Medicina Intensiva xxx (xxxx) 502395

medicina intensiva

http://www.medintensiva.org/en/

ORIGINAL ARTICLE

Critical care during natural disasters: ICU insights from Valencia's October 2024 floods

Elena Sancho[a,b,*], **Rubén Martín**[a], **Beatriz Abejaro**[c], **Rafael Zaragoza**[d], **Carmen Carrasco**[e], **Paula Ramírez**[a]

[a] *Intensive Care Unit, Hospital Universitari i Politècnic La Fe, Valencia, Spain*
[b] *Anaesthesiology and intensive care, Department of Surgical sciences, Uppsala University, Uppsala, Sweden*
[c] *Anaesthesia and Postoperative Care Unit, Hospital Universitari i Politècnic La Fe, Valencia, Spain*
[d] *Intensive Care Unit, Hospital Doctor Peset, Valencia, Spain*
[e] *Intensive Care Unit, Hospital Manises, Manises, Valencia, Spain*

Received 8 September 2025; accepted 14 December 2025

KEYWORDS
Natural disasters;
Floods;
Chronic disease;
Emergency medical services;
Critical care;
Continuity of patient care;
Health services accessibility

Abstract
Objective: To assess the impact of the October 29, 2024 DANA-related floods on Intensive Care Unit (ICU) operations and patient care in the Valencia region. This study aims to characterize the clinical profiles, logistical pathways, and outcomes of patients requiring intensive care during the month following the flood event
Design: Multicenter prospective observational study.
Setting: Nine intensive care units in the Valencia region from October 29 to November 30, 2024.
Patients or participants: All ICU admissions prospectively identified as being influenced by the DANA event using a predefined checklist
Interventions: None.
Main variables of interest: Demographic and clinical data, ICU management, length of stay, and outcomes.
Results: Twenty-six patients were included and classified as direct (15.4%) or indirect victims (84.6%). Median age was 60 years, and most had chronic comorbidities. ICU admission causes included acute cardiac events, trauma, infections, and worsening of chronic conditions due to treatment disruptions. Delays in diagnosis or transportation were reported in over 50% of cases. The median ICU stay was 3 days, with 15.4% mortality rate. ICU capacity remained sufficient throughout the event, and no surge-capacity plans were activated.

DOI of original article: https://doi.org/10.1016/j.medin.2026.502395
* Corresponding author.
E-mail address: elena.sancho.ferrando@akademiska.se (E. Sancho).

https://doi.org/10.1016/j.medine.2026.502395

Please cite this article as: E. Sancho, R. Martín, B. Abejaro et al., Critical care during natural disasters: ICU insights from Valencia's October 2024 floods, Medicina Intensiva, https://doi.org/10.1016/j.medine.2026.502395

Conclusion: The ICU burden during the DANA event was predominantly due to indirect health effects, especially in vulnerable populations with chronic diseases. Disaster preparedness strategies must prioritize continuity of care and address logistical barriers to reduce avoidable critical care admissions and mortality.

PALABRAS CLAVE
Desastres naturales;
Inundaciones;
Enfermedad crónica;
Servicios médicos de urgencia;
Cuidados críticos;
Continuidad de la atención al paciente;
Accesibilidad a los servicios de salud

Cuidados Críticos durante desastres naturales: qué ocurrió en las UCI valencianas durante las inundaciones de octubre de 2024

Resumen
Objetivo: Evaluar el impacto de las inundaciones relacionadas con la DANA del 29 de octubre de 2024 en el funcionamiento de las Unidades de Cuidados Intensivos (UCI) y en la atención a los pacientes en la región de Valencia. Este estudio tiene como objetivo caracterizar los perfiles clínicos, las rutas logísticas y los desenlaces de los pacientes que requirieron cuidados intensivos durante el mes posterior a la catástrofe.
Diseño: Observacional prospectivo multicéntrico.
Ámbito: Nueve UCI de la región de Valencia, del 29 de octubre al 30 de noviembre de 2024.
Pacientes o participantes: Todos los ingresos en UCI identificados prospectivamente como vinculados a las inundaciones según los criterios definidos.
Intervenciones: Ninguna.
Variables de interés principales: Datos demográficos y clínicos, manejo en UCI, estancia y resultados.
Resultados: Se incluyeron 26 pacientes, clasificados como víctimas directas (15,4%) o indirectas (84,6%). La mediana de edad fue 60 años y la mayoría tenía comorbilidades crónicas. Los diagnósticos incluyeron eventos cardiovasculares, traumatismos, infecciones y descompensación de enfermedades crónicas por interrupción del tratamiento. Más del 50% presentó retrasos en diagnóstico o transporte. La mediana de estancia en UCI fue 3 días, con una mortalidad del 15,4%. La capacidad de las UCI fue suficiente sin necesidad de activación de planes de contingencia.
Conclusión: La necesidad de UCI tras la DANA se debió principalmente a efectos indirectos en poblaciones vulnerables con enfermedades crónicas. La preparación ante desastres debe priorizar continuidad asistencial y superar barreras logísticas para reducir ingresos críticos y mortalidad evitables.

Introduction

The Mediterranean region is highly vulnerable to extreme meteorological events, particularly Cut-off Low phenomenon (DANA, by its Spanish acronym *Depresión Aislada en Niveles Altos*), which often results in torrential rainfall and significant flooding.[1,2] On October 29, 2024, 75 municipalities south of Valencia experienced a catastrophic DANA event, resulting in widespread flooding, severe infrastructure disruption, and prolonged interruption of essential services. Although large-scale rescue operations were deployed—thanks to the swift actions of neighbours and emergency services—the medical and public health consequences persisted and worsened in the days and weeks that followed. Official reports confirmed 230 fatalities with two remains yet to be recovered at the time of this publication.[3] However, the specific impact on critical care demand and ICU resource utilization remains insufficiently characterized.[4]

Flood disasters are known to produce a dual health burden including direct and indirect victims.[4–7] Direct victims include individuals who sustain injuries such as near-drowning, trauma, or lacerations. Indirect victims comprise patients whose acute or chronic conditions worsened due to delays, isolation, treatment disruption, or disaster-related infections. It has been described before that even long term all-cause mortality increases in populations exposed to floods.[8] Previous studies show that flooding not only increases immediate healthcare demands but also creates long-term health risks, including higher mortality rates and prolonged systemic challenges for healthcare systems.[8–11]

While much of the immediate disaster response focuses on emergency rescues and initial triage, the full spectrum of healthcare demands becomes apparent only in the aftermath of such events.[4,9,12,13] This study provides a comprehensive evaluation of ICU admissions affected by the DANA event, characterizing epidemiology, logistical barriers, and clinical outcomes during the first month.

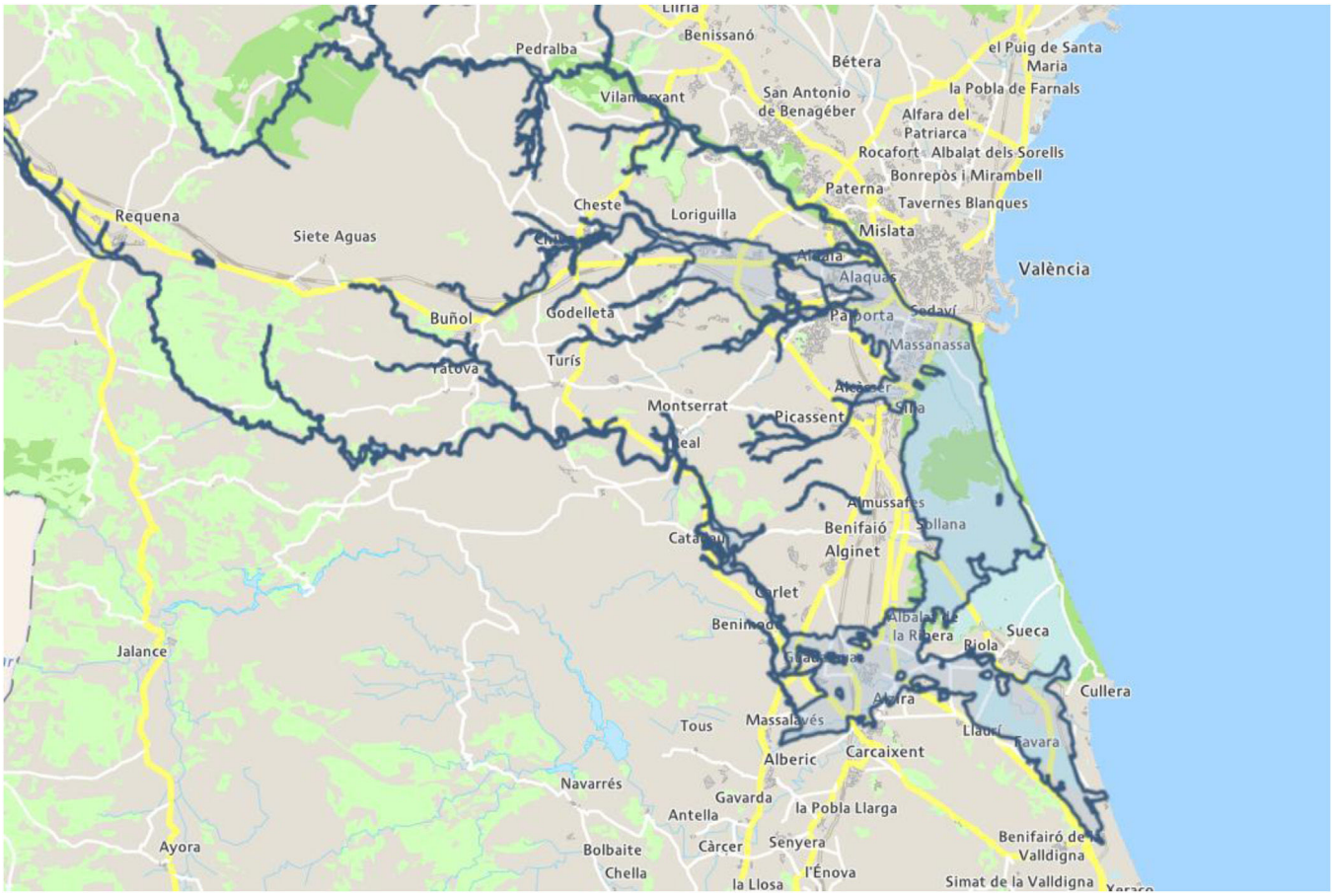

Figure 1 Flood-affected areas in the Valencia region following the October 2024 DANA event.
Base map obtained from the Visor Cartogràfic de la Generalitat Valenciana (Institut Cartogràfic Valencià, ICV), publicly accessible at the ICV web platform. © Institut Cartogràfic Valencià (Generalitat Valenciana).

Methods

This was a prospective, multicenter observational study conducted across nine ICUs in Valencia and the surrounding areas. We included all patients admitted to the ICU between October 29 and November 30, 2024, whose admission was prospectively identified as DANA-related.

Seventy-five municipalities were affected, encompassing over 570 km^2 of flood-affected terrain (Fig. 1). Authorities designated 34 municipalities and several smaller districts as ''ground zero'' or the ''most severely affected'' areas, most of which fell within the healthcare catchment area of Hospital Universitari i Politècnic La Fe (Fig. 2).[14] Nevertheless, resources were mobilized across the entire Valencian region, and data were collected from all patients, regardless of whether the planned out-of-hospital referral pathways had been followed.

To support this assessment, we developed a standardized checklist to be completed at admission, in which the attending physician determined whether the catastrophic event had affected any aspect of the patient's healthcare trajectory. When such an impact was identified, the patient was assigned a secondary diagnosis indicating DANA-related involvement. Patients were categorized into two groups based on their clinical presentations: direct victims—individuals who sustained direct injuries such as near-drowning, trauma, or lacerations—and indirect victims, defined as those patients affected by barriers to medical access, delays in diagnosis or treatment, and disruptions in the continuity of chronic care due to the isolation of affected areas, access to potable water, or infectious diseases directly related to the catastrophe. Delay in diagnosis or treatment was defined as longer-than-expected time interval between the onset of a patient's symptoms or first medical contact and a key clinical action, for example >60 min in case of myocardial infarction.[15]

Collected data included demographic characteristics, chronic comorbidities, prehospital care details, timelines of hospital admission, diagnosis, level of care required and outcomes. Qualitative variables are reported as percentages, whereas quantitative variables are expressed as medians with their respective ranges or interquartile ranges. Additionally, information regarding prehospital interventions, delays in treatment initiation, and transportation methods was recorded to assess the impact of logistical challenges on patient outcomes.

Due to the lack of digital reports and the presence of too many different emergency teams in situ, prehospital data were heterogeneous and often incomplete; therefore, infor-

Figure 2 Location of surveyed hospitals.[14]
Base map obtained from the Visor Cartogràfic de la Generalitat Valenciana (Institut Cartogràfic Valencià, ICV), publicly accessible at the ICV web platform. © Institut Cartogràfic Valencià (Generalitat Valenciana). Modified for scientific illustration
Legend: Hospital de Sagunto; Hospital Arnau de Vilanova; Hospital Clínico; Hospital de Requena; Hospital de La Ribera; Hospital Lluís Alcanyis; Hospital Manises*; Hospital Doctor Peset*; Hospital La Fe*
*Hospitals with ICU admissions related with the floods.

mation was reconstructed through structured interviews with patients and families. After the initial classification by the attending clinician, a second revision was performed by the authors of the article.

The study was approved by the ethics committee of Hospital Universitari i Politècnic La Fe with code 2025-0990-1. The study followed STROBE guidelines for observational research.

Table 1 Patients demographic data.

Variable	Value
N	26
Hospitals receiving patients	3 (H. La Fe: 18; H. Peset: 7; H. Manises: 1)
Female (%)	9 (34.6)
Median age (IQR)	60 years (52–65.8 years)
Patients with chronic conditions (%)	22 (84.6)
Patients with regular medication (%)	19 (73)
Chronic hypertension (%)	9 (34.6)
Dyslipemia (%)	11 (42.3)
Type 1 diabetes (%)	2 (7.7)
Type 2 diabetes (%)	7 (26.9)
Respiratory condition (COPD, Asthma, OSAS) (%)	6 (23.1)

Legend: COPD Chronic Obstructive Pulmonary Disease; OSAS Obstructive Sleep Apnea Syndrome.

Results

A total of 26 patients were included in the analysis from the three hospitals that received patients related to the catastrophe (Hospital La Fe: 18, Hospital Peset: 7, Hospital Manises: 1) out of the nine hospitals surveyed. The other 6 hospitals did not admit any patient matching the inclusion criteria. The median age of the patients was 60 years (IQR 52–65,8 years). Most of the patients (22) had chronic illnesses, and only 7 were not on any regular medication prior to admission (Table 1).

The majority of ICU admissions (61.5% - 16 of 26) occurred between 30 October and 2 November 2024, with all patients being admitted directly to the ICU on the day of their hospital arrival (Fig. 3). Regarding transport, 50% of the patients were transferred via medicalized ambulance (13 of 26), 30.8% arrived by their own means (8 of 26), 15.4% were transported by security forces (4 of 26), and the remaining patient (1 of 26) were conveyed in vehicles operated by volunteers.

Based on the clinical presentation, only 4 (15.4%) of the cases were classified as direct victims, 84.6% as indirect victims. Prehospital care was administered to 14 patients (53.8%); however, delays were evident in 53.8% of the cases (14), with 46.2% (12) experiencing delays in receiving the appropriate treatment and 38.5% (10) facing delays in hospital transfer (Table 2).

Regarding clinical diagnoses, there were 3 trauma patients and 1 non-fatal drowning among the four direct victims. The diagnoses for the indirect victims were diverse: 7 acute cardiac events (comprising 6 ST-segment elevation myocardial infarctions, 1 non-ST elevation myocardial infarction), 5 severe infections related to the flood, 2 polytrauma (suicide attempt and accidental fall), 2 diabetic ketoacidosis, 1 bilateral pulmonary embolism, 1 ethanol intoxication, 1 epilepsy, 1 acute pulmonary edema,1 pneumonia and 1 COPD exacerbation, observed among indirect victims. Three of the described patients were admitted to the ICU due to decompensations resulting from the inaccessibility of their chronic treatments (e.g. oxygen, insulin). Infectious etiologies included two cases of leptospirosis, two of salmonellosis, and one case of necrotizing fasciitis (Table 2). Median ICU length of stay was 3 days (IQR 2–4,75 days). Median hospital stay was 7.5 days (IQR 5–14,5 days). The overall mortality rate was 15.4% (n = 4), with 90% of the survivors discharged home. Two of the deceased patients were diagnosed with brain death (one due to a failed suicide attempt by defenestration and the other due to brain edema from diabetic ketoacidosis). The third patient died from a massive pulmonary embolism, and the fourth from ventilator-associated pneumonia following admission for myocardial infarction and cardiac arrest (Table 2).

One patient was admitted during the first hours after the floods, a STEMI case who experienced a major delay in transfer due to transport unavailability, resulting in ventricular tachycardia necessitating multiple defibrillations and onsite thrombolysis. However, most of the admissions occurred on days 2–4 (Fig. 3). During the first 36 h, the main problems were trauma-related cases and delays in initial care and transportation. On days 3 and 4, in addition to delays, admissions were also influenced by the lack of access to chronic care. For example, a COPD exacerbation aggravated by the absence of electricity, preventing the use of home oxygen and positive-pressure devices, or a case of diabetic ketoacidosis due to lack of access to oral antidiabetics and insulin. Infectious complications began to appear from day 11 onwards (Table 2).

None of the ICUs that admitted patients during the DANA event were required to activate contingency or surge-capacity plans. Patient arrivals occurred in a staggered manner over several days, allowing teams to absorb the increased demand without operational stress. At no point was the structural capacity of the units or the functional capacity of the critical care teams exceeded.

Discussion

To our knowledge this is the first multicentric study evaluating the impact on critical care units of a natural disaster in Spain. This study provides valuable insights into the critical care challenges following the DANA event in Valencia and aligns with other studies that demonstrate the relationship between climate change, urban development and flood risk, highlighting the importance of early warning systems to minimize casualties.[16–18]

It is noteworthy that all ICU admissions affected by the DANA recorded in this study occurred in only 3 of the 9 participating hospitals. This is most likely attributable to the magnitude of the catastrophe, which affected a large part of the Valencian territory and severely damaged transportation routes and systems, the absence of established protocols and limited resources during the initial days resulted in a lack of a coordinated emergency response.[19] As a consequence, patients were often transferred to the nearest hospital rather than following a structured referral pathway. This underscores the need for predefined disaster preparedness plans and resilient healthcare logistics to ensure that patient transfers and continuity of care are not left to improvisation during large-scale emergencies.[20]

Table 2 Diagnosis.

Type of victim	Diagnosis	DANA factors	Required treatment	ICU Stay (days)	Hospital stay (days)	Mortality
Indirect	STEMI	1, 2	Coronary angiography	1	6	No
Indirect	STEMI	3	Coronary angiography	3	6	No
Direct	Polytrauma	2	Surgical repair of bone fractures	5	19	No
Direct	Polytrauma	2, 4	Surgical repair of bone fractures	8	12	No
Indirect	Polytrauma *	4	Monitoring	2	6	No
Indirect	STEMI	1, 2	Coronary angiography	1	5	No
Indirect	COPD exacerbation	1, 4, 5	NIMV, bronchodilators, corticosteroids, ketamine, imipenem	4	20	No
Indirect	Ethanol intoxication	1, 2, 4	OTI	2	3	No
Indirect	Bilateral pulmonary embolism	1, 2, 4, 6, 7	Vasoactive drugs, OTI, intra-arterial thrombolysis, EKOS, advanced CPR	2	2	Yes
Indirect	Diabetic ketoacidosis	5, 6	IV insulin infusion	1	3	No
Indirect	STEMI	3	Cardiac catheterization	3	7	No
Indirect	Polytrauma†	6	OTI, surgical interventions	31	31	Yes
Direct	Traumatic vertebral artery dissection	1, 4, 6, 7	Cervical-cerebral angiography, dual antiplatelet therapy	7	13	No
Indirect	Epileptic seizure	1, 2, 4	OTI	1	3	No
Indirect	Cardiac arrest due to STEMI	1, 2,4, 7	OTI, coronary angiography	4	12	No
Indirect	Leptospirosis	8	Vasoactive drugs	7	10	No
Indirect	Cardiac arrest due to STEMI	1, 7, 10	OTI, coronary angiography	5	5	Yes
Indirect	Cardiac arrest due to diabetic ketoacidosis	1, 2, 4, 5, 6	Vasoactive drugs, OTI	1	1	Yes
Direct	Non-fatal drowning	1, 2, 4	NIMV	3	29	No
Indirect	NSTEMI	4	Cardiac catheterization	2	4	No
Indirect	Acute pulmonary edema	4	NIMV	2	7	No
Indirect	Leptospirosis	7	Monitoring	2	8	No
Indirect	Salmonellosis	6, 9	Fluid therapy, monitoring	3	16	No
Indirect	Salmonellosis	6, 9	Fluid therapy, monitoring, NIV	3	13	No
Indirect	Legionella pneumonia	1, 4	Vasoactive drugs, OTI	16	24	No
Indirect	Necrotizing fasciitis	8	Vasoactive drugs	4	15	No

Legend: * Suicide attempt triggered by stress resulting from the catastrophe; † Accidental fall due to access difficulties and ground conditions; 1. Delayed definitive treatment; 2. Delayed transport; 3. Inability to return to referral hospital; 4. Delayed initial care; 5. No access to chronic medication; 6. Isolation; 7. Delayed diagnosis; 8. Infection acquired through contaminated wet soil; 9. No access to potable water; 10. Lack of phone signal to activate STEMI code; STEMI ST-segment Elevation Myocardial Infarction; COPD Chronic Obstructive Pulmonary Disease; BiPAP Bilevel Positive Airway Pressure; OTI Orotracheal Intubation; CPR Cardiopulmonary Resuscitation; EKOS Ultrasound-Assisted Catheter-Directed Thrombolysis System; NSTEMI Non-ST segment Elevation Acute Coronary Syndrome; NIMV Other Non-invasive Mechanical Ventilation.

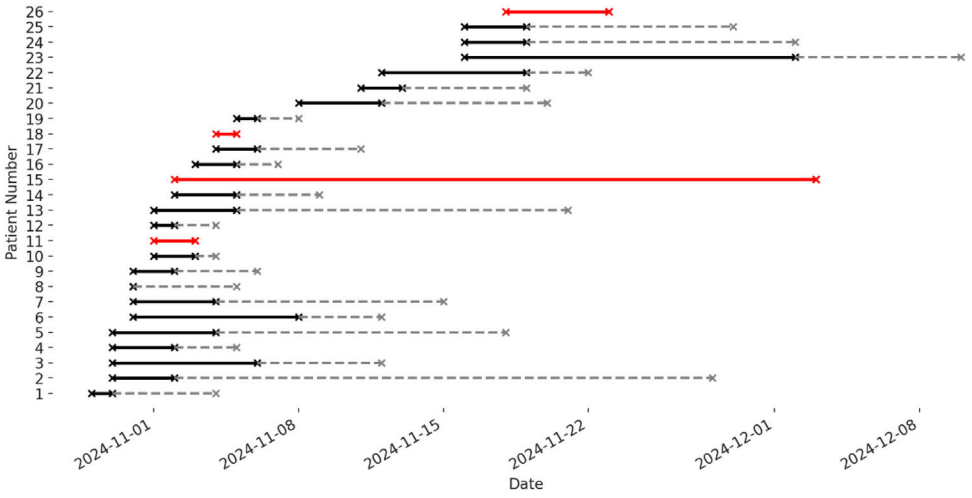

Figure 3 ICU admission timeline, ICU length of stay and total hospitalization duration.
Timeline of ICU stay (solid line) and total hospitalization (dashed line) for all admitted patients, ordered by admission date. Red lines denote patients who died during hospitalization.

In previous global examples, such as the 1997 Czech Republic floods and the 2012 Beijing floods, healthcare systems faced significant strain, particularly in ICUs, due to the compounded effects of direct injuries and indirect health crises.[6,21]

The magnitude of the tragedy resulted in the vast majority of deaths occurring within the first moments of the event, consistent with the first peak of the classic trimodal distribution of trauma-related mortality.[22,23] Forensic reports suggested that the typical second and third peaks – those resulting from potentially survivable injuries and later complications – were less apparent than in other large-scale events.[24,25]

Our findings highlight a distinct dichotomy between direct victims, who sustained direct injuries from the disaster, and indirect victims, whose pre-existing or chronic conditions were exacerbated by delays in care and logistical challenges.

The predominance of indirect victims underscores the substantial impact of flooding on health also described by Paterson et al. in a review in 2018.[10] Disruptions in medical access, delays in treatment, and the inability to maintain continuity of chronic care were significant factors contributing to ICU admissions. These findings echo the conclusions of Milojevic et al.[4] and Alderman et al.,[9] who demonstrated that the indirect health effects of floods can have long-term repercussions on patient outcomes.

Logistical challenges emerged as a critical determinant of patient prognosis. The delays in prehospital care and transport observed in our study are consistent with reports from other flood events, where similar challenges were associated with increased morbidity and even mortality.[6,8]

In our study, a clear example of how the floods disrupted healthcare logistics is the considerable number of ischemic heart disease cases that were affected by the DANA. Although this study does not include a control cohort to directly compare the incidence of ischemic events with a similar period unaffected by flooding, clinical experience from participating centers does not suggest that the disaster itself increased the number of such events. Rather, the impact was predominantly logistical: patient care was clearly compromised by the dependence on transportation for transfers from local healthcare centers to the referral hospital for catheterization adding in one case the need of thrombolysis despite being just 3 km away from a catheterization laboratory. This highlights how natural disasters may not necessarily increase the intrinsic incidence of acute ischemic events, but can critically affect the timeliness and quality of care delivery, with potential consequences for patient outcomes.[26–28]

Despite the magnitude of the catastrophe, it is striking that no ICU admissions were recorded during the first 24 h from any of the 75 flood-affected municipalities, encompassing approximately 1.8 million inhabitants. Such an absence of critically ill patients reaching tertiary care raises important questions about what occurred during the period of maximal isolation. This pattern raises concern that some acute emergencies may not have reached the hospital system during the period of maximal isolation and were therefore not formally classified as DANA-related if they resulted in death. This gap between expected and observed critical-care demand underscores the possibility of unrecognized indirect mortality and substantial unmet health needs, and highlights the need for improved systems capable of maintaining essential medical access during large-scale environmental disasters.

Furthermore, the identification of severe infectious complications and the exacerbation of chronic conditions emphasize the need for robust emergency response systems that integrate both immediate rescue efforts and strategies for maintaining public health standards and continuity of care.[7,10,29] It is particularly alarming to find cases of diabetic ketoacidosis in ICU due to lack of insulin and electricity to store it safely[30] making diabetic patients especially vulnerable to disasters.[31] This must raise awareness to better prepare and prevent the late consequences of the catastrophe, that may lead to many indirect victims even with available resources and health facilities nearby. It must be

considered that this study does not include hospital admissions or in situ emergency interventions.

The demographic profile of our patient cohort, with a median age of 60 years and a high prevalence of chronic conditions, further highlights the vulnerability of older populations during extreme weather events. This is in line with findings by Hochman et al.,[1] who reported significant societal impacts and healthcare challenges in regions affected by extreme weather phenomena in the Mediterranean.

Recent studies underlined the impact of natural disasters on continuity of care for chronic patients establishing recommendations from previous experiences as hurricane Katrina in 2005.[32] Understanding these dynamics is essential to improving healthcare system preparedness and resilience, particularly in regions prone to climate-related disasters.[33]

Protecting highly vulnerable patients during DANA events requires a combination of household preparedness and coordinated system-level measures. Home contingency plans with emergency medication kits, backup batteries, and clear instructions can reduce clinical deterioration during isolation. Maintaining registries and geolocation of high-risk patients would help prioritize outreach when access routes fail, while community education on managing supply disruptions—such as insulin preservation—remains essential, as illustrated in the recent case study of flood-risk education in Valencia.[34] In parallel, establishing alternative, traceable pharmaceutical supply chains would ensure medication availability if local pharmacies become inoperable. These actions echo evidence that extreme weather events disproportionately affect vulnerable populations, highlighting the need for proactive, equity-focused preparedness.[35]

This study presents several limitations inherent to its design and execution. Being a prospective observational study without a non-exposed or historical control group, causal inferences cannot be firmly established, and comparisons with baseline ICU activity are limited. Selection bias may have occurred, as only patients identified by attending physicians as affected by the DANA were included, possibly underestimating the total number of indirectly impacted admissions. Survivor bias must be also present in this study as potential indirect victims who died before hospital admission or not considered ICU candidates were not included. Attribution bias is also possible, since distinguishing between health events triggered by the disaster and those coincidentally occurring during the same period is challenging. The redistribution of cases among hospitals due to accessibility constraints may have led to local overloads not reflected in the aggregate data. Despite these constraints, the study provides an essential snapshot of critical care dynamics during a natural disaster, highlighting systemic vulnerabilities and areas for improvement in disaster preparedness.

In summary, our study contributes to the growing body of evidence on the multifaceted health impacts of flood disasters. The observed patterns of ICU admissions, predominantly driven by secondary complications, suggest that disaster preparedness plans should extend beyond immediate rescue operations.[34,35] Future research should focus on the long-term health outcomes of flood victims and the development of comprehensive strategies including emergency medicine, public health and critical care to mitigate the global effects of such events.[20]

Conclusions

The DANA event in Valencia led to a significant demand for intensive care services, with secondary complications predominating over direct trauma. Our study highlights that continuity-of-care failures were a major driver of indirect critical illness. These findings underscore the importance of integrated disaster response plans that address both immediate emergent needs and the continuity of chronic care to mitigate indirect health impacts. Future research should further investigate long-term outcomes and effective strategies for improving emergency response in similar catastrophic events.

CRediT authorship contribution statement

E. Sancho, P. Ramírez and R. Martín conceptualized and coordinated the study. R. Martin, B. Abejaro, R. Zaragoza and C. Carrasco contributed to data collection and interpretation from their respective centers. E. Sancho was responsible for data analysis and drafting the initial manuscript. All authors critically reviewed the manuscript, approved the final version, and agree to be accountable for all aspects of the work.

Declaration of Generative AI and AI-assisted technologies in the writing process

No artificial intelligence tools were used in the design, analysis, or writing of this study.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of competing interest

The authors declare that they have no conflicts of interest relevant to the content of this manuscript. No external funding was received for the design, conduct, analysis, or reporting of this study. The authors further confirm that they have no financial, personal, academic, or institutional relationships that could be perceived as influencing the work presented. All authors have reviewed and approved the final version of the manuscript.

Acknowledgements

We would like to express our deepest gratitude to all the volunteers who came from near and far to support the people of Valencia during the devastating floods. Their generosity, resilience, and solidarity were invaluable in providing immediate relief and in helping the affected communities begin the path to recovery. This work is dedicated in part to their

selfless efforts, which remind us of the strength of global cooperation in the face of adversity.

References

1. Hochman A, Marra F, Messori G, Pinto JG, Raveh-Rubin S, Yosef Y, et al. Extreme weather and societal impacts in the eastern Mediterranean. Earth Syst Dyn. 2022;13:749–77, http://dx.doi.org/10.5194/esd-13-749-2022.
2. García Garabal L, Nieto Muñiz R. Climatología de sistemas de Depresiones aisladas en niveles altos (DANAs) bajo condiciones de clima futuro. Av En Cienc Tierra. 2011:86–96.
3. Actualización de datos del Gobierno de España n.d. [Accessed 27 Jan 2026]. Available from: https://www.lamoncloa.gob.es/info-dana/Paginas/2026/260126-datos-seguimiento-actuaciones-gobierno.aspx.
4. Milojevic A, Armstrong B, Kovats S, Butler B, Hayes E, Leonardi G, et al. Long-term effects of flooding on mortality in England and Wales, 1994-2005: controlled interrupted time-series analysis. Environ Health. 2011;10:11, http://dx.doi.org/10.1186/1476-069X-10-11.
5. Silva DR, da Luz LG, Moura-Neto JA. Lessons from the catastrophic floods in southern Brazil: geographic and environmental factors, vulnerabilities, and the resilience of nephrology services during natural disasters. Curr Opin Nephrol Hypertens. 2025;34:514, http://dx.doi.org/10.1097/MNH.0000000000001111.
6. Obrová J, Sovová E, Ivanová K, Táborský M, Loyka S. Effects of the July 1997 floods in the Czech Republic on cardiac mortality. Disaster Med Public Health Prep. 2014;8:492–6, http://dx.doi.org/10.1017/dmp.2014.111.
7. Rae M, Van Hove M, Göpfert A. Effect of climate related flooding on health and healthcare worldwide. BMJ. 2023;381:1331, http://dx.doi.org/10.1136/bmj.p1331.
8. Yang Z, Huang W, McKenzie JE, Xu R, Yu P, Ye T, et al. Mortality risks associated with floods in 761 communities worldwide: time series study. BMJ. 2023;383:e075081, http://dx.doi.org/10.1136/bmj-2023-075081.
9. Alderman K, Turner LR, Tong S. Floods and human health: a systematic review. Environ Int. 2012;47:37–47, http://dx.doi.org/10.1016/j.envint.2012.06.003.
10. Paterson DL, Wright H, Harris PNA. Health risks of flood disasters. Clin Infect Dis. 2018;67:1450–4, http://dx.doi.org/10.1093/cid/ciy227.
11. Yang Z, Huang W, McKenzie JE, Xu R, Yu P, Wu Y, et al. Hospitalization risks associated with floods in a multi-country study. Nat Water. 2025;3:561–70, http://dx.doi.org/10.1038/s44221-025-00425-8.
12. Saulnier DD, Brolin Ribacke K, von Schreeb J. No calm after the storm: a systematic review of human health following flood and storm disasters. Prehospital Disaster Med. 2017;32:568–79, http://dx.doi.org/10.1017/S1049023X17006574.
13. Fanny SA, Kaziny BD, Cruz AT, Camp EA, Murray KO, Nichols TJ, et al. Pediatric emergency departments and urgent care visits in Houston after hurricane Harvey. West J Emerg Med. 2021;22, http://dx.doi.org/10.5811/westjem.2021.2.49050.
14. Visor cartogràfic de la Generalitat n.d. [Accessed 17 November 2025]. Available from: https://visor.gva.es/visor/?extension=559874,4260424,856582,4472123&nivelZoom=9&capasids=Imagen;,00_DANA2024;DANA2024.DelimitacionAreaInundadaUV,00_DANA2024;DANA2024.MunicipiosAfectados&nodoDesplegado=00_DANA2024&idioma=va.
15. 2023 ESC Guidelines for the management of acute coronary syndromes | European Heart Journal | Oxford Academic n.d. [Accessed 4 June 2025]. Available from: https://academic.oup.com/eurheartj/article/44/38/3720/7243210?login=false.
16. Duchenne-Moutien RA, Neetoo H. Climate change and emerging food safety issues: a review. J Food Prot. 2021;84:1884–97, http://dx.doi.org/10.4315/JFP-21-141.
17. Acosta-Coll M, Ballester-Merelo F, Martinez-Peiró M, De La Hoz-Franco E. Real-time early warning system design for pluvial flash floods—a review. Sensors. 2018;18:2255, http://dx.doi.org/10.3390/s18072255.
18. Tellman B, Sullivan JA, Kuhn C, Kettner AJ, Doyle CS, Brakenridge GR, et al. Satellite imaging reveals increased proportion of population exposed to floods. Nature. 2021;596:80–6, http://dx.doi.org/10.1038/s41586-021-03695-w.
19. Fekete A, Estrany J, Ramírez MÁA. Cascading impact chains and recovery challenges of the 2024 Valencia catastrophic floods. Discov Sustain. 2025;6:586, http://dx.doi.org/10.1007/s43621-025-01483-4.
20. Martin-Moreno JM, Garcia-Lopez E, Guerrero-Fernandez M, Alfonso-Sanchez JL, Barach P. Devastating ''DANA'' floods in Valencia: insights on resilience, challenges, and strategies addressing future disasters. Public Health Rev. 2025;46:1608297, http://dx.doi.org/10.3389/phrs.2025.1608297.
21. Yan M, Wilson A, Peel JL, Magzamen S, Sun Q, Li T, et al. Community-wide mortality rates in Beijing, China, during the July 2012 Flood compared with unexposed periods. Epidemiol Camb Mass. 2020;31:319–26, http://dx.doi.org/10.1097/EDE.0000000000001182.
22. Colorado Casado de Amezúa A, Garrido-Lestache López-Belmonte E, Giner Blasco J. Medical forensic response during the flood in Valencia (Spain), October 29th, 2024. Span J Leg Med. 2025;51:500459, http://dx.doi.org/10.1016/j.remle.2025.500459.
23. Trunkey DD. Trauma. Accidental and intentional injuries account for more years of life lost in the U.S. than cancer and heart disease. Among the prescribed remedies are improved preventive efforts, speedier surgery and further research. Sci Am. 1983;249:28–35.
24. Rodero Astaburuaga C. Valencia's DANA of October 2024: the 12 days of the state of emergency in the province of Valencia (Spain). Span J Leg Med. 2025;51:500457, http://dx.doi.org/10.1016/j.remle.2025.500457.
25. Barbería E, Grijalba M. Forensic intervention in the Valencia floods of October 2024. Span J Leg Med. 2025;51, http://dx.doi.org/10.1016/j.remle.2025.500471.
26. Babaie J, Pashaei asl Y, Naghipour B, Faridaalaee G. Cardiovascular diseases in natural disasters; a systematic review. Arch Acad Emerg Med. 2021;9:e36, http://dx.doi.org/10.22037/aaem.v9i1.1208.
27. Vanasse A, Cohen A, Courteau J, Bergeron P, Dault R, Gosselin P, et al. Association between floods and acute cardiovascular diseases: a population-based cohort study using a geographic information system approach. Int J Environ Res Public Health. 2016;13:168, http://dx.doi.org/10.3390/ijerph13020168.
28. Yamaoka-Tojo M, Tojo T. Prevention of natural disaster-induced cardiovascular diseases. J Clin Med. 2024;13:1004, http://dx.doi.org/10.3390/jcm13041004.
29. Mas-Coma S, Artigas P, Cuervo PF, De Elías-Escribano A, Fantozzi MC, Colangeli G, et al. Infectious disease risk after the October 2024 flash flood in Valencia, Spain: disaster evolution, strategic scenario analysis, and extrapolative baseline for a One Health assessment. One Health Amst Neth. 2025;21:101093, http://dx.doi.org/10.1016/j.onehlt.2025.101093.
30. Richter B, Bongaerts B, Metzendorf M-I. Thermal stability and storage of human insulin. Cochrane Database Syst Rev. 2023;11:CD015385, http://dx.doi.org/10.1002/14651858.CD015385.pub2.
31. Boulton AJM, Jenkins AJ, Makkar B, Mankovsky B, Abera MA, Tesfaye S. Diabetes and natural and man-made disasters: prevention, preparation,

response and recovery. Diabetologia. 2025;68:2465–78, http://dx.doi.org/10.1007/s00125-025-06406-6.

32. Arrieta MI, Foreman RD, Crook ED, Icenogle ML. Providing continuity of care for chronic diseases in the aftermath of Katrina: from field experience to policy recommendations. Disaster Med Public Health Prep. 2009;3:174–82, http://dx.doi.org/10.1097/DMP.0b013e3181b66ae4.
33. Tomio J, Sato H. Emergency and disaster preparedness for chronically ill patients: a review of recommendations. Open Access Emerg Med. 2014;6:69–79, http://dx.doi.org/10.2147/OAEM.S48532.
34. Morote Á-F, Tévar B, Olcina J. The 2024 floods in Valencia (Spain): case study of flood risk education in a primary education setting. GeoHazards. 2025;6:30, http://dx.doi.org/10.3390/geohazards6020030.
35. Stimpson JP, Rashed AL, Pandya J, Baudot EC, Whitfill J, Ortega AN. Health equity in the wake of disasters and extreme weather: evidence from an umbrella review. Health Aff Sch. 2025;3:qxaf207, http://dx.doi.org/10.1093/haschl/qxaf207.