depends on many patient-related factors such as platelet quantity and quality, concomitant therapies, and patient age [4]. Studies have shown that umbilical cord PRP contains more growth factors and anti-inflammatory molecules than peripheral blood-derived PRP [5].

In this study, a GenWould V10 kit was used to extract PRP from 30 ml of anticoagulated blood (1.5 ml of ACD-acid anticoagulant*).* Citrate dextrose in each tube, a total of 14.50 ± 1.18 ml of plasma from umbilical cord blood was lower than that of adults at 15.92 ± 0.58 ml ($p < 0.01$). Although PRP was extracted using the same kit and procedure, the amount of red blood cells and platelets was lower and the platelet count was higher in PRP from umbilical cord blood than in adult blood, and the platelet and thrombocytosis ratio of PRP from umbilical cord blood were higher than in adult blood (701.38 ± 124.75 vs. 457.83 ± 88.95 and 2.3 (1.95 - 2.59) vs. 1.82 (1.7 - 1.94) with $p < 0.01$), from which we can believe that the quality of PRP from umbilical cord blood is better as published observations [4 - 5].

4.2. Growth factors EGF and VEGF

Epidermal growth factor (EGF) is secreted by fibroblasts, platelets, and macrophages and is present throughout the epidermis, especially in the basal layer. EGF facilitates re-epithelialization by stimulating keratinocyte proliferation and migration, enhancing the tensile strength of new skin. In chronic wounds, a decrease in growth factors, including EGF, affects the wound-healing process [10].

Vascular Endothelial Growth Factor (VEGF) is produced not only by platelets but also by many types of cells such as endothelial cells, fibroblasts, macrophages, smooth muscle cells, and neutrophils. VEGF participates in the wound healing process with a major role in promoting neovascularization and enhancing capillary permeability [6], [11].

In normal wounds, VEGF increases starting from day 1, increases significantly

from 3 - 5 days, and returns from day 7 to day 14 after injury. In chronic wounds, VEGF decreases abnormally [6]. In chronic wounds, impaired angiogenesis leads to more tissue damage due to chronic hypoxia and compromised micronutrient supply. This phenomenon leads to a decrease in many cytokines, chemokines, and growth factors necessary for wound healing, including VEGF [10].

The use of exogenous VEGF in the treatment of chronic wounds has been mentioned in many studies. VEGF has a high concentration in PRP, which is a good source of VEGF in the treatment of chronic wounds [6], [11].

High concentrations of EGF and VEGF in PRP, when applied, will have a better effect on the wound healing process. Studies also show that when using EGF or VEGF alone at different concentrations, has a good effect on wound healing [6].

In our study, the concentration of EGF in umbilical cord blood plasma and adult blood was 85,479 ± 28,196 pg/ml and 74,974 ± 29,477 pg/ml, not significantly different ($p > 0.05$), the concentration of VEGF in umbilical cord blood was 88,090 (67,536 - 135,32) pg/ml, higher than in adult blood 10,504 (4,094 - 16,029) pg/ml ($p < 0.05$). With umbilical cord blood, PRP had a platelet to unconcentrated blood ratio of 2.3, higher than that of adult blood, which was 1.82. The EGF concentration in activated umbilical cord blood PRP and activated adult blood PRP was 115.72 (50.98 - 178.96) pg/ml and 94.91 (50.92 - 159.28) pg/ml, the difference was not significant with $p > 0.05$, the corresponding VEGF concentration was 281.48 (141.59 - 324.12) pg/ml and 32.6 (11.7 - 53.4) pg/ml ($p < 0.01$). This result of EGF is consistent with the studies of Fréchette et al., by his concentration, he obtained PRP with a platelet concentration ratio of 5.5 times, the concentration of EGF in PRP after activation was 470 ± 130 pg/ml [7].

The concentration of EGF in activated PRP is many times higher than in plasma. Using PRP in wound treatment, the concentration of EGF at the wound site will be compensated and increased compared to the deficient concentration. The concentration of VEGF in umbilical cord blood PRP is much higher than that in PRP from adult blood ($p < 0.01$). On the other hand, we see that this concentration in PRP is much higher than in whole blood. Studies have shown that when treating chronic wounds by injecting PRP at the wound site, the increased concentration of EGF and VEGF in the wound tissue has a good biological effect on the wound-healing process.

Our results are similar to the results of the study by Ju Tian et al. (2023) when comparing growth factors of umbilical cord blood with growth factors from the blood of adult females in 3 age groups (18 - 25, 26 - 45, 46 - 65) and found that VEGF from umbilical cord blood was higher and EGF in the 18 - 25 age group was higher than the other groups [8]. The study by ME Rhéaume et al. showed that EGF and VEGF in umbilical cord blood serum had higher concentrations than in adult blood. He also showed that EGF in umbilical cord blood serum was higher than in activated serum [9]. Thus, the concentrations of EGF and VEGF in umbilical cord blood were higher than in adult blood, VEGF in activated umbilical cord blood PRP was higher than in activated adult blood PRP.

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5. CONCLUSION

Umbilical cord blood had normal hematological parameters. Platelet-rich plasma from umbilical cord blood had fewer red blood cells, higher platelet counts, and higher platelet aggregation ratios than platelet-rich plasma from adult blood. VEGF concentrations were higher in umbilical cord blood than in adult blood. VEGF concentrations in activated platelet-rich plasma from umbilical cord blood were also higher than in adult blood.

PROPOSAL

Continue to evaluate the effects of PRP from umbilical cord blood experimentally and clinically for application in the treatment of wounds and burns.

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ANTIMICROBIAL SUSCEPTIBILITY PROFILE OF *Staphylococcus haemolyticus* ISOLATED FROM VIETNAMESE CANCER PATIENTS OVER 4 YEARS

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ABSTRACT

S. haemolyticus is frequently colonizing the hospital environment and resistance to multiple antibiotics. The antimicrobial-resistant data of S. haemolyticus from Vietnamese cancer patients are limited. This study aims to evaluate the antimicrobial susceptibility profile of 41 S. haemolyticus isolated from Vietnamese cancer patients over a period of 4 years.

The rate of methicillin-resistant and multidrug-resistant was 48.8% (20/41) and 95.1% (39/41), respectively. The most frequent sample was blood (65.9%, 27/41), and the second most frequent was sputum (12.2%, 5/41).

All isolates were susceptible to quinupristin-dalfopristin, linezolid, tigecycline, and nitrofurantoin, and about 97% of isolates were susceptible to vancomycin. Approximately 96.88% of isolates were resistant to Benzylpenicillin and oxacillin, 93.75% were resistant to erythromycin, and 90.63% were resistant to Ciprofloxacin and Levofloxacin. The high level of methicillin and multidrug-resistant and reduced susceptibility to many antibiotics are causes of concern since they further narrow down the therapeutic options.

Quinupristin-dalfopristin, linezolid, tigecycline, nitrofurantoin, and vancomycin are effective against S. haemolyticus infection in Vietnamese cancer patients at Vietnam National Cancer Hospital/Tan Trieu Base. Further studies are needed to surveillance bacterial resistance to guide antimicrobial therapy, reduce antimicrobial resistance rates, and improve the Vietnamese cancer patient's care.

***Keywords**: S. haemolyticus, MRSA, MDR, Vietnamese, cancer*

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1. INTRODUCTION

Staphylococci belong to the *Micrococcaceae* family. These bacteria are Gram-positive cocci and present in the mucosa, on the skin of humans, mammals, and birds. *Staphylococci* includes a total of 51 species and can be divided into two groups, e.g., coagulase-positive *Staphylococci* (e.g., *Staphylococcus aureus*) and coagulase-negative *Staphylococci* (CoNS), including *Staphylococcus haemolyticus*. The species that frequently cause human disease are *S. aureus*, *S. epidermidis*, and *S. haemolyticus*. These pathogens infections are most prevalent in the community and the hospital. The pathogens spread from person to person through direct contact or exposure to contaminated medical devices [1].

S. haemolyticus is one of the major species of CoNS. It is a major opportunistic pathogen-related nosocomial infection, especially in immunocompromised patients such as cancer patients. *S. haemolyticus* is an emerging opportunistic pathogen associated with hospital-acquired infections and with a high burden of antimicrobial resistance. *S. haemolyticus* is frequently colonizing the hospital environment and resistance to multiple antibiotics [2]. *S. haemolyticus* may cause various infections such as septicemia, peritonitis, urinary tract, and respiratory infections [3].

S. haemolyticus is the most common pathogen colonizing humans, medical materials, devices. They are also the main pathogens involved in bacteremia, accounting for 30% of bloodstream-associated infections, particularly in immunocompromised individuals, e.g. cancer patients [4].

The origin of CoNS-associated infections is in the hospital environment. The emergence of CoNS antimicrobial resistance leads to the limitation of treatment options, and that is a growing public health concern. Despite the huge antimicrobial-resistant data of *S. haemolyticus* published worldwide, the antimicrobial-resistant profile of *S. haemolyticus* from Vietnamese cancer patients remains largely unknown. Thus, the present study aims to evaluate the antimicrobial resistance profiles of *S. haemolyticus* isolated from Vietnamese cancer patients over a period of 4 years.

2. MATERIALS AND METHODS

Ethical considerations

Ethical approval for laboratory data was not required as the study was routine surveillance measures for infection control.

Isolates

The *S. haemolyticus* was isolated between 2020 and 2024 from various samples of Vietnamese cancer inpatients admitted to Vietnam National Cancer Hospital/Tan Trieu Base. Only one isolate per patient was collected.

Identification and antimicrobial susceptibility testing of *S. haemolyticus*

The samples were collected according to routine procedures of the Medical Microbiology Department. Bacteria isolates were identified by biochemical methods using an automated Vitek 2 compact system (BioMérieux).

The antibiotic susceptibility testing for isolated pathogens was performed using

and automated Vitek 2 compact system (BioMérieux). The antimicrobial susceptibility testing results were interpreted according to Clinical and Laboratory Standards Institute guidelines (2020). The multidrug-resistant pathogens were defined as acquired non-susceptibility to at least one agent in three or more antimicrobial categories.

Statistical analysis

R version 3.6.3 was used to analyze the data. The Chi-squared or Fisher's exact test evaluated associations between categorical variables. The student's T-test or the Mann-Whitney U test was used to assess associations between normalized and un-normalized continuous variables, respectively. A p-value of < 0.05 was considered statistically significant.

3. RESULTS

Clinical features

Table 3.1. Demographic, clinical and laboratory features of Vietnamese cancer patients in the present study

	Female (n = 9)	Male (n = 32)	Overall (n = 41)	P-value
Diagnostic				
Brain Tumor	1 (11.1%)	4 (12.5%)	5 (12.2%)	0.911
Breast cancer	3 (33.3%)	0 (0%)	3 (7.3%)	
Colorectal cancer	2 (22.2%)	3 (9.4%)	5 (12.2%)	
Lung cancer	1 (11.1%)	7 (21.9%)	8 (19.5%)	
Lymphomas	1 (11.1%)	3 (9.4%)	4 (9.8%)	
Renal cancer	1 (11.1%)	1 (3.1%)	2 (4.9%)	
Cholangiocarcinoma	0 (0%)	2 (6.3%)	2 (4.9%)	
Esophageal cancer	0 (0%)	3 (9.4%)	3 (7.3%)	
Gastric cancer	0 (0%)	1 (3.1%)	1 (2.4%)	
Hepatocellular carcinoma	0 (0%)	2 (6.3%)	2 (4.9%)	
Mediastinal tumor	0 (0%)	1 (3.1%)	1 (2.4%)	
Melanoma	0 (0%)	1 (3.1%)	1 (2.4%)	
Nasopharyngeal cancer	0 (0%)	2 (6.3%)	2 (4.9%)	
Spine tumor	0 (0%)	2 (6.3%)	2 (4.9%)	
Age				
Mean (SD)	52.4 (21.1)	61.5 (15.2)	59.5 (16.8)	0.456
Median [Min, Max]	53.0 [13.0, 77.0]	66.5 [17.0, 85.0]	64.0 [13.0, 85.0]	

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	Female (n = 9)	Male (n = 32)	Overall (n = 41)	P-value
Unit				
Department of Surgery	3 (33.3%)	2 (6.3%)	5 (12.2%)	0.388
Intensive care unit	4 (44.4%)	23 (71.9%)	27 (65.9%)	
Treatment on Demand	2 (22.2%)	4 (12.5%)	6 (14.6%)	
Internal Medicine	0 (0%)	3 (9.4%)	3 (7.3%)	
Sample				
Blood	7 (77.8%)	20 (62.5%)	27 (65.9%)	0.799
Cerebrospinal fluid	1 (11.1%)	1 (3.1%)	2 (4.9%)	
Pus	1 (11.1%)	0 (0%)	1 (2.4%)	
Catheter	0 (0%)	2 (6.3%)	2 (4.9%)	
Sputum	0 (0%)	5 (15.6%)	5 (12.2%)	
Urine	0 (0%)	2 (6.3%)	2 (4.9%)	
Wound fluid	0 (0%)	2 (6.3%)	2 (4.9%)	
Methicillin-resistant				
Negative	6 (66.7%)	15 (46.9%)	21 (51.2%)	0.577
Positive	3 (33.3%)	17 (53.1%)	20 (48.8%)	
D-test				
Missing	2 (22.2%)	3 (9.4%)	5 (12.2%)	0.849
Negative	6 (66.7%)	22 (68.8%)	28 (68.3%)	
Positive	1 (11.1%)	7 (21.9%)	8 (19.5%)	
Multidrug-resistant				
No	1 (11.1%)	1 (3.1%)	2 (4.9%)	0.617
Yes	8 (88.9%)	31 (96.9%)	39 (95.1%)	

The clinical features of Vietnamese cancer patients are shown in Table 3.1. A total of 41 *S. haemolyticus* were analyzed. Of the 41 *S. haemolyticus* isolates, 27 (66%) were from the blood, 5 (12%) from sputum, 2 (4.9%) from the catheter, cerebrospinal fluid, urine, and wound fluid and 1 (2.45%) from pus. Among 41 *S. haemolyticus* isolates, 27 (66%) were isolated from the Intensive Care Unit, 6 (15%) from the Department of Treatment on Demand, 5 (12%) from the Department of Surgery, 3 (7.3%) from Department of Internal Medicine.

Antimicrobial-resistant profile

Antibiotic susceptibility testing results and resistance of the *S. haemolyticus* isolates to antibiotics are shown in Table 3.2 (see below) and Figure 3.1, respectively.

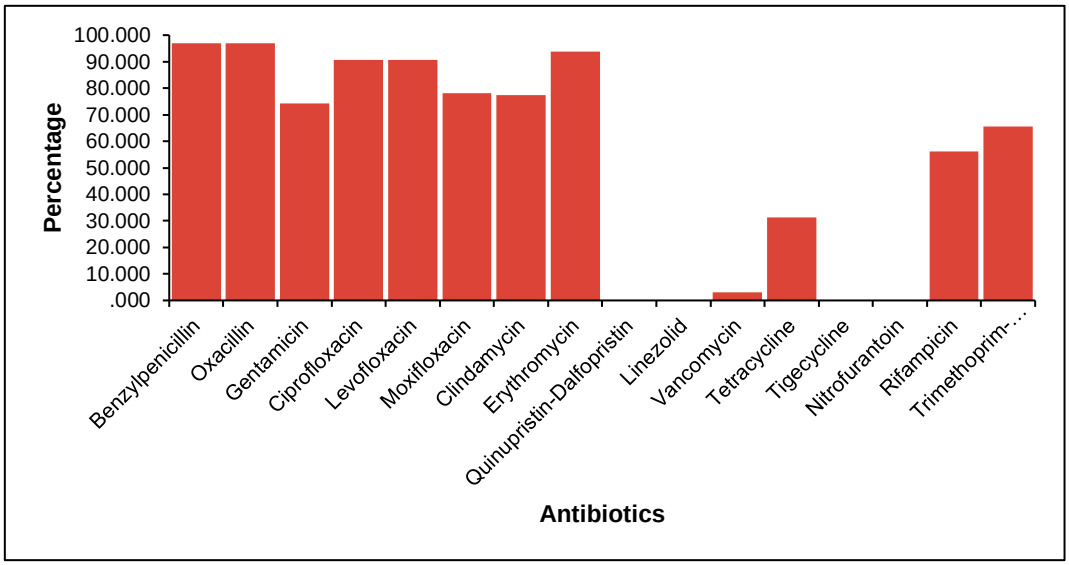

Figure 3.1. Antibiotic resistance pattern of *S. haemolyticus* in Vietnamese cancer patients

Table 3.2. The antimicrobial susceptibility testing result of *S. haemolyticus* in Vietnamese cancer patients

Antimicrobial	N	Overall (N = 41)	95% CI[1]	MRSA				
				Negative (N = 21)	95% CI[1]	Positive (N = 20)	95% CI[1]	p-value
Benzylpenicillin, n (%)	40							> 0.99[2]
R		39/40 (97.50%)	85%, 100%	19/40 (47.50%)	73%, 100%	20/40 (50.00%)	80%, 100%	
S		1/40 (2.50%)	0.13%, 15%	1/40 (2.50%)	0.26%, 27%	0/40 (0.00%)	0.00%, 20%	
Missing		1		1		0		
Oxacillin, n (%)	40							> 0.99[2]
R		39/40 (97.50%)	85%, 100%	19/40 (47.50%)	73%, 100%	20/40 (50.00%)	80%, 100%	
S		1/40 (2.50%)	0.13%, 15%	1/40 (2.50%)	0.26%, 27%	0/40 (0.00%)	0.00%, 20%	
Missing		1		1		0		

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Antimicrobial	N	Overall (N = 41)	95% CI[1]	MRSA				
				Negative (N = 21)	95% CI[1]	Positive (N = 20)	95% CI[1]	p-value
Gentamicin, n (%)	39							0.672
R		28/39 (71.79%)	55%, 84%	13/39 (33.33%)	43%, 86%	15/39 (38.46%)	51%, 90%	
S		8/39 (20.51%)	9.9%, 37%	5/39 (12.82%)	10%, 51%	3/39 (7.69%)	4.0%, 39%	
I		3/39 (7.69%)	2.0%, 22%	1/39 (2.56%)	0.28%, 28%	2/39 (5.13%)	1.8%, 33%	
Missing		2		2		0		
Ciprofloxacin, n (%)	40							> 0.99[2]
R		34/40 (85.00%)	69%, 94%	17/40 (42.50%)	61%, 96%	17/40 (42.50%)	61%, 96%	
S		5/40 (12.50%)	4.7%, 28%	3/40 (7.50%)	4.0%, 39%	2/40 (5.00%)	1.8%, 33%	
I		1/40 (2.50%)	0.13%, 15%	0/40 (0.00%)	0.00%, 20%	1/40 (2.50%)	0.26%, 27%	
Missing		1		1		0		
Levofloxacin, n (%)	40							> 0.99[2]
R		34/40 (85.00%)	69%, 94%	17/40 (42.50%)	61%, 96%	17/40 (42.50%)	61%, 96%	
S		6/40 (15.00%)	6.2%, 31%	3/40 (7.50%)	4.0%, 39%	3/40 (7.50%)	4.0%, 39%	
Missing		1		1		0		
Moxifloxacin, n (%)	40							> 0.99[2]
R		30/40 (75.00%)	58%, 87%	15/40 (37.50%)	51%, 90%	15/40 (37.50%)	51%, 90%	
S		6/40 (15.00%)	6.2%, 31%	3/40 (7.50%)	4.0%, 39%	3/40 (7.50%)	4.0%, 39%	
I		4/40 (10.00%)	3.3%, 25%	2/40 (5.00%)	1.8%, 33%	2/40 (5.00%)	1.8%, 33%	
Missing		1		1		0		
Clindamycin, n (%)	39							>

Antimicrobial	N	Overall (N = 41)	95% CI[1]	MRSA				
				Negative (N = 21)	95% CI[1]	Positive (N = 20)	95% CI[1]	p-value
								0.99[2]
R		31/39 (79.49%)	63%, 90%	15/39 (38.46%)	54%, 93%	16/39 (41.03%)	56%, 93%	
S		7/39 (17.95%)	8.1%, 34%	4/39 (10.26%)	7.0%, 46%	3/39 (7.69%)	4.0%, 39%	
I		1/39 (2.56%)	0.13%, 15%	0/39 (0.00%)	0.00%, 21%	1/39 (2.56%)	0.26%, 27%	
Missing		2		2		0		
Erythromycin, n (%)	40							0.492
R		38/40 (95.00%)	82%, 99%	18/40 (45.00%)	67%, 98%	20/40 (50.00%)	80%, 100%	
S		2/40 (5.00%)	0.87%, 18%	2/40 (5.00%)	1.8%, 33%	0/40 (0.00%)	0.00%, 20%	
Missing		1		1		0		
Quinupristin-Dalfopristin, n (%)	40							
S		40/40 (100.00%)	89%, 100%	20/40 (50.00%)	80%, 100%	20/40 (50.00%)	80%, 100%	
Missing		1		1		0		
Linezolid, n (%)	39							> 0.99[2]
S		38/39 (97.44%)	85%, 100%	19/39 (48.72%)	73%, 100%	19/39 (48.72%)	79%, 100%	
R		1/39 (2.56%)	0.13%, 15%	1/39 (2.56%)	0.26%, 27%	0/39 (0.00%)	0.00%, 21%	
Missing		2		1		1		
Vancomycin, n (%)	40							> 0.99[2]
S		39/40 (97.50%)	85%, 100%	20/40 (50.00%)	80%, 100%	19/40 (47.50%)	73%, 100%	
R		1/40 (2.50%)	0.13%, 15%	0/40 (0.00%)	0.00%, 20%	1/40 (2.50%)	0.26%, 27%	
Missing		1		1		0		
Tetracycline, n (%)	40							0.513

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Antimicrobial	N	Overall (N = 41)	95% CI[1]	MRSA				
				Negative (N = 21)	95% CI[1]	Positive (N = 20)	95% CI[1]	p-value
S		26/40 (65.00%)	48%, 79%	14/40 (35.00%)	46%, 87%	12/40 (30.00%)	36%, 80%	
R		14/40 (35.00%)	21%, 52%	6/40 (15.00%)	13%, 54%	8/40 (20.00%)	20%, 64%	
Missing		1		1		0		
Tigecycline, n (%)	36							
S		36/36 (100.00%)	88%, 100%	20/36 (55.56%)	80%, 100%	16/36 (44.44%)	76%, 100%	
Missing		5		1		4		
Nitrofurantoin, n (%)	40							
S		40/40 (100.00%)	89%, 100%	20/40 (50.00%)	80%, 100%	20/40 (50.00%)	80%, 100%	
Missing		1		1		0		
Rifampicin, n (%)	40							0.753
R		23/40 (57.50%)	41%, 73%	11/40 (27.50%)	32%, 76%	12/40 (30.00%)	36%, 80%	
S		17/40 (42.50%)	27%, 59%	9/40 (22.50%)	24%, 68%	8/40 (20.00%)	20%, 64%	
Missing		1		1		0		
Trimethoprim-Sulfamethoxazole, n (%)	40							0.743
R		27/40 (67.50%)	51%, 81%	14/40 (35.00%)	46%, 87%	13/40 (32.50%)	41%, 84%	
S		13/40 (32.50%)	19%, 49%	6/40 (15.00%)	13%, 54%	7/40 (17.50%)	16%, 59%	
Missing		1		1		0		

[1]CI = Confidence Interval, [2]Fisher's exact test, [3]Pearson's Chi-squared test

All isolates of *S. haemolyticus* were sensitive to quinupristin-dalfopristin, linezolid, tigecycline, and nitrofurantoin.

Only 3.13% (1/41) of the *S. haemolyticus* isolates resistant to vancomycin while 96.88% of *S. haemolyticus* isolates were resistant to benzylpenicillin and oxacillin, 93.75% of *S. haemolyticus* isolates were resistant to erythromycin, 90.63% of *S. haemolyticus*

isolates were resistant to ciprofloxacin and levofloxacin.

The average multidrug-resistant was 95.1% (39/41) in all *S. haemolyticus* isolates. The average resistance to methicillin was 48.8% (20/41).

4. DISCUSSION

In the present study, the most common *S. haemolyticus* isolates were from blood (66%), which is much higher than other samples. The results indicate that among CoNS, *S. haemolyticus* isolates are responsible for a significant number of bloodstream infections in Vietnamese cancer patients. This finding is consistent with previous reports [5].

Antibiotic resistance is a public health concern all over the world. Antibiotic resistance pathogens are emerging from different countries [6]. We found that the average multidrug-resistant was 95.1% in all *S. haemolyticus* isolates, much higher than previously reported that about 70% of clinical and commensal *S. haemolyticus* strains were multidrug-resistant [4]. *S. haemolyticus* has a great potential of developing multidrug-resistant. The high multidrug-resistant rate highlights *S. haemolyticus* as a multidrug-resistant pathogen that is difficult to treat with conventional antibiotics.

In the present study, the average resistance to methicillin was high (48.8%, 20/41). The methicillin-resistant implications for a worse prognosis and increased demand for healthcare resources. Patients infected with methicillin-resistant *S. haemolyticus* require a greater cost and are associated with prolonged hospital stays and higher mortality. Thus, the identification of colonized individuals to reduce the risk of acquiring a methicillin-resistant infection is needed [1].

CoNS-related human infection resistance to antimicrobials is increasingly common, especially resistance to oxacillin and/or methicillin [4]. Methicillin-resistant *Staphylococci* are a global health concern. In the present study, the resistance rates of *S. haemolyticus* to oxacillin and benzylpenicillin were 96.88% which is much higher than that in other reports that the prevalence of CoNS methicillin resistance rate ranged from 70% to 80%, whereas oxacillin resistance rate ranged from 75 - 85% in recent years [4], and that is a growing concern.

The resistance rates of CoNS to linezolid range from 1% to 2% [7]. However, the isolates in the present study were 100% susceptible to linezolid, which is consistence with other reported [4]. The frequent use of linezolid is associated with resistance, mainly involving cases of clonal dissemination. Linezolid is an oxazolidinone antibiotic, with activity against Gram-positive pathogens including MRSA. The unique linezolid-resistant mechanism involves the inhibition of bacterial protein synthesis through the 23 Sr RNA gene. Resistance to linezolid is an infrequent phenomenon [8]. Our results showed that linezolid remains one of the most effective antibiotics against *S. haemolyticus*.

Tigecycline is a glycylcycline molecule and derivative of the tetracycline minocycline. Tigecycline has a great potent activity against tetracycline-resistant pathogens. Resistant clinical isolates were associated with efflux pumps [8]. Tigecycline is effective in the treatment of

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S. haemolyticus infections [4]. Accordingly, in the present study, all isolates are sensitive to tigecycline.

All of our isolates are susceptible to quinupristin-dalfopristin. Another study reported that they detected one (1.2%) isolate that was resistant to quinupristin-dalfopristin [4]. The quinupristin-dalfopristin is a combination of two semisynthetic agents quinupristin and dalfopristin, in a 30:70 ratio. The mechanisms of resistance to quinupristin-dalfopristin were increasing enzymatic modification, active transport of specific efflux pumps, and alteration of the target site. Resistance is rare in *Streptococci* and *Enterococcus faecium* species. Quinupristin-dalfopristin has good efficacy and the possibility of developing resistance to quinupristin-dalfopristin is low due to its prolonged post-antibiotic effect. Most CoNS strains are highly susceptible to daptomycin, and quinupristin-dalfopristin [8]. This study results showed that quinupristin-dalfopristin is effective in the treatment of *S. haemolyticus* infections.

All *S. haemolyticus* are susceptible to nitrofurantoin, the nitrofurantoin resistance is uncommon among CoNS. Thus, nitrofurantoin shows high efficacy against *S. haemolyticus* infections.

The present study results showed the efficacy of vancomycin against *S. haemolyticus*. We detected one (3.13%) isolate that was resistant to vancomycin. Vancomycin-resistant *S. haemolyticus* has emerged as an increasingly problematic cause of hospital-acquired infections and spreading into the community. The MIC values of vancomycin for *Staphylococcus* spp. are increasing worldwide [8].

The CoNS-reduced susceptibility to vancomycin has been increasing, posing the need for novel antimicrobials to solve the CoNS resistance concern. *S. haemolyticus* resistant to vancomycin is a matter of concern and CoNS were the first pathogens resistant to glycopeptide. The resistant MICs of vancomycin have increased progressively in recent years (more than 2 mg/ml was observed in a large number of *S. haemolyticus*). These results may indicate a decrease the efficacy (in vivo) of Vancomycin [4].

The rates of resistance to many antibiotics and the reduction in sensitivity to vancomycin steadily increasing posed the needed for the new drugs to treat CoNS infections. In this study, antibiotics such as quinupristin-dalfopristin, linezolid, tigecycline, nitrofurantoin, and vancomycin show excellent in vitro activity against *S. haemolyticus,* which is consistence with previously reported [8].

5. CONCLUSION

S. haemolyticus are important pathogen causing infections in Vietnamese cancer patients. The high level of methicillin and multidrug-resistant and reducing susceptibility to many antibiotics, e.g., benzylpenicillin and oxacillin, erythromycin, ciprofloxacin, and levofloxacin are causes of concern since they further narrow down the therapeutic options in Vietnamese cancer patients. However, antibiotics such as quinupristin-dalfopristin, linezolid, tigecycline, nitrofurantoin, and vancomycin are effective against *S. haemolyticus* infection in Vietnamese cancer patients at Vietnam National Cancer Hospital/Tan Trieu Base. Ongoing surveillance of antimicrobial resistance of *S. haemolyticus* is needed to understand emerging patterns of resistance,

which is important for hospital biosecurity and guiding treatment decisions.

Disclosure Statement

No competing financial interests exist.

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EVALUATION OF NURSING CARE QUALITY FOR HEART FAILURE PATIENTS AND RELATING FACTORS AT HANOI HEART HOSPITAL

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ABSTRACT

Objective: *To assess the nursing care quality and some factors related to the outcome of care for hospitalized heart failure patients at Hanoi Heart Hospital in 2024.*

Method: *We performed a cross-sectional study evaluating 21 routine nursing care activities for the level of completion on three days: day 1, day 3, and the day of discharge. We also identified the relevant factors to the patient care outcome. The data was collected from medical records and patient interviews.*

Results: *Among the total of 156 hospitalized heart failure patients participating in the study, 83.3% of patients received good nursing care at the hospital, while only 16.7% of heart failure patients did not receive adequate nursing care. Factors related to the outcome of patient care include: Age group, gender, socioeconomic status, number of hospitalizations per year, disease duration, and patient satisfaction. ($p < 0.05$).*

Conclusion: *Proper nursing care for hospitalized.*

Keywords: *Nursing care for heart failure patients, nursing care, heart failure*

I. INTRODUCTION

Heart failure is a common medical issue, which is the consequence of many cardiovascular diseases such as hypertension, coronary artery disease, valvular heart disease, cardiomyopathy, congenital heart disease, arrhythmia. This health problem is significantly increasing in incidence rate due to an aging population. Worldwide, approximately 23 million people have heart failure. In Vietnam, each year, there are about 550.000 new cases of heart failure diagnosed and this number is predicted to reach 1.5 million per year by 2040 [1]. Nurses play a crucial role in the doctor's urgent treatment. This demands careful assessment, comprehensive monitoring, and swift decision-making.

Caring for heart failure patients is a challenging task with many difficulties, especially due to their high risk of death, high mortality, and frequent

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readmissions. According to research by Minlu Li and colleagues, improving the quality of care and monitoring heart failure patients contributes to reducing in-hospital mortality, shortening hospital stays, reducing early mortality after discharge, and reducing readmission rates [2]. Caring for heart failure patients also helps prevent disease progression, reduce mortality, and prolong life.

In Vietnam, there have been many research topics on patient care in general, but the issue of caring for hospitalized heart failure patients remains an open question. Hanoi Heart Hospital is one of the successful hospitals in managing heart failure patients. The hospital has established a program to manage heart failure patients from inpatient to outpatient care for nearly 4,000 patients. However, there have been no studies evaluating the care of hospitalized heart failure patients.

To evaluate the results of heart failure patient care activities at Hanoi Heart Hospital, thereby making recommendations for better nursing care for heart failure patients, we conducted a study entitled: "Nursing care for heart failure patients and related factors at Hanoi Heart Hospital in 2024" with the objective: *To describe the nursing care activities and some factors related to the outcomes of nursing care for hospitalized heart failure patients at Hanoi Heart Hospital in 2024*.

2. OBJECTIVES AND METHODS

- Research design: Descriptive cross-sectional study.

- Sampling method: Convenience sampling.

- Study population: Heart failure patients hospitalized at the Hanoi Heart Hospital.

  - Inclusion criteria:

    - Patients aged 18 and over

    - Patients diagnosed with heart failure with EF ≤ 50% on ultrasound

    - Patients voluntarily agree to participate in the study

  - Exclusion criteria:

    - Patients who are not mentally capable of answering questions

    - Patients in medical or surgical emergency conditions

- Research period: from February 2024 to August 2024 at Hanoi Heart Hospital research protocol:

  - Data collection:

Data will be collected from patient medical records, patient interviews, and family interviews using a questionnaire to be filled in the research medical record. Subsequently, the collected data will undergo statistical analysis.

Patient-related data from medical records: Administrative information, patient status before treatment, evaluation of clinical condition, and laboratory results of patients at three time points: Admission day (day 1), day 3, and discharge day.

Care-related data from medical records: Vital signs monitoring sheets, patient care sheets, and patient interview results using a questionnaire to collect data on diseases, nursing care activities, and health education counseling provided by nurses to hospitalized heart failure patients at Hanoi Heart Hospital in 2024

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Data collection training: Organizing training for interviewers and supervisors

o Evaluation criteria:

Our study evaluates 21 routine nursing care activities. Each activity is evaluated for the level of care on three days: Day 1, day 3, and the day of discharge. Care activities are considered achieved when nurses perform the above care activities on all three days. Each activity has a specific evaluation level.

- Data analysis and processing:

The collected data is analyzed using medical statistical algorithms with SPSS 20.0 software.

- Ethical Considerations in Research

The study was approved by the Scientific and Ethical Council of Thang Long University, No. 24030402/QD-DHTL, and was approved for data collection by the Hanoi Heart Hospital administration.

All research subjects will be explained in detail about the purpose and content of the study and will be asked for voluntary participation and cooperation in the research process. The study is conducted with respect for the privacy of the research subjects and with the consent of the research subjects. Information of research participants is processed and published in the form of data, without mentioning personal names. Questionnaires and personal data of research subjects are kept strictly confidential. All collected information is not used for any purpose other than research purposes.

3. RESULTS

3.1. Patient characteristics

Table 3.1. Demographic characteristics of the research subjects

Demographic characteristics		n	Percentage (%)
Age groups	18 - 39	6	3.9
	40 - 59	28	17.9
	≥ 60	122	78.2
Sex	Male	114	73.1
	Female	42	26.9
Ethnics	Kinh	151	96.8
	Others	5	3.2
Areas	Rural	119	76.3
	Urban	37	23.7

The total of 156 research subjects, the highest proportion is in the eldest age group (>= 60 years old) (78.2%), followed by the 40 - 59 age group with 28 people (17.9%), and the lowest proportion is in the 18 - 39 age group with 6 people (3.9%). Most of the research subjects are male, accounting for 73.1%, while the remaining 26.9% are

female. Almost all research subjects are Kinh ethnic, accounting for 96.8%, with only a very small proportion of other ethnicities at 3.2%. Most patients live in rural areas, accounting for 76.3%, while only 23.7% live in urban areas.

3.2. Results of heart failure patient care

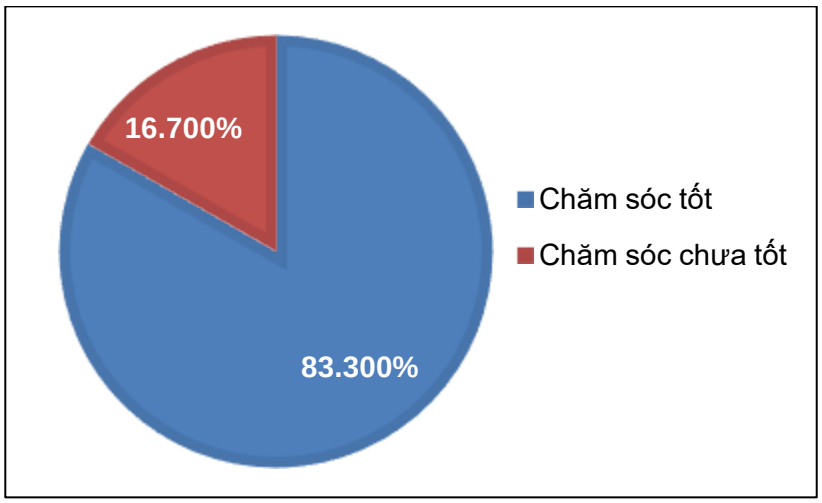

Figure 3.1. Results of heart failure patient care by nurses

The 83.3% of the 156 heart failure patients involved in the study received good nursing care at the hospital. Conversely, 16.7% of the patients did not receive adequate nursing care.

3.3. Factors related to nursing care outcomes

Table 3.2. Factors related to nursing care outcomes

Patient's factors		Outcomes		OR (95%CI)	p
		Adequate n (%)	Inadequate n (%)		
Age group	≥ 60	107 (87.7)	15 (12.3)	3.41 (1.39 - 8.38)	0.006
	< 60	23 (67.6)	11 (32.4)		
Gender	Female	41(97.6)	1 (2.4)	11,5 (1.5 - 87.9)	0.004
	Male	89 (78.1)	25 (21.9)		
Socioeconomic status	Non-low-income	128 (84.8)	23 (15.2)	8,3 (1.3 - 52.7)	0.008
	Low-income	2 (40)	3 (60)		
Disease duration	< 3 years	107 (93.9)	7 (6.1)	12,6 (4.7 - 33.5)	< 0.001
	≥ 3 years	23 (54.8)	19 (45.2)		
Number of	< 3 times	126 (86.3)	20 (13.7)	9,4	0.002

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hospitalizations/year	≥ 3 times	4 (40)	6 (60)	(2.4 - 36.4)	
Patient satisfaction	Satisfied	128 (85.3)	22 (14.7)	11,6 (2.0 - 67.4)	0.001
	Dissatisfied	2 (33.3)	4 (66.7)		

Factors such as age group, gender, economic status, number of hospitalizations, disease duration, and patient satisfaction are related to the outcome of patient care ($p < 0.05$).

4. DISCUSSION

4.1. Characteristics of the study population

The average age of the study population was 68.5 ± 13.7 years. The majority were aged ≥ 60, accounting for 78.2%. This result clearly reflects the increasing risk of heart failure in the elderly, consistent with many studies in Vietnam and abroad. In the study by La Thi Duong at the Vietnam Heart Institute, 80% of heart failure patients were over 60 years old [3].

The study by Le Thi Hong at Thai Binh University of Medicine and Pharmacy in 2023 also showed a similar result, with 80.2% of heart failure patients aged 60 and over. The clinical characteristics of heart failure patients studied by Nguyen Van Lanh in 2024 also showed similar results to those in our study [4].

In the United States, the American Heart Association (AHA) report also emphasized that about 75% of heart failure patients are over 65 years old, confirming that this is the age group with the highest risk [1].

The increased risk of heart failure among the elderly can be attributed to several factors. These include the development and progression of cardiovascular conditions like high blood pressure and coronary artery disease over time. Additionally, age-related changes in the heart's structure and function may also contribute to this increased risk, even in individuals without diagnosed cardiovascular diseases.

4.2. Outcomes of heart failure patient care and some related factors

Our study found that the success rate of heart failure patient care by nurses reached 83.3%, which is an encouraging result, reflecting the effectiveness of the applied care methods and the continuous efforts of the nursing team. To better understand the results and their significance in the context of global healthcare, we compared them with similar studies in Vietnam and abroad.

In Vietnam, the study by Nguyen Cong Thanh (2020) at the Geriatric Cardiology Department of An Giang Heart Institute showed that the success rate of nursing care for heart failure patients reached 59.3%. The difference between the success rate of 59.3% in Nguyen Cong Thanh's study and the rate of 83.3% in our study shows a significant improvement in the patient care protocol [6]. This reflects the improvement in training quality and the application of more effective treatment methods. This improvement may be due to the application of more advanced nursing care methods and the application of up-to-date treatment guidelines.

Results showed a significant difference in nursing care outcomes between age groups. Patients aged ≥ 60 had a significantly higher rate of good care compared to those aged < 60. Several factors may explain this difference, including Elderly patients are often given attention by nurses due to their high risk of complications and their deteriorating health.

Treatment adherence is important: Elderly patients are often more aware of the importance of adhering to medical advice, possibly due to their experience with healthcare or a more serious attitude towards treatment. This can improve the effectiveness of the care process.

Family support is crucial: Elderly patients often receive positive support from their families, helping them adhere better to treatment instructions. The results of Eimer and colleagues' study also support our findings, showing that non-adherence to treatment in elderly heart failure patients can lead to irreversible conditions, reduced lifespan, readmission, and increased treatment costs [7].

Socioeconomic status also affects the quality of healthcare for heart failure patients. Specifically, the rate of good care among patients from non-low-income households was 84.8%, compared to only 40% of those from low-income families. Despite having health insurance, patients often face significant financial burdens due to uncovered medical expenses and co-payments, which can hinder their ability to continue treatment or maintain regular healthcare. Some studies on barriers to heart failure treatment have identified related factors such as healthcare costs, difficulties in making lifestyle modifications, treatment adherence, lack of disease knowledge, lack of trust and motivation in the treatment process [8].

Our study revealed a significant correlation between patient satisfaction and the quality of care received by heart failure patients. A substantial 85.3% of patients who were satisfied with the care provided exhibited positive health outcomes, compared to only 33.3% of dissatisfied patients. This finding underscores the critical role of patient satisfaction in assessing healthcare quality. Satisfied patients demonstrate a greater tendency to adhere to treatment regimens, actively engage in the care process, and maintain consistent communication with the healthcare team. Consequently, these patients experience improved health outcomes as a result of enhanced collaboration and providing effective responses to their needs by nursing staff.

5. CONCLUSION

Among the total of 156 heart failure patients participating in the study, 83.3% of patients had good care outcomes at the hospital, while only 16.7% of heart failure patients did not receive adequate care from nurses.

Factors related to the outcomes of heart failure patient care provided by nurses include: age group, gender, socioeconomic status, number of hospitalizations, disease duration, and patient satisfaction ($p < 0.05$).

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APPLICATION OF DISTALLY BASED ANTEROLATERAL THIGH FLAP IN A KNEE SOFT-TISSUE DEFECT RECONSTRUCTION

(CASE REPORT)

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Le Huu Trac National Burns Hospital

SUMMARY

Bone-exposed knee defects are a challenge for surgeons in choosing an appropriate reconstruction method. Distally based anterolateral thigh flap is a top option due to its texture and color which are quite similar to the knee region, its large size, and its sufficiently long pedicle. We report a clinical case of using a distally based anterolateral thigh flap in the reconstruction of a large soft tissue defect around the knee with exposed patella due to high-voltage electrical burns. The outcome is complete flap survival and good functional recovery, the flap donor site is covered by a split-skin graft, which heals during the early stages of healing.

Keywords: *Knee soft-tissue defect, distally based anterolateral thigh flap*

1. CASE REPORT

1.1. Patient information

A 33-year-old male patient, with no significant past medical history, suffered a high-voltage electrical burn due to a work accident, was treated at a local hospital, and transferred to Le Huu Trac National Burn Hospital on the third day of illness. The burn injury caused a wound in the right knee region exposing the patella, not affecting the joint. He was treated by transferring the medial sural artery perforator flap into the soft defect of the knee region on the nine days of illness. However, the flap was necrosis apart in the distal part, still exposing the patella, with an 8 x 8 cm dimension.

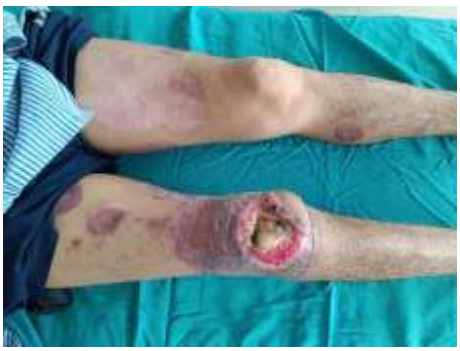

Figure 1.1. A soft tissue defect exposing the right patella, size 8 x 8 cm

1.2. Flap selection and design

On the 14th day of illness, the debridement of necrotic tissue and the

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necrotic patella in the right knee wound was taken. The size of the defect region after debridement is approximately 10 x 15 cm.

After debridement, the ipsilateral distally based anterolateral thigh flap was used to cover the right tissue defect region. The flap is located in the anterolateral thigh, the axis of the flap is determined by a straight line connecting the right anterior superior iliac spine and the superior lateral point of the ipsilateral patella. The flap is nourished by the perforating branch of the lateral femoral circumflex artery and venae comitantes. The perforator vessel is identified by hand Doppler within the mid-range of the above-mentioned straight line. Design a 16 x 10 cm anterior lateral thigh flap, located about 20 cm from the upper edge of the lesion.

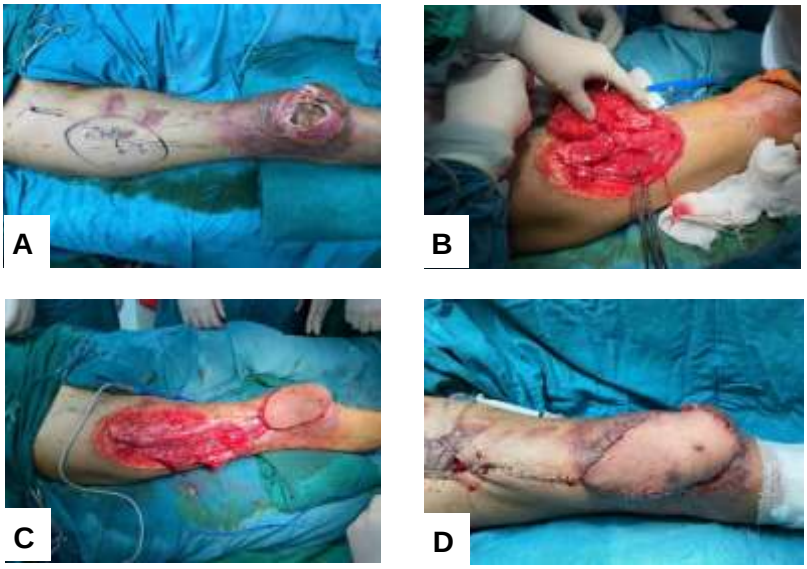


Figure 1.2. A: Design a distally based anterolateral thigh flap, size 16 x 10 cm. B: Dissection of the flap to find and ligate the proximal descending branch of the lateral femoral circumflex artery. C and D: Rotate the flap to cover the defect and fix it with sutures.

1.3. Dissection and flap transfer

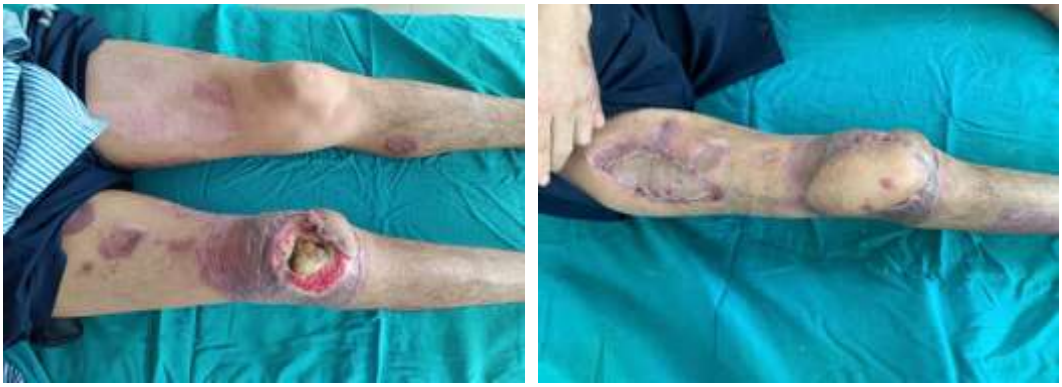
Perforator vessels dissection: Making an incision in the skin, dissecting from the outer edge inward, two branches penetrated the flap at the marking position. These penetrating branches were dissected from surrounding tissues to be free mobile. The dissection process was very meticulous and careful because the penetrating branches had small diameters. We used Lidocaine for irrigation to avoid vessel spasms and used hand Doppler to check regularly.

Vascular pedicle dissection: Dissection from the identified perforating branch up to its origin, divided from the descending branch of the lateral femoral circumflex artery. The descending branch of the lateral femoral circumflex artery was clamped near its origin, and the flap edge was found to be oozing blood evenly. The proximal vascular pedicle is ligated and cut. Dissecting the distal vascular pedicle, taking a part of the vastus lateralis muscle to increase the flexibility of the vascular

pedicle. The flap vascular pedicle after dissection is about 15 cm long.

Flap transfer to cover the soft tissue defect: Rotation of the flap to cover the bone-exposed defect in the knee region, fix it with sutures, and place a drain under it. The flap donor site was covered with a split-thickness skin graft.

The flap survived completely, the donor site was healed at the early stage of healing. The patient was discharged 10 days post-operation.



Pre-operation 8 days Post-operation

Figure 1.3. Images of the wound before and after surgery

2. DISCUSSION

2.1. Surgical methods for treating bone-exposed wounds in the knee region

Bone-exposed knee defects are complex wounds, for large defects that cannot be closed with sutures, other reconstructive methods such as flaps are required.

The local fasciocutaneous flaps of the knee are the first choice to be considered due to their similarity in color and texture to the knee area. However, these flaps can be damaged in cases of extensive knee defects. The lateral superior and medial superior genicular artery perforator flaps are limited in size and rotation arc which are not enough to cover large defects around the knee. The medial sural artery perforator flap can also be applied.

Although it does not damage the gastrocnemius muscle, the saphenous nerve is always sacrificed. Moreover, this flap cannot cover a large defect [1]. In this patient, a medial sural artery perforator flap was used, however, there was partial necrosis of the distal end.

Pedicled muscle flaps are the first choice for covering knee defects, especially in cases of knee injuries with exposed bone and joints. However, the vastus lateralis and gastrocnemius flaps are quite cumbersome, and the mobility impairment after transferring the flap is significant, and the flap pedicle is also quite short when covering anterior knee defects [2].

The use of free flaps such as the anterolateral thigh flap, latissimus dorsi muscle flap, etc. is not always preferred in this area due to the high rate of leaving defects at the donor site, long surgical time, and difficulty in selecting appropriate recipient blood vessels located deep around the knee area [3].

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2.2. The application of distally based anterolateral thigh flap in a knee soft-tissue defect reconstruction

2.2.1. Anatomical basis

Distally based anterolateral thigh flap was first described by Zhang. G in 1990 [4], and then the anatomical basis and feasibility of the flap were clearly demonstrated. Studies on the anatomy and hemodynamics of the distally based anterolateral thigh flap were published by Pan.S et al. in 2004 [5], Yamada.S et al. in 2014 [6].

In 2011, Demirseren. M.E et al [7] reported 17 cases of using distally based anterolateral thigh flap in reconstructing injuries of the knee and upper third of the lower leg. All flaps survived and had good cosmetic and functional results. In 2017, Liu. Y et al. [8] specifically classified the types of anterolateral thigh flaps based on the origin of the perforator vessels feeding the flap from the branches of the lateral femoral circumflex artery, which has great value in clinical practice.

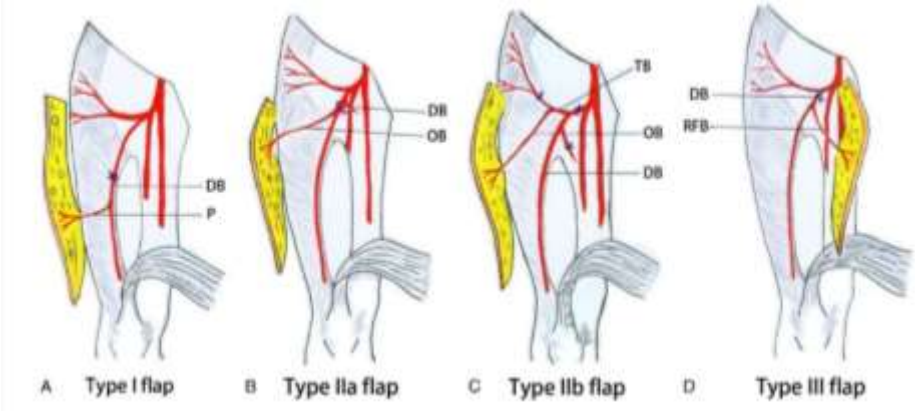

Figure 2.1. Classification of distally based anterolateral thigh flap according to Liu. Y et al. DB: Descending branch of the lateral circumflex femoral artery, TB: Transverse branch; OB: Oblique branch arising from the descending or transverse branch of the lateral circumflex femoral artery, RFB: Rectus femoris branch arising from the descending branch of the lateral circumflex femoral artery

According to Liu. Y et al, there were three different types of distally based anterolateral thigh flap: the type I flap was based on perforating vessels originating from the lateral circumflex femoral artery descending branch (Fig. 2.1A). The type II flap was subdivided into type IIa and type IIb, which were based on the perforating vessels of the oblique branch from the descending and transverse branches of the lateral circumflex femoral artery, respectively (Figs. 2.1B, C). The type III flap was based on the perforating vessel of the rectus femoris branch from the lateral circumflex femoral artery descending branch (Fig. 2.1D).

2.2.2. Advantages and disadvantages

a) Advantages

Gravvanis. G., et al. [9] demonstrated that the use of distally based anterolateral thigh flaps for knee reconstruction is superior to gastrocnemius muscle flaps:

- Large size: in the report of Yamada.S et al., the flap length was 9 - 23 cm, the flap width was 7 - 14 cm (the largest flap size was 14 x 23 cm) [6]. In our clinical case, it was 10 x 16 cm.

- The flap pedicle is long enough to cover anterior knee defects: The pedicle length is 14.5 - 16 cm [5].

- The flap has a moderate thickness, and the structure and color are quite similar to the knee area.

- The flap donor site is relatively convenient, with no need to sacrifice large blood vessels, and it is closed with sutures or skin grafts, covered by clothing.

b) Disadvantages

- Difficulty in dissecting the perforating branch: Due to small size of perforator vessels, a wide range of anatomical variations, especially when the flap's perforating branches bifurcate from the diagonal branches of group II according to Liu. Y., classification et al. [5], [6], [8].

- It is difficult to assess the safety of the flap before flap transfer: the distally based anterolateral thigh flap is nourished by the distal vascular pedicle, but a hand doppler can only identify the perforating branch supplied by the proximal vascular pedicle. Therefore, it is necessary to prescribe angiography for the flap donor site.

- Difficulty in covering the defect on the medial side of the knee region: The distal pedicle is relatively long, from 14.5 - 16 cm [5], but cannot reach the medial side of the knee area.

2.2.3. Technical notes

- Flap design:

Angiography before operation: Because the perforating branches of the distally based anterolateral thigh flap have many anatomical variations [5], [6], [8]. Furthermore, it is difficult to assess the safety of the flap before transferring, because this type of flap is nourished by the distal vascular pedicle.

- Flap dissection:

The dissection of the flap must be very careful and meticulous because the perforating branches piercing the flap have very small diameters [6], [7]. Clamp the proximal vascular pedicle to assess the circulation of the flap from the distal vascular pedicle. If the blood supply is safe, then use a distally based anterolateral thigh flap, otherwise, switch to another option to cover the knee defect.

- Postoperative care:

Immobilization of the knee joint with a splint: the knee joint is immobilized to ensure blood circulation through the anastomosis site, the flap nutrition is stable, and the anastomosis site is well-healing.

3. CONCLUSION

The distally based anterolateral thigh flap has flexibility and, a large enough flap size, color, and texture match, making it a suitable choice in reconstructing anterior knee joint lesions with exposed bone. However, before surgery, angiography should be prescribed to examine the anatomical characteristics of the blood vessels in the anterolateral thigh region. Surgeons must be meticulous during the dissection of the perforator vessels and must assess the nutrition of the flap from the distal pedicle before transferring the flap.

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A SUCCESSFUL LOW-DOSE SPINAL ANESTHESIA IN A PATIENT WITH SEVERE MITRAL VALVE STENOSIS FOR PARTIAL HIP REPLACEMENT SURGERY: A CASE REPORT

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SUMMARY

Anesthesia for patients with mitral valve stenosis presents a great challenge for anesthesiologists. The choice of spinal anesthesia or general anesthesia for these patients is still controversial, each method has its own advantages and disadvantages. We describe the anaesthetic management for a 73-year-old female patient with a left closed intertrochanteric fracture of the femur with many concomitant diseases: atrial fibrillation, severe mitral valve stenosis, and previous cerebral stroke.

The patient had successful partial hip replacement surgery under spinal anesthesia. In the preoperative period, the patient had no difficulty breathing, no chest pain, echocardiography showed severe mitral stenosis due to rheumatism with valve orifice area 0.9 cm^2, left atrial enlargement, systolic pulmonary artery pressure 46 mmHg, normal ejection fraction 59% and electrocardiogram showed atrial fibrillation with ventricular response of 93 beats/minute.

Left partial hip replacement surgery was successfully performed under spinal anesthesia using 5 mg 0.5% hyperbaric bupivacaine. Loss of sensation reaching the umbilicus provides adequate anesthesia for the surgery. The patient recovered without any complications and was discharged on the 14th day after surgery.

***Keywords**: Severe mitral valve stenosis, hip replacement surgery, spinal anesthesia*

1. INTRODUCTION

Rheumatic heart disease is still the primary cause of mitral stenosis in most developing countries. A study of rheumatic heart disease (RHD) cases estimated that in 2015, there were globally 33.4 million cases of RHD, 10.5 million disability-adjusted life-years due to RHD, and 319400 deaths due to RHD. The incidence of rheumatic heart disease is highest in Oceania, central sub-Saharan Africa, and South Asia [1].

Mitral valve stenosis reduces left ventricular filling due to reduced blood flow from the left atrium to the left ventricle. Blood pooling in the left atrial blood in the long term causes left atrial dilation, atrial fibrillation, and pulmonary hypertension. Selecting spinal anesthesia in patients with

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severe mitral stenosis requires extreme caution because it causes sympathetic blockage, reduces preload, thereby reducing cardiac output, causing severe hypotension.

In addition, in patients with severe mitral valve stenosis due to blood pooling in the left atrium, it is necessary to avoid fluid overload during surgery because it can lead to pulmonary edema. Heart rate should be maintained between 70 - 80 beats/minute because a fast rate further reduces blood flow from the left atrium to the left ventricle during diastole.

Therefore, patients with severe mitral valve stenosis need to be evaluated and well-controlled in heart rate, blood pressure, and circulating volume before, during, and after surgery [2]. In this case, a 72-year-old female patient was diagnosed with a left closed intertrochanteric femoral fracture with severe mitral valve stenosis, atrial fibrillation, and a previous stroke. The patient had performed partial left hip replacement surgery under spinal anesthesia without any complications.

2. CASE REPORT

A 73-year-old female patient (height 154 cm, weight 55 kg) with a known history of atrial fibrillation, mitral valve stenosis and she was treated with Vitamin K antagonists (Sintrom 4 mg x 1/4 pill per day), left hemiplegia due to a previous stroke (2022). The patient was diagnosed with a left femoral intertrochanteric fracture and was scheduled for left partial hip replacement surgery. At the time of admission (November 16, 2023), the patient was fully conscious, with no edema, no fever, no chest pain, no difficulty breathing, no bleeding on the skin or mucous membranes. Irregular pulse 93 beats/min, blood pressure 130/80 mmHg, no rales in lungs, SpO_2 98 - 99% breathing air. Left arm muscle strength was 1/5, left leg muscle strength was difficult to assess due to left intertrochanteric fracture of the femur.

Complete blood count and blood chemistry tests were in a normal range. Coagulation tests: Prothrombin time 15%, INR 5.1, APTT 50.6 s, Fibrinogen 4.21 g/L. An electrocardiogram indicated atrial fibrillation with a ventricular rate response of 90 beats/min (figure 1).

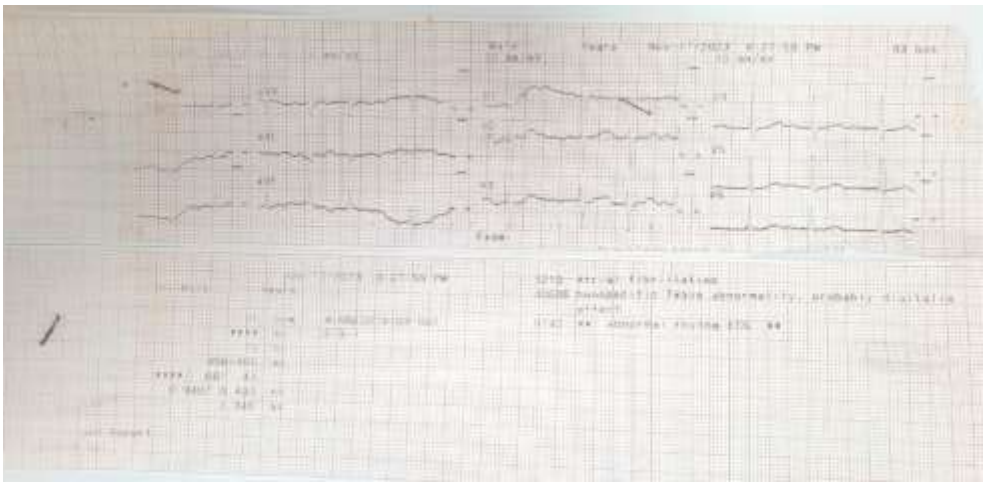

Figure 1. Preoperative electrocardiogram (November 17, 2023)

Chest X-ray (November 17, 2023): Enlarged heart silhouette, no signs of pulmonary edema.

Echocardiogram (November 27, 2023): Severe mitral valve stenosis due to rheumatism with valve orifice area 0.9 cm^2, left atrial dilatation, no thrombus, high systolic pulmonary artery pressure (46 mmHg), normal ejection fraction (EF 59%), moderate tricuspid regurgitation (figure 2).

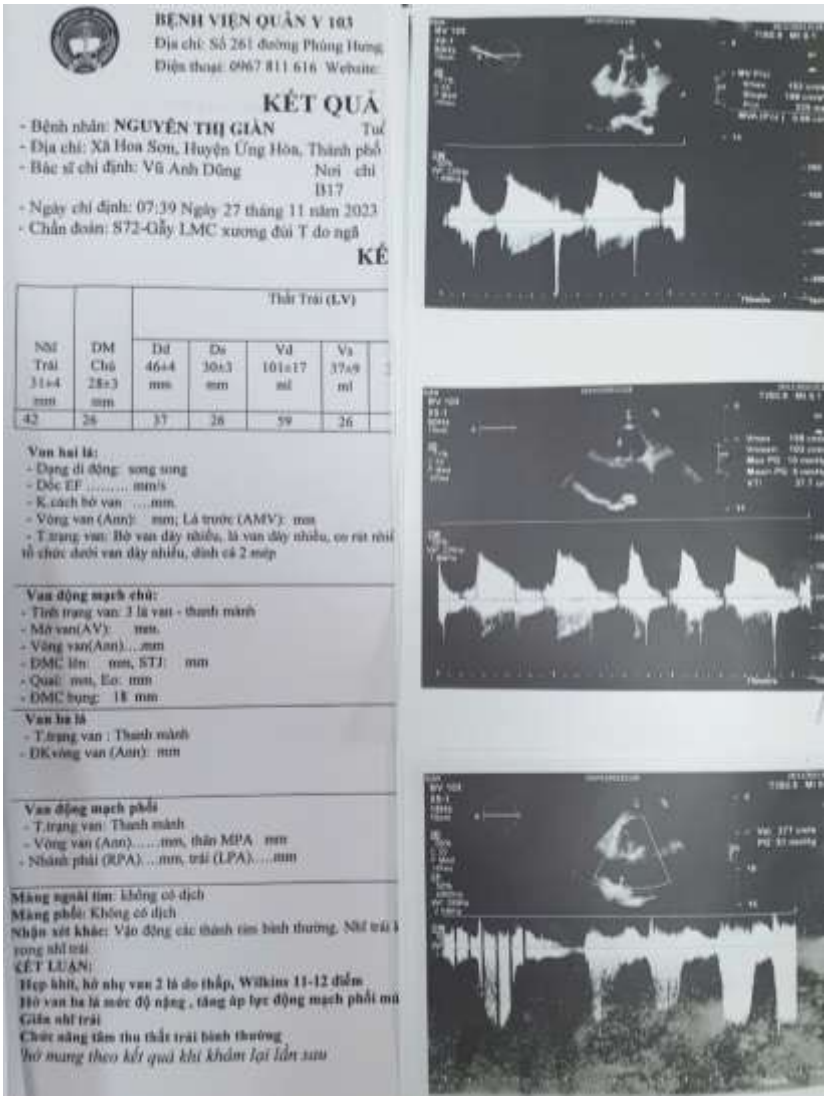

Figure 2. Preoperative echocardiography

The patient was consulted by a cardiologist and neurologist, she was advised to stop taking oral anticoagulants and switch to low-molecular-weight heparin (LMWH) subcutaneously injection. The preoperative INR test was 1.2 (November 27, 2023).

November 30, 2023, the patient was transferred to the operating room. She was inserted and monitored invasive blood pressure on the right radial artery, central venous catheter (CVC) was inserted in the right internal jugular vein, continuously monitored ECG, heart rate, SpO_2. 500 mL

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red blood cells (A group) were prepared in advance. Before anesthesia: blood pressure was 104/65 mmHg, ECG showed atrial fibrillation heart rate with ventricular response 100 - 104 beats/min, SpO_2 98% with 3 L/min oxygen support via nostril, central venous pressure (CVP) = 6 mmHg.

Spinal anesthesia was performed in the sitting position, using hyperbaric Bupivacaine 0.5% with a low dose 5 mg and 20 mcg Fentanyl, needle insertion at the L2-3 level. After removing the spinal needle, the patient was laid down immediately and the table was rotated 15 degrees to the left.

The level blockage was tested using cold sensation (alcohol cotton was used), reaching T10 level after 5 minutes of spinal anesthesia, blood pressure 100/61 mmHg, ECG atrial fibrillation with ventricular response 136 b/m. After 13 minutes, the surgeon began to incise the skin, blood pressure was 111/60 mmHg, pulse was 120 b/m. The surgery time from skin incision until skin closure was 45 minutes, no complications occurred during surgery, hemodynamics minimally fluctuated in the range (blood pressure 100/67 - 104/65 mmHg, pulse rate of 130 - 135 L/min), intraoperative fluid infusion was 100 ml of normal saline, CVP after skin closure was 8 mmHg. Blood loss during surgery was approximately 50 ml, so there was no need for blood transfusion. During the surgery, the patient did not complain of any pain, discomfort, or other abnormalities.

At the end of surgery, the patient was transferred to the post-anesthesia care unit (PACU). After 1 hour, the blockage level had decreased to L1 dermatome and she could move his knee (Bromage grade 2). The patient was infused with continuous intravenous fentanyl at a dose of 15 mcg/h in combination with paracetamol x 1 g intravenous infusion twice daily for postoperative pain management. She was then transferred to the Orthopaedic Surgery department for continued monitoring and treatment.

Table 1. Perioperative hemodynamic changes

Parameter \ Time		Before anesthesia	5 mins after spinal anesthesia	Skin incision	Skin closure
HR (b/m)		104	136	130	118
BP (mmHg)	Systolic	104	100	100	110
	Diastolic	65	61	67	70
CVP (mmHg)		6	5	5	8

On the 1st day after surgery, the total blood count tests, coagulation tests, electrocardiogram, and chest x-ray were made and the results were within normal limits. On the 2nd day after surgery, the patient continued to use LMWH x 4000 IU subcutaneous injection at the time of 8 and 20 o'clock. The patient was discharged on the 14th day after surgery without any other complications.

3. DISCUSSION

Rheumatic heart disease remains the leading cause of mitral valve stenosis in

developing countries. In addition, other causes such as valve degeneration with age or congenital heart abnormalities. According to the American Society of Echocardiography, the grading of mitral valve stenosis is based on echocardiography, when the mitral valve orifice area is less than 1 cm^2, it is considered severe stenosis [3]. Anesthesia for patients with severe mitral stenosis requires focusing on the maintenance of heart rate, blood pressure, preload, and avoiding hypoxia or hypercarbia. Because tachycardia will reduce left ventricular diastolic filling time, hypoxia causes pulmonary hypertension, causing acute right ventricular failure. High blood pressure and fluid overload can promote pulmonary edema.

Our patient was scheduled for partial hip replacement surgery. This was a major surgery, carrying a high risk of blood loss, causing severe pain after surgery. In addition, hip replacement surgery in elderly patients also carries a potential risk of pulmonary embolism. In particular, this patient has many concomitant diseases: Atrial fibrillation, severe mitral valve stenosis, left hemiplegia due to stroke. Possible risks during and after surgery include: Acute right heart failure, hemodynamic disorders, pulmonary edema, venous thromboembolism (Caprini DVT risk score 11 points), and recurrent stroke [4]. Therefore, it is necessary to optimize the patient prior to the surgery.

Blood coagulation test at the time of admission showed PT 15%, INR 5.1 due to vitamin K antagonists treatment. Our patient was asked to stop taking vitamin K antagonists. After the INR ratio reached 0.8 - 1.2, the patient was given subcutaneous injection of LMWH and stopped 24 hours before surgery. INR result (November 27, 2023) 3 days before surgery was 1.2. Additionally, another issue needs to be considered, whether a mitral valve replacement surgery should proceed first and be followed by a hip replacement surgery afterward. Our patient was diagnosed with severe mitral valve stenosis without any symptoms. Besides, the systolic pulmonary artery pressure was 48 mmHg, which was not very high. According to the guidelines of AHA for the management of patients with Valluvar disease, there was no indication for mitral valve replacement surgery in this situation [5]. However, it is necessary to optimize heart rate, blood pressure, circulatory volume and correct coagulation disorders prior to the surgery.

Many authors recommend that neuraxial anaesthesia should be considered cautiously and titrated to effect in patients with severe aortic stenosis or mitral stenosis. The main concern is that neuraxial anaesthesia can dilate blood vessels, reduce preload, and reduce left ventricular filling, causing reduced cardiac output and severe hypotension [2].

However, no studies are available to inform clinical practice on the risk of spinal anaesthesia in patients with severe mitral valve stenosis. There are no controlled studies examining the best anaesthesia technique. Besides, general anaesthesia also has many risks, especially hemodynamic disorders at induction of general anaesthesia and acute pulmonary edema at intubation and extubation. Because our patient has severe mitral stenosis with valve orifice area 0.9 cm^2, moderate pulmonary hypertension (PAPs =

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46 mmHg), preserved EF (59%), the patient had no other cardiovascular symptoms, no rales on lung auscultation, chest X-ray showed no pulmonary edema. Therefore, low-dose spinal anesthesia can be applied safely in our patients.

There have been many reports on the successful application of neuraxial anesthesia in patients with severe mitral stenosis. Gai B., (2009) successfully performed low-dose spinal anesthesia combined with epidural anesthesia for cesarean section for pregnant women with severe mitral valve stenosis and severe pulmonary hypertension [6].

The patient was a 36-week pregnant woman scheduled for a planned cesarean section. The echocardiogram showed mitral valve stenosis (valve area 0.8 - 1 cm^2), systolic pulmonary artery pressure 51 mmHg, EF 56%, the patient had no difficulty breathing, no signs of pulmonary edema on x-rays. This patient was given spinal anesthesia with 0.5% Bupivacaine at a dose of 5 mg with 25 mcg Fentanyl at L3-L4, combined with 3 ml of 2% Lidocaine via epidural catheter. The surgery was preceded uneventfully with hemodynamic stability throughout the surgery, with no complications occurring after surgery.

Manish Kela (2017) also performed labor epidural analgesia on pregnant women with severe mitral stenosis (valve area: 0.6 cm^2) and severe aortic valve stenosis (aortic area: 0.8 cm^2) without any complications [7]. The epidural catheter was inserted at the L2 - L3 interspace, a carefully titrated mixture of Fentany 1 - 2 µg/mL and 0.125% Bupivacaine was given through the epidural catheter, a total of 16 ml was given to ensure the patient had analgesia up to T10 dermatomal level without motor blockade. The patient remained pain-free and hemodynamically stable throughout the procedure. The above two cases show that choosing neuraxial anesthesia helps reduce pain during and after surgery, reduces blood loss, and also avoids unnecessary endotracheal anesthesia.

In our patient, in addition to severe mitral valve stenosis, the patient also had combined atrial fibrillation. Atrial fibrillation in patients with mitral valve stenosis is the result of blood pooling in the left atrium, causing atrial dilatation, long-term dilated atrial muscle causing atrial arrhythmias, the most common of which is atrial fibrillation. Patients with atrial fibrillation are often prescribed anticoagulants to prevent thrombosis, but sometimes non-compliance with treatment can lead to bleeding disorders.

Therefore, it is necessary to optimize coagulation disorders before surgery. In addition, patients with atrial fibrillation should be careful to avoid risk factors that can cause paroxysmal tachycardia such as hypoxia, sympathetic stimulation such as pain, anxiety, fluid overload, etc. In the case of atrial fibrillation, atrial contractions that eject blood from the left atrium to the left ventricle are less effective in diastole, so anesthesia requires maintaining preload to avoid hypotension. We use low-dose spinal anesthesia with 5 mg of 0.5% Bupivacaine, thus minimizing vasodilation and ensuring preload to help maintain relatively stable hemodynamics throughout the surgery.

In fact, after performing spinal anesthesia technique and during surgery, hemodynamic changes were minimal, the level of blockage was T10 which was

sufficient for surgery. The total amount of intraoperative fluid infusion was 100 mL of normal saline. CVP at the end of surgery was 8 mmHg, no vasopressor bolus or continuous infusion was needed. Optimization of circulatory volume, use of low doses of Bupivacaine, and minimal blood loss during surgery (50 ml of blood loss) are the reasons for hemodynamic stability during the surgery.

During the postoperative period, our patient may still be at risk of pulmonary edema due to tachycardia, hypertension due to pain, and pulmonary embolism. Our patient received multimodal pain relief including Paracetamol x 1 g intravenous infusion twice daily and continuous intravenous infusion of Fentanyl at a rate of 15 mcg/h. The patient had little pain and maintained stable hemodynamics in the postoperative period.

4. CONCLUSION

Although patients with severe mitral stenosis are considered a relative contraindication of spinal anesthesia, our case showed that applying low-dose spinal anesthesia for surgery in patients with severe mitral stenosis is safe and efficient.

However, anesthesia for this group of patients requires close coordination between surgeons, anesthesiologists and cardiologists to optimize the patient before surgery, prepare appropriate anesthesia strategies and limit maximize blood loss as well as ensure good pain relief in the postoperative period. Low-dose spinal anesthesia in patients with severe mitral valve stenosis needs to be studied further to evaluate the safety, effectiveness and benefits of this method.

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SEPTIC SHOCK WITH DERMATITIS AND NECROTIZING MYOSITIS DUE TO *Vibrio Vulnificus* INFECTION

(CASE REPORT)

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SUMMARY

Vibrio vulnificus (V. vulnificus) is a gram-negative bacterium that can cause serious, potentially fatal infections. V. vulnificus causes three distinct syndromes: Overwhelming primary septicemia caused by consuming contaminated seafood, wound infections acquired when an open wound is exposed to contaminated warm seawater, and gastrointestinal tract-limited infections. Case-fatality rates are higher than 50% for primary septicemia, and death typically occurs within 72 hours of hospitalization.

Risk factors for V. vulnificus infection include chronic liver disease, alcoholism, and hematological disorders. When V. vulnificus infection is suspected, appropriate antibiotic treatment and surgical interventions should be performed immediately. Third-generation cephalosporin with doxycycline, or quinolone with or without third-generation cephalosporin, may be potential treatment options for patients with V. vulnificus infection.

Keywords: *Septic shock, infection*

1. INTRODUCTION

Vibrio vulnificus (V. vulnificus) is a gram-negative, motile, halophilic bacterium commonly found in marine and brackish coastal waters. It can cause three distinct syndromes: gastroenteritis, primary septicemia, and wound infections, all of which have high mortality rates. The disease primarily affects individuals with chronic liver disease, immunocompromised states, or conditions associated with iron overload. Upon suspicion of *V. vulnificus* infection, based on patient history, epidemiology, clinical progression, and microbiological findings, prompt initiation of appropriate antibiotics and surgical intervention (when indicated) is crucial.

Vibrio vulnificus is a free-living organism found globally, primarily in saltwater and brackish environments, thriving in tropical and subtropical regions. Its optimal growth temperature is above 18^0C, with a preferred salinity range of 15 to 25 parts per thousand. This bacterium is ingested by filter-feeding animals such as oysters, clams, and mussels, with bacterial

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concentrations in their intestines reaching 1.0 x 10^3 to 1.0 x 10^6 cells per gram of oyster at warmer water temperatures. It is also present in the intestines of coastal and estuarine fish.

Vibrio vulnificus consists of 3 biotypes:

+ Biotype 1: The most common, primarily pathogenic to humans, with mortality rates exceeding 50% in wound infections and over 75% in cases of septicemia.

+ Biotype 2: Reported to cause disease in eels, with potential pathogenicity in humans.

+ Biotype 3: Believed to be a hybrid of biotype 1 and biotype 2, documented to cause infections in humans in freshwater environments in Israel.

Transmission Pathways: Infection occurs through the consumption of contaminated food (e.g., raw oysters) and exposure through skin wounds or mucous membranes (e.g., individuals frequently in contact with brackish or saltwater).

The disease typically manifests in individuals with chronic liver disease, alcoholism, immunosuppression, or conditions that lead to iron overload (e.g., thalassemia). The incidence is more common in middle-aged adults, likely due to the prevalence of chronic illnesses, cirrhosis, and alcoholism in this demographic. Males are affected more than females, possibly due to higher exposure to the bacterium from occupational activities and a greater prevalence of alcohol use and chronic diseases. Some studies in murine models suggest a protective role of estrogen against bacterial virulence.

The bacterium proliferates rapidly when transferrin saturation exceeds 70%. Many chronic liver diseases are associated with iron metabolism disorders, which partially explain the pathogenesis of the disease.

2. DISCUSSION OF CLINICAL COURSE AND TREATMENT METHODS

2.1. Case progression

A 44-year-old male, a fisherman involved in aquaculture in Quynh Luu, Nghe An, was admitted at 14:50 on January 5, 2024. Three days prior to admission, he sustained a minor wound to his left thigh while inspecting a fish farm. Subsequently, he developed redness, swelling, and warmth in the left thigh, which progressively extended to the knee and lower leg. The following day, a necrotic area with black discoloration appeared at the wound site, accompanied by several brown-black vesicles measuring 4 x 5 cm surrounding the wound on the left thigh and lower leg. The patient experienced fever but reported no abdominal pain or diarrhea.

Upon arrival at Nghe An Friendship General Hospital, he was alert but severely fatigued, with complaints of headache and dizziness, alongside extensive lesions on the left thigh and lower leg, including hemorrhagic vesicles, swelling and tenderness in the lower leg, and ecchymosis with extensive necrotic lesions extending from the lateral thigh to the lower leg.

Vital signs were as follows: Blood pressure: 70/50 mmHg; Temperature: 40^0C; Respiratory rate: 28 breaths/min; Heart rate: 120 beats/min.

Initial laboratory test results upon admission: WBC: 22.86 G/L; NEU: 93.1%; Hb: 95 g/L; RBC: 2.82 T/L; HCT: 0.257 L/L; PLT: 29 G/L; Prothrombin time (PT): 15.2 s (by automated analyzer); PT ratio: 47.2%;

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INR: 1.41; APTT: 32.7 s; APTT (control): 1.23; pO2: 88.1 mmHg; pCO2: 28.0 mmHg; Na: 127.3 mmol/L; K: 5.88 mmol/L; Cl: 94.4 mmol/L; HCO3: 20.9 mmol/L; Pro-calcitonin: 36.23 ng/mL; Serum albumin: 13.2 g/L; Total bilirubin: 33.3 µmol/L; Serum lactate: 6.14 mmol/L; ALT: 38.9 U/L; AST: 75.2 U/L; HBsAg (+), Anti-HBs (-), Anti-HCV (-), Elisa AFP (-); Electrocardiogram (ECG): Sinus tachycardia at a rate of 122 beats/min; ST segment is isoelectric. Doppler Ultrasound of Lower Limb Arteries and Veins: Atherosclerosis in the bilateral lower extremity arterial system.

The patient underwent blood cultures and drainage cultures from the vesicles and necrotic tissue for susceptibility testing prior to the initiation of antibiotic therapy. The patient had not received any antibiotics before this.

The patient has a history of alcohol use disorder, consuming approximately 250 mL of alcohol per day.

The assessment showed a qSOFA score of ≥ 2 and a SOFA score of > 2.

Diagnosis: Suspected skin-related septic shock due to *Vibrio vulnificus*, based on epidemiological characteristics, medical history, and disease progression. The patient was admitted to the ICU and immediately started on antibiotic therapy, including levofloxacin, metronidazole, and vancomycin, along with fluid resuscitation using 0.9% NaCl and human albumin to maintain a central venous pressure (CVP) of ≥ 12 mmHg. Additionally, levonordefrin (norepinephrine) and dobutamine were administered to ensure systolic blood pressure > 90 mmHg and mean arterial pressure > 65 mmHg.

At 21h30 on January 5, 2024, the patient was indicated for emergency continuous renal replacement therapy, which was completed at 02:00 on January 6, 2024. After the dialysis session, the patient was alert, with a heart rate of 100 beats/min, blood pressure of 110/70 mmHg, and a temperature of 37^0C, breathing spontaneously with supplemental oxygen.

At 09h00 on January 6, 2024, a multidisciplinary consultation with the Burn Unit agreed on the need for emergency surgical debridement of necrotic tissue.

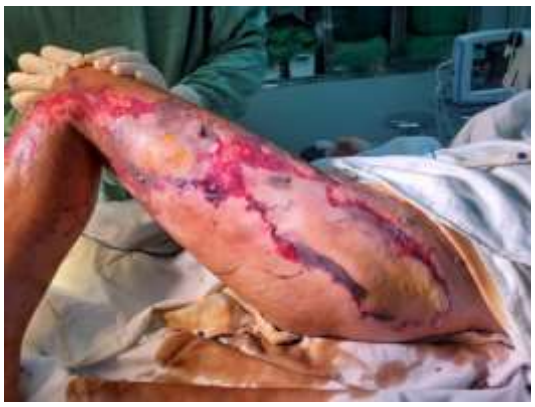

Figure 2.1. Preoperative images of the lesion

Figure 2.2. Post-debridement images of the necrotic tissue

After surgery, the patient received continuous irrigation of the wound with diluted Betadine and normal saline, with daily dressing changes.

Culture results from the necrotic tissue were positive for *Vibrio vulnificus* and demonstrated sensitivity to multiple antibiotics, including third-generation cephalosporins (Ceftazidime, Cefotaxime, Ceftriaxone), Carbapenems (Meropenem, Imipenem), Aminoglycosides (Gentamicin, Amikacin), and Fluoroquinolones (Levofloxacin, Ciprofloxacin). Vancomycin was discontinued, and treatment was switched to Ceftazidime at a dosage of 4 g/day based on the susceptibility results.

After six days of treatment, the patient was alert and breathing independently but appeared cachectic. The abdomen was soft, and there was no hepatosplenomegaly. Peripheral pulses were palpable, with no focal neurologic deficits. Vital signs were as follows: heart rate 95 beats/min, blood pressure 130/90 mmHg, temperature 37^0C, and urine output 2500 ml/24 hours.

Laboratory results included: pO2: 121.3 mmHg; pCO2: 34.3 mmHg; pH: 7.511; Na: 137.8 mmol/L; K: 3.88 mmol/L; Cl: 98.6 mmol/L; serum creatinine: 90 µmol/L; serum lactate: 5.11 mmol/L; RBC: 2.36 T/L; HGB: 77 g/L; HCT: 0.216 L/L; WBC: 17.67 G/L; %NEUT: 85.6%; PLT: 72 G/L; PT: 79.8%; INR: 1.10; APTT: 29.3 seconds; APTT ratio: 1.09.

Local necrotic tissue was beginning to develop granulation tissue, although there was still significant necrotic debris and exudate present.

On January 11, 2024, the patient was transferred back to the Burn Unit for further treatment.

In the Burn Unit, the patient continued on ceftazidime 4 g/day, human albumin 50 g twice daily, 5% amino plasma 500 mL/day, along with electrolyte replacement and daily dressing changes. By January 14, 2024, the patient was alert, with pale mucous membranes and a cachectic appearance. Laboratory results included: serum cortisol: 413.1 nmol/L; pro-calcitonin: 1.36 ng/mL; Na: 135 mmol/L; K: 4.05 mmol/L; Cl: 101.6 mmol/L; serum creatinine: 54 µmol/L; pre-albumin: 7.46 g/L; RBC: 2.56 T/L; HGB: 76 g/L; HCT: 0.279 L/L; WBC: 12.66 G/L; %NEUT: 75.6%; PLT: 98 G/L. Accordingly, the patient was indicated for a transfusion of 750 mL of red blood cells.

On January 16, 2024, the patient underwent thin split-thickness skin grafting to cover the skin defect on the left thigh and lower leg.

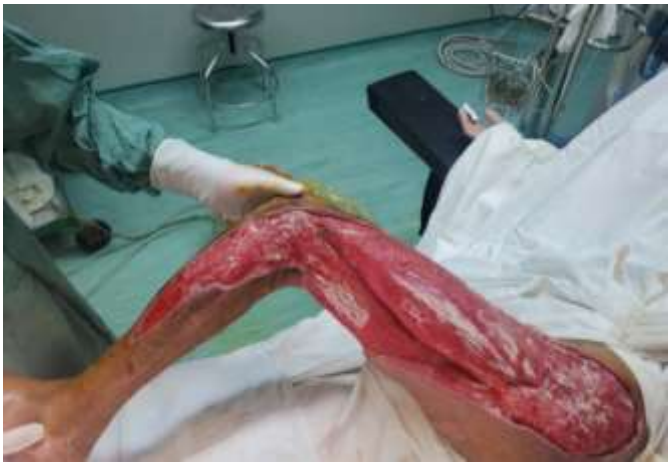

Figure 2.3. Preoperative images of the lesion before skin grafting

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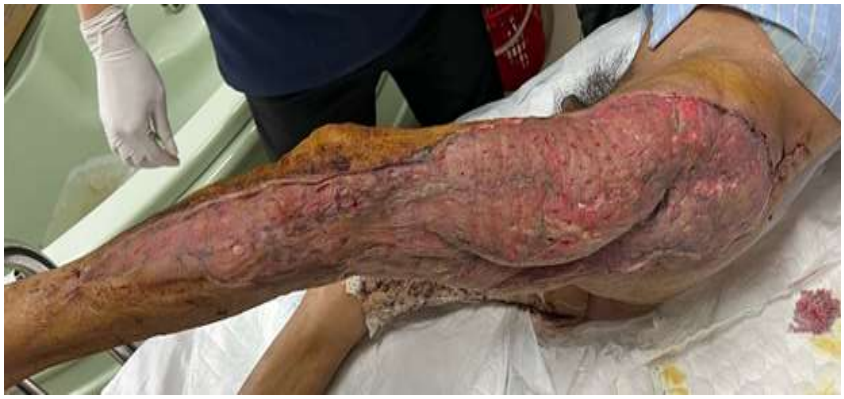

Figure 2.4. Post-skin graft images on the 6th day

After the skin graft procedure, the patient's overall condition improved, with increases in hemoglobin and hematocrit levels, as well as elevated albumin levels. Locally, the split-thickness skin graft adhered well, and the donor site healed satisfactorily.

On January 25, 2024, the patient was discharged with an outpatient management plan that included levofloxacin 0.5 g, two tablets daily, and a follow-up appointment scheduled for two weeks later.

2.2. Discuss of diagnosis and treatment

V. vulnificus infection is suspected based on clinical and epidemiological findings and is confirmed by bacteriological culture [1, 2]. Because bacteremia is common, routine blood cultures should be performed when *V.vulnificus* infection is suspected. Gram stain and culture of a specimen obtained from skin lesions such as abscesses or bullae are helpful to rapidly identify bacteria. Stool cultures are occasionally useful, requiring thiosulfate-citrate-bile salts-sucrose agar for isolation [1]. Culture tests using blood or skin lesion samples are the most important method for diagnosing *V. vulnificus* sepsis. However, since *V. vulnificus* is highly sensitive to antibiotic administration, it is necessary to check whether any antibiotic has been administered prior to performing the culture test.

Microbiological culture provides high specificity, but diagnosis takes a long time. Furthermore, *V. vulnificus* is susceptible to many antibiotics; therefore, infection in patients previously treated with antibiotics before culture is difficult to diagnose accurately [3]. Polymerase chain reaction (PCR) is also useful for early diagnosis of V. vulnificus infection, even in patients previously treated with antibiotics [3]. Using blood samples, the conventional PCR and nested PCR assays showed specificities of 100% and 73%, respectively. The real-time PCR assay had 100% sensitivity and specificity as a positive result using a cutoff value of < 38 cp [3]. The real-time PCR assay to detect *V. vulnificus* specific genes is not only the most sensitive and specific diagnostic method but also the most rapid technique [3].

In a recent study, *V. vulnificus* DNA copy numbers were higher in tissue samples than in blood samples from V. vulnificus-infected patients, showing that skin lesions are more useful than blood

samples for PCR-based diagnosis of V. vulnificus-infected patients [4]. Real-time PCR using serum samples collected from 14 patients at admission showed a median *V. vulnificus* DNA load of 638.5 copies/mL of blood (interquartile range [IQR], 37 to 3,225), while real-time PCR using the initial tissue specimen at admission showed a median of 16,650 copies/mL of tissue fluid (IQR, 4,419 to 832,500; p = 0.022.

Data on 62 cases of *V. vulnificus* infection reported by Florida health authorities showed that the mortality rate was 33% when antibiotics were administered within 24 hours after admission, but increased to 63% and 100% when antibiotic administration was delayed to 48 to 72 and > 72 hours post-admission, respectively [5]. These results demonstrate the importance of timely early antibiotic administration.

V. vulnificus is sensitive to most antibiotics in vitro, except for colistin; antibiotics that are effective against *V. vulnificus* in vitro are third-generation cephalosporins ceftriaxone, cefotaxime, or ceftazidime), Piperacillin-Tazobactam, Carbapenems (Imipenem or Meropenem), Tetracyclines (Doxycycline or Tetracycline), aminoglycoside (gentamicin or amikacin), fluoroquinolones (ciprofloxacin, levofloxacin, or moxifloxacin), and Sulfamethoxazole-Trimethoprim [6].

In most in vitro or in vivo mouse model experiments on antibiotic susceptibility, tetracyclines are reported to have significantly higher efficacy than penicillin or cephalosporins. This has been attributed to the fact that the tetracycline class of antibiotics achieves better penetration into tissues with poor perfusion when V. *vulnificus* infection occurs, and has inhibitory effects against the synthesis of proteins, such as various toxins and enzymes produced by *V. vulnificus* [7].

The CDC recommends doxycycline 100 mg intravenously or orally twice a day plus ceftazidime (or any other third-generation cephalosporin) 1 to 2 g intravenously every 8 hours for the treatment of *V. vulnificus* infection [8]

Case fatality rates for V. vulnificus infections have been shown to increase with delays between the onset of illness and the administration of antibiotics. Therefore, if a patient is suspected to be infected with V. vulnificus, appropriate antibiotic treatment should be immediately administered [5, 9].

Furthermore, in many patients with serious skin and soft tissue infections such as necrotizing fasciitis, surgical interventions such as debridement or fasciotomy are necessary in addition to antibiotics treatment to remove necrotic tissue and bacteria [6, 9]. A retrospective study on necrotizing soft-tissue infections including *V. vulnificus* related necrotizing fasciitis in 65 patients demonstrated the importance of early surgical intervention based on the time from admission to surgery (25 ± 39 hours in the survival group and 90 ± 95 hours in the mortality group) [10].

3. LESSONS LEARNED

Vibrio vulnificus is a gram-negative, halophilic, motile bacterium primarily found in warm coastal waters. It has the potential to cause illnesses ranging from mild to severe, including gastroenteritis and septic shock. Severe infections often occur in patients with chronic liver disease, immunocompromised states, and conditions leading to iron overload in the

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body. Despite the number of individuals at risk of exposure to V. vulnificus, the incidence of related illnesses remains relatively low. Cases tend to occur during warmer months when bacterial counts increase. The primary routes of infection are through the consumption of raw or undercooked seafood or through direct contact via open wounds when wading, fishing, or handling infected seafood.

Vibrio vulnificus possesses several virulence factors, including resistance to gastric acid, endotoxins, exotoxins, a capsule, flagella, pili, and siderophores. It is characterized by three syndromes: gastroenteritis, primary sepsis, and wound infection. Diagnosis is based on clinical symptoms, epidemiology, and microbiological testing, with real-time PCR showing high sensitivity and specificity. Early antibiotic therapy is strongly recommended and should be combined with surgical intervention in severe cases. Several antibiotics show in vitro sensitivity to V. vulnificus, with ceftazidime in combination with doxycycline being recommended by the CDC. Comprehensive care, along with patient education, guidance, and counseling, is essential and crucial for improving patient outcomes and preventing complications such as necrotizing fasciitis and secondary infections with other dangerous bacteria.

Patients with a presumptive diagnosis of V. vulnificus infection should be immediately started on antibiotics therapy and surgical interventions if needed. The recommended antibiotics treatment regimen is ceftriaxone plus doxycycline or ceftriaxone plus ciprofloxacin. pH level upon admission, APACHE II score, and V. vulnificus DNA load can help predict the prognosis for patients with V. vulnificus infection.

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