

When the World Goes Up in Smoke: A Scoping Review of Emergency Medical Approaches to Wildfire Crisis Management

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Scan to access the preliminary scoping review.

RESEARCH QUESTION

How can current frontline healthcare workers best prepare for the increasing impacts of wildfires on both affected communities and wildland firefighters?

INTRODUCTION

Wildfire incidence is rising, with climate change increasing the frequency, severity, and duration of wildfires worldwide [1]. The 2024 Jasper wildfire, which destroyed approximately one third of the townsite's buildings [2–4], illustrates how quickly communities can be affected, and the health burden falls on both affected communities and the wildland firefighters who respond [5]. Emergency departments, primary care, and prehospital services are increasingly the first points of contact for both groups, yet health system preparedness and the involvement of frontline professionals in planning remain underdeveloped [8]. This review examines the health burden of wildfires and the health system response, and synthesises the evidence into practical recommendations for frontline clinicians with little or no prior experience in wildfire medicine.



FIGURE 1. Plume-driven fire spreads along Mount Tekarra [3]

METHODS

A scoping review was conducted using a population, concept, and context (PCC) framework:

- **Population:** wildfire-affected populations, emergency medical responders, wildland firefighters, and frontline healthcare professionals.
- **Concept:** emergency and crisis management strategies, occupational health, and clinical practice challenges during large-scale wildfire events.
- **Context:** wildfire-affected communities and healthcare settings during wildfire emergencies, in resource-constrained conditions.

Inclusion Criteria:

- Human populations only, English language
- Peer-reviewed research or review, or a case study, report or practice document on health-system or clinical response (peer review not required)
- Addressed ≥1 of: clinical care/health-system operations; evacuation/patient transfer/surge capacity; firefighter occupational health; disaster preparedness/incident command/emergency management
- Specific to wildfire, wildland fire, or bushfire

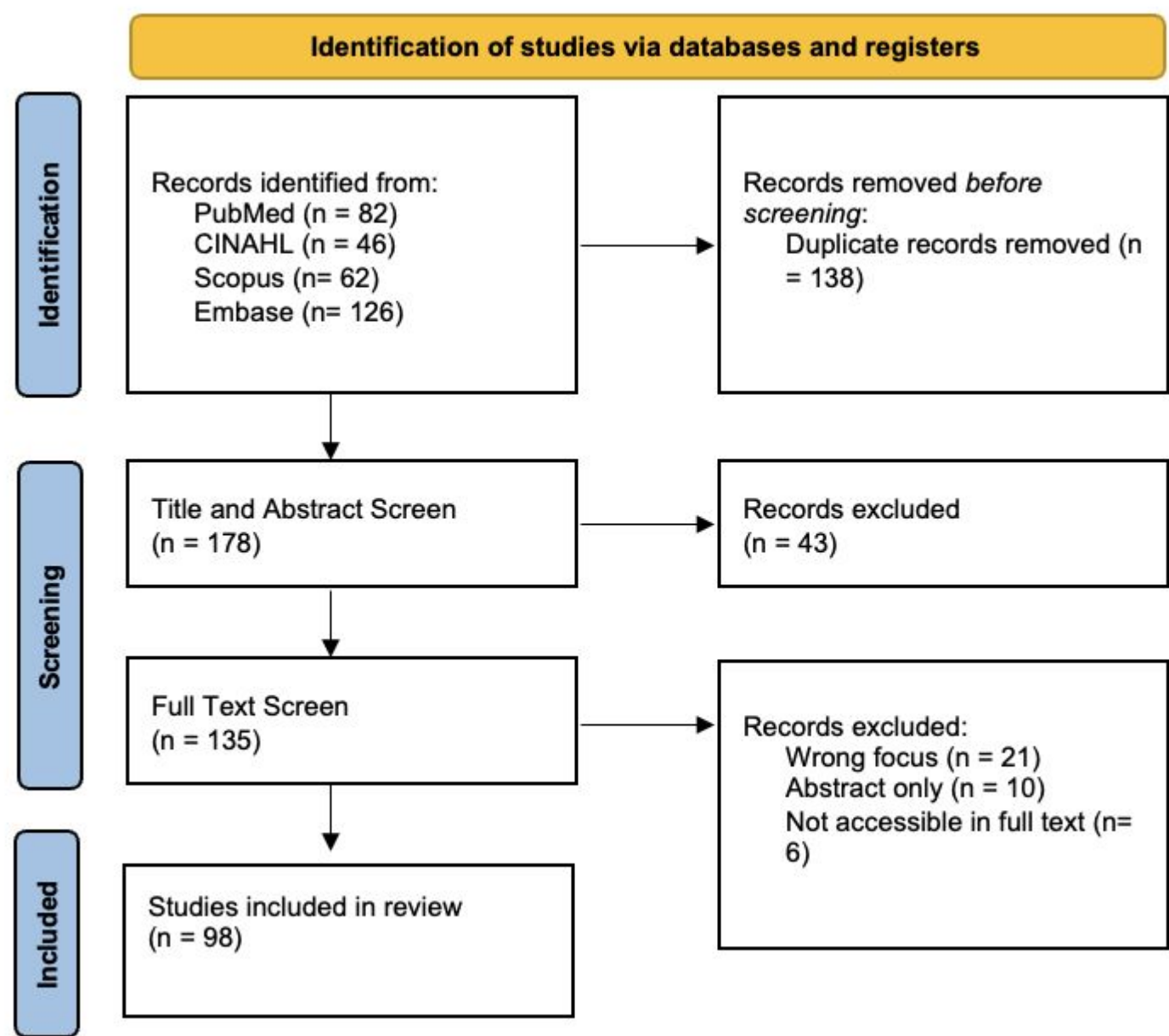
Exclusion Criteria:

- Non-English sources without an available translation
- Climate-change health studies not specific to wildfires
- Animal studies unrelated to human healthcare
- Conference abstracts, editorials or commentaries with limited clinical content; and duplicate publications

Search Strategy:

- **Databases:** PubMed, CINAHL, Scopus, Embase
- Search strategy combined controlled vocabulary and free-text terms relating to **wildfires, healthcare/emergency response, occupational health, and disaster management**, using Boolean operators **AND/OR**

FIGURE 2. SCREENING FLOW DIAGRAM



Screening & Data Extraction

- 316 records identified
- Duplicates manually removed in Google Sheets
- Two independent reviewers (A. Meredith, S. Reid) screened titles/abstracts and full texts in parallel
- Full-text exclusions were recorded by reason
- Extracted: publication characteristics, study design, population/setting, country, sample size, research question, and key findings

RESULTS: INCIDENT COMMAND & MEDICAL INTEGRATION

During the 2016 Fort McMurray fire, emergency department (ED) nurses reviewed the code orange evacuation guidelines after smoke was noticed at lunchtime and, with management approval, began preparing. By 2 pm all units were readying patients for evacuation, two hours before the official order at 4 pm [18]. Staff safely evacuated 105 patients that night, 73 from acute care and 32 from continuing care [18].

During the 2018 Camp Fire in Paradise, California, ED medical director Ted Muller was at home when a colleague phoned to say the hospital was being evacuated [19]. A local pastor had evacuated three hospital patients in his own car, which may indicate that formal patient transport was strained [19]. Dr Muller drove through the active wildfire to a church parking lot, where he advised on conserving oxygen for a hospice patient and two oxygen-dependent patients, and later treated others in a second parking lot using the equipment in his backpack [19].

In both cases, early warning reached clinicians through informal channels rather than a formal directive [18,19]. At Fort McMurray, an existing plan allowed staff to act on that warning and have patients ready before the order came. At Paradise, care was improvised in parking lots. Together, these accounts suggest that formal notification can lag behind events, and that medical input into evacuation planning before fire season may help hospitals act early and keep care organised.



FIGURE 3. Thick smoke envelops Jasper townsite [3]

RESULTS: FIREFIGHTER & COMMUNITY MENTAL HEALTH

Wildland firefighters face extreme heat, sustained work hours, particulate exposure, and higher sudden cardiac death risk [8]. A Delphi study of British Columbia firefighters found consensus on five top research priorities: smoke and respiratory health (89%), fatigue and sleep (80%), mental health (78%), stress (76%), and workplace structure and organisational culture (71%); but did not find consensus on long-term disease risk (67%) [20]. One month after the 2007 Greek wildfires, 18.6% of 102 firefighters had post-traumatic stress disorder (PTSD); permanent firefighters had 70% lower odds of PTSD than seasonal ones [21]. This psychological burden also extends well beyond the fireline, as primary care patients surveyed 18 months after the 2016 Fort McMurray wildfire evacuation showed increased one-month prevalence of likely PTSD (13.6%), depression (24.8%), and anxiety (18.0%), all above the pre-wildfire baseline [22]. Among firefighters, the psychological risk from wildfire response therefore remains increased for at least a month afterwards. Among affected community members, the psychological risk persists at 18 months post-wildfire [22].

RESULTS: FIELD MEDICAL CARE & ED SURGES

Backer et al. found that at wildfire base-camp medical tents, dermatological complaints (54%) were the most frequent presentation, followed by respiratory (7.7%), musculoskeletal (7.6%), and minor trauma (7.4%) complaints [23]. Only 4.5% of patients required emergency department transfer, despite some camps being located about 64 kilometres (40 miles) or more away [23].

Communities frequently show a surge in respiratory ED visits after wildfire smoke exposure, with a one to two day lag and up to five days of elevated presentations in Ontario [25,26]. Not all studies found a surge [30–32], so regions newly affected by wildfires may anticipate one but cannot specify its size or timing.

Cardiovascular ED findings are inconsistent, with increases reported in California [33], North Carolina [34] and Australia [35,36], but the literature described as mixed [33,34]. A cardiovascular surge therefore cannot be planned on the same timeline as a respiratory surge.

A cohort of children with obesity and asthma showed the largest rise in rescue-medication use after the Southern California 2003 wildfires, a pattern not clearly repeated after the 2007 wildfires [37]. In contrast, a separate study found paediatric headache-related ED visits fell during wildfires [38].

RESULTS: MUTUAL AID & RESOURCE COORDINATION

In 2003, the San Diego County wildfires forced two large hospitals to plan rapid evacuations [12]. The response drew on formal contingency planning, with the US Navy hospital ship placed on standby to receive transferred patients, which was not ultimately required [12]. Cross-jurisdictional deployment brings its own coordination demands. A mental-health mutual-aid partnership between a rural and a metropolitan health district during Australia's 2019-2020 Black Summer bushfires ultimately worked well [39]. Still, early deployments were disorganised, with tension over the visibility of deployed staff and clarity of roles before an effective rhythm was established [39].

RESULTS: INEQUITY & VULNERABLE POPULATIONS

Vulnerable groups carry the greatest wildfire health burden [5]. A scoping review of 44 paediatric asthma studies found wildfire smoke to be up to 10 times as harmful for children under 5 as for older groups [1].

Exposure to bushfire smoke was proposed to be linked to reduced birth weight and prematurity [40]. A separate Australian cohort linked prenatal smoke exposure to later allergy and rash-related ED visits [41].

Guidance for pregnant patients is difficult to find [42] and neonatal intensive care units (NICUs) were underprepared for evacuation [43]. In two VA home-based primary care programmes, no medically complex homebound patient died during a 2017 fire, and early preparedness was among the factors credited, although this small qualitative study cannot establish causation [44].

After the 2007 California wildfires, a household survey found prescription needs reported by 29.2% of displaced households, 42.6% of which went unmet, and mental health needs reported by a smaller 8.7% of households, half of which went unmet [13].



FIGURE 4. Well-developed fire between Edith Lake and Annette Lake [3]

RECOMMENDATIONS

Establish Incident Command and Medical Integration

1. Appoint a named medical or emergency medical services (EMS) liaison in advance of fire season to ensure that incident command and mass-evacuation logistical planning sufficiently incorporate medical leadership. EMS physicians are often underrepresented in wildfire mitigation and preparedness planning [8]. Fort McMurray shows what early preparation can achieve [18]; at Paradise, the ED director learned of the evacuation by phone [19]. Hospital evacuation plans, including backup patient transport, should be reviewed with this liaison each season.

Screen for PTSD in Firefighters and Anticipate Worsening Community Mental Health

2. Wildland firefighters should be screened for their risk of developing or having PTSD, with particular attention to seasonally employed crews, who face substantially higher odds of PTSD than permanent staff [21]. This screening should also extend to the surrounding community, as psychological burden persisted among primary care patients 18 months after the Fort McMurray fire [22]. Screening and follow-up should remain available to both groups beyond the immediate post-fire period.

Improve Injury Management Infrastructure and Prepare for Community ED Surge Patterns

3. Pre-season care plans for high-risk individuals with chronic illnesses (e.g., respiratory and cardiac patients) should be implemented and include defined follow-up pathways. There should also be pre-established familiarity with telemedicine before fire season begins [45].
4. Anticipate ED surges and the staffing shortages that accompany them by pre-stocking indoor air filtration and establishing staffing contingencies for days when smoke conditions make commuting unsafe [46].
5. Plan wildland firefighter base camp resourcing around a "small team, low-acuity" model, with clear transfer protocols, especially where the nearest hospital is approximately 60 or more kilometres away [23].

Establish Mutual Aid and Resource Coordination

6. Cross-jurisdictional mutual-aid protocols should be established and rehearsed before they are needed. They should define the scope of practice, identification (for example, visible tabards or vests), and reporting lines for deployed clinical staff, rather than negotiating them once deployment is underway [12,39]. These protocols should cover both formal mutual aid, such as pre-arranged transfer agreements with military or out-of-region hospital assets, and informal contributions from community resources [12,39]. They should be treated as prerequisites for entering any mutual-aid agreement [39].

Incorporate an Equity Lens into Emergency Planning

7. Given the documented gaps in guidance and evacuation readiness for pregnant, NICU, paediatric, and homebound patients, there should be proactive engagement with these patients in pre-season planning [40,42,43]. This planning should include a named point of contact for smoke-exposure guidance during pregnancy, evacuation criteria specific to oxygen-dependent or otherwise immobile patients [19], and a pre-identified receiving site for NICU transfers, modelled on the preparedness practices of two VA home-based primary care programmes [44].
8. Build equity into evacuation and resource planning by pre-identifying which services, such as prescription refills and mental health referrals, are most likely to go unmet among vulnerable populations, and by establishing a proactive outreach or check-in process for these needs rather than relying on households to seek them out during a wildfire response [13].

LIMITATIONS: broad research question; evidence predominantly from the United States, Australia and Canada, with no studies from the Global South; some included sources not peer reviewed; heterogeneous study designs synthesised narratively without critical appraisal; no registered protocol; English-language sources only.