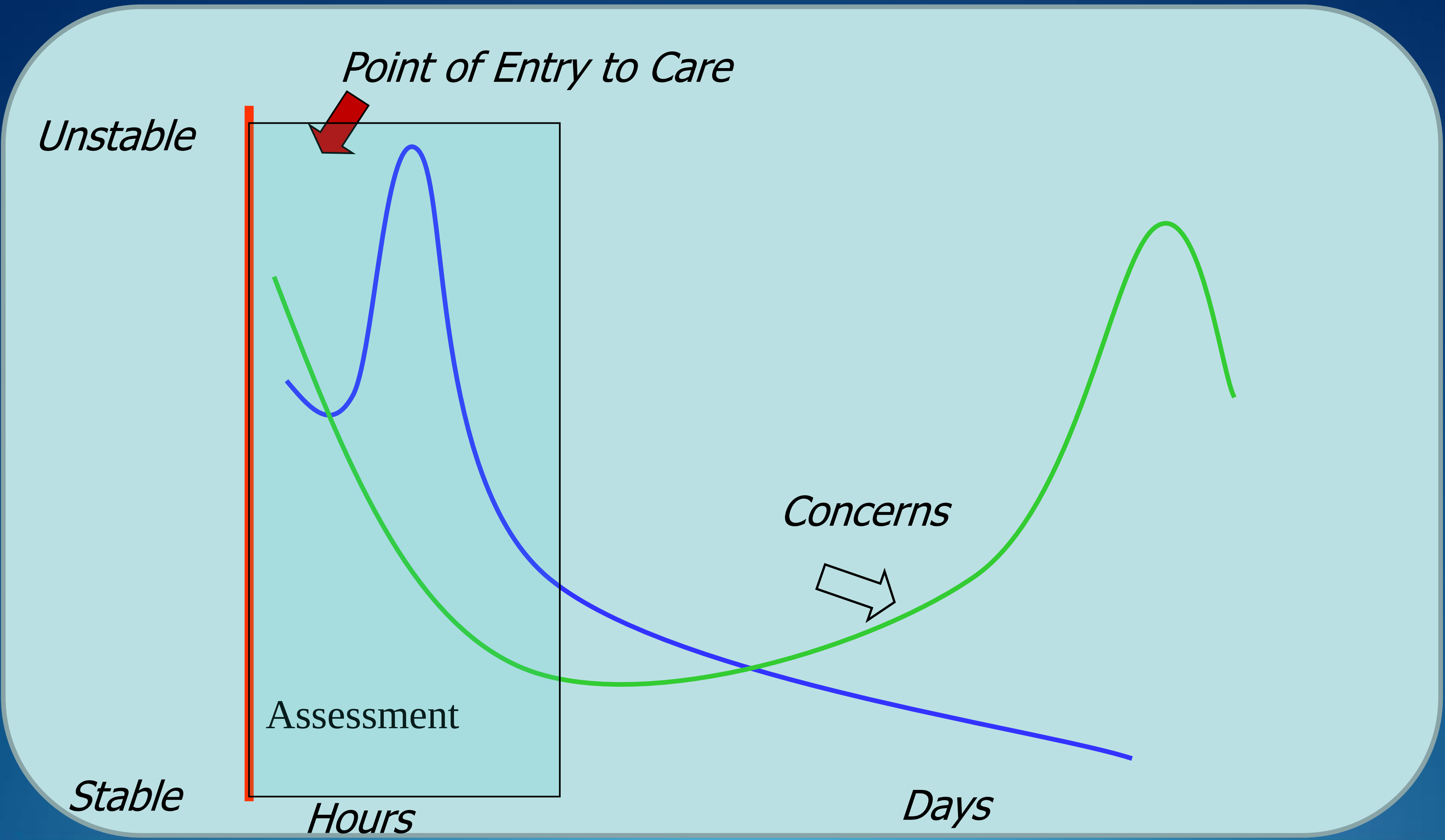
# Making acute medical services safer

**Dr Louella Vaughan**
**Senior Clinical Research Fellow**
**Northwest London CLAHRC**

# A Risky Business

- Admission to hospital marks onset of a period of high clinical risk
- Immediate risk is recognised (mostly)
- But risk lasts for around 1 year

# Patterns of Illness behaviour – time matters



For ages X and above

| Age X and up | N people with em admission 2011* | Died within yr of index em adm | % dying within year of index em admission |
|---|---|---|---|
| **0** | 3,613,326 | 402,464 | 11.1% |
| **5** | 3,249,619 | 401,339 | 12.4% |
| **10** | 3,154,532 | 401,136 | 12.7% |
| **15** | 3,062,758 | 400,922 | 13.1% |
| **20** | 2,925,939 | 400,503 | 13.7% |
| **25** | 2,746,112 | 399,873 | 14.6% |
| **30** | 2,573,061 | 398,967 | 15.5% |
| **35** | 2,411,625 | 397,598 | 16.5% |
| **40** | 2,252,462 | 395,436 | 17.6% |
| **45** | 2,076,637 | 391,509 | 18.9% |
| **50** | 1,893,494 | 385,284 | 20.3% |
| **55** | 1,717,844 | 376,315 | 21.9% |
| **60** | 1,547,472 | 362,862 | 23.4% |
| **65** | 1,344,022 | 340,712 | 25.4% |
| **70** | 1,138,495 | 311,958 | 27.4% |
| **75** | 912,317 | 272,716 | 29.9% |
| **80** | 656,670 | 218,443 | 33.3% |
| **85** | 386,078 | 145,701 | 37.7% |
| **90** | 157,479 | 68,502 | 43.5% |
| **95** | 39,715 | 19,709 | 49.6% |
| **100** | 5,908 | 2,521 | 42.7% |

- **Assessment at point of entry to care**
- **Inpatient monitoring**
- **Other things to think about**

# Presentations to the ED

## Emergency Department Care in the United States: A Profile of National Data Sources

Pamela L. Owens, PhD, Marguerite L. Barrett, MS, Teresa B. Gibson, PhD, Roxanne M. Andrews, PhD, Robin M. Weinick, PhD, Ryan L. Mutter, PhD

*From the Center for Delivery, Organization and Markets, Agency for Healthcare Research and Quality, Department of Health and Human Services, Rockville, MD (Owens, Andrews, Mutter); ML Barrett Inc., Del Mar, CA (Barrett); Thomson Reuters, Ann Arbor, MI (Gibson); and RAND, Arlington, VA (Weinick).The views expressed in this article are those of the authors and do not necessarily represent those of the Agency for Healthcare Research and Quality or the US Department of Health and Human Services.*

| | | | | |
|---|---|---|---|---|
| **Number of records for ED visits that result in admission, in thousands** | 17,746 | | 13,867 | |
| **Top 10 all-listed diagnoses, %*** | | | | |
| Essential hypertension (CCS 98) | 37.6 | 1 | 4.4 | 7 |
| Fluid and electrolyte disorders (CCS 55) | 24.6 | 2 | 7.0 | 2 |
| Coronary atherosclerosis and other heart disease (CCS 101) | 22.4 | 3 | | |
| Cardiac dysrhythmias (CCS 106) | 18.3 | 4 | 4.1 | 10 |
| Disorders of lipid metabolism (CCS 53) | 18.0 | 5 | | |
| Congestive heart failure (CCS 108) | 17.3 | 6 | 5.4 | 5 |
| Screening and history of MHSA codes (CCS 663) | 16.9 | 7 | | |
| Chronic obstructive pulmonary disease (CCS 127) | 16.3 | 8 | 4.1 | 9 |
| Diabetes mellitus without complication (CCS 49) | 15.9 | 9 | | |
| Deficiency and other anemia (CCS 59) | 15.4 | 10 | | |
| Nonspecific chest pain (CCS 102) | | | 11.4 | 1 |
| Pneumonia (except that caused by tuberculosis or sexually transmitted disease) (CCS 122) | | | 6.9 | 3 |
| Abdominal pain (CCS 251) | | | 6.2 | 4 |
| Residual codes; unclassified (CCS 259) | | | 5.1 | 6 |
| Other lower respiratory disease (CCS 133) | | | 4.3 | 8 |

*CCS*, Clinical Classification Software; *MHSA*, mental health and substance abuse.
*Diagnoses classified by the CCS.

doi:10.1016/j.annemergmed.2009.11.022

# Weekend mortality for emergency admissions. A large, multicentre study

P Aylin,[1] A Yunus,[1] A Bottle,[1] A Majeed,[1] D Bell[2]

**Table 2** Top 50 causes of death (by volume) for weekend and weekday emergency admissions to acute NHS hospitals 2005/2006

| Condition | No. of admissions | Mortality rate: Weekday admission – Mortality % (number of deaths) | Mortality rate: Weekend admission – Mortality % (number of deaths) | p Value | OR (95% CI)‡ |
|---|---|---|---|---|---|
| All admissions | 4 317 866 | 4.9 (162 639) | 5.2 (52 415) | <0.001‡ | 1.10 (1.08 to 1.11) |
| Medical | | | | | |
| Acute and unspecified renal failure (CCS 157) | 14 134 | 25.6 (2924) | 33.3 (909) | <0.001† | 1.45 (1.32 to 1.60) |
| Acute bronchitis (CCS 125) | 103,224 | 5.3 (4142) | 5.6 (1409) | 0.920 | 1.00 (0.94 to 1.07) |
| Acute cerebrovascular disease (CCS 109) | 70 500 | 27.5 (14 451) | 30.2 (5437) | <0.001† | 1.13 (1.09 to 1.18 |
| Acute myocardial Infarction (CCS100) | 68 932 | 13.5 (6803) | 14.4 (2650) | 0.002* | 1.08 (1.03 to 1.14) |
| Aspiration pneumonitis, food/vomitus (CCS 129) | 6233 | 49.2 (2222) | 49.1 (843) | 0.640 | 0.97 (0.86 to 1.10) |
| Cardiac arrest and ventricular fibrillation (CCS 107) | 2576 | 64.9 (1238) | 68.1 (455) | 0.048* | 1.22 (1.00 to 1.48) |
| Cardiac dysrhythmias (CCS 106) | 86 134 | 1.9 (1270) | 2.4 (453) | <0.001† | 1.31 (1.17 to 1.47) |
| Chronic obstructive pulmonary disease and bronchiectasis (CCS 127) | 106 951 | 7.7 (6174) | 7.6 (2005) | 0.840 | 1.00 (0.94 to 1.05) |
| Chronic ulcer of skin (CCS 199) | 9402 | 10.3 (831) | 11.5 (154) | 0.104 | 1.17 (0.97 to 1.42) |
| Congestive heart failure non-hypertensive (CCS 108) | 56 394 | 17.9 (7944) | 19.6 (2351) | <0.001† | 1.11 (1.05 to 1.17) |
| Coronary atherosclerosis and other heart disease (CCS 101) | 91 836 | 2.4 (1676) | 2.8 (583) | 0.008* | 1.14 (1.04 to 1.26) |
| Deficiency and other anaemia (CCS 59) | 30 422 | 3.5 (951) | 4.2 (152) | 0.015* | 1.25 (1.04 to 1.49) |
| Fluid and electrolyte disorders (CCS 55) | 17 436 | 9.6 (1359) | 11.3 (365) | 0.013* | 1.17 (1.03 to 1.33) |
| Gastrointestinal haemorrhage (CCS 153) | 57 937 | 7.3 (3196) | 7.8 (1087) | 0.042* | 1.08 (1.00 to 1.17) |
| Intestinal infection (CCS 135) | 40 519 | 2.9 (886) | 2.7 (274) | 0.385 | 0.94 (0.81 to 1.09) |
| Liver disease, alcohol-related (CCS 150) | 10 401 | 18.5 (1576) | 20.4 (382) | 0.042* | 1.14 (1.01 to 1.30) |
| Other circulatory disease (CCS 117) | 20 659 | 6.1 (1015) | 7.0 (280) | 0.025* | 1.18 (1.02 to 1.36) |
| Other gastrointestinal disorders (CCS 155) | 50 774 | 3.9 (1535) | 4.4 (485) | 0.114 | 1.09 (0.98 to 1.22) |
| Other liver diseases (CCS 151) | 13 376 | 9.8 (1107) | 13.1 (276) | <0.001† | 1.40 (1.20 to 1.62) |
| Other lower respiratory disease (CCS 133) | 23 515 | 6.7 (1239) | 8.6 (432) | <0.001† | 1.26 (1.12 to 1.42) |
| Peripheral and visceral atherosclerosis (CCS 114) | 4347 | 28.9 (1018) | 38.4 (315) | <0.001† | 1.61 (1.36 to 1.90) |
| Pleurisy, pneumothorax pulmonary collapse (CCS 130) | 23 000 | 7.6 (1442) | 10.1 (403) | <0.001† | 1.42 (1.26 to 1.60) |
| Pneumonia (CCS 122) | 102 465 | 24.3 (18 619) | 25.4 (6574) | 0.899 | 1.00 (0.97 to 1.04) |

*Qual Saf Health Care* 2010;**19**:213–217. doi:10.1136/qshc.2008.028639

# Other badness

- Ruptured AAA
- Dissected thoracic aorta
- Subarachnoid haemorrhage
- Bacterial meningitis
- Severe hyperkalaemia
- Necrotising fascitis
- Diabetic ketoacidosis
- Brittle asthma
- Variceal bleeding

# Primary Triage

- Historically, triage based mostly on physiological parameters, with discretion left for type of presentation
- Observed that decision making was entirely inconsistent and often 'surprising'

- Development of systematic triage tools to:

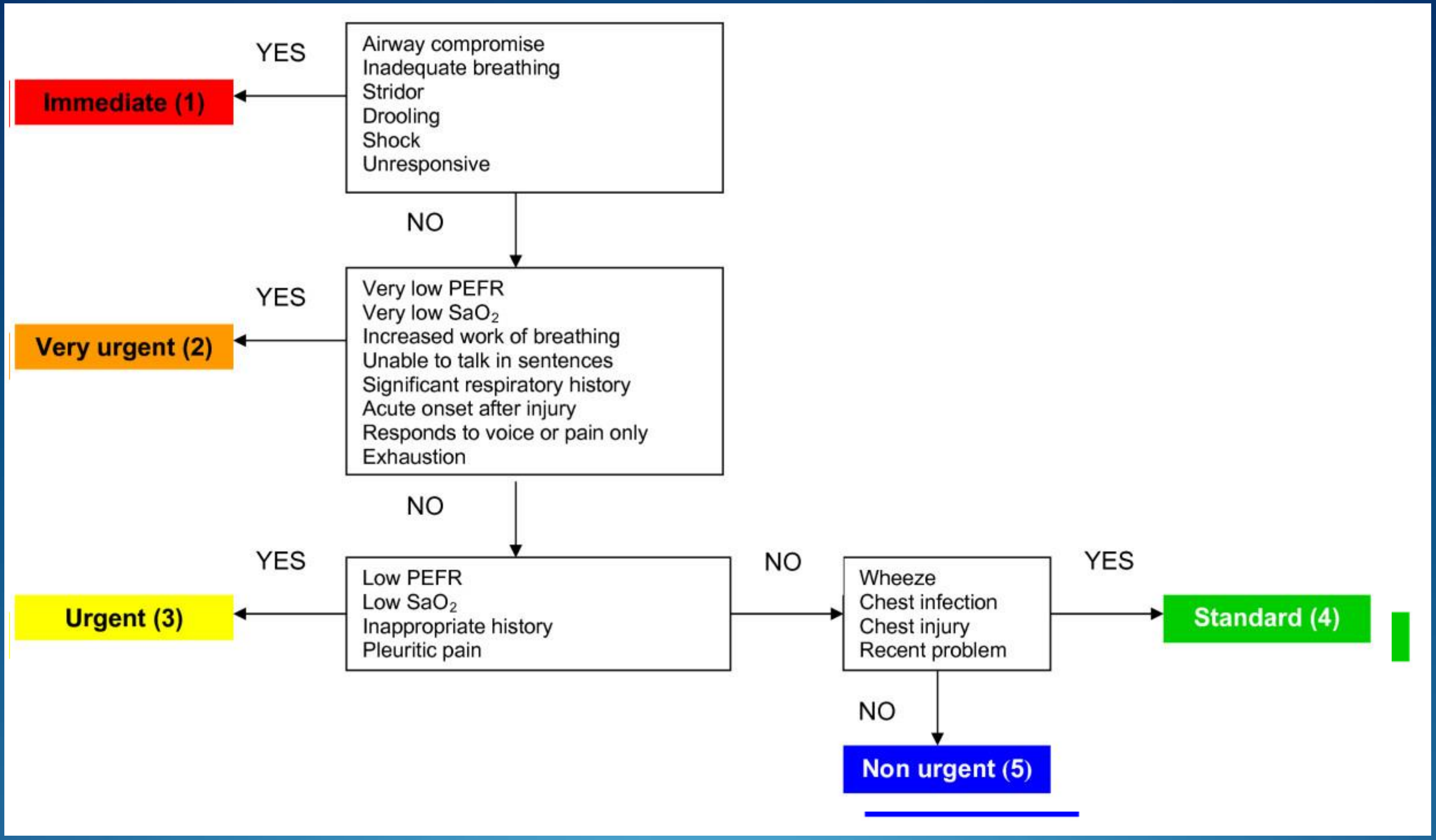
    - identify who might die in the next 10 minutes (ie length of appropriate waiting times)

    - allow for allocation of resource

# Manchester Triage

- Based solely around waiting times
    - how long is it safe to wait
    - how long is it reasonable to wait
- Starting point is presentation type
- Assumes ALL patients are category 1 until proven otherwise

# MTS Pathway for Shortness of Breath



| LEVEL OF PRIORITY | COLOUR | SAFETY MINUTES UNTIL FIRST MEDICAL EXAMINATION |
|---|---|---|
| IMMEDIATE | RED | IMMEDIATLY |
| VERY URGENT | ORANGE | Up to 10 MINUTES |
| URGENT | YELLOW | Up to 60 MINUTES |
| STANDARD | GREEN | Up to 120 MINUTES |
| NON-URGENT | BLUE | Up to 240 MINUTES |

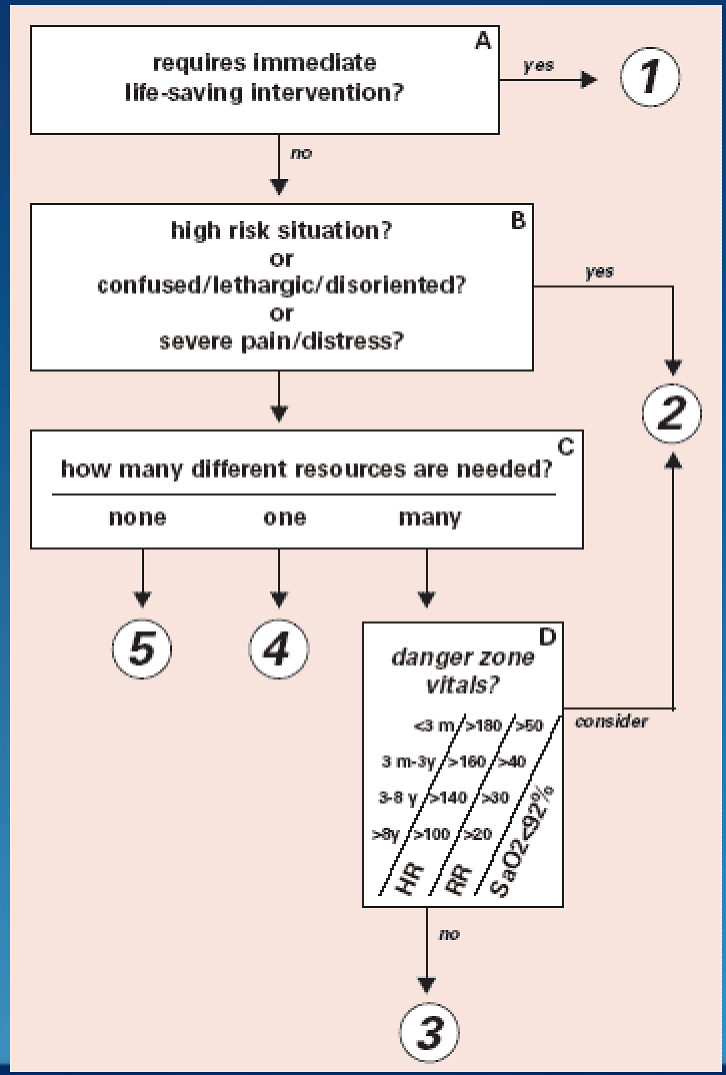
# Utility of MTS

- More sensitive than physiological scoring alone at predicting death or admission to ITU
- Odds of dying ~40x higher in categories 1 and 2
- High levels of inter-user reliability
- Allows earlier identification and management of certain subsets of patients eg. chest pain

- NOT demonstrated to:
  - predict need for inpatient admission
  - predict resource requirement
  - help manage the department

# Emergency Severity Index

- Primary concern is patient safety
- ALSO seeks to maximise patient streaming
- Premised on predicting resource needed to allow safe disposal of patient from the ED
- Does NOT allocate times, unlike almost other triage systems


A
requires immediate
life-saving intervention?
yes
1
no
B
high risk situation?
or
confused/lethargic/disoriented?
or
severe pain/distress?
yes
2
C
how many different resources are needed?
none
one
many
5
4
D
danger zone
vitals?
<3 m >180 >50
3 m-3y >160 >40
3-8 y >140 >30
>8y >100 >20
HR
RR
SaO2<92%
consider
no
3

# Utility of ESI

- Simpler and faster to use than other triage systems
- Correlates well with need for hospitalisation, ED LoS and mortality
- Some evidence of improved streaming in the ED
- Poorer correlation with physician evaluation and nursing workload measures
- Some evidence that it is less good for elderly patients

# Are patients safe after admission?

# NO

# Time to Intervene?

A review of patients who underwent cardiopulmonary resuscitation as a result of an in-hospital cardiorespiratory arrest

NCEPOD

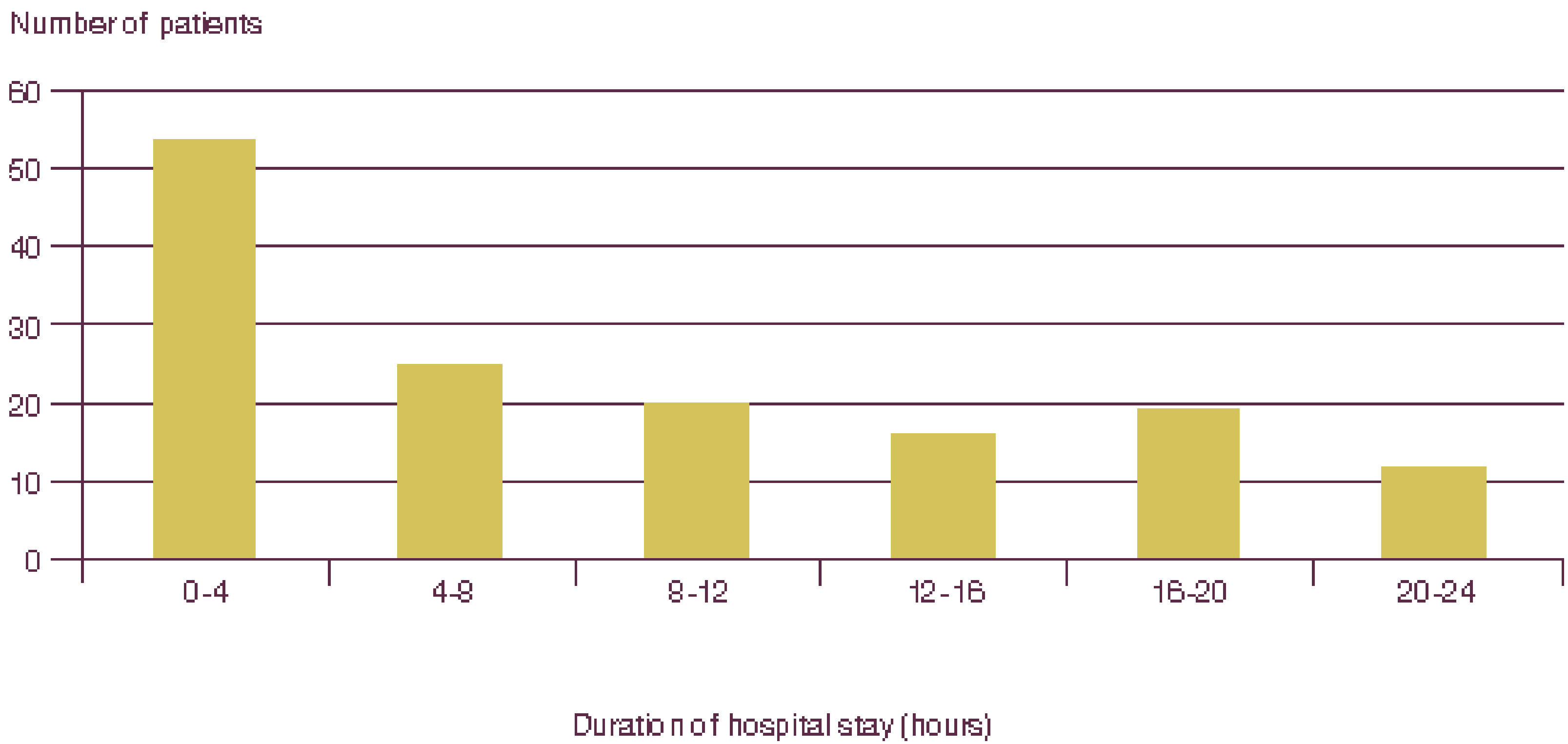



**Figure 4.3 Duration of hospital stay in those that stayed less than 24 hours**
***(n=146, not answered in 43)***

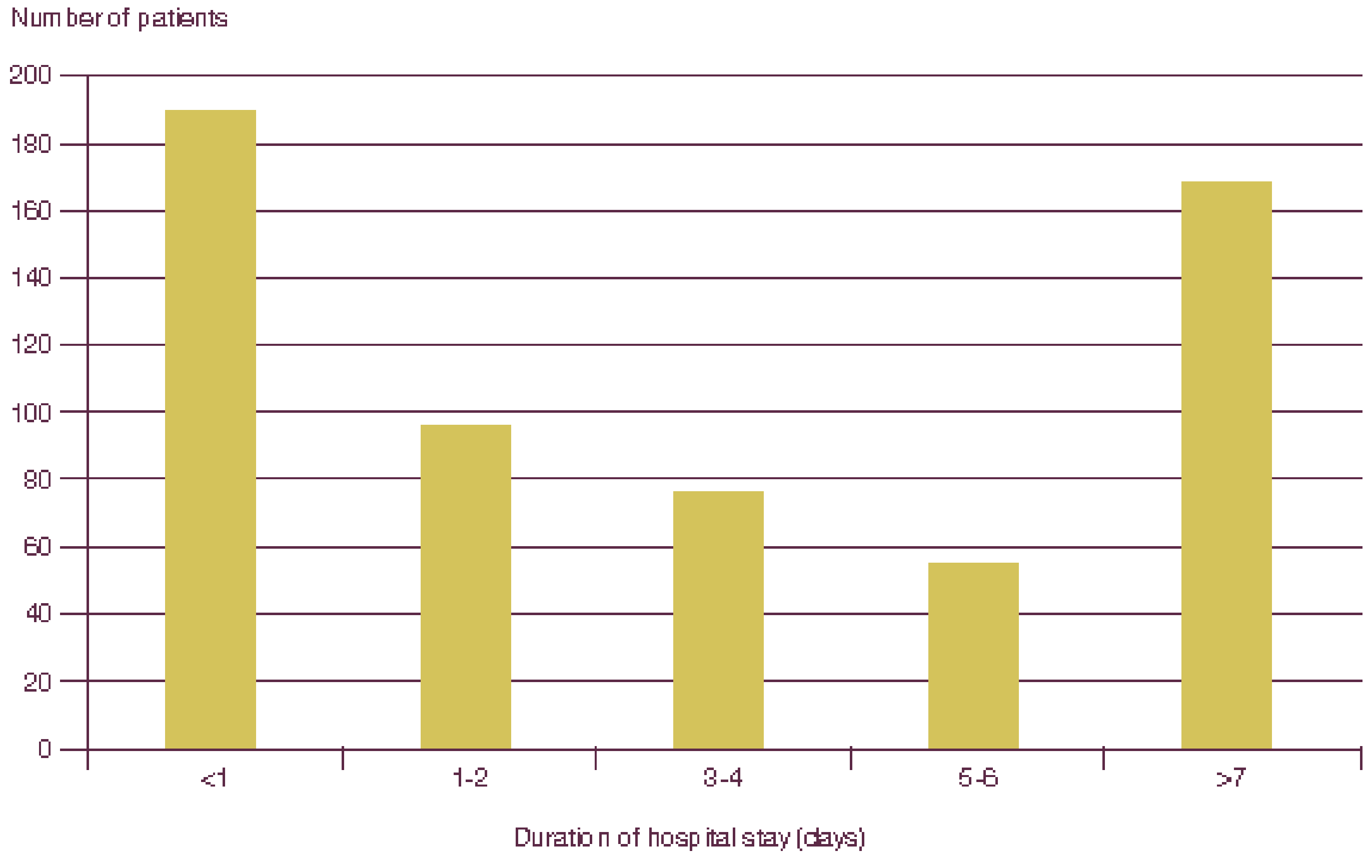



**Figure 4.2 Duration of hospital stay prior to cardiac arrest**
***(n=583, not answered in 2 cases)***

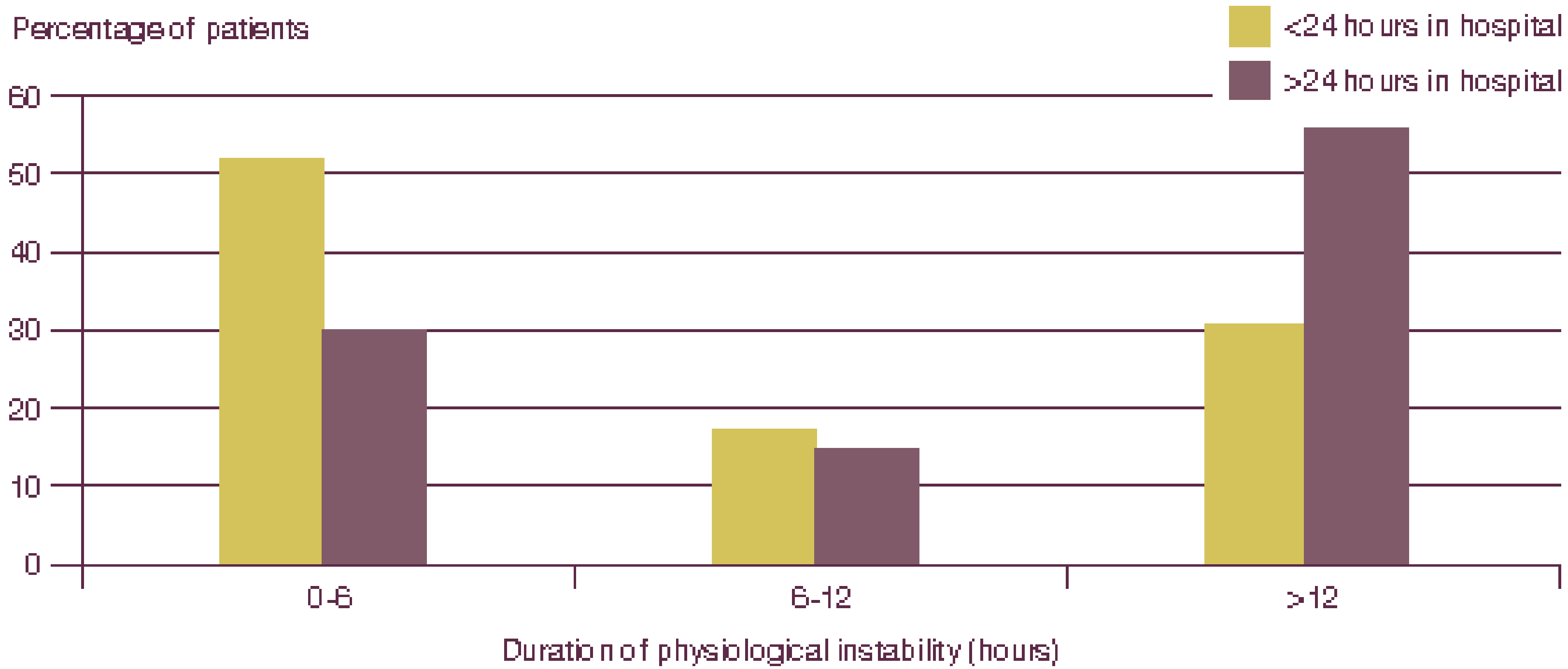



**Figure 4.6 Duration of physiological instability for those patients in hospital either less than or longer than 24 hours** ***(n= 179, not answered in 101)***

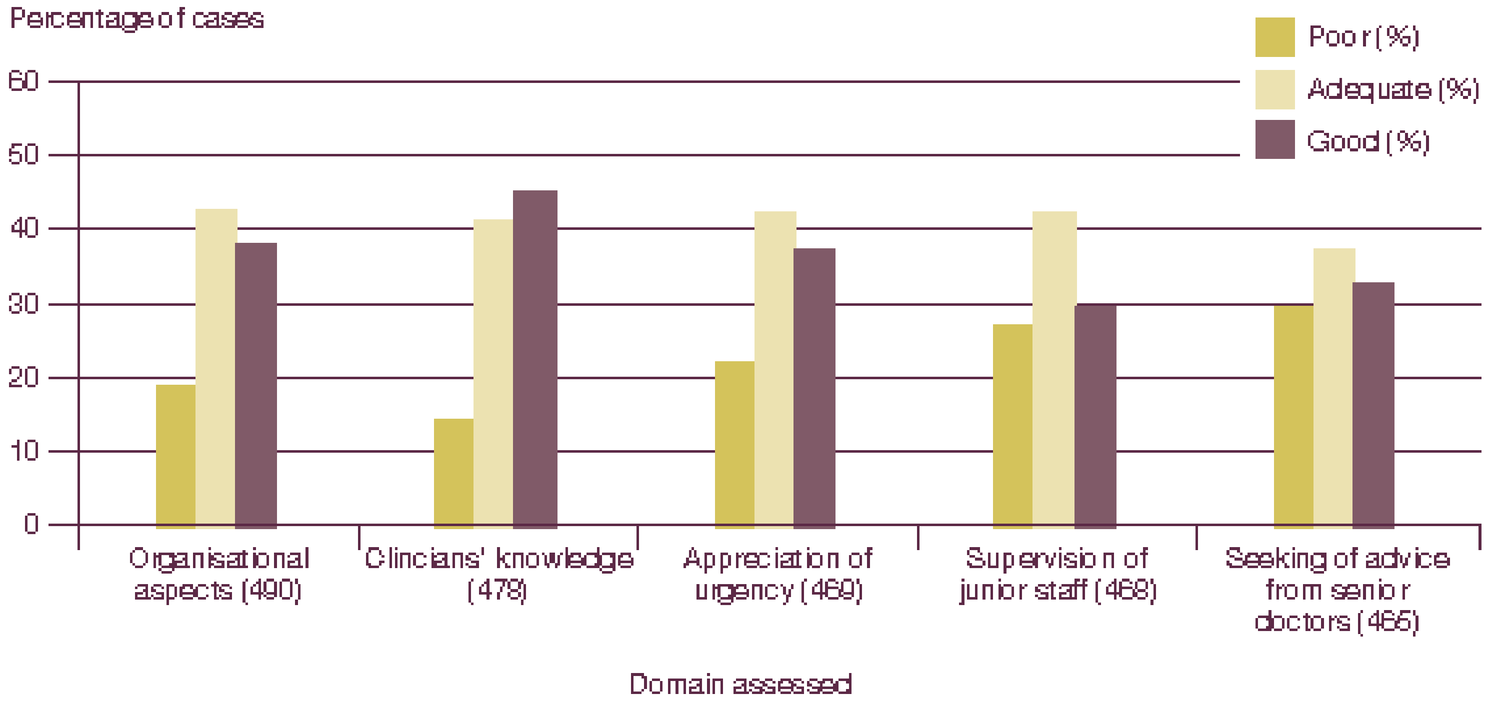
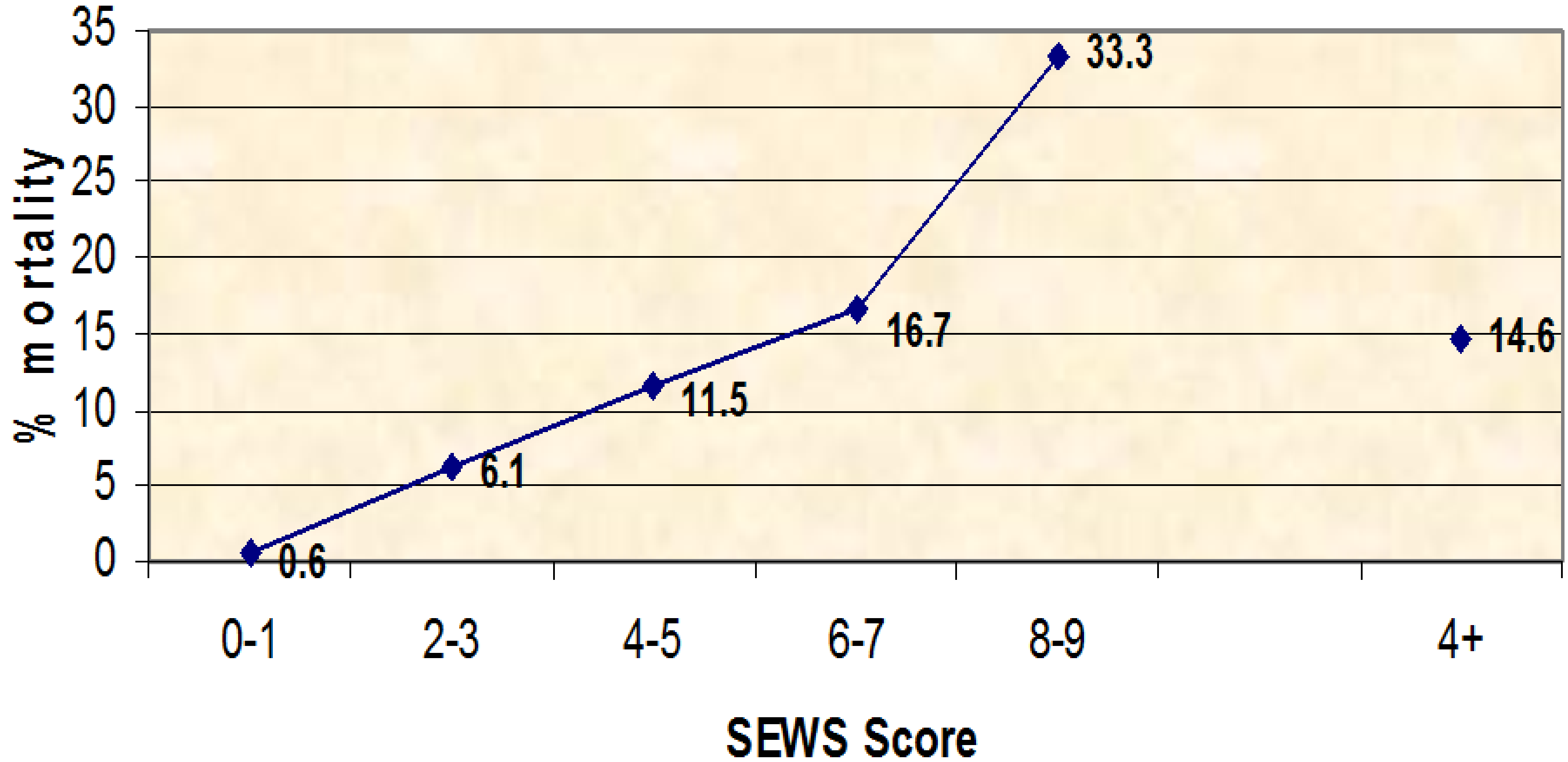



**Figure 4.10 Advisor grading of clinical aspects of care in 48 hours prior to cardiac arrest** ***(the denominator for each domain are shown in brackets)***

# Early Warning Systems

- Predicated on patient physiology
- Death related to derangement of physiology (obviously!)
- Have two ‘limbs’
  - ‘afferent’ refers to the detection of patient deterioration
  - ‘efferent’ refers to the response once deterioration detected

## Post SEWS - % in-hospital mortality according to SEWS Score (n=439)



# Search for the perfect system

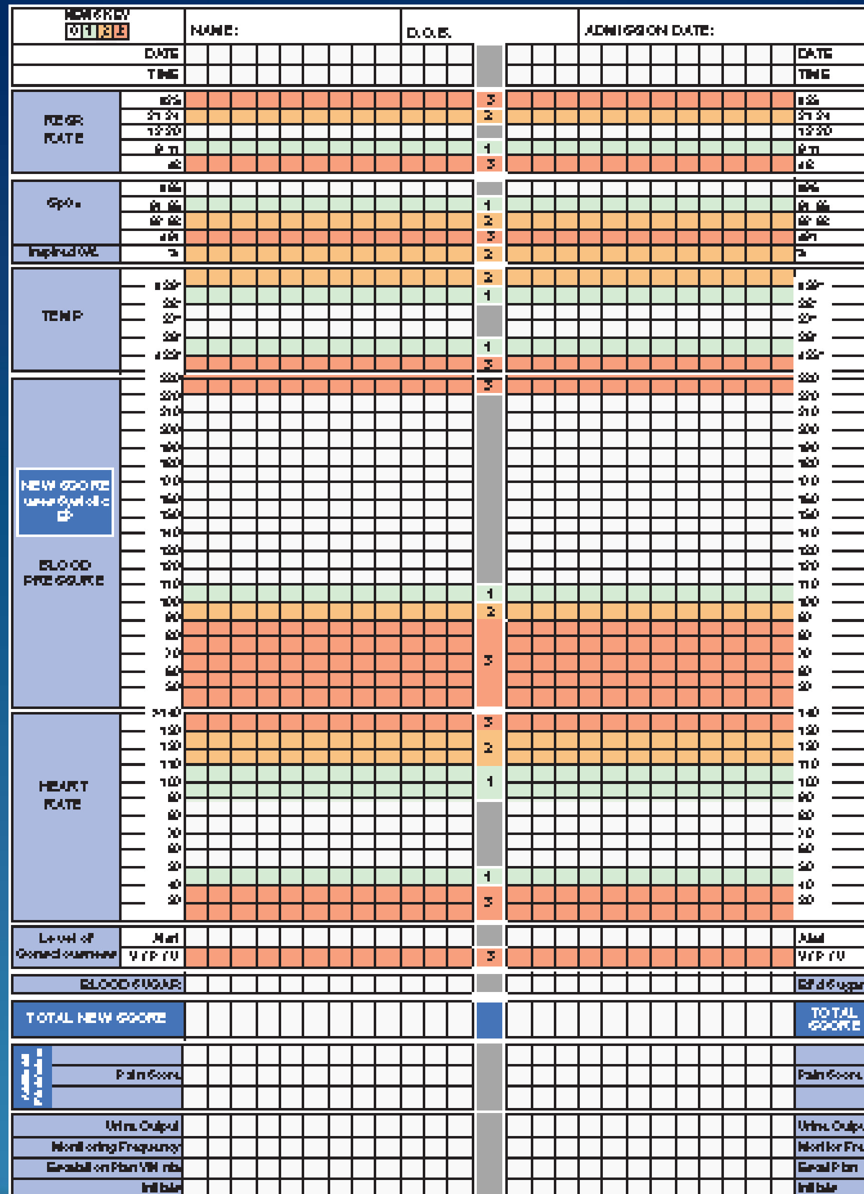
- More than 80 systems in use in the UK
- Most are locally derived and unvalidated

- Single parameter, multiple parameter and aggregate weighted systems
- Single parameter systems perform worst, aggregate weighted best

**BUT NONE WORK VERY WELL**

# National Early Warning Score

- Derived from a large vital signs database (*n* = 198,755 observation sets) collected from 35,585 consecutive, completed acute medical admissions
- Subsequently validated prospectively
- Significant time spent messing about deciding on accompanying escalation protocols




Imperial College London

Chelsea and Westminster Hospital NHS
NHS Foundation Trust

| PHYSIOLOGICAL PARAMETERS | 3 | 2 | 1 | 0 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|---|
| Respiration Rate | ≤8 | | 9 - 11 | 12 - 20 | | 21 - 24 | ≥25 |
| Oxygen Saturations | ≤91 | 92 - 93 | 94 - 95 | ≥96 | | | |
| Any Supplemental Oxygen | | Yes | | No | | | |
| Temperature | ≤35.0 | | 35.1 - 36.0 | 36.1 - 38.0 | 38.1 - 39.0 | ≥39.1 | |
| Systolic BP | ≤90 | 91 - 100 | 101 - 110 | 111 - 219 | | | ≥220 |
| Heart Rate | ≤40 | | 41 - 50 | 51 - 90 | 91 - 110 | 111 - 130 | ≥131 |
| Level of Consciousness | | | | A | | | V, P, or U |

| NEW scores | Clinical risk |
|---|---|
| 0 | Low |
| Aggregate 1–4 | |
| RED score* (Individual parameter scoring 3) | Medium |
| Aggregate 5–6 | |
| Aggregate 7 or more | High |

# Human and cultural issues with EWS

- The ‘Efferent Limb’ is the weak point
- Evidence consistently shows that staff fail to use EWS as intended
- Series of studies around this revealing

# EWS as 'work'

- Taking of routine observations considered by nurses to be LEAST important task that they do
- Routinely delegated to most junior nurses or healthcare assistants

- EW charts aided escalation of care when:
  - Electronic systems are introduced
  - signs of deterioration mapped to the trigger system
  - when triggering was happening for the first few times

  - Effects tend to wear over time unless:
    - systematic audit in place
    - presence of feedback/penalties

# EWS as 'permission'

- **EWS often used as pretext for seeking help ie. nursing or other staff will notice that pt does not look well and then repeatedly do observations until patient triggers escalation**
- **EWS used a 'permission' to call for senior help**

- **Can also make it HARDER to seek help**

*if people score 5 or 6 continuously for days and then they just don't look as good as they did yesterday… If I said, 'Mr B looks a lot worse today but their observations are exactly the same,' … it's harder for [a doctor] to see where you're coming from'* (Westward, Nurse)

# Times when EWS is ignored

- **Ward rounds – considered to be highly protected time**
- **When specialist teams need to become involved**
- **Fears of negative reaction from other staff**
- **Concerns about limited resource (knowing that ITU is already full)**

*'People are scared of one another, [if] there's a neurology problem in A&E, the medical registrar sees the patient because the neurologist doesn't want to come, the neurology registrar says, "Just admit the patient and I'll come and see them in a couple of weeks time." And then what should happen is that the medical registrar should get on the phone to his consultant. But the registrar doesn't want to bother the consultant and the medical consultant doesn't want to have any hassle with the neurology consultant'* (Eastward, 16, Consultant Medicine).

# Role of relationships

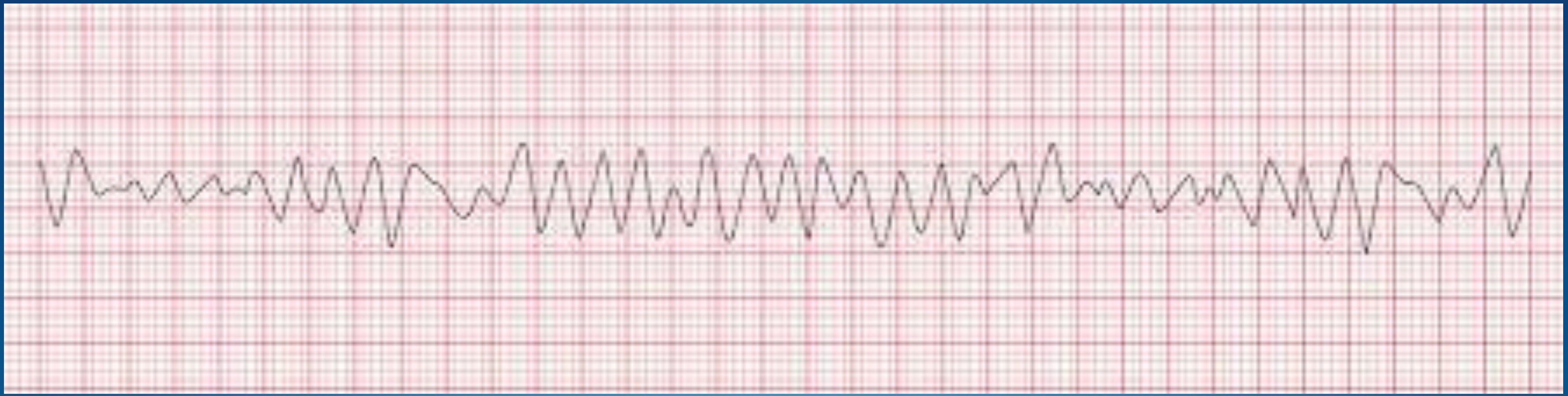
- Patients and their relatives often able to detect even subtle deterioration
- This is often dismissed in favour of more 'objective' data (such as the EWS score)
- Families frequently act as 'safety nets'
- Importance of continuity of care wrt nursing and medical staff and establishment of relationships with patients and families
- Doctor-doctor relationships also important and these may be undermined by team structure of many outreach services

# Enablers of EWS

- Education, education, education
- Robust audit and feedback
- Appropriate cultural climate and approach to risk

# EWS limitations

- Only good at detecting certain types of death
- Not good at predicting sudden catastrophic events



# EWS limitations

- People fail to understand basic physiology that underlies EWS
- EWS do not include diastolic BP, which may be first sign of bleeding or sepsis
- Respiratory rate is MOST powerful predictor of death, but is observation that is least well done

CHEST

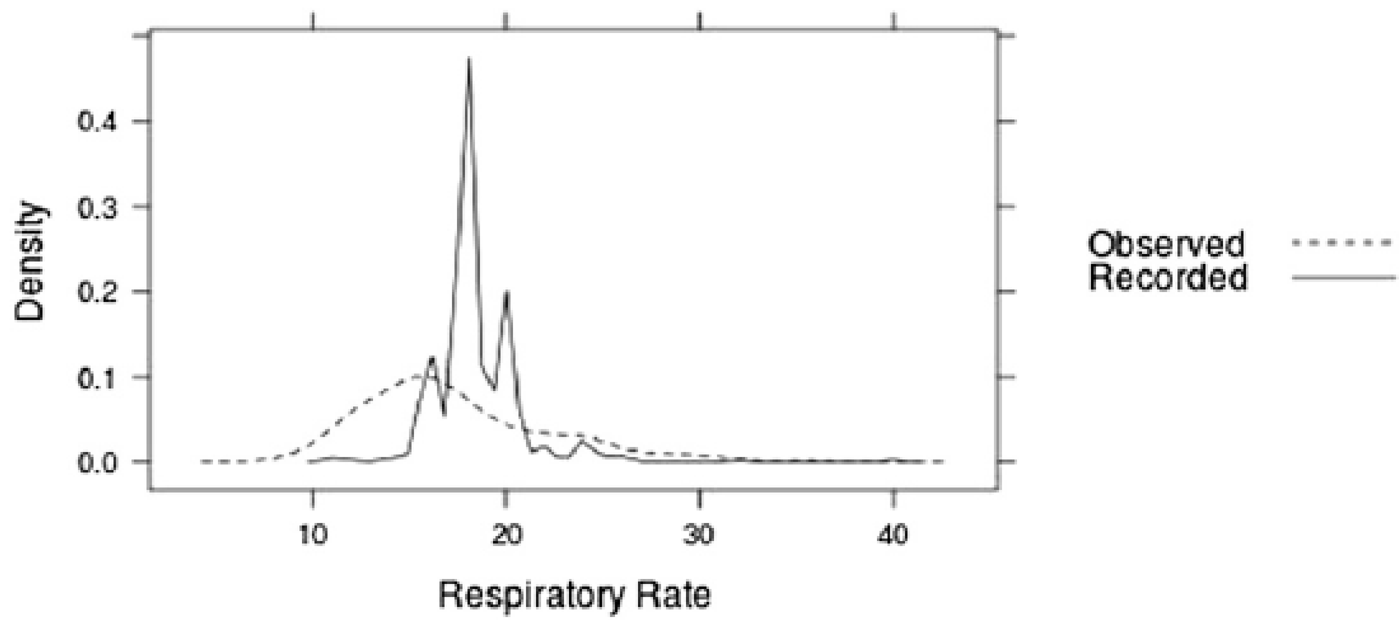
Original Research

SIGNS AND SYMPTOMS OF CHEST DISEASES

# Flash Mob Research

## A Single-Day, Multicenter, Resident-Directed Study of Respiratory Rate

Matthew W. Semler, MD; Daniel G. Stover, MD; Andrew P. Copland, MD; Gina Hong, MD; Michael J. Johnson, MD; Michael S. Kriss, MD; Hannah Otepka, MD; Li Wang, MS; Brian W. Christman, MD; and Todd W. Rice, MD, FCCP



# EWS limitations

- **Based on physiological norms – need to be interpreted with caution in the young and the fit**

# The elderly are evil….

- 18% of all in-hospital deaths within 30 days are in patients with a low AbEWS on admission. Those admitted with a low AbEWS are more likely to increase their score and those admitted with a high score are more likely to lower it. Paradoxically, patients who have an averaged score over the first 6 h in hospital that is lower than on admission have increased in-hospital mortality. Thereafter patients with an increase in the averaged score have almost twice the mortality of those with a decreased score. 4.7% of patients have a low averaged score on the day they die.

Kellett. Resus 2014

# The elderly are evil…

- Many die with minimal physiological derangement
- CHANGE in EWS seems to be key - this need NOT be big
- Appear to need minimum of 6-8 hours of monitoring to detect change, if it is going to occur
- Few patients deteriorate in period 2-4 days

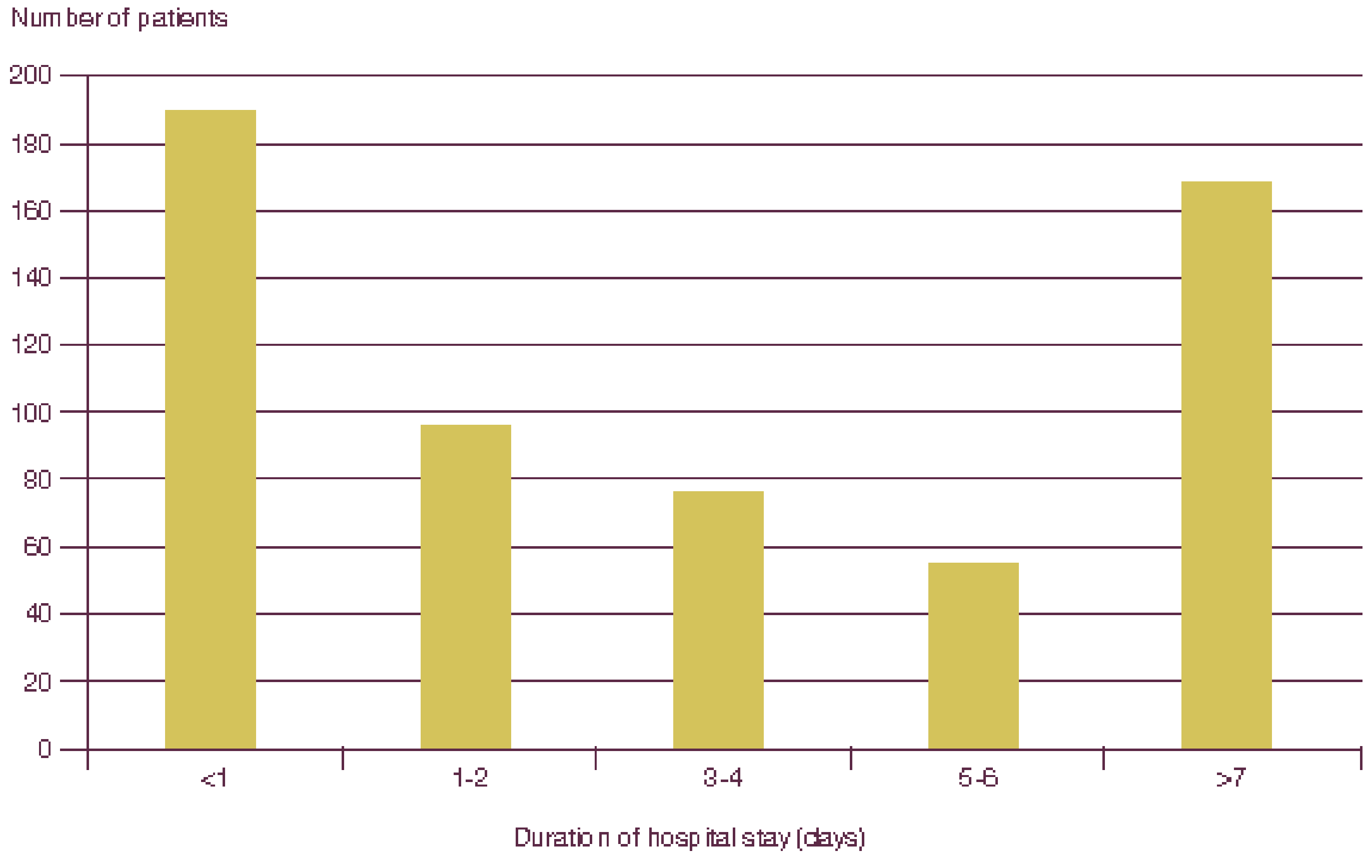


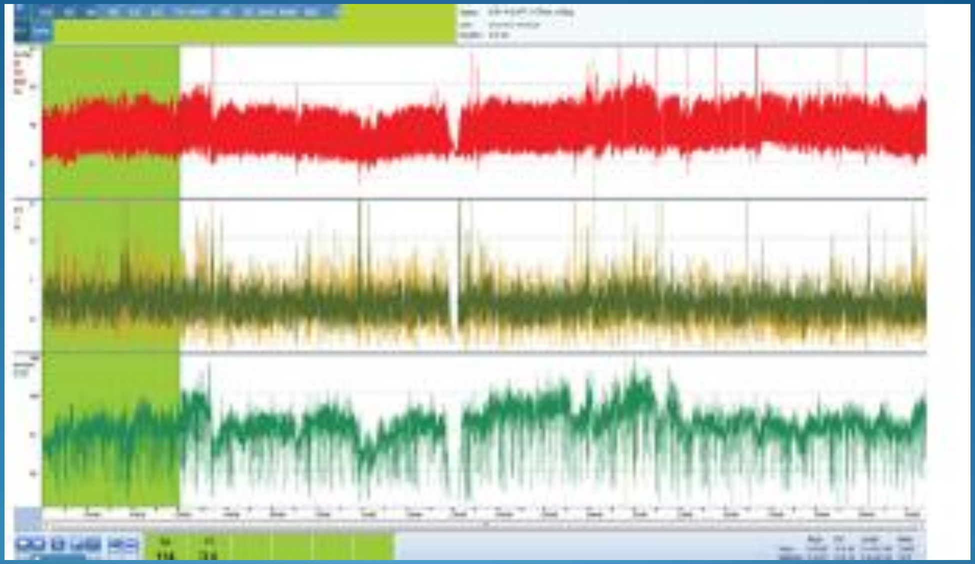

**Figure 4.2 Duration of hospital stay prior to cardiac arrest**
***(n=583, not answered in 2 cases)***

# CANNOT USE EWS TO DETERMINE SAFETY AT HOME

# Nextfin

Figure 2. Finger cuff—the only sensor on the patient.

# Noninvasive Hemodynamic Monitoring in Emergency Patients with Suspected Heart Failure, Sepsis and Stroke: The Premium Registry



Imperial College London

Chelsea and Westminster Hospital NHS
NHS Foundation Trust

Table 4. Significant hemodynamic predictors for 30-day mortality.

| | Optimal cut point | AUC | p-value |
|---|---|---|---|
| Acute heart failure | | | |
| Systolic BP | 116.9 | 0.677 | 0.03 |
| Heart rate | 76.6 | 0.703 | 0.02 |
| Cardiac output | 5.81 | 0.685 | 0.01 |
| Stroke volume | 39.91 | 0.783 | <0.01 |
| SVI | 24.2 | 0.730 | 0.01 |
| SVR | 1177.6 | 0.637 | 0.03 |
| Sepsis | | | |
| Cardiac output | 5.80 | 0.702 | 0.01 |
| Cardiac index | 3.17 | 0.685 | 0.01 |
| Stroke volume | 64.2 | 0.694 | 0.01 |
| SVI | 35.3 | 0.687 | 0.01 |
| SVR | 1310.1 | 0.605 | 0.02 |
| SVRI | 2334.5 | 0.583 | 0.04 |
| Stroke | | | |
| SVI | 22.16 | 0.741 | 0.05 |

*ROC*, receiver operator characteristic curve; *AUC*, area under curve; *BP*, blood pressure; *SVI*, stroke volume index; *SVR*, systemic vascular resistance; *SVRI*, systemic vascular resistance index

# Autonomic variability

- Highly complex and previously domain of physiology labs only
- Issue now is number of markers available and which is best
- Very strong predictors of death in 'normal' people and in those with heart disease

# Heart rate variability:
# a noninvasive electrocardiographic method to measure the autonomic nervous system

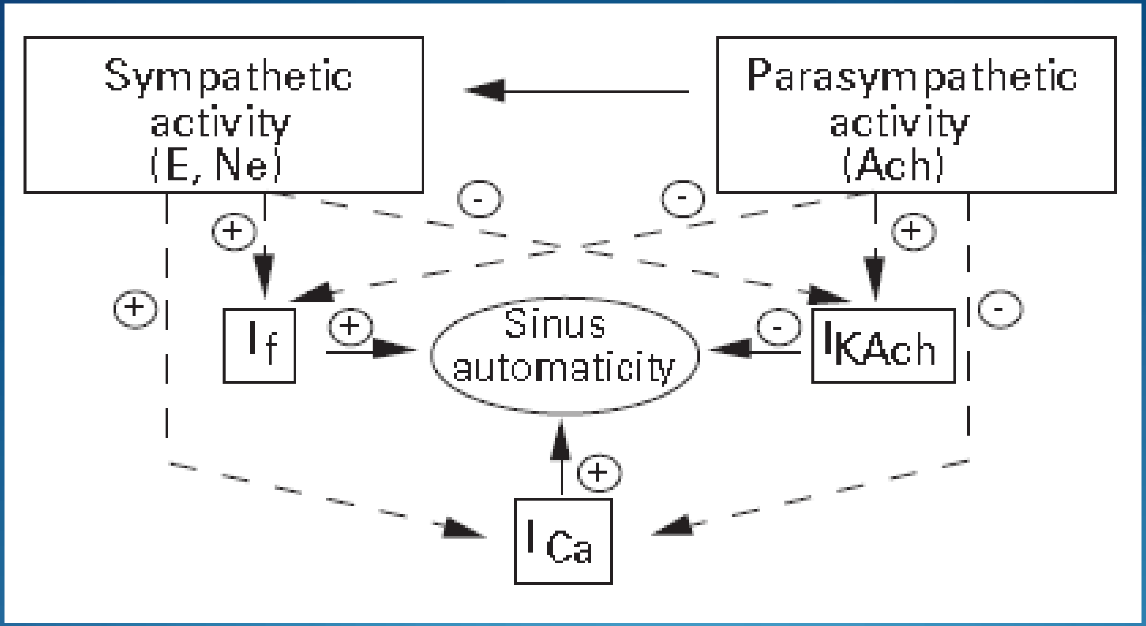
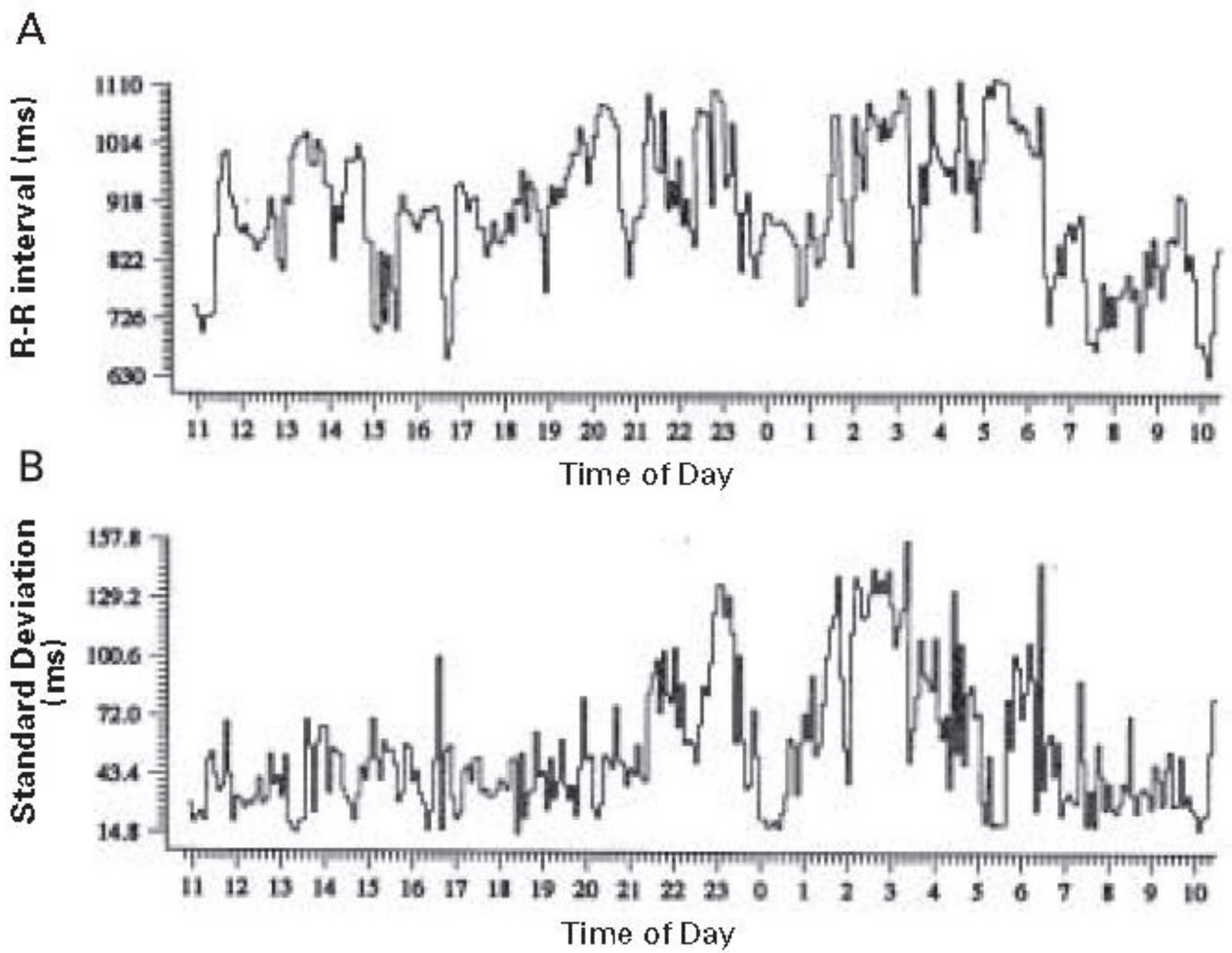


**Figure 2**

Time domain and power spectral recordings taken from a 72-year-old man after myocardial infarction.
A. 24-hour RR interval variation.
B. 24-hour standard deviation of all normal RR intervals.
C. Power spectral components corresponding to three different pics of frequency bands: the VLF, the LF and the HF bands.
HF = high frequency power; LF = low frequency power; PSD = power spectral density; VLF = very low frequency power.



# Take home messages

- Triage and physiological monitoring systems serve different purposes
- They are designed to predict DIFFERENT types of death!
- Need to understand physiology
- Need to understand culture

# CULTURE
# EATS
# PROCESS
# EVERY TIME