



Epidemiology of upper limb necrotising fasciitis in England: A national study (1998-2018)

Ky-Leigh Ang^{a,b}, Justin Wormald^{a,b,*}, Soma Farag^{a,b},
Michael Ng^b, Jennifer Lane^{b,c}, Dominic Furniss^{a,b}

^a Department of Plastic Surgery, Oxford University Hospitals NHS Foundation Trust, John Radcliffe Hospital, Headley Way, Headington, Oxford, UK

^b Nuffield Department of Orthopaedics, Rheumatology and Musculoskeletal Science (NDORMS), University of Oxford, Oxford, UK

^c Barts Bone and Joint Health, Queen Mary University of London, London, UK

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Summary Background: Necrotising fasciitis (NF) is a surgical emergency characterised by rapidly progressive infection of the subcutaneous tissues and fascial planes, leading to widespread fascial necrosis and systemic toxicity. Although NF can affect any part of the body, the upper limbs are a notable site, accounting for 27% of cases. Antibiotics and surgical debridement form the basis of treatment.

Methodology: We conducted a retrospective study on NF of the upper limb requiring surgical intervention from 1998-2018 using data from Hospital Episode Statistics. Age, sex, deprivation index, length of stay (LOS) and complications were analysed.

Results: We identified 728 patients, comprising 468 males and 260 females, with a mean age of 54.97 years (95% CI: 53.76-56.17 years). The incidence of NF in the upper limb increased from 0.0035 per 100,000 in 1998 to 0.01 per 100,000 in 2018. Lower index of multiple deprivation scores correlated with higher NF prevalence, with 67.32% (n=474) presenting scores between 0 and 5. The average LOS was 27.55 days (95% CI: 25.08-30.02 days). Complications within 30 days of surgery included 8 (1.10%) cases of renal failure, 8 (1.10%) urinary tract infections (UTIs), and 103 (14%) deaths. Meanwhile, 90-day complications included 23 (3.15%) cases of renal failure, 6 (0.82%) pulmonary embolisms, 22 (3.02%) UTI, and 113 (16%) deaths.

Conclusion: This study highlights the impact of upper limb NF and provides crucial insights into its incidence, demographic correlations, and clinical outcomes, which can inform clinical management.

This paper is not based on any previous communication to a society meeting.

* Correspondence to: John Radcliff Hospital, Headley Way, Headington, Oxford OX3 9DU, UK.

E-mail address: justin.wormald@ndorms.ox.ac.uk (J. Wormald).

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Necrotising fasciitis (NF) is a surgical emergency characterised by rapidly progressing infection of the subcutaneous tissues and fascial planes, leading to widespread tissue necrosis and systemic toxicity.^{1,2} NF may present with nonspecific signs and symptoms such as erythema, severe pain, and pyrexia, which then rapidly progress to more critical signs, such as skin necrosis and septic shock. All parts of the body can be affected by NF, but the extremities are the most common sites of infection.³ The lower limbs are affected in approximately two-thirds of all cases, whereas the upper limbs are affected in up to 27%.⁴ Historically, the incidence of NF in the United Kingdom ranges from 4-5.3 cases per 1,000,000 population.⁵ However, there have been no recent studies describing the incidence of NF in the UK.⁶ NF is also associated with high mortality, with rates in the literature ranging from 6% to 76%.⁷

NF can be caused by various aerobic and anaerobic bacterial species, but it is often polymicrobial. The most common isolated pathogens include Group A Streptococcus and *Staphylococcus aureus*. Antibiotics and surgical debridement form the basis of treatment, as this is the most effective method of reducing bacterial load.⁸ Outcomes are generally poor, with significant morbidity and mortality. NF has significant biopsychosocial implications leading to physical disability, with more complex long-term socioeconomic consequences, especially in individuals undergoing amputation.⁹

There is limited data on factors associated with the risk of amputation and death. Existing studies are limited by selection bias, sample size, and confounding factors.^{2,5,10-13} We conducted a national cohort study of prospectively collected routine healthcare data to evaluate the incidence, clinical characteristics, and surgical outcomes of NF affecting the upper extremities.

The overall aim of this study was to identify the incidence, complications, and mortality associated with NF of the upper limb.

Methods

This national cohort study was performed using prospectively collected data from the Health Episode Statistics (HES) Admitted Patient Care (APC) database from 1998 to 2018. HES is a national database that contains details of all admissions to NHS hospitals in England. To identify patients with upper limb NF, the International Classification of Diseases, 10th Revision (ICD-10) was used to identify all NF cases, while the Office of Population Censuses and Surveys of Survival Operations and Procedures, 4th revision (OPCS-4) codes were used to determine the specific anatomical location (Appendix A). There were no exclusion criteria for this study. Patient demographics (sex and age), length of hospital stay, Charlson comorbidity index, 30-day complication rate, 90-day complication rate, and mortality were analysed.

All data used were extracted from the HES database, which collects data from routine aspects of NHS secondary

care (approval number: DARS-NIC-295342-W3Z6L-v0.5). Consent is not required for collection of this data by NHS Digital, and it may be used, on application, in a fully anonymised format in accordance with the relevant section of the Data Protection Act 2006, Health Service Regulations 2002, the National Health Service Act 2006 and the Care Act 2004. The raw dataset received from NHS Digital was inspected, manipulated and cleaned to allow subsequent statistical analysis. Data analysis was performed using Python.

Results

A total of 728 patients were identified, including 468 (64%) men and 260 (36%) women (Table 1). The mean age of the patient cohort was 55 years (95% CI: 54-56 years) (Figure 1).

The highest proportion of cases (19%) were documented among individuals residing in the most deprived 10% of the population, followed by 15% in the 10%–20% bracket of deprivation, 14% in the subsequent decile, and 11% in the 30%–40% decile of deprivation (Figure 2). The incidence of upper extremity NF increased from 0.004 per 10,000 persons in 1998 to 0.01 per 10,000 persons in 2013 (250% increase). The incidence remained relatively stable from 2013-2018 (Figure 3).

The average length of inpatient stay of individuals diagnosed with NF of the upper limb was 28 days (95% CI: 25-30 days). Complications at 30 days included acute renal failure (1.10%, n=8) and UTI (1.10%, n=8). Meanwhile, the 30-day mortality rate was 14% (n=103). Ninety-day complications included acute renal failure (3.15%, n=23), pulmonary embolism (0.82%, n=6), and urinary tract infection (3.02%, n=22). The mortality rate at 90 days was 16% (n=113).

Discussion

NF is a rare and life-threatening surgical emergency. It most commonly occurs in the extremities, but other parts of the body, including the perineum, trunk, and the head and neck region, can also be affected.^{10,14} Early diagnosis and prompt surgical intervention are essential to improve the chances of survival. To our knowledge, this is one of the largest epidemiological studies of NF of the upper limb. We provide new information on the incidence, clinical features, and outcomes of upper limb NF in England over a 20-year period.

Overall, we found that the incidence of upper limb NF in England has more than doubled between 1998 and 2018. This finding reflects other studies that have suggested an increase in the overall incidence of NF.¹⁵ One possible cause is an increase in predisposing factors, such as an aging population, and comorbidities, such as diabetes mellitus.¹⁶ However, the increase could also potentially be attributed to better reporting systems or changes in diagnostic criteria or underlying

Table 1 Demographic data of upper limb necrotising fasciitis in England.

	Number (%)
Sex	
Male	468 (64)
Female	260 (36)
Age, years	
20–29	15 (2)
30–39	86 (13)
40–49	129 (20)
50–59	164 (25)
60–59	145 (22)
70–79	89 (14)
80–89	18 (3)
Missing	82
Ethnicity	
White	572 (80)
Black	22 (3)
Indian	9 (1)
Unknown + other	108 (15)
Missing	17
Laterality	
Right	262 (45)
Left	252 (43)
Bilateral	6 (1)
Ambiguous	60 (10)
Missing	148
Index of multiple deprivation	
Most deprived 10%	133 (19)
More deprived 10–20%	104 (15)
More deprived 20–30%	96 (14)
More deprived 30–40%	78 (11)
Less deprived 40–50%	63 (9)
Less deprived 30–40%	58 (8)
More deprived 40–50%	58 (8)
Least deprived 10%	46 (7)
Less deprived 10–20%	35 (5)
Less deprived 20–30%	33 (5)
Missing	44
Charlson comorbidity index	
0	296 (41)
1	162 (22)
2	136 (19)
3	86 (12)
4	26 (4)
5	19 (3)
Missing	3

risk factors within the population, which could explain the plateau in incidence between 2013 and 2018.

The demographic profile of patients with NF in this study was consistent with that of previous studies,^{2,4,5,17,18} demonstrating a predominance in men compared with women and in individuals from a more deprived socioeconomic background.⁶ Similarly, the mean age observed in our study mirrors that of other studies investigating NF in the upper limb.^{4,19} However, contrary to the prevailing notion that NF primarily inflicts individuals with pre-existing medical conditions,^{4,10,14,17,18,20} we observed that a substantial proportion of patients within our cohort had a Charlson comorbidity index of 1, indicating minimal comorbidities.

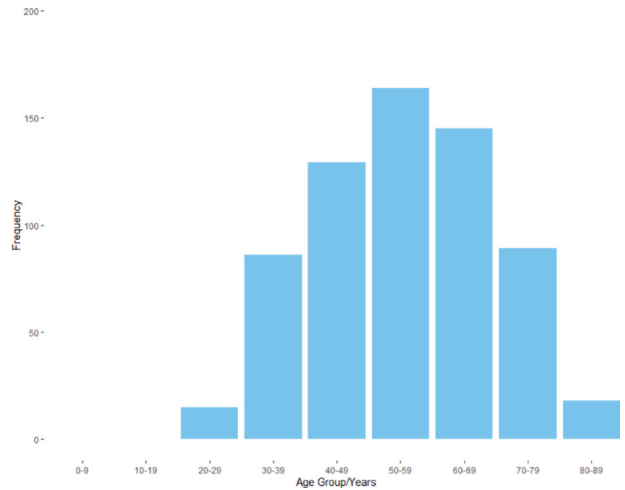


Figure 1 Distribution of upper limb necrotising fasciitis by age.

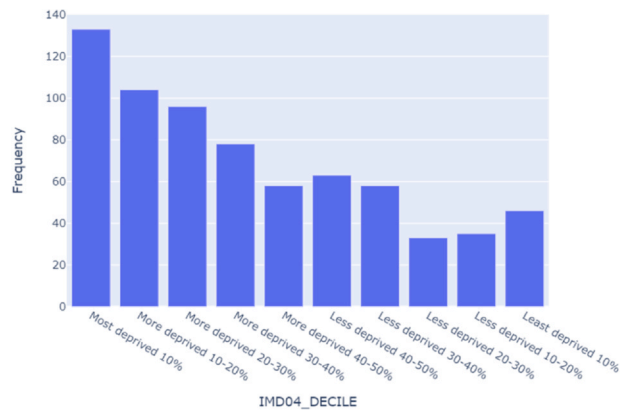


Figure 2 Incidence of necrotising fasciitis by index of multiple deprivation.

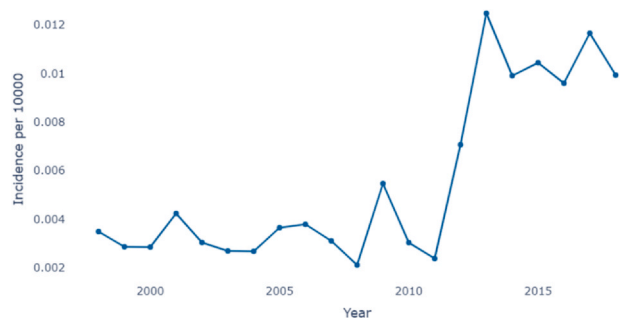


Figure 3 Incidence of necrotising fasciitis of the upper limb over time.

This finding underscores the importance of recognising NF as a potential diagnosis even among individuals without significant comorbidities. This observation may be influenced by intravenous drug use among fitter patients, which was not accounted for in this study.

The overall mortality rate for NF in the literature ranges from 6%–76%.⁷ We found a 16% mortality rate for NF of the upper extremity in England. This is comparable with a small study of NF of the upper limb in Japan (16%¹⁷) but higher than rates reported in the United States (11%^{21,22} and 9%²³).

Table 2 Death rates of upper limb necrotising fasciitis reported in different studies.

Title	Author/year	Study type/country	Total upper limb NF cases	Percentage mortality (n)
Necrotizing fasciitis of the extremities: a prospective study	Espandar et al. ² /2011	Prospective cohort/Iran	9	22.2% (2)
Necrotizing fasciitis of the upper extremity - a review	Ditsios et al. ⁴ /2022	Review/Greece	340	15.9% (54)
Necrotising soft-tissue infections of the upper limb: risk factors for amputation and death	Uehara et al. ¹⁷ /2014	Retrospective cross-sectional/Japan	116	15.5% (18)
Factors affecting the mortality of necrotizing fasciitis involving the upper extremities	Cheng et al. ²⁰ /2008	Retrospective cross-sectional/Taiwan	14	35.7% (5)
Factors associated with mortality and amputation caused by necrotizing soft tissue infections of the upper extremity: a retrospective cohort study	Nawijn et al. ²¹ /2019	Retrospective cross-sectional/United States	122	10.7% (13)
Physiology, not modern operative approach, predicts mortality in extremity necrotizing soft tissue infections at a high-volume centre	Lauerman et al. ²² /2018	Retrospective cross-sectional/United States	27	11.1% (3)
Necrotizing fasciitis of the upper extremity	Schechter et al. ²³ /1982	Retrospective cross-sectional/United States	33	9.1% (3)
Necrotising fasciitis of the extremities: implementation of new management technologies	Corona et al. ²⁴ /2016	Retrospective cross-sectional/Spain	7	28.6% (2)
Factors affecting mortality in Hong Kong patients with upper limb necrotising fasciitis	Yeung et al. ²⁵ /2011	Retrospective cross-sectional/Hong Kong	29	27.6% (8)
Necrotising fasciitis of a limb	Tang et al. ²⁶ /2001	Retrospective cross-sectional/Hong Kong	12	33.3% (4)

However, it is significantly lower than mortality rates described in many other studies investigating NF in the upper limb^{2,20,24-26} that showed mortality rates ranging up to 36% (Table 2). The difference in mortality rates may be due to several factors. None of the studies were based in the United Kingdom, and healthcare systems vary considerably between countries, resulting in differences in access to medical care, treatment protocols, and resources. Moreover, many previous studies investigating upper limb NF were small, with participant numbers ranging from 7-340. In addition, it is suggested that mortality in NF of the extremity is lower than NF of other anatomical regions because they are less widespread at initial presentation.^{15,21}

Despite advances in medical and surgical interventions, the substantial mortality rates at both 30 and 90 days highlight the need for improved strategies for early recognition and aggressive treatment^{2,27} of NF of the upper extremity. Furthermore, observed complications and long hospital stays emphasise the importance of vigilant monitoring to prevent complications and mortality. The analysis of data from HES allows us to study an unselected population of upper limb NF across England, making the results particularly relevant and representative of the general population. However, HES uses routinely collected data that is not created specifically for research. The accuracy of the data is determined by physicians, who report their findings

in patients' notes, and clinical coders. Hence, the data are subject to missing data and misclassification bias.

Additionally, patients who died before presenting to hospital are not included in HES data and hence, mortality and incidence may be underestimated. Furthermore, to identify individuals with NF of the upper limb, OPSC-4 codes were used because the ICD-10 code alone cannot identify the anatomical location of NF. This means that patients who died before surgery were not included in the study. However, surgery is the mainstay of treatment of NF, and most patients who present to the hospital are likely to undergo surgical debridement. Finally, intravenous drug use remains a large contributor to NF.³ However, data on intravenous drug use were not included in this study, which limits our ability to assess its impact on the outcomes observed.

Conclusion

This study contributes to our understanding of the epidemiology and clinical outcomes of NF affecting the upper extremities in England. Our findings show an increasing incidence of NF of the upper limb across England, which has plateaued in the last 5 years. Despite advancements in

critical care management, the high mortality rates highlight the continued need for vigilance and optimisation of treatment protocols.

Ethics approval

Studies using non-identifiable records from HES are exempt from Research Ethics Committee approval. This research was approved by an NHS Data Access Advisory Group based on an NHS Digital Data Sharing Agreement (DARS-NIC-295342-W3Z6L).

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Conflict of interest

None.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.bjps.2025.03.018](https://doi.org/10.1016/j.bjps.2025.03.018).

References

1. Wilson B. Necrotizing fasciitis. *Am Surg* 1952;18:416–31.
2. Espandar R, Sibdari SY, Rafiee E, Yazdani S. Necrotizing fasciitis of the extremities: a prospective study. *Strategies Trauma Limb Reconstr* 2011;6:121–5.
3. Puvanendran R, Huey JC, Pasupathy S. Necrotizing fasciitis. *Can Fam Physician* 2009;55:981–7.
4. Ditsios K, Chitas K, Christidis P, et al. Necrotizing fasciitis of the upper extremity - a review. *Orthop Rev (Pavia)* 2022;14:35320.
5. Angoules AG, Kontakis G, Drakoulakis E, et al. Necrotising fasciitis of upper and lower limb: a systematic review. *Injury* 2007;38:S19–26.
6. Bodansky DM, Begaj I, Evison F, et al. A 16-year longitudinal cohort study of incidence and bacteriology of necrotising fasciitis in England. *World J Surg* 2020;44:2580–91.
7. Hasham S, Matteucci P, Stanley PR, Hart NB. Necrotising fasciitis. *BMJ* 2005;330:830–3.
8. Bellapianta JM, Ljungquist K, Tobin E, Uhl R. Necrotizing fasciitis. *J Am Acad Orthop Surg* 2009;17:174–82.
9. Widjaja AB, Tran A, Cleland H, Leung M, Millar I. The hospital costs of treating necrotizing fasciitis. *ANZ J Surg* 2005;75:1059–64.
10. Anaya DA, McMahon K, Nathens AB, et al. Predictors of mortality and limb loss in necrotizing soft tissue infections. *Arch Surg* 2005;140:151–7. discussion 58.
11. Golger A, Ching S, Goldsmith CH, Pennie RA, Bain JR. Mortality in patients with necrotizing fasciitis. *Plast Reconstr Surg* 2007;119:1803–7.
12. Khamnuan P, Chongruksut W, Jearwattananok K, Patumanond J, Tantraworasin A. Necrotizing fasciitis: epidemiology and clinical predictors for amputation. *Int J Gen Med* 2015;8:195–202.
13. Ogilvie CM, Miclau T. Necrotizing soft tissue infections of the extremities and back. *Clin Orthop Relat Res* 2006;447:179–86.
14. Lemsanni M, Najeb Y, Zoukal S, et al. Necrotizing fasciitis of the upper extremity: a retrospective analysis of 19 cases. *Hand Surg Rehabil* 2021;40:505–12.
15. Trent JT, Kirsner RS. Diagnosing necrotizing fasciitis. *Adv Skin Wound Care* 2002;15:135–8.
16. Nazerani S, Maghari A, Kalantar Motamedi MH, et al. Necrotizing fasciitis of the upper extremity, case report and review of the literature. *Trauma Mon* 2012;17:309–12.
17. Uehara K, Yasunaga H, Morizaki Y, et al. Necrotising soft-tissue infections of the upper limb: risk factors for amputation and death. *Bone Joint J* 2014;96-b:1530–4.
18. Nagata K, Shinozaki T, Yamada K, et al. Necrotizing fasciitis of the extremities in high and low Charlson comorbidity index: a multi-center retrospective cohort study. *J Orthop Sci* 2022;27:1056–9.
19. La Padula S, Pensato R, Zaffiro A, et al. Necrotizing fasciitis of the upper limb: optimizing management to reduce complications. *J Clin Med* 2022;11:2182.
20. Cheng NC, Su YM, Kuo YS, Tai HC, Tang YB. Factors affecting the mortality of necrotizing fasciitis involving the upper extremities. *Surg Today* 2008;38:1108–13.
21. Nawijn F, Verhiel S, Lunn KN, et al. Factors associated with mortality and amputation caused by necrotizing soft tissue infections of the upper extremity: a retrospective cohort study. *World J Surg* 2020;44:730–40.
22. Lauerma MH, Scalea TM, Eglseider WA, et al. Physiology, not modern operative approach, predicts mortality in extremity necrotizing soft tissue infections at a high-volume center. *Surgery* 2018;164:105–9.
23. Schechter W, Meyer A, Schechter G, et al. Necrotizing fasciitis of the upper extremity. *J Hand Surg Am* 1982;7:15–20.
24. Corona PS, Erimeiku F, Reverté-Vinaixa MM, et al. Necrotising fasciitis of the extremities: implementation of new management technologies. *Injury* 2016;47(3):S66–71.
25. Yeung YK, Ho ST, Yen CH, et al. Factors affecting mortality in Hong Kong patients with upper limb necrotising fasciitis. *Hong Kong Med J* 2011;17:96–104.
26. Tang WM, Ho PL, Fung KK, Yuen KY, Leong JC. Necrotising fasciitis of a limb. *J Bone Joint Surg Br* 2001;83:709–14.
27. McHenry CR, Piotrowski JJ, Petrinic D, Malangoni MA. Determinants of mortality for necrotizing soft-tissue infections. *Ann Surg* 1995;221:558–63. discussion 63-5.