SPEED, CHAOS, AND ESTABLISHING A CHAIN OF SURVIVAL

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April 7, 2017

ORIGINS
- EM Residency observations
  - Shane Cline and the Blue Bird Café
  - Linear Medicine vs Chaotic Medicine

ROADMAP
- Time Critical Diagnosis
  - Biology of Speed
  - Evolution of time
- Discuss Chaos theory (General)
  - Newtonian (linear) principles
  - Chaos Theory
- Chain of Survival: Team
THE PARADOX OF TIME

Rapid evaluation and disposition without rapid intervention

The concept of Time

The Golden Hour

“REAL TIME”

- Retronym (redundant intensifier)
- Fastest time = real time
- In 1980 the term was used in the New York Times 4 times. In 1990, the term was used 31 times with quotation marks, now daily
- Ultimate compliment for provider

IS REAL TIME IMPORTANT?

- Door to needle time for Thrombolytics
- AMI
- CVA
- The “Golden Hour” of trauma
- Door to tpa in stroke..
- Early Goal-Directed Therapy (Sepsis)
- Early Goal Directed Ultrasound
  - Decreases DDX from 9 to 4 possibilites
- Early antibiotics?
- FAST Exam (not SLOW exam)

Patient Mortality

- Delay in provider evaluation
- Increased time from end of management to ICU Admission
- Increased ED Length of stay
- Delayed Diagnosis
- Incorrect Disposition


Metcalfe MA. “Mortality among appropriately referred patients refused admission to the ICU.” Lancet. 350: 1997

The Golden Hour

- “the first hour after injury will largely determine a critically injured person’s chances for survival”
  
  -- R. Adams Cowley, 1975
  Baltimore Shock Trauma


Metcalfe MA. “Mortality among appropriately referred patients refused admission to the ICU.” Lancet. 350: 1997
The Platinum 10 Minutes

- The period during which emergency crews, upon their arrival at the scene, assess the situation and initiate treatment and transport of casualties
- 10.7% KIA and 1.7% DOW vs DOD rates of 16.4% and 5.8%

Speed and Trauma

Speed and Trauma


- No Association between time and Outcome
  - All trauma pts meeting shock criteria
  - Favorable in Pts requiring Critical intervention

The origin of Thrombolytic Therapy

- Pathophysiology of Acute MI
- Streptokinase
- GISSI-1 (1986)
  - Intravenous thrombolytic therapy with streptokinase improves survival
- GUSTO-1 (t-PA)
  - 15% Mortality reduction with vessel patency at 90 minutes
  - Short “Door to Needle” Times
HISTORY OF CHAOS THEORY

- 1963 Lorenz (meteorologist)
  - "Sensitive dependence on initial conditions"
- The Butterfly effect
  - Butterfly beating wings in Brazil produces a tornado in Texas 2 weeks later
  - Detail depends on Observer's Perspective

**Traditional science**
Everything is predictable

**Chaos Theory**
Science cannot predict complex systems
EXAMPLES OF CHAOS THEORY

- Physics
- Economics
- Meteorology
- Biology
  - Medicine
    - Emergency Medicine
    - Basic Research
    - Clinical


NEWTONIAN THEORY

<table>
<thead>
<tr>
<th>CHEST PAIN</th>
<th>DYSPNEA</th>
<th>Trauma</th>
</tr>
</thead>
<tbody>
<tr>
<td>EKG, CXR, CK, Troponin, ASA, Nitrates, B-Blockers, Morphine</td>
<td>EKG, CR</td>
<td>ABCDE</td>
</tr>
<tr>
<td>Cardiology</td>
<td>CK, Troponin, BNP, D-DIMER, CBC, CHEM 7 Antibiotics, IVF’s, Ventilatory support</td>
<td>2 Large Bone IV</td>
</tr>
<tr>
<td>Stroke Symptoms</td>
<td></td>
<td>CXR, CBC, CMPUA, AP Pelvis</td>
</tr>
<tr>
<td>EKG, Accucheck</td>
<td></td>
<td>PAST</td>
</tr>
<tr>
<td>CBC, CMP</td>
<td></td>
<td>CT Head, Capine</td>
</tr>
<tr>
<td>CT</td>
<td></td>
<td>Chest, abd, pelvis</td>
</tr>
</tbody>
</table>

Abdominal Pain

- IVF’s, Morphine, Phenergan
- CBC, LFT’s, UA/HGS
- AAS, CT, US Cardiology

Back Pain

- Toradol, Morphine, Valium
- ? X-rays
- UA

1 + 1 = 2
CHAOS

WADING INTO CHAOS:
INSIDE THE LIFE & DEATH OF A PARAMEDIC

Time of Onset?
Trauma Arrest?
Interventions?

Screening Tools

No Disease
Disease

Sensitivity
Specificity

Screening Tools

# of Patients

Establish Systems
Training
Chain of Survival (Passing the Baton)
FLIGHT HOME

At daybreak a McDonnell Douglas Super 80, No 241 in the American Airlines fleet takes off from St. Louis for Chicago

A quick stop, and the plane goes to Los Angeles and then to San Diego

THE PARADOX OF EFFICIENCY

The next day, the jet returns to St. Louis before flying to Los Angeles then back to Austin

The next day Austin to San Jose to Dallas to Nashville to Chicago to Denver

Thru the week from Denver to Chicago to Boston to Chicago to Tampa to Chicago to Dallas to Chicago to Dallas to Chicago to San Diego

Now the computers show 241 going to St. Paul, the 15th destination this week

THE PARADOX OF EFFICIENCY

The ramblings are not random, they are precisely charted by computers, the best calculation of a quadrillion solutions

Goal and outcome is saving minutes

But Wait. There is a plane with engine failure in Chicago which is supposed to fly to San Diego

(In a less efficient time, with the waste of back and forth scheduling there was an idle aircraft. . . Now as scheduling approaches perfection, less than 2% of the fleet is idle)
The nearest replacement plane is in Dallas. . . A crew must fly it to Chicago. Another crew-scheduling problem is developing as the minutes tick by. . . The pilots in Chicago have been sitting. . . This time counts as time on duty and now the trip to San Diego would push them over the legal maximum.

Another crew must now replace them. I keep looking at my watch, thinking about my connecting flight in Dallas. As the web tightens, it grows more vulnerable to small disturbances.

Loosely coupled systems can incorporate shocks and failures and pressures for change without destabilization. Tightly coupled systems respond more quickly, but the response may be disastrous. Perfectly efficient systems with no slack are more likely candidates for serious disruption.
"Chain of Survival"

- As strong as it’s weakest link
- Formed from Individuals
  - Training
  - Chaos

Why Speed Matters

- Framework and Foundation for Systems of Care
  - Establishes Goals
  - Streamlines processes
  - Dictates a response
  - Mandates Quality

<table>
<thead>
<tr>
<th>Time interval</th>
<th>New target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Door triage</td>
<td>60 sec</td>
</tr>
<tr>
<td>Arrival in hospital</td>
<td>90 min</td>
</tr>
<tr>
<td>Door-to-CT scan completed</td>
<td>45 min</td>
</tr>
<tr>
<td>Door-to-CT scan interpretation</td>
<td>45 min</td>
</tr>
<tr>
<td>Door-to-treatment</td>
<td>60 min</td>
</tr>
<tr>
<td>Median time to receive ED</td>
<td>15 min</td>
</tr>
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*National Institute of Neurological Disorders and Stroke*
**Why Speed Matters**

- The Ischemic Penumbra

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**Why Speed Matters**

*Time-to-Treatment*

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**REAL TIME???

- That’s not our job, Matt. We don’t have time to put in central lines and do all of that early goal-directed therapy stuff. The ICU shouldn’t dictate how we take care of our patients. You don’t get real world medicine.

- The Butterfly Effect
  - When does the transition from SIRS to Severe Sepsis occur?

**SIRS** ----**SEPSIS** ----**SEVERE SEPSIS** ----**SEPTIC SHOCK**
TCD’s, Cervical Radiculopathies, and Dropping Bombs

The Golden Fleece, The Golden Hour, and The Golden Rule

Stand in the gap
Strive to hold back death

Chain of Survival
- Individuals
- The Dance
- The Team

