

Disseminated intravascular coagulation – a rare, difficult-to-anticipate complication of limb infections

Catalin Gheorghe Bejinariu¹, Vladimir-Aurelian Enachescu³, Anca Bordianu^{1,2}

¹“Bagdasar-Arseni” Emergency Clinical Hospital, Department of Plastic and Reconstructive Surgery, Bucharest, Romania

²“Carol Davila” University of Medicine and Pharmacy, Bucharest, Romania

³Bucharest University of Economic Studies, Bucharest, Romania

ABSTRACT

Disseminated vascular coagulation is a serious complication of upper and lower limb infections. The marked reduction in the number of platelets, characteristic of this type of complication, constitutes a major impediment for classical surgical treatment, consisting of wide debridements and large exploratory incisions. The increased risk of hemorrhage associated with this type of surgical approach is the main concern of plastic surgeons involved in the treatment of these conditions. The present paper highlights the difficulty of early identification of CID-type complications, by presenting some clinical cases with similar onset, but whose evolution is characterized by diametrically opposite clinical forms.

Keywords: disseminated intravascular coagulation, thrombocytopenia, cellulitis, infection, anemia

INTRODUCTION

Sepsis represents one of the main health problems worldwide, the associated high morbidity and mortality requiring the improvement of specific protocols designed on the one hand to stimulate the general systemic response, and on the other hand to provide the best opportunity for healing of the septic outbreak, which was the basis for the emergence of systemic symptoms [1].

The rapid establishment of appropriate treatment for the identified clinical form is the only option for limiting the associated morbidity and avoiding life-threatening complications. In this sense, the interest of the international scientific community has turned to the use of artificial intelligence for the early identification of cases that may evolve into sepsis, in order to administer specific treatment from the onset of symptoms [2].

Recent research shows that the development and use of protocols for the early identification of signs

of sepsis is an effective method to reduce the morbidity and mortality associated with this pathological entity [3].

Sepsis represents one of the main reasons for disseminated intravascular coagulation, the modification of the coagulation cascade generating the appearance of thrombosis that can have devastating consequences at the level of the affected organs. At the same time, the marked reduction in the number of thrombocytes, characteristic of CID, may result in the occurrence of difficult-to-control hemorrhages in the context of severe thrombocytopenia [4].

Starting from this pathological entity in the context of the desire to reduce the consumption of antibiotics worldwide, the international scientific community directed its attention to the development of new techniques to increase the specificity and sensitivity of cellulitis diagnosis. Imaging analysis of skin temperature offering encouraging insights in this regard [5].

Corresponding author:
Catalin Gheorghe Bejinariu
E-mail: drbejinariu@gmail.com

Article History:
Received: 10 June 2024
Accepted: 21 June 2024

Disseminated intravascular coagulation is a rare life-threatening complication of upper and lower limb infections. Its early identification and the establishment of specific treatment is mandatory to save patients' lives. Emergency surgical treatment in combination with systemic supportive treatment are the main tools in the fight against this type of complication of septic shock [6-7].

Surgical treatment consists of making large exploratory incisions, in association with extensive excisional debridements and removal of the affected superficial fascia which contributes to the progressive remission of the paraclinical changes underlying the appearance of disseminated intravascular coagulation [8]. In most situations, it is necessary to carry out a rigorous chemical lavage twice a day, as well as to carry out serial excisions, in order to remove devitalized tissues, which constitute the ideal culture medium for bacterial proliferation.

The installation of disseminated vascular coagulation, characterized by a marked reduction in the number of figurative elements of blood, especially platelets, makes it significantly more difficult to carry out surgical treatment, by markedly increasing the risk of intraoperative bleeding. Considering that in most situations the patients are anemic, the surgically induced hemorrhage is hardly tolerated by them, the blood volume rebalancing it is a hard goal to achieve [9-10].

The complications of disseminated intravascular coagulation are extremely serious, presenting a life-threatening risk in the absence of emergency corrective measures. Acute renal failure often requires, in addition to specific surgical treatment, emergency dialysis in order to overcome the critical moment [11-14]. Cardiac tamponade is also an extremely serious complication of CID, its treatment being carried out by a complex medical team that must include the attending anesthesiologist, cardiologist and the plastic surgeon. Gangrene is also a clinical form of manifestation of the consequences of CID,

requiring, most of the time, to carry out necessary amputations in order to save the patients' lives [15]. Thrombosis and severe hemorrhages are also associated with CID and represent medical and surgical emergencies, for the management of which close collaboration between the plastic surgeon and the anesthesiologist is mandatory [16-18].

In the absence of the establishment of specific therapeutic measures, CID associated with septic shock evolves to death, therefore thorough knowledge of the therapeutic protocols particular to each type of complication is essential to save patients' lives [18].

MATERIALS AND METHODS

The paper presents a comparative analysis of the cases diagnosed with cellulitis of the limbs, whose pathological history and local presentation is similar, but whose evolution took diametrically opposite clinical forms.

Paraclinical investigations were carried out using the Beckman Coulter DXH600 system to determine the hemogram, ACL Elite PRO2 to calculate coagulation times and Dimension EXL 200 to evaluate serum ions.

The first patient was admitted to the clinic for the treatment of cellulitis of the right upper limb. The medical history began approximately 30 days prior to hospital presentation, when the patient sustained a right elbow trauma resulting in a circular wound approximately 8 mm in diameter. In his personal pathological antecedents, hepatic steatosis was noted in an ethanolic context. At admission, the patient had marked edema of the right thoracic limb, perilesional erythema and minimal impairment of muscle strength manifested by a decrease in hand force (Figure 1).

The patient was admitted as a life threatening emergency, benefiting from surgical treatment consisting of an exploratory incision located at the level



FIGURE 1. Local aspect at admission – upper limb infection

of the posterior surface of the right elbow, followed by specimen collection for cultures and excisional debridement of the devitalized tissues.

At admission, the patient had thrombocytopenia, marked anemia, dyselectrolytemia, the coagulogram being undetectable on repeated evaluations. The drug treatment administered was represented by triple antibiotic therapy by administration of Gentamicin (80 mg, intravenously every 12 hours), Metronidazole (500 mg, intravenously every 8 hours) and Cefuroxime (1 g, intravenously every 12 hours), in association with anti-inflammatory treatment and gastric protection. The unfavorable evolution required the transfer of the patient to the intensive care unit (for 3 days).

During hospitalization, the patient received one unit of fresh plasma, two units of platelet concentrate and one unit of erythrocyte concentrate. In the first four days, the general condition of the patient was critical. The results of the paraclinical investigations carried out in the first 4 days, showed significant changes of the main indicators (Tabel 1).

The second patient was hospitalized for the treatment of cellulitis of the right lower limb. The history of the disease began approximately 30 days before presentation to the emergency room, the patient suffering a domestic trauma resulting in a circular wound with a diameter of approximately 9 mm, located at the level of the anterior face of the middle 1/3 of the right calf.

At admission, the patient had marked edema of the right pelvic limb, perilesional erythema and marked impairment of the mobility of the right knee and leg (Figure 2).

The patient was admitted as an emergency, benefiting from an exploratory incision, followed by specimen collection for cultures (in order to carry out the antibiogram) and excisional debridement of the devitalized tissues.

The drug treatment administered was represented by triple antibiotic therapy by administration of Gentamicin (80 mg, intravenously every 12 hours), Metronidazole (500 mg, intravenously every 8 hours) and Ceftriaxone (1g, intravenously every 12

TABLE 1. The trend of the main indicators evaluated in the first 4 days after the admission

Parameter / Physiological values	1st day	2nd day	3rd day	4th day
CL (98-107mmol/L)	87.00	95.00	100.00	102.00
K (3.5-5.1 mmol/L)	3.60	3.60	3.10	3.70
Na (136-145 mmol/L)	124.00	131.00	134.00	138.00
ALT/GPT (12-78 U/L)	84.00	60.00	49.00	63.00
AST/GOT (15-37 U/L)	132.00	124.00	98.00	102.00
PLT (130-400 × 10 ³ /uL)	38	46	72	82
HGB (14-18 g/dL)	14.1	10.9	9.1	9.2
WBC (4.8-10.8 × 10 ³ /uL)	8.1	9.1	10.7	9.8
PT (11.8-15.1 s)	Error	Error	14.800	14.000
INR (0.85-1.15%)	Error	Error	1.109	1.044
APTT (70-140 %)	Error	Error	90.420	100.561
CK (39-308 U/L)	1431.00	2621.00	2093.00	1134.00

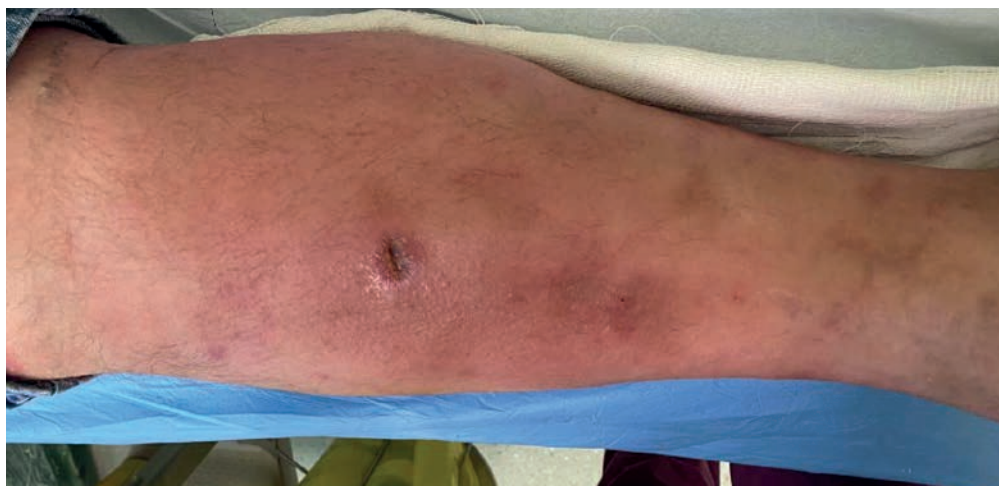


FIGURE 2. Local aspect at admission – lower limb infection

hours), in combination with anti-inflammatory treatment and gastric protection.

RESULTS AND DISCUSSIONS

CID is a rare complication of sepsis, its early identification being essential to save patients' lives. Although the patients included in the study had a similar history and similar clinical presentation at admission, their evolution was different, without being able to identify relevant supporting elements.

In the case of the patient diagnosed with cellulitis of the upper limb, the surgical treatment was characterized by serial daily debridements (Figure 3). Local lavage was performed twice a day to control septic phenomena. The result of the cultures performed from the secretions collected at admission was negative, no pathogenic germs were identified.

However, the clinical evolution was marked by progressive worsening, in the first 3 days after admission, later in the context of rigorous surgical treatment and broad-spectrum antibiotic treatment, the evolution being slowly favorable.

The patient hospitalized for the treatment of cellulitis of the lower limb had a favorable local evolution in the context of performing the same therapeutic protocol as in the previously presented patient (Figure 4). The result of the cultures performed from the secretions collected at admission revealed the presence of *Staphylococcus aureus*

(methicillin-resistant). After performing the exploratory incision and emergency excisional debridement, the favorable evolution allowed the surgical wound to be sutured 3 days later, the patient being discharged 5 days after admission.

Following the treatment, the patients were discharged in the course of healing, the outpatient monitoring revealing full functional recovery, the patients being socio-professionally integrated 14 days after discharge (Figure 5).

Performing the comparative analysis of the patients revealed similar elements regarding the local appearance at admission, age and history of the disease, the only element that differentiates these cases being represented by the presence of hepatic steatosis in the personal pathological history of the patient who developed CID.

Considering that from the experience of the authors and in accordance with the general opinion of the specialists in the field, the impairment of liver function can represent a risk factor for the triggering CID, the authors believe that in this situation also, the unfavorable evolution of the patient diagnosed with cellulitis of the upper limb can be justified by changes in the liver.

CONCLUSIONS

CID is a severe complication of upper and lower limb cellulitis, the clinical evolution towards this pathological entity being unpredictable. Therefore,



FIGURE 3. The evolution of the upper limb surgery – a. 1st day postop; b. 7th day postop; c. 10th day postop

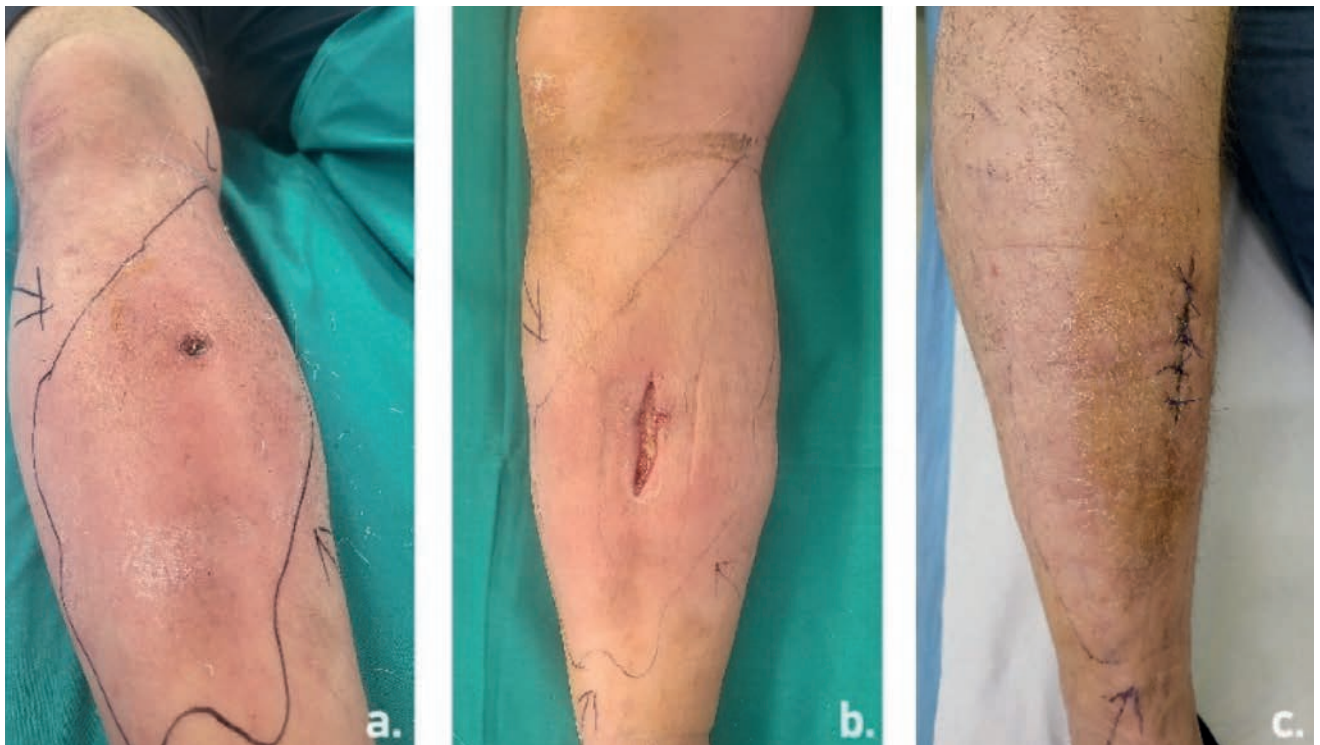


FIGURE 4. The evolution of the lower limb surgery – a. preoperative aspect; b. 1st day postop; c. 5th day postop



FIGURE 5. Postoperative scar aspect – a. Right upper limb infection associated with CID (21 days postop); b. Right lower limb infection (21 days postop)

the authors recommend that practitioners have a multimodal therapeutic approach in these cases, aiming on the one hand at rigorous surgical treatment, and on the other hand at careful paraclinical

monitoring, through repeated evaluations of the hemogram, leukogram, transaminases, serum ions and coagulation times. The authors also consider that in these cases, the treatment should be per-

formed by a multidisciplinary team, which must necessarily include a plastic surgeon and an experienced anesthesiologist.

Compliance with ethics requirements: The authors declare no conflict of interest regarding this article. The authors declare that all the procedures and experiments of this study respect the ethical

standards in the Helsinki Declaration of 1975, as revised in 2008(5), as well as the national law. Informed consent was obtained from all the patients included in the study.

Conflict of interest: none declared

Financial support: none declared

REFERENCES

- Giamarellos-Bourboulis EJ, Aschenbrenner AC, Bauer M, Bock C, Calandra T, Gat-Viks I, Kyriazopoulou E, Lupse M, Monneret G, Pickkers P, Schultze JL. The pathophysiology of sepsis and precision-medicine-based immunotherapy. *Nature Immunol.* 2024 Jan;25(1):19-28. <https://doi.org/10.1038/s41590-023-01660-5>
- Kamran F, Tjandra D, Heiler A, Virzi J, Singh K, King JE, Valley TS, Wiens J. Evaluation of Sepsis Prediction Models before Onset of Treatment. *NEJM AI.* 2024 Feb 7:Aloa2300032. <http://doi.org/10.1056/Aloa2300032>
- Boussina A, Shashikumar SP, Malhotra A, Owens RL, El-Kareh R, Longhurst CA, Quintero K, Donahue A, Chan TC, Nemati S, Wardi G. Impact of a deep learning sepsis prediction model on quality of care and survival. *npj Digital Medicine.* 2024 Jan 23;7(1):14. <https://doi.org/10.1038/s41746-023-00986-6>
- Levi M, Scully M. How I treat disseminated intravascular coagulation. *Blood, The Journal of the American Society of Hematology.* 2018 Feb 22;131(8):845-54. <https://doi.org/10.1182/blood-2017-10-804096>
- Pulia MS, Schwei RJ, Alexandridis R, et al. Validation of Thermal Imaging and the ALT-70 Prediction Model to Differentiate Cellulitis From Pseudocellulitis. *JAMA Dermatol.* 2024;160(5):511-7. <http://doi.org/10.1001/jamadermatol.2024.0091>
- Zhao H, Dong Y, Wang S, Shen J, Song Z, Xue M, Shao M. Comparison between sepsis-induced coagulopathy and sepsis-associated coagulopathy criteria in identifying sepsis-associated disseminated intravascular coagulation. *World J Emerg Med.* 2024;15(3):190-6. <http://doi.org/10.5847/wjem.j.1920-8642.2024.041>. PMID: 38855376; PMCID: PMC11153374.
- Thompson S, Cooper K, Thomas T, Alexander K, Hem-Lee-Forsyth S. A Comparison of the Application of Two Different Scoring Systems in a Patient With Upper Limb Necrotizing Fasciitis. *Cureus.* 2024 Jun 4;16(6):e61682. <http://doi.org/10.7759/cureus.61682>. PMID: 38835559; PMCID: PMC11150016.
- Muller I, Teasdale E, Cowdell F, Smart P, Santer M, Francis N. Practice and community nurses' views and experiences of helping people manage risk factors for recurrent lower limb cellulitis: A qualitative interview study. *Skin Health and Disease.* 2024 Apr 30:e395. <https://doi.org/10.1002/ski2.395>
- Nightingale RS, Etheridge N, Sweeny AL, Smyth G, Dace W, Pellatt RA, Snelling PJ, Yadav K, Keijzers G. Cellulitis in the Emergency Department: A prospective cohort study with patient-centred follow-up. *Emergency Medicine Australasia.* 2024 Mar 13. <https://doi.org/10.1111/1742-6723.14401>.
- Tienpratarn W, Yuksen C, Pauly JD, Vu D, Benbouenane AN, Sangskul N. Factors and clinical prediction score for complication development after cellulitis diagnosis in adult patients. *Int J Emerg Med.* 2024 May 22;17(1):68. <https://doi.org/10.1186/s12245-024-00646-w>.
- Bejinariu C, Marinescu S, Enescu DM. The Romanian National Breast Reconstruction Program - Results and Conclusions after 5 Years. *Modern Medicine.* 2019;26(1):23-30. <https://doi.org/10.31689/rmm.2019.26.1.23>.
- Yürük Atasoy P, Gürbüz E, Alkan S. Prognostic Significance of NLR, LMR, PLR, and CRP-Albumin Ratio in Lower Extremity Cellulitis: A Hospitalization and Recurrence Analysis. *Internat J Lower Extremity Wounds.* 2024 Feb 28:15347346241235873.
- Pandian SS, Kumar AM. Clinical study of risk factors, clinical presentation and management of cellulitis lower limb. *Int J Acad Med Pharm.* 2024;6(2):7-11. doi: 10.47009/jamp.2024.6.2.2.
- Bordianu A, Bobirca F, Patrascu T. Skin grafting in the treatment of diabetic foot soft tissue defects. *Chirurgia (Bucur).* 2018;113(5): 644-50.
- Zhou J, Liu J, Zhang C, Zhou Y, Zheng Z, Li H. Elucidating the molecular mechanisms of sepsis: identifying key aging-related biomarkers and potential therapeutic targets in the treatment of sepsis. *Environmental Toxicology.* 2024 Jun;39(6):3341-55. <https://doi.org/10.1002/tox.24198>
- Weledji EP. Disseminated Intravascular Coagulation (DIC): What the Surgeon Should Know. *Clin Surg.* 2024;9:3682.
- Sun Y, Ding R, Sun H, Liang Y, Ma X. Efficacy and safety of heparin for sepsis-induced disseminated intravascular coagulation (HepSIC): study protocol for a multicenter randomized controlled trial. *Trials.* 2024 Jan 2;25(1):4. <https://doi.org/10.1186/s13063-023-07853-5>
- Lee S, Kim J, Ji M, Moon H, Lee W. Clinical outcomes of antithrombin III supplementation in an overt disseminated intravascular coagulation: a longitudinal single-institutional experience and retrospective analysis. *Ann Palliat Med.* 2024 Apr 23:apm-23. <https://dx.doi.org/10.21037/apm-23-535>