ICU SCORING SYSTEMS
INCLUDING SEPSIS

CSIM 2018
Banff AB

Scott McKee MD MPH FACP
- Basic elements of Scoring Systems
- Widely used ICU scoring systems and relative performance data
- Examples of 2 special cases outside of the ICU
- SOFA data support for 2016 Sepsis Guidelines
- Conclusions
- Website calculator reference
Scoring systems are widely used in critical care medicine. A few are used widely for ICU predictions and infinite others for selected disease states and outcomes.

Usually quantify severity of illness (the Score) used to assign probability of mortality (the Prediction).

Should always be used with an understanding of their limitations.

Some systems have been compared but there is no one “best” model.
Scoring System categories

- Infinite variables available, no universal approach

- May be single set or repeated over time:
  - First day: APACHE, SAPS, MPM
  - Repetitive: SOFA, OSF, MODS
Essential features:

- Assemble the scoring components
- Validation
- Discrimination
- Calibration
Calculators used primarily in a general ICU:

- **APACHE (II-IV)**
  - Acute Physiology and Chronic Health Evaluation

- **MPM (1-3)**
  - Mortality Prediction Model

- **SOFA**
  - Sequential Organ Failure Assessment

- **SAPS (1-3)**
  - Simplified Acute Physiology Score
Populations and variables:

Table 1

Comparison of general outcome prediction models

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<tbody>
<tr>
<td>Countries</td>
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<td>1</td>
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<td>12</td>
<td>12</td>
<td>35</td>
<td>1</td>
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<tr>
<td>ICUs</td>
<td>2</td>
<td>2</td>
<td>13</td>
<td>1</td>
<td>40</td>
<td>137</td>
<td>140</td>
<td>303</td>
<td>104</td>
<td>135</td>
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<td>Patients</td>
<td>705</td>
<td>679</td>
<td>5,815</td>
<td>2,783</td>
<td>17,440</td>
<td>12,907</td>
<td>19,124</td>
<td>16,784</td>
<td>110,558</td>
<td>124,855</td>
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<tr>
<td>Selection of variables and their weights</td>
<td>Panel of experts</td>
<td>Panel of experts</td>
<td>Panel of experts</td>
<td>Multiple logistic regression</td>
<td>Multiple logistic regression</td>
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Variables

- **Age**: No, Yes
- **Origin**: No, No, No
- **Surgical status**: No, No, Yes
- **Chronic health status**: Yes, No, Yes
- **Physiology**: Yes, Yes

*These models are based on previous versions, developed by the same authors. The numbers presented are those for the admission component of the model (MPM II). MPM uses only 13 variables. Plus 7 interaction terms. APACHE, Acute Physiology and Chronic Health Evaluation; SAPS, Simplified Acute Physiology Score; MPM, Mortality Probability Model. Adapted from [64] with permission.
### Main advantages and disadvantages for the Acute Physiology and Chronic Chronic Health Evaluation-IV, MPM0-III and Simplified Acute Physiology Score 3 scores

<table>
<thead>
<tr>
<th>Scoring system</th>
<th>Advantages</th>
<th>Disadvantages</th>
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</table>
| APACHE-IV[^1] | - Coefficients regularly updated  
- Provides algorithms for LOS prediction  
- Specific algorithm to predict mortality in CABG surgery patients  
- Less prone to be affected by the case-mix | - Developmental sample restricted to one country  
- More complex data collection  
- High abstraction burden  
- Proprietary scoring system* |
| MPM0-III[^2]  | - Low abstraction burden  
- Less prone to interobserver variability  
- By using less physiologic data, may be preferred when laboratory resources are constrained | - Developmental sample mostly restricted to one country  
- More susceptible to case-mix effects |
| SAPS 3[^3-^4] | - Lowest abstraction burden  
- Less prone to interobserver variability  
- Developmental sample from 35 countries in five continents  
- Customized equations to predict hospital mortality according to seven different geographic regions  
- Potential use for international benchmarking | - Does not provide estimation for LOS  
- Some regional equations were developed using relatively low sample size |

**APACHE:** acute physiology and chronic health evaluation; **LOS:** length of stay; **CABG:** coronary artery bypass graft; **MPM:** mortality probability model; **SAPS:** simplified acute physiology score.

* Cerner Corporation has made the score algorithms publicly available.

### References:

From: Salihu JI, Soares M. ICU severity of illness scores: APACHE, SAPS and MPM. Curr Opin Crit Care 2014; 20:557. DOI: [10.1097/MCC.0000000000000135](https://doi.org/10.1097/MCC.0000000000000135). Copyright © 2014. Reproduced with permission from Lippincott Williams & Wilkins. Unauthorized reproduction of this material is prohibited.
Severity of illness scoring systems in the intensive care unit.

Keegan MT\textsuperscript{1}, Gajic O, Afessa B.

Department of Anesthesiology, Mayo Clinic, Rochester, MN, USA.
Keegan, et al summary:

- “The areas under the receiver operating characteristic curve of SAPS 3, Acute Physiology and Chronic Health Evaluation IV, and Mortality Probability Model0 III were 0.85, 0.88, and 0.82, respectively.”

- “All three fourth-generation models had good calibration.”
Comparison of newer scoring systems with the conventional scoring systems in general intensive care population.

Aujuneja D, Singh O, Nasa P, Dang R SO.

“Overall, the newer scoring systems performed better than their older counterparts and were more accurate.”

“Nevertheless, the difference in efficacy was not statistically significant and the choice of scoring system may depend on the ease of use and local preferences.”
Early Warning System Scoring

**Patient Assessment, Observation and Infusion Monitoring Chart**

**Patient I.D. Label**

**Consultant:**

**Ward:**

**Area of Numbness Epidurals Only**

- Use multi-mix solutions in cold water to determine area of sensory loss e.g. if left upper thigh affected, then slide L2 epidural
- Mark areas of loss with marker pen
- Check pressure areas intact

**Special Instructions:**

**Pain Score (On Movement)**

- 0: No pain
- 1: Mild
- 2: Moderate
- 3: Severe
- 4: Unbearable

**Respiratory Rate**

- Whilst patient is at rest, count respiratory rate for 1 minute and record

**Nausea & Vomiting Score**

- 0: No Nausea
- 1: Nausea
- 2: Vomiting & Retching

**MEWS (Modified Early Warning System)**

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<tr>
<th>Respiratory Rate per minute</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
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<th>2</th>
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<td>21-29</td>
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<tr>
<th>Heart Rate per minute</th>
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<th>0</th>
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<td>51-100</td>
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<td>101-110</td>
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<td>111-129</td>
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<td>More than 129</td>
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<th>Systolic Blood Pressure</th>
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<td>81-100</td>
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<td>More than 200</td>
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<th>Conscious Level (AVPU)</th>
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<th>Temperature (°C)</th>
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<td>36.1-38</td>
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<td>More than 38.8</td>
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<th>Hourly Urine For 2 hours</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
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<tbody>
<tr>
<td>Less than 10/6 ml / hr</td>
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<td>Less than 30/6 ml / hr</td>
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<td>More than 45/6 ml / hr</td>
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**Early Warning Scoring System for Detecting Adult Patients Who Have or Are Developing Critical Illness**

- Is the Score for your Patient 1-2?
- Perform 1-2 Hourly Observations and Inform Nurse in Charge
- Is the Score for your Patient 3?
- Perform 1-2 Hourly Observations and Inform Nurse in Charge
- "If the MEWS Score is deteriorating; the Ward S.H.O. or Duty Doctor Must Attend"
- Is the Score for your Patient 4 or More?
- Perform Observations at Least 1/2 Hourly. Ensure Medical Advice is Sought and Contact Outreach Team (see below)

**Outreach Bleep No: 4495: Contact for MEWS Advice / Assistance**

Ymddiriedolaeth GIG Siroedd Conwy a Dinebych
Conwy & Denbighshire NHS Trust
In surgical patients with IA sepsis:

- Derivation of a PIRO Score for Prediction of Mortality in Surgical Patients With Intra-Abdominal Sepsis

- Juan G. Posadas-Calleja, MD, MSc,
- Henry T. Stelfox, MD, PhD, FRCPC,
- Andre Ferland, MD, FRCPC,
- Danny J. Zuege, MD, MSc, FRCPC,
- Daniel J. Niven, MD, PhD, FRCPC,
- Luc Berthiaume, MD, MSc, FRCPC and
- Christopher James Doig, MD, MSc, FRCPC†

+ Author Affiliations

All authors are at the University of Calgary, Calgary, Alberta, Canada. Juan G. Posadas-Calleja is a clinical assistant professor, Department of Critical Care Medicine. Henry T. Stelfox is a professor, Departments of Critical Care Medicine, Community Health Sciences, and Medicine. Andre Ferland is a clinical associate professor, Departments of Critical Care Medicine and Medicine. Danny J. Zuege is a clinical professor, Department of Critical Care Medicine and Division of Respiratory Medicine. Daniel J. Niven is an assistant professor, Departments of Critical Care Medicine and Community Health Sciences. Luc Berthiaume is a clinical associate professor, Departments of Critical Care Medicine and Community Health Sciences and Division of Respiratory Medicine. Christopher James Doig is a professor and head, Department of Critical Care Medicine, and a professor, Departments of Community Health Sciences and Medicine.

Corresponding author:
Christopher James Doig, MD, MSc, FRCPC, Foothills Medical Centre, ICU Administration McCaig Tower, Room 0449, 3134 Hospital Dr NW, Calgary, AB T2N 5A1 (e-mail: cdoig@ucalgary.ca).
The SOFA (Sepsis-related Organ Failure Assessment) score to describe organ dysfunction/failure. On behalf of the Working Group on Sepsis-Related Problems of the European Society of Intensive Care Medicine.

Vincent JL, Moreno R, Takala J, Willatts S, De Mendonça A, Bruining H, Reinhart CK, Suter PM, Thijs LG.
Serial evaluation of the SOFA score to predict outcome in critically ill patients.

CONCLUSIONS:
“Sequential assessment of organ dysfunction during the first few days of ICU admission is a good indicator of prognosis. Both the mean and highest SOFA scores are particularly useful predictors of outcome. Independent of the initial score, an increase in SOFA score during the first 48 hours in the ICU predicts a mortality rate of at least 50%.”
January 17, 2017

Prognostic Accuracy of the SOFA Score, SIRS Criteria, and qSOFA Score for In-Hospital Mortality Among Adults With Suspected Infection Admitted to the Intensive Care Unit

Eamon P. Raith, MBBS, MACCP1,2; Andrew A. Udy, MBChB, PhD, FCICM1,3; Michael Bailey, PhD3; et al

CONCLUSIONS In this retrospective cohort analysis of 184,875 adults, SOFA (area under the receiver operating characteristic curve [AUROC], 0.753) demonstrated significantly greater discrimination for in-hospital mortality than SIRS criteria (AUROC, 0.589) or qSOFA (AUROC, 0.607).
General ICU scoring systems have been developed and updated over ~30 years and perform well at predicting mortality in populations.

Score should NOT be used in the management decisions on individual patients.

Scores most helpful in research and in QI projects.

When choosing a system, factors that should be taken into consideration include performance in the population of interest, feasibility, ease of use, and availability.
Quick website calculators:


- Scores:
  - APACHE II
  - APACHE IV
  - APGAR
  - CHILD
  - ISS - RTS - TRISS
  - MPM II (Admission)
  - MPM II (24-48-72h)
  - MODS
  - SAPS II
  - SOFA
Thank you
Mortality prediction model III (MPM_0-III)

Variable Response Points

Patient age* Medical or unscheduled surgical admission? Yes 1 No 0
Cardiopulmonary resuscitation prior to admission? Yes 1 No 0
Coma (Glasgow coma scale 3-5)? Yes 1 No 0
(Does not include patients whose coma is due to overdose or who received neuromuscular blocking agents) Yes 1 No 0
Heart rate ≥150 bpm? Yes 1 No 0
Systolic blood pressure ≤90 mmHg? Yes 1 No 0
Mechanical ventilation? Yes 1 No 0
Acute renal failure? Yes 1 No 0
Cardiac dysrhythmias? Yes 1 No 0
Cerebrovascular accident? Yes 1 No 0
Intracranial mass effect? Yes 1 No 0
Gastrointestinal bleeding? Yes 1 No 0
Metastatic carcinoma? Yes 1 No 0
Cirrhosis? Yes 1 No 0
Chronic renal insufficiency? Yes 1 No 0
In acute or chronic care facility before admission to ICU? Yes 1 No 0
Time between hospital and ICU admission >1 day? Yes 1 No 0
Full resuscitation status? Yes 1 No 0

* Patient age does not receive points when calculating the severity score; however, it is used in the formula to calculate predicted mortality.

“We recommend fluid resuscitation with either natural/artificial colloids or crystalloids. There is no evidence-based support for one type of fluid over another (grade 1B)”.  

Predictive models abound:

- **Anatomical**: e.g. Trauma. Abbreviated Injury Score (AIS), Injury Severity Score (ISS).

- **Subjective**: clinician judgement: e.g. live or die

- **Organ Specific**: Assumes that sicker patients have more organ derangements (SOFA).

- **Physiologic Assessment**: degree of derangement of routinely measured variables (APACHE, SAPS).

- **Disease-specific**:
  - Ranson’s criteria - pancreatitis
  - MELD – liver failure
  - WFNS – Subarachnoid hemorrhage

Short communication:

The Severity of Dependence Scale (SDS) in an adolescent population of cannabis users: Reliability, validity and diagnostic cut-off

Martin G, Copeland I, Gates P, Gilmour

https://doi.org/10.1016/j.drugalcdep.2005.10.014