

Research Letters

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Abstract

Objectives: Fires are among the most feared incidents that can occur in a hospital. Hospital fires will disrupt care continuity, may require the evacuation of patients and have the potential to result in injuries or even deaths. The aim of this study is to gain insight into hospital fires in the Netherlands over a 20-year period.

Methods: Systematic scoping review of news articles mentioning hospital fires in the Netherlands retrieved from the LexisNexis database, Google, Google News, PubMed, and EMBASE between 2000 and 2020. Hospital fires were included if they were associated with the closure of hospital departments or intervention units and/or evacuations. The cause, location, involved departments, need for evacuation, and the number of casualties were evaluated.

Results: Twenty-four major hospital fires were identified. More than half of these were caused by technical failures, and in 6 cases (25%), the fires were attributed to patients. In 71% of the incidents, acute care departments were affected by the fire. Twenty fires (83%) resulted in the evacuation of patients. In 2 cases, the fire resulted in the death of a patient.

Conclusions: Patient-attributed fires are a significant cause of major hospital fires in the Netherlands. Prevention and mitigation measures should be implemented accordingly.

Fires are among the most feared incidents that can occur within hospital buildings. Hospitals are densely populated and contain numerous flammable gases and other noxious substances. Resultantly, internal fires carry a high risk of injury and mortality, particularly among the most vulnerable patients inside, who may be completely dependent.

Although severe hospital fires are relatively rare, there were 10 662 reported fires in hospitals in the UK between 1994 and 2004.¹ During 2011–2015, the US fire departments responded to an annual average of 1130 fires in medical institutions.² Specific data about fires in Dutch hospitals are lacking, but it is estimated that there are 250–500 fires in Dutch health care facilities per year.³

Most literature focuses on fires in Intensive Care Units (ICUs) and operation rooms (ORs), where flammable medical gasses likely play a substantial role and may contribute to explosion hazards.⁴ There is a lack of hospital fire studies outside of the ICU and OR, or that focus on the impact on acute care delivery. In addition, the frequency and characteristics of hospital fires in the Netherlands are not particularly assessed. Therefore, the aim of this study was to characterize major hospital fires in Dutch hospitals and their impact on acute care delivery. These findings may improve hospital fire preparedness.

Methods

A systematic scoping review of internal hospital crises and disasters in the Netherlands between 2000 and 2020,⁵ from which hospital fires were extracted. The framework described by Arksey and O'Malley⁶ was followed and the review was reported per PRISMA-ScR guidelines.

The search terms “hospital,” “closed,” “ICU,” “ED,” “department,” “failure,” “fire,” and “evacuation” and their synonyms were combined using Boolean operators. The scoping review assessed news articles retrieved from the LexisNexis database, Google, Google News, PubMed, and EMBASE, and included articles if 1 or more hospital departments or intervention units of Dutch hospitals faced sudden and unexpected closure.

Hospital fires were extracted from the primary database.⁵ Grey literature searches were performed to collect additional data on the fire incidents, if necessary. The data were descriptively analyzed using mathematical summations based upon the data gathered in an Excel document (Microsoft® Excel for Mac, version 16.62, 2021). The institutional review board of VieCuri Medical Center approved the primary scoping review (#439).

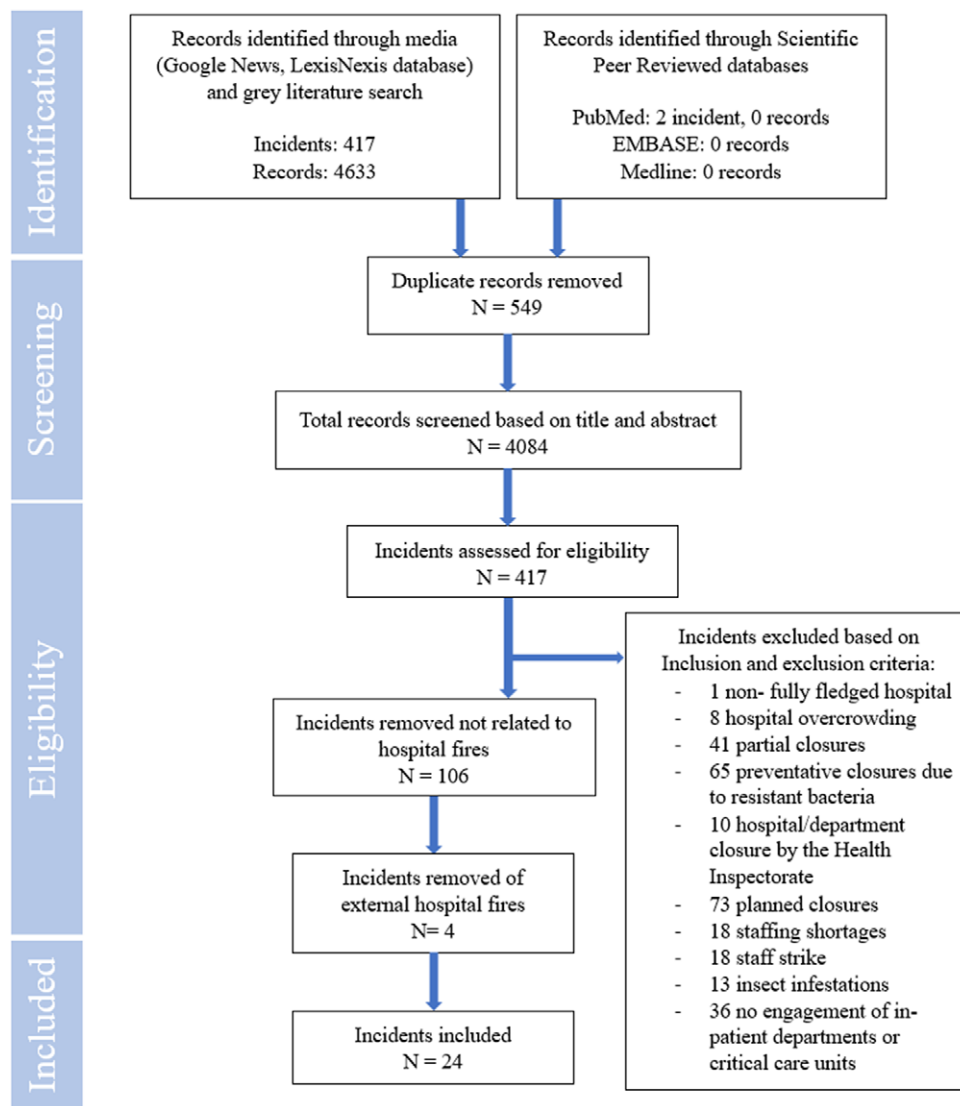


Figure 1. Flowchart of scoping review.

Table 1. Major internal fires reported in Dutch Hospitals during 2000-2020

Nr.	Department fire started	Departments affected	Cause of fire	Evacuation needed? (number of people)	Injuries	Deaths
1	OR	OR	Technical failure	Yes (whole OR)	0	1
2	OR	OR, ED	Technical failure	Yes (32)	0	0
3	ED	ED	Unknown	Yes (whole ED)	0	0
4	ED	ED, OR	Patient related	Yes (unknown)	1	0
5	Hospital ward	Hospital ward	Patient related	Yes (10)	0	0
6	Hospital ward	Hospital ward	Patient related	Yes (19)	Several	0
7	Hospital ward	Hospital ward	Patient related	Yes (6)	Several	0
8	Hospital ward	ED, IC and 2 hospital wards	Patient related	Yes (5)	2	1
9	Hospital ward	2 hospital wards	Patient related	Yes (36)	0	0
10	Non-patient	Hospital ward	Technical failure	Yes (34)	0	0
11	Non-patient	OR, ED, IC and 2 hospital wards	Technical failure	Yes (150)	0	0
12	Non-patient	Several hospital wards, ED and OR	Construction work	Yes (200)	Several	0
13	Non-patient	Whole hospital	Technical failure	No	0	0

(Continued)

Table 1. (Continued)

Nr.	Department fire started	Departments affected	Cause of fire	Evacuation needed? (number of people)	Injuries	Deaths
14	Non-patient	Non-patient, ED	Technical failure	No	1	0
15	Non-patient	Whole hospital	Technical failure	No	0	0
16	Non-patient	3 hospital wards	Technical failure	Yes (50)	0	0
17	Non-patient	IC	Technical failure	Yes (10)	0	0
18	Non-patient	ED	Unknown	Yes (unknown)	0	0
19	Non-patient	Hospital ward	Technical failure	Yes (unknown)	0	0
20	Non-patient	Whole hospital	Technical failure	Yes (172)	0	0
21	Non-patient	ED, OR	Technical failure	Yes (unknown)	0	0
22	Non-patient	Whole hospital	Technical failure	No	0	0
23	Non-patient	ED, non-patient	Construction work	Yes (whole ED)	0	0
24	Non-patient	ED, OR, non-patient	Construction work	Yes (unknown)	0	0

Results

Twenty-eight major fires were reported in Dutch Hospitals during 2000-2020. Twenty-four of these fires originated inside the hospital (Table 1), compared to 4 fires that occurred externally. The external fires caused smoke hazards with the risk of smoke entering the ventilation systems of the approximate hospitals. These were excluded from further analysis.

Of the 24 internal hospital fires, 7 originated in a hospital ward, 2 in the OR, 2 in the emergency department (ED), and 13 in the outpatient clinic or non-patient parts of the hospital. More than half of these fires (54%) were caused by technical failures. The main causes were failures in electrical switchboards, generators, or transformers. In 1 case, a heating probe in the pathology lab overheated; and in another case, an anesthesia column in the OR leaked oxygen, which resulted in a fire.

At least 6 fires (25%) were caused by or related to patients' behavior. Of these, 4 fires were certainly caused by patients: 2 cases resulted from confused patients who set their rooms on fire and in the other 2 fires, the patients had been smoking. The remaining 2 fires originated in a patient's room, but the source of the fires was not mentioned in the news reports. Three hospital fires (12.5%) occurred due to construction projects inside the hospital.

In 17 fires (71%), at least 1 acute care department was affected. The ED was affected most frequently with a total of 15 cases. In 4 cases (17%), the entire hospital was affected due to major power failures.

In 20 fires (83%), it was decided to evacuate patients. In 5 of these cases, patients were evacuated to external hospitals. Seven fires (29%) were associated with injuries among patients and/or staff. Two patients died as a result from a hospital fire.

Discussion

The results of this study suggest that the human factor should be considered as an important cause of hospital fires. Although the sample size was limited, a significant proportion of fire incidents was caused by patients, who intentionally or accidentally set their room on fire.

Previously, the US National Fire Incident Report System⁷ reported that intentional actions were responsible for 12% of major,

non-confined hospital fires. A report of the US National Fire Protection Association² analyzing fires in health care facilities from 2011-2015 stated that 38% of injuries were associated with fires that started in a patient's room. These reports suggest that patient behavior is a risk factor for health care fires and may be associated with higher casualty rates. The Dutch Health Care Inspectorate assessed fires in mental health care facilities and found that both the unpredictable and hazardous (smoking) behavior of patients and their high dependency during an emergency evacuation are important risk factors for fire casualties.⁸

In the Netherlands, all buildings must comply with a building code. For health care facilities, it is mandatory to use a risk stratification, which includes flight routes and patient dependency during evacuations. In addition, all hospitals should have a disaster plan.⁹ This plan should pay specific attention to fire safety procedures, and all personnel must regularly pass fire extinguishing and evacuation trainings.

Emergency hospital evacuations are complex procedures and are even more challenging during fire disasters. Fire characteristics, patient characteristics, hospital preparedness, command and control, and planning and logistics significantly impact the evacuation procedure and duration.¹ Assigning dependency codes to patients upon hospital admission ("warn, assist, or save?") may improve the speed and efficiency of hospital evacuations.⁸ Furthermore, detection and suppression systems may reduce the impact of hospital fires.¹⁰

This study is subject to limitations. Underreporting may have occurred due to the subjective nature of news releases; bias towards newsworthy events may have arisen, leaving out smaller and less impactful incidents. Furthermore, the study is geographically limited to the Netherlands and only acute care hospitals were included. Finally, the etiology of major hospital fires is likely different from less impactful fire incidents, and this study should not be used as an estimation of hospital fire frequency in the Netherlands.

Author contribution. All authors had an equal contribution to conceptualization and writing of the manuscript. All authors read and approved the final manuscript.

Competing interest. None declared.

References

1. **Murphy GR, Foot C.** ICU fire evacuation preparedness in London: a cross-sectional study. *Br J Anaesth.* 2011;**106**(5):695–698.
2. **Richard Campbell.** *Structure Fires in Health Care Facilities.* National Fire Protection Association; October 2017.
3. **Nederlandse Organisatie voor Brandveiligheid (NOVB).** [Brandveiligheid in de zorg]; Published 1 September 2014. Dutch. Accessed 13 March 2024. <https://federatieveilignederland.nl/documenten/novb-publicatie-brandveiligheid-in-de-zorg.pdf>.
4. **Barten DG, Klokman VW, Cleef S,** et al. When disasters strike the emergency department: a case series and narrative review. *Int J Emerg Med.* 2021;**14**(1):49.
5. **Klokman VW, Barten DG, Peters NALR,** et al. A scoping review of internal hospital crises and disasters in the Netherlands, 2000-2020. *PLoS One.* 2021; **16**(4):e0250551.
6. **Arksey H, O'Malley L.** Scoping studies: towards a methodological framework. *International journal of social research methodology.* 2005;**8**(1):19–32.
7. **National Fire Incident Report System.** Data Snapshot: Hospital Fires (2012-2014). U.S. Fire Administration. Published 31 August 2022. Accessed 17 March 2024. https://www.usfa.fema.gov/data/statistics/reports/snapshot_hospital.html.
8. **GGZ Nederland.** [Handreiking Integrale aanpak brandveiligheid]. Published November 2012. Publication number 2012-386. Dutch. Accessed March 2023. https://www.dezorgbrandveilig.nl/sites/default/files/bestanden/kennisbank/handreiking_brandveiligheid_def-los.pdf.
9. **Landelijk netwerk acute zorg (LNAZ).** Kwaliteitskader crisisbeheersing en OTO 2.0; October 2016. Dutch. Published 1 October 2016. Accessed 29 March 2023. https://www.lnaz.nl/cms/Kwaliteitskader_Crisisbeheersing_en_OTO_2.0_uitgave_oktober_2016.pdf.
10. **Greenidge C, Cawich SO, Burt R,** et al. Major hospital fire in Saint Lucia. *Prehosp Disaster Med.* 2021;**36**(6):797–802.