

The 2007 San Diego Wildfire Impact on the Emergency Department of the University of California, San Diego Hospital System

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Abbreviations:

LWBS = Left Without Being Seen
PM2.5 = 2.5 micron Particulate Matter
UCSD = University of California, San Diego

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Abstract

Introduction: In October 2007, San Diego County experienced a severe firestorm resulting in the burning of more than 368,000 acres, the destruction of more than 1,700 homes, and the evacuation of more than 500,000 people.

Hypothesis: The goal of this study was to assess the impact of the 2007 San Diego Wildfires, and the acute change in air quality that followed, on the patient volume and types of complaints in the emergency department.

Methods: A retrospective review was performed of a database of all patients presenting to the Emergency Departments of University of California, San Diego (UCSD) hospitals for a six-day period both before (14–19 October 2007) and after (21–26 October 2007) the start of the 2007 firestorm. Charts were abstracted for data, including demographics, chief complaints, past medical history, fire-related injuries and disposition status. As a measure of pollution, levels of 2.5 micron Particulate Matter (PM 2.5) also were calculated from data provided by the San Diego Air Pollution Control District.

Results: Emergency department volume decreased by 5.8% for the period following the fire. A rapid rise in PM2.5 levels coincided with the onset of the fires. The admission rate was higher in the period following the fires (19.8% vs. 15.2%) from the baseline period. Additionally, the Left Without Being Seen (LWBS) rate doubled to 4.6% from 2.3%. There was a statistically significant increase in patients presenting with a chief complaint of shortness of breath (6.5% vs. 4.2% $p = 0.028$) and smoke exposure (1.1% vs. 0% $p = 0.001$) following the fires. Patients with significant cardiac or pulmonary histories were no more likely to present to the emergency department during the fires. **Conclusions:** Despite the decreased volume, the admission and LWBS rate did increase following the onset of the firestorm. The cause of this increase is unclear. Despite a sudden decline in air quality, patients with significant cardiac and pulmonary morbidity did not vary their emergency department utilization rate. Based on the experience at UCSD, it appears that significant wildfires like that seen in 2007, only may marginally affect emergency department operations, and may not require significant changes to normal staffing levels.

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Introduction

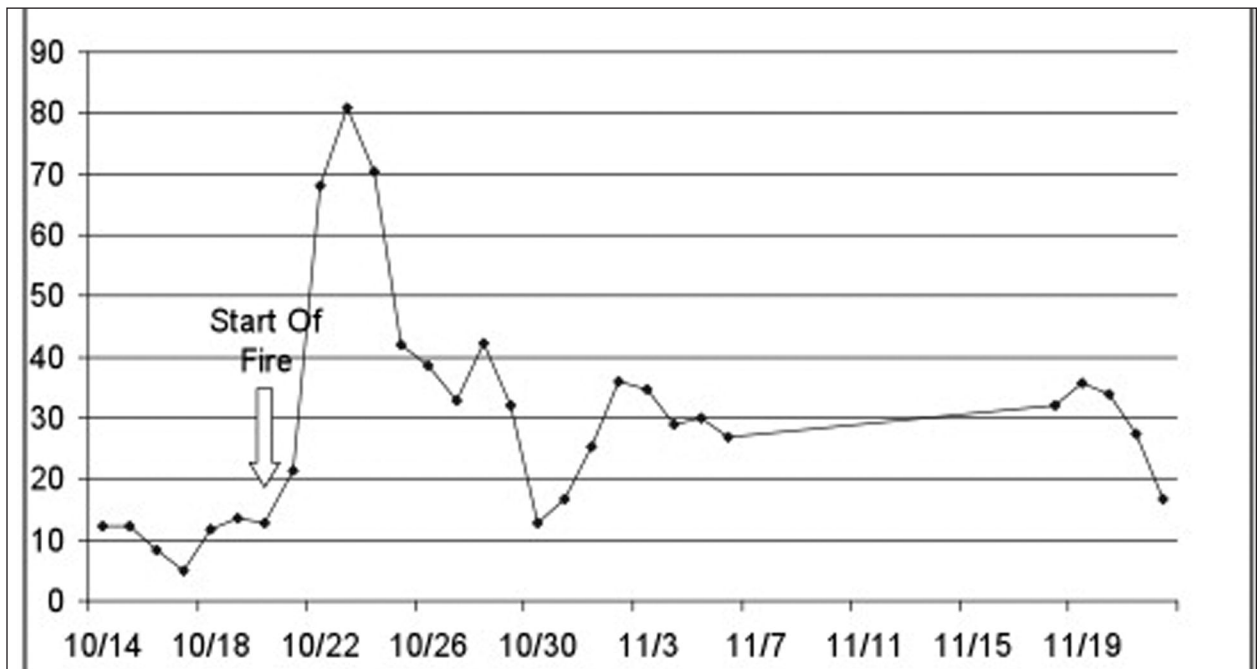
In 2007, San Diego County, California was engulfed by wildfires consisting of multiple fires that started over a four day period from 21–24 October 2007. These fires consumed more than 368,000 acres, including 1,721 residences and 923 out-buildings, with a total of seven fatalities and 105 firefighter injured.¹ The first two and largest of the fires, the Witch Fire and Harris Fire, started early in the day of 21 October.¹ A breakdown of the impact of the major fires is in Table 1.

The wildfires had a profound effect on the local population and a dramatic change on its air quality with increases in particulate matter.² More than 500,000 people were evacuated throughout San Diego County, which was the largest evacuation in the region's history.² The proximity of the wildfires to a

Fire	Acres	Structures burned—Residences	Structures burned		
			Outbuilding/Businesses	Fatalities	Injuries
Witch	197,990	1,125	509	2	40
Harris	90,440	253	295	5	61
Poomacha	49,410	138	79	0	15
Ammo	21,004	0	0	0	6
Rice	9,472	206	42	0	5
Totals	368,316	1,722	925	7	127

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Table 1—Statistics from the major individual fires during the firestorm



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Figure 1—Level of 2.5 micron particulate matter (PM 2.5) level in San Diego Metro area in October–November 2007

large urban area presents an opportunity to evaluate its effects on local emergency departments (EDs).

There is surprisingly little research on the impact of a large fire on ED visits. This information is crucial for contingency planning for future disasters due to natural hazards. Besides the immediate impact on fire evacuees, the abrupt changes of air quality had the potential to affect the health of individuals throughout San Diego County over the days and weeks that followed. During the 2007 fire, there was a dramatic increase in pollution levels that persisted for several weeks (Figure 1). The impact of sudden declines in air quality has not been well-studied and its impact on the emergency department is unknown.

The objective of this study was to examine the impact on emergency department volumes of patients during the 2007 San Diego wildfires and examine if the acute changes in air quality led to significant changes in the types of presenting complaints, frequency of visits for patients with chronic respiratory and/or cardiac medical problems, and patient acuity.

Methods

This is a multi-center, retrospective review of ED records to evaluate all patients who sought medical care in the emergency department six days prior to the fires (14–19 October 2007) and to the first six days of the firestorm (21–26 October 2007). The study hospitals included an urban academic medical center with an annual emergency department census of approximately 37,000 visits and a suburban community-based hospital with an annual census of approximately 24,000 visits. Data from 20 October were excluded from this analysis to allow for each group to represent the same days of the week to account for daily variation in ED volume. Data were abstracted from the emergency department computerized record (WebCHARTS) and included demographic information, date of visit, hospital, acuity and vital signs at triage, mode of arrival, smoking history, chief complaint, past and present medical history, medications, and final disposition.

The air pollution levels during the time prior to and after the start of the firestorm were obtained from auto-

	Before fire Mean \pm SD	After fire Mean \pm SD	<i>p</i> -value
Age (years)	42.5 \pm 19.4	44.5 \pm 19.5	0.027
	n (%)	n (%)	<i>p</i> -value
Sex			
Female	479 \pm 51.6	451 \pm 51.5	0.994
Male	450 \pm 48.4	424 \pm 48.5	
Triage Acuity			
Emergent	67 \pm 7.2	61 \pm 7.0	0.189
Acute	520 \pm 56.0	526 \pm 60.1	
Urgent	342 \pm 36.8	288 \pm 32.9	
Mode of Arrival			
Car	619 \pm 66.6	600 \pm 68.6	0.564
Bus	79 \pm 8.5	62 \pm 7.1	
Walked	30 \pm 3.2	38 \pm 4.3	
EMS	182 \pm 19.6	161 \pm 18.4	
Police	19 (2.0)	14 (1.6)	

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Table 2—Demographics of emergency department patients

mated 2.5 micron Particulate Matter (PM_{2.5}) sensor readings operated by the San Diego Air Pollution Control District in four locations throughout San Diego County. Each sensor records a level hourly and readings then are averaged to arrive at a daily average level. The PM_{2.5} levels were obtained from three of these four locations and averaged: (1) downtown San Diego; (2) Escondido; (3) El Cajon; and (4) Alpine. Readings from the Alpine area were excluded from this analysis due to its location east of the fire, thus, making its data unreflective of the level of particulate matter over San Diego due to the prevailing westerly winds during the time of the fire. The PM_{2.5} levels are a measure for air pollution associated with fires as they predominately form from sources of combustion and serve as a common component of smoke.³

Date were processed using Microsoft Excel (Microsoft Corporation, Redmond, WA) and transferred into SPSS (version 17) for analysis (SPSS Inc., Chicago, IL). Patient characteristics are described using descriptive statistics, specifically frequencies, percentages, mean values, and standard deviations. Differences among characteristics between the two study periods were compared using chi-square tests for categorical data and a *t*-test for age. The study protocol was approved by the University of California, San Diego (UCSD) Human Research Protections Program.

Results

The PM_{2.5} levels surrounding the onset of the 2007 wildfires are plotted in Figure 1. Levels increased significantly soon after

the beginning of the Witch and Rice Fires on 22 October, 2007, and persisted at high levels for the subsequent three days.

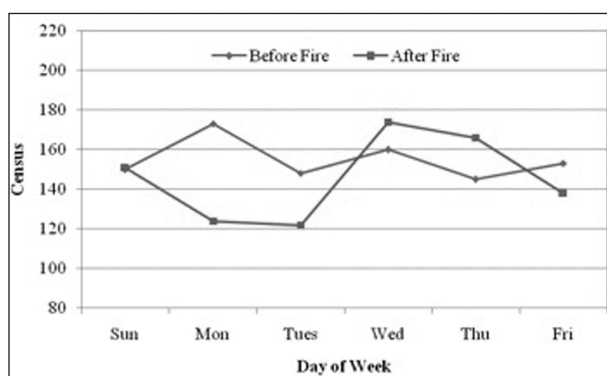
Patient characteristics are reported in Table 2. There was a slight increase in the mean of the ages of patients after the fire started (mean difference of 2.0 years, 95% confidence interval = 0.2 to 3.8, *p*-value = 0.027), but no differences in sex, mode of arrival, or triage acuity of patients between the two periods. There was a 5.8% decline (154.8 to 145.8) in daily mean emergency department volume as compared to the six day period before the fire. However, a daily review of ED volumes demonstrate a substantial drop during the first two days of the fire followed by greater than normal volumes later in the week (Figure 2). The hospital admission rate was higher during the period following the fires 19.8% vs. 15.2% from the baseline period (*p* = 0.012). Additionally the Left Without Being Seen (LWBS) rate doubled to 4.6% from 2.3% in the post-fire period (*p* = 0.010; Table 3) details selected chief complaints of patients presenting to the emergency department. There was a statistically significant increase in the number of patients presenting with shortness of breath (6.5% vs. 4.2%; *p* = 0.028) and smoke exposure (1.1% vs. 0%; *p* = 0.001) following the fires. The frequency of patients presenting with chief complaint of headache did decline in the post-fire period (4.3% to 1.1%; *p* < 0.001).

Patients with significant cardiac or pulmonary histories were no more likely to present to the emergency department following the fires than before the fires (Table 4). A total of 49 patients (2.7%) of patients presenting to the emergency department after the onset of the wildfires were

Chief Complaint	Before fire n (%)	After fire n (%)	p-value
Chest Pain	58 (6.2)	44 (5.0)	0.264
Shortness of Breath	39 (4.2)	57 (6.5)	0.028
Cough	27 (2.9)	24 (2.7)	0.834
Burns	2 (0.2)	3 (0.3)	0.606
Smoke exposure	0 (0.0)	10 (1.1)	0.001
Sore throat	17 (1.8)	11 (1.3)	0.325
Skin/eye/throat irritation	18 (1.9)	11 (1.3)	0.251
Headache	40 (4.3)	10 (1.1)	<0.001
Psychiatric	22 (2.4)	16 (1.8)	0.425
Medication Refill	14 (1.5)	17 (1.9)	0.477

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Table 3—Chief complaints of patients presenting to the emergency department



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Figure 2—Daily variations in patient volume before and after the fire

found to be fire-related based on notations in the chart by either nurses or physician that ascribed the wildfires to be at least partially contributory to the presenting chief complaint.

Discussion

The dramatic rise of PM2.5 levels coincided with the rapid spread of the wildfires. During the 72-hour period of 22–24 October, 2007, PM2.5 levels exceeded National Ambient Air Quality Standards (NAAQS) of 35 micrograms per cubic meter over a 24-hour period.⁴ This dramatic decline in air quality provided for a strong experimental model to assess its role on ED demand particularly relating to patients with co-morbidities.

Several studies have examined the impact of local fires on regional hospitals. A review of a 2001 Baltimore chemical fire did find an increase in shortness of breath and smoke exposure emergency department visits, but no increase in hospital admissions.⁵ A Canadian review of a regional plastics fire did not demonstrate a change in emergency department visits or admission rates.⁶ A review of the impact of wildfires in Sydney, Australia found no change in asthma

presentations and suggested that extensive media exposure of the event may have influenced behavior.⁷ A recent study of the 2003 San Diego wildfire experience did describe the impact to prehospital transport systems, but offered little on the effects on hospitals from self-directed patient visits.⁸

Past research has been conflicted on the impact of air quality and the emergency department. Wang *et al* found no correlation in pediatric visits for asthma and rising pollutant levels.⁹ Brito *et al* found that cities with higher pollutant levels do have increased rates of asthma exacerbations.¹⁰ Braga *et al* noted that inhalable particulate matter levels are associated with increased emergency department visits due to respiratory and cardiovascular complaints.¹¹ There also have been suggestions that increased particulate matter increases hospital admissions rates.¹²

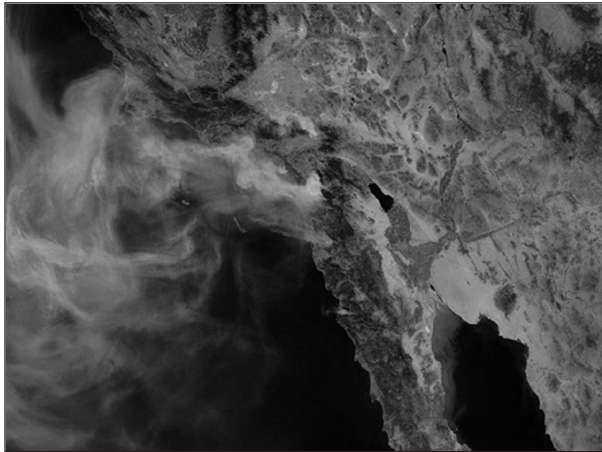
The current study suggests that during the immediate period following a large fire emergency department volume actually may diminish. Possible explanations include evacuation efforts with patients leaving the area. Additionally, public announcements advising the local population to remain indoors may have been successful in reducing environmental exposures. Patients may be less likely to come to the emergency department for less urgent complaints. This may explain why admission rates rose during the fire period although there was no significant difference in triage acuity noted.

The expectation is that patients most at risk to the environmental effects of the fires would be those with significant cardiac and/or pulmonary histories to include asthma, chronic obstructive pulmonary disease (COPD), coronary artery disease (CAD), and congestive heart failure (CHF). However, these patients were no more likely to present to the emergency department in the immediate period following the fires than before the fires. It is unclear whether complications from these comorbidities may be present with increasing frequency over a longer time horizon than the six-day post-fire period studied.

	Before fire n (%)	After fire n (%)	p-value
Past Medical History			
Asthma	57 (6.1)	67 (7.7)	0.202
Chronic obstructive pulmonary disorder	27 (2.9)	32 (3.7)	0.370
Coronary artery disease	45 (4.8)	49 (5.6)	0.470
Congestive heart failure	18 (1.9)	28 (3.2)	0.089

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Table 4—Prevalence of selected cardiac or pulmonary medical conditions in patients presenting to the emergency department



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Figure 3—Satellite photo of Southern California on 23 October 2007 showing the active fire zones and smoke plumes¹

Limitations to the current study include the possibility that the past medical history of patients presenting to the emergency department were incompletely obtained and, thus, not reflected in the medical record. Geographical regions within the city of San Diego likely had varied expo-

sure to the effects of the fire, and it is possible that the findings within the UCSD system differed from the experience of other local hospitals. Additionally, some medical visits may have been ascribed to the fire by the treating physician, but not documented in the medical record.

Conclusions

While the firestorm had the potential to have a significant impact on the emergency department, there actually was a decrease in volume for the first 48 hours of the fire. Despite the decreased volume, the admission and LWBS rates did increase. The cause of these increases is unclear. As would be expected a larger percentage of patients during the fire presented with a chief complaint of shortness of breath and smoke exposure, but patients with significant cardiac and pulmonary medical histories were no more likely to present to the emergency department despite the decline in air quality. A small percentage of patient visits during the six day period following the onset of the wildfires were directly ascribed in the medical record as being fire related. Based on the experience at UCSD, it appears that significant wildfires like those seen in 2007, only marginally affect emergency department operations and may not require significant changes to normal staffing levels. Further research is necessary to see if the pollution effects of the wildfires have had longer lasting health effects on the local population.

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