Critical Care

## RESEARCH LETTER

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# Severe necrotizing soft-tissue infection-associated mortality: Have a look at the computed tomography!

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Necrotizing soft-tissue infection (NSTI) is a life-threatening pathology, and the cornerstone treatment is based on early diagnosis, surgical source control and antimicrobial therapy [1]. Even if the diagnosis remains essentially clinical, computed tomography (CT) could be helpful in the diagnosis but remains controversial [2]. To date, there are no data screening the criteria for the place of initial CT-scan and patient outcomes. We aimed to evaluate the relationship between CT signs and the outcome of severe NSTI patients.

We retrospectively collected data for 100 patients with severe NSTI hospitalized in our intensive care unit (ICU) between 2009 and 2019 and whose diagnoses were surgically confirmed. Methods of this cohort have been previously published [3]. Patients who were clinically suspected of having NSTI benefited from urgent surgical exploration. CT was performed prior to surgery at the discretion of the clinician if the diagnosis of NSTI was uncertain or to assess the extent of the damage.

Four criteria for CT were evaluated according to previous guidelines [4, 5]:

- Gas in the soft tissues,
- Multiple fluid collections,
- Absence or heterogeneity of tissue enhancement by IV contrast,
- Significant inflammatory changes of the fascia and under.

The presence of these criteria was compared between survivors and nonsurvivors at day-90.

Of the 100 patients, 54 underwent CT before surgical exploration. Table 1 shows the comparison of general characteristics between the patients with and without CT. The median (IQR) delay between CT and the surgical procedure was 5 [2–20] hours. Table 2 shows the clinical and CT characteristics according to the survival or death status at day-90. In the multivariate analysis, in addition to the surface parameter (OR 1.15, 95% CI 1.34, $p = 0.01$), the criterion for inflammatory changes of the fascia was associated with mortality at day-90 (OR 8.09, 95% CI 63.5, $p = 0.015$). Inflammatory changes of the fascia parameter had a sensitivity of 60% (32-84), specificity of 92% (79-98), positive predictive value of 75% (43–95) and negative predictive value of 86% (71–95).

In this study involving 100 severe ICU NSTI patients, we found that even if CT is not a diagnostic tool, it can

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**Table 1** Overall baseline and outcome features of the study patients according to CT evaluation

|  | Overall *n* = 100 | No CT *n* = 46 | CT *n* = 54 | *p* value |
|---|---|---|---|---|
| Age (years), median [IQR] | 58 [50–68] | 57 [48–68] | 59 [53–68] | 0.31 |
| Male sex, *n* (%) | 63 (63) | 26 (56.5) | 37 (68.5) | 0.299 |
| BMI (kg/m$^2$), median [IQR] | 28 [23–34] | 29 [26–37] | 25 [22–32] | 0.059 |
| Localization: limbs, *n* (%) | 52 (52) | 35 (76) | 17 (31) | < 0.001 |
| Localization: pelvis, *n* (%) | 28 (28) | 12 (26) | 16 (30) | 0.824 |
| Localization: cephalic, *n* (%) | 23 (23) | 10 (22) | 13 (24) | 0.97 |
| Localization: trunk, *n* (%) | 13 (13) | 1 (2) | 12 (22) | 0.008 |
| Skin surface (%), median [IQR] | 4.5 [4.5–9] | 4.5 [4.5–9.0] | 4.50 [4.5–9.0] | 0.467 |
| SAPS-II on admission, median [IQR] | 28 [23–37] | 33 [25–44] | 39 [23–56] | 0.369 |
| SOFA score on admission, median [IQR] | 5 [3–6] | 4 [1, 7] | 4 [1, 9] | 0.721 |
| LRINEC score on admission, median [IQR] | 2 [1–4] | 3 [2, 5] | 3 [1, 5] | 0.709 |
| Septic shock on admission, *n* (%) | 65 (65) | 30 (65) | 35 (65) | 1 |
| Day-1 cardiovascular failure (HD SOFA ≥ 1), *n* (%) | 87 (87) | 42 (91) | 45 (83) | 0.372 |
| Day-1 respiratory failure (respiratory SOFA ≥ 1), *n* (%) | 44 (44) | 20 (44) | 24 (44) | 1 |
| Day-1 renal failure (renal SOFA ≥ 1), *n* (%) | 42 (42) | 18 (39) | 24 (44) | 0.685 |
| Charlson score on admission, median [IQR] | 4 [3–7] | 3 [2–5] | 5 [3–7] | 0.008 |
| Underlying medical conditions |  |  |  |  |
|   Malignancy, *n* (%) | 23 (23) | 7 (15) | 16 (30) | 0.101 |
|   Obesity, *n* (%) | 24 (24) | 13 (28) | 11 (20) | 0.482 |
|   Diabetes mellitus, *n* (%) | 24 (24) | 9 (20) | 15 (28) | 0.359 |
|   Coronary disease, *n* (%) | 20 (20) | 5 (11) | 15 (28) | 0.044 |
|   Peripheral vascular disease, *n* (%) | 17 (17) | 6 (13) | 11 (20) | 0.426 |
|   Alcohol use, *n* (%) | 20 (20) | 8 (17) | 12 (22) | 0.621 |
|   Active smoking, *n* (%) | 54 (54) | 24 (52) | 30 (55) | 0.841 |
|   Immunosuppression, *n* (%) | 10 (10) | 6 (13) | 4 (7) | 0.506 |
| Renal replacement therapy during ICU stay, *n* (%) | 22 (22) | 8 (17) | 14 (26) | 0.342 |
| Vasoactive support during ICU stay, *n* (%) | 53 (53) | 23 (50) | 30 (55) | 0.422 |
| Mechanical ventilation during ICU stay, *n* (%) | 50 (50) | 24 (52) | 26 (48) | 0.841 |
| Limb amputation, *n* (%) | 13 (13) | 8 (17) | 5 (9) | 0.234 |
| Mortality at day-28, *n* (%) | 18 (18) | 7 (15) | 11 (20) | 0.448 |
| Mortality at day-90, *n* (%) | 23 (23) | 8 (17) | 15 (28) | 0.243 |

*BMI* body mass index, *HD* hemodynamic, *LRINEC* laboratory risk indicators for necrotizing fasciitis score, *SAPS-II* simplified acute physiology score-II, *SOFA* sequential organ failure assessment

nevertheless provide some information on the patient's outcome. It is well established that the contribution of CT for an NSTI diagnosis is not only unreliable but can also delay the management of the patient, which is why in most cases, the diagnosis is made on the basis of clinical examinations and operative findings [4]. Our work partly confirms these elements since, when comparing patients who had a CT-scan versus those who did not, no difference according to the initial severity was found.

There are many diagnostic studies in which changes in the fascia (thickness, presence of edema, nonenhancement) can help in the diagnosis, but to our knowledge, our study is the first to evidence a link between fascia imaging and prognosis [6]. Nevertheless, as the fascia is a key structure in the spread of infection, our findings seem quite consistent.

Our study has limitations, including its monocentric design with only 100 NSTI patients and a long cohort period. Of course, almost half of the patients in the cohort did not have a CT-scan, which is an undeniable source of bias. A multicenter prospective larger cohort study has to be performed to confirm these results.

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**Table 2** Relationship between the clinical and CT criteria and mortality at day-90

| | Univariate analysis | | | Multivariate analysis | | | |
|---|---|---|---|---|---|---|---|
| | Alive at day-90 *n* = 39 | Deceased at day-90 *n* = 15 | *p* value | Odds ratio | 5% | 95% CI | *p* value |
| Age (years), median [IQR] | 58 [51-67] | 66 [56-68] | 0.203 | | | | |
| Male sex, *n* (%) | 26 (67) | 11 (73) | 0.751 | | | | |
| Obesity, *n* (%) | 8 (21) | 3 (20) | 1 | | | | |
| Diabetes mellitus, *n* (%) | 12 (31) | 3 (20) | 0.515 | | | | |
| Localization: limbs, *n* (%) | 10 (26) | 7 (47) | 0.192 | | | | |
| Localization: pelvis, *n* (%) | 10 (26) | 6 (40) | 0.333 | | | | |
| Localization: cephalic, *n* (%) | 12 (31) | 1 (7) | 0.083 | | | | |
| Localization: trunk, *n* (%) | 8 (21) | 4 (27) | 0.719 | | | | |
| Skin surface (%), median [IQR] | 5 [5–9] | 18 [9-19] | < 0.001 | 1.15 | 1.03 | 1.34 | 0.01 |
| SOFA score on admission, median [IQR] | 4 [1–7] | 8 [3-10] | 0.053 | | | | |
| SAPS-II on admission, median [IQR] | 33 [21-52] | 47 [40-56] | 0.023 | | | | |
| LRINEC score on admission, median [IQR] | 2 [1–5] | 4 [3–6] | 0.096 | | | | |
| Septic shock on admission, *n* (%) | 23 (59) | 12 (80) | 0.208 | | | | |
| Delay of antibiotic initiation (days), median [IQR] | 1 [0–4] | 1 [0–3] | 0.82 | | | | |
| CT characteristics | | | | | | | |
| Gas in the soft tissues | 32 (82) | 15 (100) | 0.171 | | | | |
| Multiple fluid collections | 6 (15) | 8 (53) | 0.012 | | | | |
| Absence or heterogeneity of tissue enhancement | 33 (85) | 15 (100) | 0.17 | | | | |
| Significant inflammatory changes of the fascia and under | 10 (26) | 13 (87) | < 0.001 | 8.09 | 1.5 | 63.5 | 0.015 |

Multivariate analysis was performed with the selection of the best model according to the lower AIC by a stepwise logistic regression

*LRINEC* laboratory risk indicators for necrotizing fasciitis score, *SAPS-II* simplified acute physiology score-II, *SOFA* sequential organ failure assessment

**Abbreviations**
CT: Computed tomography; ICU: Intensive care unit; NSTI: Necrotizing soft-tissue infection.

**Declarations**

**Ethics approval and consent to participate**
This study was declared to the French Data Protection Authority (CNIL: 2096382) and was approved by the French Institutional Review Board (Comité d'Éthique de la Recherche en Anesthésie-Réanimation, IRB Number 00010254-2020-153). Due to the retrospective nature of this study, the need for signed informed consent was waived.

**Consent for publication**
Not applicable.

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