Bum Disaster Response: Are We Ready?

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Assistant Chief of Burns, Shriners Hospitals for Children Northern California
Conflicts

- No financial disclosures related to this talk
- Financial Relationships - Grant funding
  - Department of Defense, AMRMC
  - Shriners Hospitals for Children
  - Cytori Therapeutics: participating in study
  - Biomedical Advanced Research and Development Authority; Polynovo Study
- Nonfinancial Relationships
  - Member of ABuRN
  - Director of UC Davis Burn Data Coordinating Center
The Real Disclosure...

- Burn disasters are my ongoing passion
  - Editor, ABA Burn Disaster Austere Care Guidelines
  - Disaster Committee, American College of Surgeons Committee on Trauma
  - Author Burn chapter, Fundamentals of Disaster Management course
  - Developed burn disaster triage diagram
  - Military experience, Air Force: CCAT team leader, deployed Operation Joint Guard
  - Triage leader, multiple burn disasters:
    - Hermosillo day care fire (149 children aged 2-3 years)
    - Tubbs fire (Napa)
    - Camp fire (Paradise)
Objectives

- Understand the changing landscape of burn disasters
- Identify the advances in regional and national burn disaster preparation
- Describe the gaps in burn disaster preparedness
Are There More Burn Disasters or Are We Just Imagining It???
Bum Disasters 1990-2000

Bum Disasters 2001-2015

Burn Disasters are Increasing...Are We Ready?

Yes...and No
What Steps Have We Taken?
Step 1: Burn Center Referral Guidelines

Burn Center Referral Criteria
A burn center may treat adults, children, or both.
Burn injuries that should be referred to a burn center include:
1. Partial thickness burns greater than 10% total body surface area (TBSA).
2. Burns that involve the face, hands, feet, genitalia, perineum, or major joints.
3. Third degree burns in any age group.
4. Electrical burns, including lightning injury.
5. Chemical burns.
6. Inhalation injury.
7. Burn injury in patients with preexisting medical disorders that could complicate management, prolong recovery, or affect mortality.
8. Any patient with burns and concomitant trauma (such as fractures) in which the burn injury poses the greatest risk of morbidity or mortality. In such cases, if the trauma poses the greater immediate risk, the patient may be initially stabilized in a trauma center before being transferred to a burn unit. Physician judgment will be necessary in such situations and should be in concert with the regional medical control plan and triage protocols.
9. Burned children in hospitals without qualified personnel or equipment for the care of children.
10. Burn injury in patients who will require special social, emotional, or rehabilitative intervention.

Severity Determination
First Degree (Partial Thickness)
Superficial, red, sometimes painful.
Second Degree (Partial Thickness)
Skin may be red, blistered, swollen. Very painful.
Third Degree (Full Thickness)
Whitish, charred or translucent, no pin prick sensation in burned area.

Percentage Total Body Surface Area (TBSA)
Step 2: Courses to Teach Burn Care

Advanced Burn Life Support Course

Provider Manual
Step 3: National Disaster Austere Guidelines
Step 4: Regional Disaster Teams

- **Burn Disaster Regional Emergency Hotline Numbers**
- Northeast Region: (866) 778-3659
- Midwest Region: (800) 995-2876
- Great Lakes Region: (734) 936-2876
- Southern Region: (800) 359-0123
- Western Region: (866) 354-8824

Burn disaster regions do not match those of other organizations

![Map of the United States with regional divisions marked for Burn disaster regions.](image)
Step 5: Disaster Triage Table

- Guidelines for immediate care
- Triage algorithms
- Acute transportation guidelines

Triage table, noninhalation injury

<table>
<thead>
<tr>
<th>Age</th>
<th>0–9.9</th>
<th>10–19.9</th>
<th>20–29.9</th>
<th>30–39.9</th>
<th>40–49.9</th>
<th>50–59.9</th>
<th>60–69.9</th>
<th>70–79.9</th>
<th>80–89.9</th>
<th>≥ 90</th>
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<tr>
<td>0–1.99</td>
<td>Very High</td>
<td>Very High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
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<td>2–4.99</td>
<td>Outpatient</td>
<td>Very High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
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<tr>
<td>5–19.99</td>
<td>Outpatient</td>
<td>Very High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>20–29.99</td>
<td>Outpatient</td>
<td>Very High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
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<tr>
<td>30–39.99</td>
<td>Outpatient</td>
<td>Very High</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
<td>Expectant</td>
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<tr>
<td>40–49.99</td>
<td>Outpatient</td>
<td>Very High</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
<td>Expectant</td>
</tr>
<tr>
<td>50–59.99</td>
<td>Outpatient</td>
<td>Very High</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
<td>Expectant</td>
<td>Expectant</td>
<td>Expectant</td>
</tr>
<tr>
<td>60–69.99</td>
<td>Very High</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
<td>Expectant</td>
<td>Expectant</td>
<td>Expectant</td>
<td>Expectant</td>
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<tr>
<td>≥ 70</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
<td>Expectant</td>
<td>Expectant</td>
<td>Expectant</td>
<td>Expectant</td>
<td>Expectant</td>
</tr>
</tbody>
</table>
And Some Progress Has Been Made

- Communication networks established
- Funding for disaster preparedness
- More equipment
- Local infrastructures established
- Providers educated
- Decreased deaths

![Graph: More, but less deadly]

Global deaths from natural disasters*

Source: EM-DAT

*Smoothed trend

Economist.com
But There are Difficulties

- Lack of training
  - Burns not required training rotation in U.S. general surgical training
  - Limited number of centers limits exposure
- Lack of experience/knowledge
  - Overall decrease in burn incidence (regional)
  - Loss of wound care knowledge from wound care practices
  - Decreased number of burn centers
- Rapid transport to burn centers = loss of local skills, supplies
  - One bum >20% stresses most hospital ERs

The Result: Average error in estimating burn size by nonbum providers: 20% (both under and over)
Bum Center Challenges

- Limited number of bum centers (123 with <1800 beds nationally); not all verified
- Regionalization = longer transport times
- Operating room availability, needs
- Limited number of trained bum surgeons, nurses, therapists, nutritionists, pharmacists
- Medication availability: drug shortages, multiple drugs
  - Mean of 40 different agents/patient
- Resource need high: people, things, knowledge
- Pressure to cut costs = loss of supply, equipment, and personnel reserves
Limited Number of Burn Centers

With a limited number of beds...85% of 1800 occupied at any time.
The Good News: We Have a Plan...Western Burn Center Network

- Total Centers: 24
- States represented:
  - Arizona (1); California (13); Colorado (4); Hawaii (1); Nevada (1); Oregon (1); Utah (1); Washington (1)
- Total adult burn beds: 390 (if all beds empty)
- Average immediate availability: 127
- Average surge capacity 219
- 22 bed counts since 2014
The Bad News... California Issues

- Large state: big catchment area
- Not all burn centers verified
- Uneven distribution of medical assets
- Hospital overcrowding
  - Emergency rooms go on diversion
- Transportation
- Drug shortages
- Vast open spaces interspersed with large cities

[Map of California with verified burn centers marked in red and non-verified burn centers marked in grey]
### Deadliest Fires in Modern History

<table>
<thead>
<tr>
<th>Deaths</th>
<th>Event</th>
<th>Location</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 2500</td>
<td>Peshtigo Fire</td>
<td>Wisconsin</td>
<td>1871</td>
</tr>
<tr>
<td>2. 1200</td>
<td>Kursha-2 Fire</td>
<td>Soviet Union</td>
<td>1936</td>
</tr>
<tr>
<td>3. 453</td>
<td>Cloquet Fire</td>
<td>Minnesota</td>
<td>1918</td>
</tr>
<tr>
<td>4. 418+</td>
<td>Great Hinckley Fire</td>
<td>Minnesota</td>
<td>1894</td>
</tr>
<tr>
<td>5. 282</td>
<td>Thumb Fire</td>
<td>Michigan</td>
<td>1881</td>
</tr>
<tr>
<td>6. 240</td>
<td>Indonesian Forest Fires</td>
<td>Sumatra, Kalimantan</td>
<td>1997</td>
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<tr>
<td>7. 223</td>
<td>Matheson Fire</td>
<td>Ontario, Canada</td>
<td>1916</td>
</tr>
<tr>
<td>8. 191</td>
<td>Black Dragon Fire</td>
<td>China, Soviet Union</td>
<td>1987</td>
</tr>
<tr>
<td>9. 180</td>
<td>Black Saturday Bushfires</td>
<td>Australia</td>
<td>2009</td>
</tr>
<tr>
<td>10. 160-300</td>
<td>Miramichi Fire</td>
<td>Canada</td>
<td>1825</td>
</tr>
<tr>
<td>11. 100</td>
<td>Attica Wildfires</td>
<td>Greece</td>
<td>2018</td>
</tr>
<tr>
<td><strong>12. 88</strong></td>
<td><strong>Camp Fire</strong></td>
<td><strong>Paradise, California</strong></td>
<td><strong>2019</strong></td>
</tr>
<tr>
<td>13. 87</td>
<td>Great Fire 1910</td>
<td>Montana, Idaho</td>
<td>1910</td>
</tr>
<tr>
<td>14. 84</td>
<td>Greek Forest Fires</td>
<td>Greece</td>
<td>2007</td>
</tr>
<tr>
<td>15. 82</td>
<td>Landes Forest Fire</td>
<td>France</td>
<td>1949</td>
</tr>
</tbody>
</table>
The California Camp Fire

- Deadliest fire in state history
- 88 deaths
- Up to 1,200 people missing
- Thousands displaced
- Innumerable animals injured
The Fire Response

- Fire initially noted at approximately 0630
- Upgraded rapidly as fire spread due to winds
- Resources
  - 8,400 firefighters
  - 980 fire engines
  - 106 dozers
  - 155 hand crews
  - 99 water tenders
  - 40 helicopters, numerous firefighting air tankers from throughout the state along with numerous out-of-state resources

Took 24 hours to get Federal assistance approval
Lots of People Helped...

- **California National Guard**
  - General use shelters, 28 "Alaska Shelters", Chico Airport
  - Deployed 930 personnel
  - 13 aircraft (rotary, fixed-wing), 115 vehicles

- **California Conservation Corps**
  - Deployed 179 members
  - Base camp establishment, Chico Airport (capacity 200)
  - Establish Emergency Medical Services Authority (EMSA) base for 50 medical staff

- **Emergency Medical Services Authority**
  - Deployed 31 California Medical Assistance Team (CalMAT) members
  - Supported four shelters, 12 shelter tents to Butte County
  - Disaster Healthcare Volunteer, Medical Reserve Corp deployed
  - Coordination of nursing support to Butte County

- **California Department of Public Health**
  - >1,000,000 N95 masks
  - Vital records staff to assist LAC's
  - 2 immunization teams to shelters
Agencies and Resources

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Perspectives are Important

- No major roads
- Paradise with one road in and out
- Abuts national forest
- Single hospital for area
- 90 miles to nearest burn center
Why UC Davis?
We have been here before...

- Tubbs fire, October 2017; “Northern California Firestorm”
  - Burned 36,810 acres (149 km²)
  - 22 people killed in Sonoma County
- UC Davis, Shriners Hospital primary receiving centers-10 patients, 2 deaths
- Western Burn Consortium alerted
- 3 hospitals evacuated
- Burn area-8 counties, including:
  - Santa Rosa
  - Napa, Sonoma, and Lake Counties
- Cost: $1.2 billion
The Camp Fire Burn Response

- One of three fires in California
- Patients initially triaged at Adventist Health Feather River Hospital
- Adventist Health Feather River Hospital evacuated—loss of organized triage
- 3300 students, 11 schools in Paradise evacuated
- UC Davis primary receiving burn center
  - Patients arrived with no warning
  - Unable to predict if new patients would be coming
- Two patients triaged to Shriners Hospital
- Western Burn Center triage network activated
The Bad News...Western Burn Consortium Data

- 4 immediately available burn beds in Northern California
- 53 beds immediately available in all California
- 97 immediately available adult beds, 3 pediatric beds in consortium
- Surge capacity increased numbers to 214
But That Wasn’t All… The Woolsey and Hill Fires

- Southern California
- November 8-21, 2018
- Burned 96,949 acres
- Destroyed 1,643 structures
- Killed three people
- *Evacuation of more than 295,000 people*
- “Celebrity Fire”: destroyed celebrity houses
  - Independent fire crews hired for select areas
- Deployment of additional fire resources
- Media attention divided
Admissions From Camp Fire (Human)

- 10 patients UC Davis, 1 Bothin, 1 Santa Clara, 1 San Diego
- Firefighters: 2
- Mean Age: 59±6.4 years (range 27-103)
- Gender: 9 males, 3 females
- Mean Burn Size: 14.5±5.0% TBSA (range 2-50%)
- Inhalation injury: 2
- Mechanical ventilation: 4 (all UC Davis)
- Operations (mean/patient): 1.8
- Mean Hospital Length of Stay (days): >40 days
- 1 in-hospital death (80 year old)
Outpatient Visits

- Started 1 day post fire
- 5 additional patients, 3 firefighters
- Mean age (years): 34.2±15.5 (range 23-61)
- Mean burn size: 1.6±1.2% (all hands, neck, or face)
- Mean visits: 2
- Also followed discharged inpatients in clinic; one readmitted for finger amputation
UC Davis Veterinary Emergency Response Team (VERT)

- Arrived Butte County Fairgrounds November 9
- Most serious cases transferred to UC Davis that day
  - 8 goats, 2 pigs, miniature horse, 3 full sized horses, llama, 5 chickens, duck, goose, 27 cats
- Facebook album of cats
- Assisted in moving animals from Butte County Fairgrounds (300 doves, 100 chickens)
- Second team sent to Red Cross shelter for people and pets
- Fish (Center Aquatic Biology, Aquaculture): 89 coi saved
- California Raptor Center: 17 resident raptors moved indoors due to poor air quality
# Camp Fire Human Injuries

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Missing</th>
<th>Injured</th>
<th>Fatalities</th>
<th>Evacuated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civilian</td>
<td>3</td>
<td>12</td>
<td>87</td>
<td>52,000</td>
</tr>
<tr>
<td>Firefighter</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>n/a</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>3</td>
<td>17</td>
<td>87</td>
<td>52,000</td>
</tr>
</tbody>
</table>
And if the fire wasn’t bad enough...

- >140 people at 4 shelters with norovirus symptoms;
- Neighborhood Church (21/179), Chico
- Oroville Church of the Nazarene (10/352)
- Butte County Fairgrounds (9/142)
- East Avenue Church in Chico (1/200)
## Estimated Structural Damage and Destruction of Camp Fire

<table>
<thead>
<tr>
<th>Structure Type</th>
<th>Damaged</th>
<th>Destroyed</th>
<th>Total</th>
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<tbody>
<tr>
<td>Single Family Residential</td>
<td>465</td>
<td>9879</td>
<td>10344</td>
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<tr>
<td>Multiple Family Residential</td>
<td>22</td>
<td>276</td>
<td>298</td>
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<tr>
<td>Mobile Home Residential</td>
<td>6</td>
<td>3695</td>
<td>3701</td>
</tr>
<tr>
<td>Mixed Commercial/Residential</td>
<td>0</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Commercial</td>
<td>105</td>
<td>514</td>
<td>619</td>
</tr>
<tr>
<td>Other</td>
<td>77</td>
<td>4286</td>
<td>4363</td>
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<tr>
<td><strong>Total</strong></td>
<td>675</td>
<td>18661</td>
<td>19336</td>
</tr>
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</table>
Lessons Learned

- Disasters can happen any time
  - Staffing shortage
  - Burn center already at surge when started
  - Need plan to expand to other ICUs, institutions
- Knowledgeable support staff available for weeks-months rate-limiting factor
- Need service line specific disaster declaration
- The fire service will get people out, but it may take a while
- Communications become fragmented
  - Do not count on cell towers
Lessons Learned: Triage

- Wildfires are more than a “one and done”
- Admissions unpredictable
  - How do you triage for what may happen in 2 hours when the wind changes direction?
- EMS protocols ESSENTIAL
- Communication problematic during flux
- Hospitals CAN burn down
  - Lose inter-hospital communication
  - Rapid patient influx without warning
  - Ability to flex admissions locally essential
Lessons Learned: Treatment

- People don’t stop getting burns because there is a wildfire
- Delayed bum treatment = difficult resuscitation
- Wounds more severe, different than simple flame bum, required higher fluid volumes
- Myoglobinuria but no identifiable compartment syndrome: possible role of toxins
- Acute respiratory distress syndrome in those with smoke exposure
- Early excision helpful, but needed to be thorough; delayed grafting
Lessons Learned: Human and Animal Nature

- People loyal to their houses
  - Lack of knowledge on evacuation routes, self-protection, dangers
  - May avoid efforts to evacuate
  - Late presentation of injuries
- Need to include animals in disaster planning
  - Animals are family members will be brought to shelter
  - Cats increased injury: difficult for owners to find
  - Disaster response for animals in California fragmented
  - Public health implications of injured animals
Lessons Learned: Support

- Resources, media coverage split with other fires
- Generosity post-incident both good and bad
- Housing and sanitation post incident can be problematic
- Air quality causes problems
- Animals need to be in the support equation
Lessons Learned: Systems

- Need better integration of specialty consortium to disaster efforts
- Resource system based on situational needs, not just loss of all resources
- Hospital systems need organizational plans for their evacuation need
- Animals are part of families—need to integrate into planning
- System for evaluating long-term impact on environment, people: toxins, air quality, finance
- Reexamine fire safety gear for wildfires
Lessons Learned: Post Fire

- Wildfires expensive: cost $16.5 billion
- Burn patients long hospitalization
- Long term impact of toxins, air quality changes
- Loss of homes real
- Shelter use variable, need to plan for diseases and duration

Paradise in March
Burn Disaster Planning Needs Some Work

- Specialty disaster preparedness needs to be integrated into local, regional, and national networks
- More burn disasters WILL happen
- More guidelines will be developed
- More people will get burn-specific training

- We will eventually figure out how to work together, but the clock is ticking...
Predictions...

- More wildfire disasters WILL happen
- More guidelines will be developed
- Technology will be introduced into disaster management (both good and bad)
- We will link specialty disaster preparedness to local, regional, and national networks
- We will finally figure out how to work together...
Conclusions

- Wildfire burn disasters are here to stay
- Teamwork, flexibility, communication, preparedness keys to disaster management improvement
- We will all be learning how to do more with less
A Priority Change is Needed in Burn Disaster Planning

“The needs of the many outweigh the needs of the few.”

How do we serve the many with the capable few?
Thank you!