

START Triage: Performance Under Operational Conditions

Ken Miller, MD, PhD

Orange County Fire Authority

Orange County Health Care Agency/EMS

Triage Strategies

- Trauma triage
 - Individual, 'small number' triage
 - Physiologic, anatomic, mechanism of injury, comorbidities
 - Manifest & potential instability
- Multicasualty/disaster triage
 - Rapid triage for incident organization
 - Physiologic: manifest instability
 - Secondary triage
- Largely critically unvalidated
 - Consensus, 'expert panel'
 - Retrospective chart review 'validation'

Orangethorpe Train Incident Placentia, CA

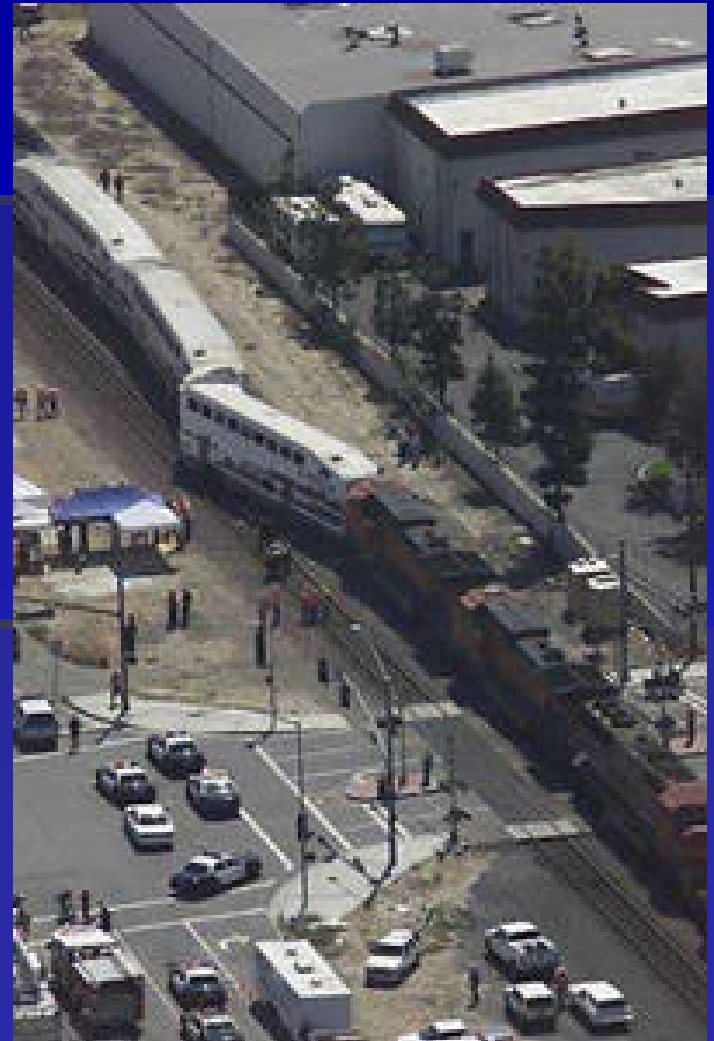
Tuesday, April 23, 2002

0810 hours

80°F

wind at SSW at 5-7 mph

45% humidity



Train Information



Burlington Northern Santa Fe (BNSF) 5340

- 3 Locomotives
- 67 Loaded Cars
- 5765 Tons
- 6498 Feet Long



Train Information



Metrolink 809

- 1 Locomotive
- 3 Passenger Cars
- Approximately 300 Passengers



Accident Narrative



Metrolink 809 BNSF 5340

- Traveling westbound, slows to enter the Olive Branch Switch at about 25 mph.
- Engineer places train in “emergency” when realizing another train was on the same track.
- Train came to complete stop prior to the collision.
- Traveling eastbound at 48 mph just prior to red Atwood signal.
- Engineer places train in “emergency” and slows to about 23 mph prior to the collision.
- Collision occurs at intersection of Orangethorpe Ave. and Richfield Rd.

Emergency Response

- Engines: 20
- Trucks: 3
- Medic Vans: 4
- Ambulances: 45
- Support Units: 3
- Chief Officers: 12
- Support Staff: 18
- Chaplains: 16

Triage

163 total patients

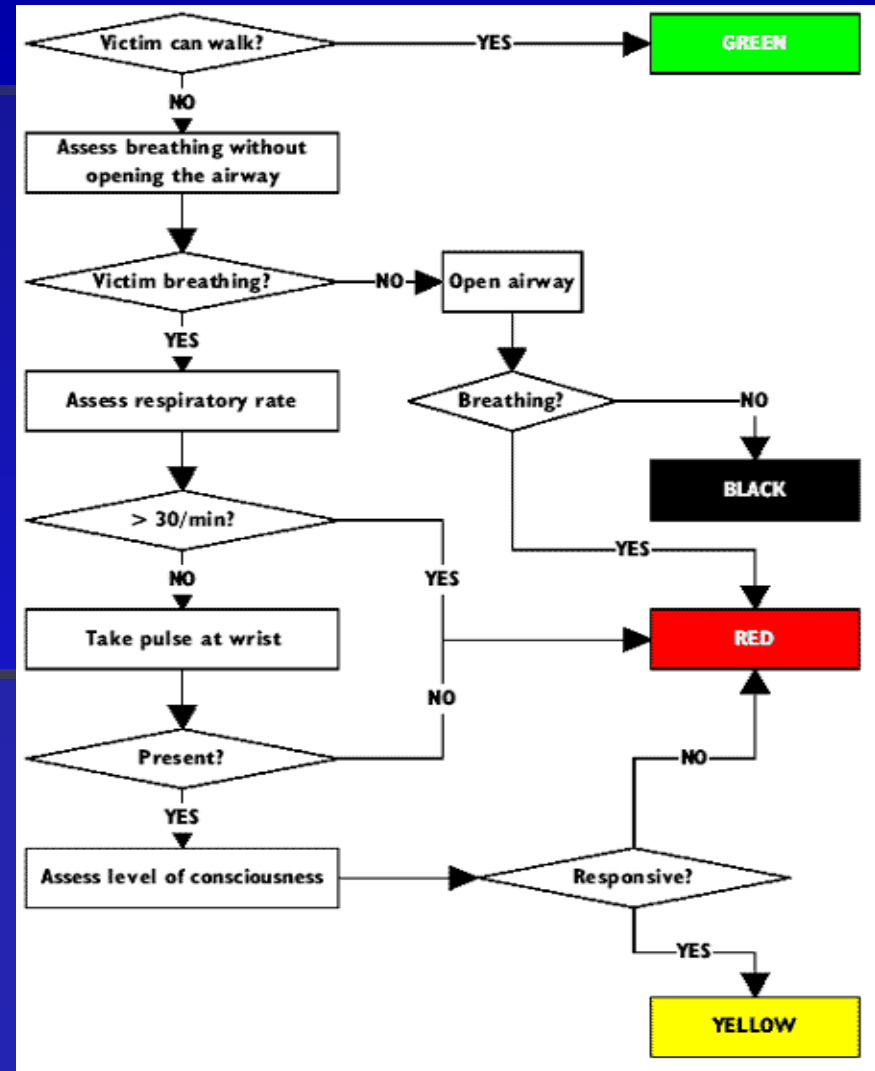
- 19 Immediates (1 died enroute to hospital)
- 67 Delayed
- 76 Minor
- 1 Dead (pronounced at scene)

Patient Transportation

- 162 patients (one on-scene fatality)
- 1 injured Firefighter
- 13 area hospitals used
- 41 ground ambulances, 2 busses
- Golden hour objective met
- All patients transported by 1030 hours

START Algorithm

- Physiologic triage
 - Ambulatory vs. Non-Ambulatory (spontaneous rather than by command; clinical spine clearance vs. spinal stabilization)
 - Respiration ≥ 30
 - Perfusion
 - Radial pulse
 - Capillary refill
 - Mental Status
 - Follows commands
 - GCS Motor = 6



Triage Efficacy

- Triage performance in detecting injury acuity against a validated standard
- Sensitivity: true positives
 - $1 - \text{sensitivity} = \text{false negatives}$
 - Under-triage
- Specificity: true negatives
 - $1 - \text{specificity} = \text{false positives}$
 - Over-triage

Triage Efficacy

- Positive likelihood ratio (+LR)
 - Likelihood that the test will be **positive** in a patient **with** the disease compared to the likelihood the test will be **positive** in a patient **without** the disease
 - Sensitivity/ (1 – specificity)
 - True positives/false positives
 - ≥ 10 convincingly rules in a disease
 - ≥ 3 reliably rules in a disease
 - Post-test odds of a disease = pre-test odds of a disease x LR

Triage Efficacy

- Negative likelihood ratio (-LR)
 - Likelihood that a test will be negative in a patient without the disease compared to the likelihood the test will be negative in a patient with the disease
 - $(1 - \text{sensitivity})/\text{specificity}$
 - False negatives/true negatives
 - ≤ 0.1 convincingly rules out a disease
 - ≤ 0.3 reliably rules out a disease

Standards of Acuity

- Injury Severity Score (ISS)
 - Sum of the squares of the Abbreviated Injury Scale (AIS, 0-5/6) of the 3 most injured body systems (face, head/neck, thorax, abdomen, extremities including pelvis, external)
 - 0-75, major trauma ≥ 16
 - Various combinations of AIS can result in the same ISS
 - No reflection of medical resource utilization

Standards of Acuity

- Modified Baxt Criteria
 - Assigned a priori
 - Within 6 hours of patient arrival
 - Measurement of medical resource utilization
 - Immediately life-threatening conditions
 - Immediates: Baxt criteria met
 - Delayed: Baxt criteria not met but admitted for at least 24 hours
 - Minor: Baxt criteria not met and admitted for less than 24 hours or not admitted

Chest decompression (needle or tube thoracostomy)

Intravenous fluids for a systolic blood pressure <90 mm Hg,
or absence of radial pulse

Blood transfusion

Assisted ventilation or airway procedure

Invasive central nervous system monitoring with brain
imaging or other evidence of increased intracranial pressure

Nonorthopedic operation (except pelvic stabilization) with
positive findings

Figure 2. Modified Baxt criteria.

Interpreting Triage Performance

- Minor vs. not-Minor
 - First step of START
 - Specificity of Minor
 - $1 - \text{specificity} = \text{over-triage}$
- Immediate vs. Delayed
 - Second step of START
 - Sensitivity of Immediates
 - $1 - \text{sensitivity} = \text{under-triage}$

Results

	Sensitivity (%, 95%CI)	Specificity (%, 95%CI)	Positive Predictive Value (%, 95%CI)	Negative Predictive Value (%, 95%CI)
Red	100 (15.8-100)	84.9 (74.6-92.2)	15.4 (1.9-45.5)	100 (94.2-100)
Yellow	57.1 (28.9-82.3)	11.5 (4.7-22.2)	12.9 (5.7-23.9)	53.9 (25.1-80.8)
Green	47.8 (38.3-57.4)	84.2 (60.4-96.6)	94.7 (85.4-98.9)	21.3 (12.7-32.3)

Table 2. Descriptive statistics by triage level.

Triage Level	Sensitivity, % (95% CI)	Specificity, % (95% CI)	Positive Predictive Value, % (95% CI)	Negative Predictive Value, % (95% CI)	Positive Likelihood Ratio (95% CI)	Negative Likelihood Ratio (95% CI)
Red	2/2 100 (15.8–100)	68/88 77.3 (67.1–85.5)	2/22 9.1 (1.1–29.2)	68/68 100 (94.7–100)	4.4 (3.0–6.5)	0*
Yellow	9/23 39.1 (19.7–61.5)	8/67 11.9 (5.3–22.2)	9/68 13.2 (6.2–23.6)	8/22 36.4 (17.2–59.3)	0.44 (0.26–0.75)	5.1 (2.5–10.6)
Green	55/120 45.8 (36.7–55.2)	25/28 89.3 (71.8–97.7)	55/58 94.8 (85.6–98.9)	25/90 27.8 (18.9–38.2)	4.3 (1.4–12.7)	0.61 (0.49–0.75)

*Unable to calculate a negative likelihood ratio CI for a value of zero.

START Outcomes vs. Application

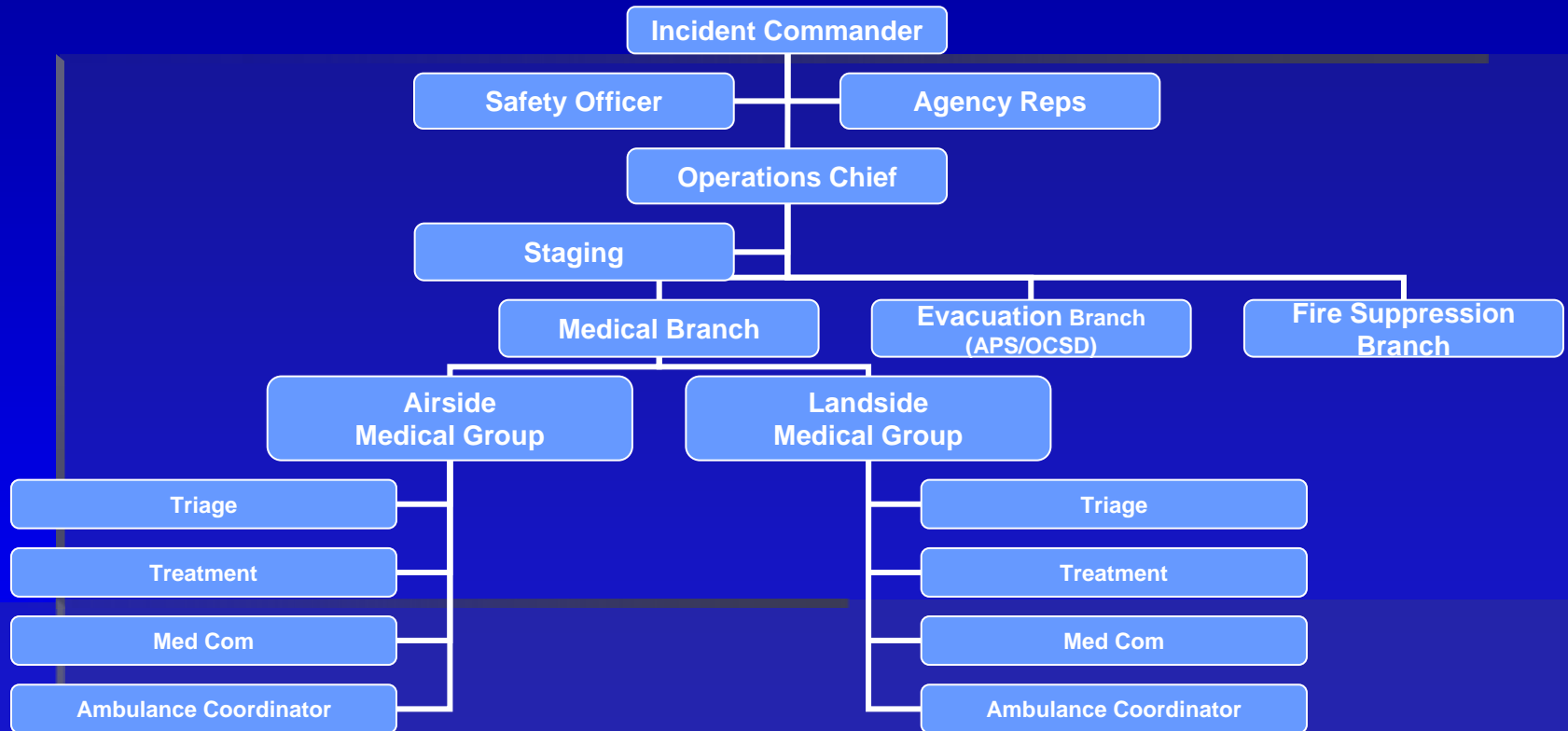
- Do these results reflect the performance of START Triage in predicting clinical outcome or inaccuracies in the application of the algorithm?

JWA Air Ex 2008: MCI Triage & Victim Transport

Scenario

- Earthquake
 - Terminal structural damage
 - Falling debris
 - Fuel fire adjacent to occupied aircraft at gate
 - Injuries & Evacuation (exercise design)
 - 120 injured
 - 50 on aircraft
 - 13 (26%) non-ambulatory
 - 70 in terminal
 - 18 (26%) non-ambulatory
 - 105 evacuated
 - 51 on aircraft
 - 54 in terminal
 - Total 225 volunteer victims/evacuees
 - 101 on aircraft
 - 124 in terminal

Incident Command



Triage Tag Data

START Triage Application	Sensitivity	Specificity	Pos LR	Neg LR
Immediate	0.9	0.74	3.4	0.14
Delayed	0.68	0.95	13.7	0.33
Minor	0.74	0.95	14.5	0.27

Triage Tag Data

Mistriaged (excluding missing tags)		Observed			
		Immediate	Delayed	Minor	Total
Design	Immediate		RR n=1	RR n=1	2
	Delayed	RPM nl, non-amb n=5		RPM nl, non-amb n=1	6
	Minor	RPM nl, amb n=3	RPM nl, amb n=16		19
	Total	8	17	2	27

Triage: Future Education

- Med Com triage data reflects planned victim acuity, however...
- Triage tag use was inconsistent
 - Triage criteria application seems largely correct
 - Triage tag acuity reflecting triage criteria inconsistent
 - Mostly due to tearing off or leaving behind wrong acuity markers on the triage tag
 - Victims apparently placed in correct triage category in Treatment Unit
- Trauma & Burn System utilization
 - CTV and burn secondary triage (after START)
 - Med Com request Trauma or Burn Center destinations from OCC

Triage: Future Education

- Triage Performance
 - Application of criteria for Immediate (sensitivity 90%) better than for Delayed (sensitivity 68%) or Minor (sensitivity 74%)
 - Immediate under-triaged by respiratory rate (n=2)
 - Delayed and Minor mostly over-triaged despite normal RPM (n=24)

'Conclusion' (for now)

- Over-triage is common
 - Mostly due to mental status assessment
- START Immediate can be reasonably trusted to rule in major injury
 - Attention to RPM
- START Minor can be reasonably trusted to rule out major injury
 - Serial re-triage
- START Delayed requires secondary triage to determine priority determination