

CHAPTER

1

Scores and Definitions Used in Respiratory and Critical Care Research

Current articles use several scores and definitions to describe the population being studied. We present the scores as well as the original source. We also include the latest consensus in some definitions used in respiratory and critical care.

■ CHARLSON COMORBIDITY INDEX

Method for classifying comorbid conditions that might alter the risk of mortality for use in longitudinal studies. The one-year mortality rates for the different scores were 0: 12%; 1–2: 26%; 3–4: 52%; and greater than or equal to 5: 85%. The predicted risk of death from comorbid disease at a 10-year follow-up is 0: 8%; 1: 25%; 2: 48%; and greater than or equal to 3: 59%. Assigned weight for each patient's condition. The total equals the score.

- 1 point: Myocardial infarct, Congestive heart failure, Peripheral vascular disease, Cerebrovascular disease, Dementia, Chronic pulmonary disease, Connective tissue disease, Ulcer disease, Mild liver disease, and Diabetes
- 2 points: Hemiplegia, Moderate or severe renal disease, Diabetes with end-organ damage, Any tumor, Leukemia, and Lymphoma
- 3 points: Moderate or severe liver disease
- 6 points: Metastatic solid tumor, and AIDS

Data from Charlson, M. E. et al. *J Chronic Dis* 40 (1987), 373–383.

■ MCCABE CLASSIFICATION

Classification generated to obtain comparisons regarding the importance of host factors based on the severity of the underlying disease. *In parentheses we give the disease examples from the original article (McCabe, W. R. and Jackson, G. G. Arch of Int Med 110 (1962), 847–891). Evidently the prognosis for some has changed.*

- Category 1: Nonfatal disease (diabetes, genitourinary, gastrointestinal or obstetrical conditions)
- Category 2: Ultimately fatal disease (diseases estimated to become fatal within 4 years, e.g., aplastic anemia, metastatic carcinomas, cirrhosis, chronic renal disease)

Category 3: Rapidly fatal disease (acute leukemia, blastic relapse of chronic leukemia)

■ THE KNAUS CHRONIC HEALTH STATUS SCORE

Score used in the original APACHE article, and now used to describe base-line health status of the patients enrolled in studies.

Class A: Normal health status

Class B: Moderate activity limitation

Class C: Severe activity limitation due to chronic disease

Class D: Bedridden patient

Data from Knaus et al. *Crit Care Med* 9(8) (1981), 591–597.

■ GLASGOW COMA SCALE

(See [Table 1-1](#).) Scale used to describe the neurological status of a patient, the neurological prognosis, and levels of brain injury. Points are added for each section.

Table 1-1 Glasgow Coma Scale

		Points
Eye opening	Spontaneous	4
	To voice	3
	To pain	2
	None	1
Verbal response	Oriented	5
	Confused	4
	Inappropriate words	3
	Incomprehensible words	2
Motor response	None	1
	Obeys commands	6
	Localizes	5
	Withdraws	4
	Flexion (decorticate)	3
	Extension (decerebrate)	2
	None	1

Data from Teasdale, G. M. and Jennet, B. *Lancet* 304 (1974), 81–84.

■ TRAUMA SCORE

(See [Table 1–2](#).) A field scoring system in which values are correlated with probability of survival. Points are added from each category. A score of 1–5 points has a probability of survival of 0%; 6–7 points, 10%; 8–9 points, 22 to 37%; 10 points, 55%; 11 points, 71%; 12 points, 83%; and above 13 points, 90%.

Table 1–2 Trauma Score

Points	4	3	2	1	0
Respiratory Rate	10-24	25-35	>35	<10	Apnea
Respiratory Effort				Normal	Shallow or retractions
Systolic Blood Pressure	>90	70-90	50-69	<50	Not palpable
Capillary Refill			Normal	Delayed	None
Glasgow Coma Scale	14-15	11-13	8-10	5-7	3-4

Data from Champion, H. R. et al. *Crit Care Med* 9 (1981), 672-676.

■ REVISED TRAUMA SCORE (RTS)

(See [Table 1–3](#).) A revised form of the trauma score used by the Trauma-Injury Scoring System (TRISS). It only uses three categories, for which a value is assigned. Each category value is multiplied by an assigned category weight, and the resultant values for each category are then added to obtain the RTS.

Table 1–3 Revised Trauma Score (RTS)

Points	4	3	2	1	0	Value	Weight*	Final Value
Respiratory Rate	10-29	>29	6-9	1-5	0		0.2908	
Systolic Blood Pressure	>89	76-89	50-75	1-49	0		0.7326	
Glasgow Coma Scale	13-15	9-12	6-8	4-5	3		0.9368	

*Multiply Value by Weight to get Final Value. Add all final values to obtain RTS scores.

Adapted from Champion, H. R. et al. *J Trauma* 29(5) (1989), 623-629.

■ PEDIATRIC TRAUMA SCORE

(See Table 1–4.) A score used to predict injury severity in pediatric patients. The sum of the points correlates with survival. Scores greater than 8 had a 0% mortality; between 0 and 8 had an increasing mortality. Scores below 0 had 100% mortality.

Table 1-4 Pediatric Trauma Score

Points	+2	+1	-1
Size	>20 kg	10-20 kg	<10 kg
Airway	Normal	Maintainable	Unmaintainable
Systolic Blood Pressure or Pulse	>90 mmHg Pulse palpable wrist	50-90 mmHg Pulse palpable groin	<50 mmHg No pulse palpable
Mental Status	Awake	Obtunded	Coma/ Decerebrate
Skeletal	None	Closed fracture	Open/Multiple fractures
Cutaneous	None	Minor	Major/ Penetrating

Adapted from Tepas, J. J. et al. *J. Trauma* 38 (1988), 425-429.

■ INJURY SEVERITY SCORE (ISS)

An anatomical scoring system that provides an overall score for patients with multiple injuries (Baker, et al. *J Trauma* 14 (1974), 187–196). Each injury is assigned an Abbreviated Injury Scale (AIS) score, allocated to one of six body regions (head, face, chest, abdomen, extremities, and external). Only the highest AIS score in each body region is used. The three most severely injured body regions have their score squared and added together to produce the ISS score.

The AIS ranges from 0 to 6, 0 being no injury, and 6 unsurvivable injury. The ISS values range from 0 to 75. A patient with an ISS score of 6 in any category automatically obtains the maximum ISS score (75). The AIS scores used are revised and published by the Association for the Advancement of Automotive Medicine.

■ TRAUMA-INJURY SEVERITY SCORE (TRISS)

A score that uses values from the ISS, the RTS, the patient age, and the type of injury to quantify the probability of survival (Boyd, C. R. et al. *J Trauma* 27(4) (1987), 370–378).

Age points: ≥ 55 years old = 1 point, otherwise 0 points.

$$\text{TRISS (blunt): } b = -0.4499 + \text{RTS} \times 0.8085 + \\ \text{ISS} \times -0.0835 + (\text{age points}) \times -1.7430$$

or

$$\text{TRISS (penetrating): } b = -2.5355 + \text{RTS} \times 0.9934 + \\ \text{ISS} \times -0.0651 + (\text{age points}) \times -1.1360$$

then

$$\text{Probability of survival} = 1/(1 + e^b) \\ \text{Probability of death} = 1 - \text{probability of survival.}$$

■ ACUTE PHYSIOLOGY AND CHRONIC HEALTH EVALUATION (APACHE II)

(See [Tables 1–5](#) and [1–6](#).) Used as a clinical scoring system to classify the severity of illness. APACHE II uses the worst last values in the last 24 hours.

To calculate the predicted death rate:

APACHE II SCORE = Acute Physiology Score + Age points + Chronic Health points

$\text{Ln}(R/1 - R) = -3.517 + (\text{Apache II}) * 0.146 + \text{Diagnostic Category Weight} + 0.603$ if postemergency surgery.

Predicted Death Rate = $e^{\text{Ln}(R/1 - R)} / (1 + e^{\text{Ln}(R/1 - R)})$ where “ e ” is the base of natural logarithm, 2.718.

■ SEQUENTIAL ORGAN FAILURE ASSESSMENT (SOFA) SCORE

(See [Table 1–7](#).) Score designed to describe the degree of organ dysfunction in critically ill patients.

Table 1-5 Acute Physiology and Chronic Health Evaluation (APACHE II)
 APACHE II is used as a clinical scoring system to classify the severity of illness. It uses the worst last values in the last 24 hrs.

Physiologic Variable	Points								
	4	3	2	1	0	1	2	3	4
Temperature—rectal (°C)	≥41	39.9–40.9		38.5–38.9	36–38.4	34–35.9	32–33.9	30–31.9	≤29.9
Mean Arterial Pressure—mmHg	≥160	130–159	110–129		70–109		50–69		≤49
Heart Rate (ventricular response)	≥180	140–179	110–139		70–109		55–69	40–54	≤39
Respiratory Rate (total)	≥50	35–49		25–34	12–24	10–11	6–9		≤5
Oxygenation:			200–349		<200				
a. FiO_2 ≥0.5 record A-a DO_2									
b. FiO_2 <0.5 record only Pao_2						61–70		55–60	<55
Arterial pH	≥7.7	7.6–7.69		7.5–7.59	7.33–7.49		7.25–7.32	7.15–7.24	<7.15
Serum HCO_3 use only if no ABG	≥52	41–51.9		32–40.9	22–31.9		18–21.9	15–17.9	<15
Serum Sodium (mMol/L)	≥180	160–179	155–159	150–154	130–149		120–129	111–119	≤110
Serum Potassium (mMol/L)	≥7	6–6.9		5.5–5.9	3.5–5.4	3–3.4	2.5–2.9		<2.5
Serum Creatinine (mg/100 mL) double point score if acute renal failure	≥3.5	2–3.4	1.5–1.9		0.6–1.4		<0.6		

(continued)

Table 1-5 Acute Physiology and Chronic Health Evaluation (APACHE II) (continued)

Physiologic Variable	Points								
	4	3	2	1	0	1	2	3	4
Hematocrit (%)	≥60		50-59.9	46-49.9	30-45.9		20-29.9		<20
White Blood Cells Count total/ mm ³	≥40		20-39.9	15-19.9	3-14.9		1-2.9		<1
Glasgow Coma Score	Score = 15 minus actual Glasgow coma scale								

Total Acute Physiology Score: Add points from the 12 parameters above

Age	Points	Chronic Health Points: If patient has history of severe organ insufficiency or is immunocompromised assign points as follows:
≤44	0	
45-54	2	5 points if nonoperative or emergency postoperative patients
55-64	3	2 points if elective postoperative patients
65-74	5	
≥75	6	

Definitions: Organ insufficiency or immunocompromised state must have been evident prior to hospital admission. **Liver failure:** Cirrhosis and portal hypertension or manifestations of liver failure. **Cardiovascular:** New York Heart Association Class IV. **Respiratory:** Chronic restrictive, obstructive, or vascular pulmonary disease with severe exercise restriction or documented chronic hypoxia hypercapnia, secondary polycythemia, severe pulmonary hypertension, or ventilator dependency. **Renal:** Chronic dialysis. **Immunocompromised:** Patient receiving therapy or has disease that suppresses resistance to infection. R = risk of hospital death.

Table 1-6 Diagnostic Categories Weight Leading to ICU Admission (APACHE II)

Nonoperative			
Respiratory Failure		Trauma	
Asthma/allergy	-2.108	Multiple trauma	-1.228
COPD	-0.367	Head injury	-0.517
Pulmonary edema (noncardiogenic)	-0.251	Neurologic	
Postrespiratory arrest	-0.168	Seizure disorder	-0.584
Aspiration/poisoning/toxic	-0.142	ICH/SDH/SAH	0.723
Pulmonary embolus	-0.128	Other	
Infection	0	Drug overdose	-3.353
Neoplasm	0.891	Diabetic ketoacidosis	-1.507
Cardiovascular Failure		GI Bleeding	0.334
Hypertension	-1.798	If Not in One of These Groups, What System Was the Principal Reason for Admission?	
Rythm disturbance	-1.368		
Congestive heart failure	-0.424		
Hemorrhagic shock/hypovolemia	0.493		
Coronary artery disease	-0.191	Metabolic/renal	-0.885
Sepsis	0.113	Respiratory	-0.890
Post cardiac arrest	0.393	Neurologic	-0.759
Cardiogenic shock	-0.259	Cardiovascular	0.470
Dissecting thoracic/ abdominal aneurysm	0.731	Gastrointestinal	0.501
Postoperative			
		If Postemergency Surgery	
Multiple trauma	-1.684	-1.081	
Admission due to chronic cardio-vascular disease	-1.376	-0.773	
Peripheral vascular surgery	-1.315	-0.712	
Heart valve surgery	-1.261	-0.658	
Craniotomy for neoplasm	-1.245	-0.642	
Renal surgery for neoplasm	-1.204	-0.601	
Renal transplant	-1.042	-0.439	
Head trauma	-0.955	-0.352	
Thoracic surgery for neoplasm	-0.802	-0.199	
Craniotomy for ICH/SDH/SAH	-0.788	-0.185	
Laminectomy and other spinal cord surgery	-0.699	-0.096	
Hemorrhagic shock	-0.682	-0.079	

(continued)

Table 1-6 Diagnostic Categories Weight Leading to ICU Admission (APACHE II cont.)

Postoperative		
		If Postemergency Surgery
GI bleeding	-0.617	-0.014
GI surgery for neoplasm	-0.248	0.355
Respiratory insufficiency	-0.140	0.463
GI perforation/obstruction	0.060	0.663
If Not in One of the Above, What System Led to ICU Admission Postsurgery?		
Neurologic	-1.150	-0.574
Cardiovascular	-0.797	-0.194
Respiratory	-0.610	-0.007
Gastrointestinal	-0.613	-0.01
Metabolic/renal	-0.196	0.407

Adapted from Knaus, W. A. et al. *Crit Care Med* 13 (1985), 818-829.

Table 1-7 Sequential Organ Failure Assessment (SOFA) Score

Points	1	2	3	4
Respiration Pao ₂ /Fio ₂ , mmHg	<400	<300	<200	<100
Coagulation Platelets × 10 ³ /mm ³	<150	<100	<50	<20
Liver Bilirubin, mg/dl	1.2-1.9	2.0-5.9	6.0-11.9	>12
Cardiovascular Hypotension*	MAP <70	Dopamine ≤5 or dobu- tamine (any dose)	Dopamine >5 or epi- nephrine ≤0.1 or nor- epinephrine ≤0.1	Dopamine >15 or epinephrine >0.1 or nor- epinephrine >0.1
Central Nervous System Glasgow Coma Score	13-14	10-12	6-9	<6
Renal Creatinine mg/dl or Urine Output	1.2-1.9	2.0-3.4	3.5-4.9 or <500 mL/ day	>5 or <200 mL/day

*Vasopressors agents administered for at least 1 hr (μg/kg-min)

Adapted from Vincent, J. L. et al. *Int Care Med* 22 (1996), 707-710.

MULTIPLE ORGAN DYSFUNCTION (MOD) SCORE

(See Table 1–8.) Score designed to describe the degree of organ dysfunction in critically ill patients. It correlates with intensive care and hospital mortality and intensive care unit length of stay as originally described.

Table 1-8 Multiple Organ Dysfunction Score

Organ System	0	1	2	3	4
<i>Respiratory</i> Pao ₂ /Fio ₂	>300	226-300	151-225	76-150	≤75
<i>Renal</i> Serum creatinine μmol/L (mg/dl)	≤100 (1.1)	101-200 (1.1-2.3)	201-350 (2.3-4)	351-500 (4-5.7)	>500 (5.7)
<i>Liver</i> Serum bilirubin μmol/L (mg/dl)	≤20 (1.2)	21-60 (1.2-3.5)	61-120 (3.6-7)	121-240 (7.1-14)	>240 (14)
<i>Cardiovascular</i> Pressure-adjusted heart rate*	≤10	10.1-15	15.1-20	20.1-30	>30
<i>Hematologic</i> Platelet count mL 10 ⁻³	>120	81-120	51-80	21-50	≤20
<i>Neurologic</i> Glasgow coma score**	15	13-14	10-21	7-9	≤6

*Pressure-adjusted heart rate = (heart rate × right atrial pressure)/mean arterial pressure.

**For patients receiving sedation or muscle relaxants normal brain function is assumed unless there is evidence of altered mentation.

MOD Score	Intensive Care Unit Mortality	Hospital Mortality	Intensive Care Unit Stay (days)
0	0%	0%	2
1-4	1-2%	7%	3
5-8	3-5%	16%	6
9-12	25%	50%	10
13-16	50%	70%	17
17-20	75%	82%	21
21-24	100%	100%	n.a.

Adapted from Marshall, J. C. et al. *Crit Care Med* 23 (1995), 1638-1652.

SIMPLIFIED ACUTE PHYSIOLOGY SCORE (SAPS II) AND EXPANDED VERSION

(See Table 1–9.) Score to calculate to probability of hospital mortality. The score revised in 2005 is referred to as the expanded version. The score uses the worst value (the one that gives the most points) in last 24 hours.

Table 1-9 Simplified Acute Physiology Score (SAPS II) and Expanded Version

SAPS II	0 points	Abnormal value points				
Age, years	<40	40-59 7 points	60-69 12 points	70-74 15 points	75-79 16 points	≥ 80 18 points
Heart rate, beats/min	70-119	40-69 2 points	120-159 4 points	≥ 160 7 points	< 40 11 points	
Systolic Blood Pressure, mmHg	100-199	>200 2 points	70 -99 5 points	≤ 70 13 points		
Body Temperature, °C	<39	≥ 39 3 points				
Only if on Mechanical Ventilation* Pao ₂ mmHg/ Fio ₂		≥ 200 6 points	100-199 9 points	<100 11 points		
Urinary Output, L/day	≥ 1	0.5-0.9 4 points	< 05 11 points			
Blood Urea Nitrogen, mg/dL	<28	28-83 6 points	≥ 84 10 points			
White Blood Cell Count, mm ³	1-19.9	≥ 20 3 points	< 1.0 12 points			
Potassium, mEq/L	3-4.9	< 3 or ≥ 5 3 points				
Sodium, mEq/L	125-144	≥145 1 point	< 125 5 points			
Bicarbonate, mEq/L	≥20	15-19 3 points	< 15 6 points			
Bilirubin, mg/dl	<4	4-5.9 4 points	≥ 6 9 points			
Glasgow Coma Score	14-15	11-13 5 points	9 - 10 7 points	6 - 8 13 points	<6 26 points	

(continued)

Table 1-9 Simplified Acute Physiology Score (SAPS II) and Expanded Version (cont.)

SAPS II	0 points	Abnormal value points	SAPS II SCORE: add worst value for last 24 hours
Chronic Disease		Metastatic cancer 9 points Hematological malignancy 10 points AIDS 17 points	
Type of Admission	Scheduled surgical	Medical 6 points Unscheduled surgical 8 points	

*Mechanical ventilation includes the use of continuous positive airway pressure (CPAP).

SAPS II expanded		
	Value	Points
Age, years	<40	0
	40-59	0.1639
	60-69	0.2739
	70-79	0.369
	>79	0.6645
Sex	Male	0.2083
	Female	0
Length of Hospital Stay Before ICU Admission	<24 hours	0
	1 day	0.0986
	2 days	0.1944
	3-9 days	0.5284
	>9 days	0.9323
Patient's Location Before ICU	Emergency room or mobile emergency unit	0
	Ward in same hospital	0.2606
	Other hospital	0.3381
Clinical Category	Medical patient	0.6555
	Other	0
Intoxication	No	1.6693
	Yes	0
SAPS II (Expanded) = 0.0742 × SAPS II score + the sum of the expanded variables		

To calculate the predicted mortality:

$$\text{Logit} = -14.4761 + 0.0844 \times \text{SAPS II}(\text{expanded}) + 6.6158 \times \log[\text{SAPS II}(\text{expanded}) + 1]$$

then

$$\text{predicted mortality} = e^{(\text{Logit})} / [1 + e^{(\text{Logit})}]$$

Adapted from Le Gall, J. R. et al. *JAMA* 270 (1993), 2957-2963; and Le Gall, J. R. et al. *Critical Care* (2005), R645-R652.

■ PEDIATRIC RISK OF MORTALITY (PRISM)

(See Table 1–10.) Score designed to calculate the mortality risk in the pediatric intensive care unit. Developed from the original Physiologic Stability

Table 1-10 Pediatric Risk of Mortality (PRISM)

	Infants (<1 year old)	Children	All ages	Score
Systolic Blood Pressure, mmHg	55-65 or 130-160	65-75 or 150-200		2
	40-54 or >160	50-64 or >200		6
	<40	<50		7
Diastolic Blood Pressure, mmHg			>110	6
Heart Rate, beats per minute	<90 or >160	<80 or >150		4
Respiratory Rate, breaths per minute	61-90	51-70		1
	apnea or >90	apnea or >70		5
PaO ₂ /F _{IO} ₂			200-300	2
			<200	3
Paco ₂ torr			51-65	1
			>65	5
Glasgow Coma Score			<8	6
Pupillary Reaction			unequal or dilated	4
			fixed and dilated	10
PT/PTT			1.5 × control	2
Total Bilirubin, mg/dl			>3.5 (>1 month old)	6
Potassium, mEq/L			3-3.5 or 6.5-7.5	1
			<3.0 or >7.5	5
Calcium, mg/dL			7-8 or 12-15	2
			<7 or >15	6
Glucose, mg/dL			40-60 or 250-400	4
			<40 or >400	8
Bicarbonate, mEq/L			<16 or >32	3

Adapted from Pollack, M. M. et al. *Crit Care Med* 16 (1988), 1110-1116.

Index. Values are measured during the first 24 hours after intensive care admission.

First, calculate the risk of death (r).

$$r = (0.207 \times \text{PRISM}) - [0.005 \times (\text{age in months})] - 0.433 \times 1 \\ (\text{if postoperative}) - 4.782$$

Then

$$\text{predicted death rate} = e^r / (1 + e^r)$$

■ PEDIATRIC INDEX OF MORTALITY II (PIM II)

(See [Table 1–11](#).) Score used to estimate mortality risk from data obtained for each variable measured within the period from the time of first contact (anywhere by an ICU doctor) to 1 hour after arrival to the intensive care unit.

Table 1-11 Pediatric Index of Mortality II (PIM II)

Variable	Value
a	Systolic blood pressure, mmHg MV if unknown = 120 cardiac arrest = 0 shock with unmeasurable SBP = 30
b	Pupillary reactions to bright light >3 mm and both fixed = 1 other or unknown = 0
c	($\text{FiO}_2 \times 100$)/PaO_2, mmHg MV if unknown = 0
d	Base excess in arterial or capillary blood, mmol/L MV if unknown = 0
e	Mechanical ventilation at any time during the first hour in ICU no = 0, yes = 1
f	Elective admission to ICU no = 0, yes = 1
g	Recovery from surgery or a procedure is the main reason for ICU admission no = 0, yes = 1
h	Admitted following cardiac bypass no = 0, yes = 1

(continued)

Table 1-11 Pediatric Index of Mortality II (PIM II) (continued)

Variable		Value
i	High-risk diagnosis is the main reason for ICU admission Cardiac arrest preceding ICU admission Severe combined immune deficiency Leukemia or lymphoma after first induction Spontaneous cerebral hemorrhage Cardiomyopathy or myocarditis Hypoplastic left heart syndrome HIV infection Liver failure is the main reason for ICU admission Neurodegenerative disorder	no = 0, yes = 1
j	Low-risk diagnosis is the main reason for ICU admission Asthma Bronchiolitis Croup Obstructive sleep apnea Diabetic ketoacidosis	no = 0, yes = 1

MV = Measured value. Enter the value for each variable in the equation.

Adapted from Slater et al. *Int Care Med* 29 (2003), 278-285.

$$\begin{aligned} \text{PIM2} = & \{0.01395 \times [\text{absolute } (a - 120)]\} + (3.0791 \times b) + (0.2888 \times c) \\ & + (0.104 \times \text{absolute } d) + (1.3352 \times e) - (0.9282 \times f) - (1.0244 \times g) + \\ & (0.7507 \times h) + (1.6829 \times i) - (1.5770 \times j) - 4.8841 \end{aligned}$$

Then

$$\text{probability of death} = e^{\text{PIM2}} / (1 + e^{\text{PIM2}})$$

■ APGAR SCORE

(See [Table 1-12](#).) Score that is assessed at 1 and 5 minutes after delivery. It may be repeated at 5-minute intervals for infants with 5-minute scores <7. Add points for each category.

Table 1-12 Apgar Score

Sign	0	1	2
Heart Rate	Absent	<100 bpm	>100 bpm
Respiratory Effort	Absent	Irregular, shallow	Good, crying
Muscle Tone	Limp	Some flexion of extremities	Active motion
Reflex Irritability	No response	Grimace	Cry
Color	Blue, pale	Body pink, extremities blue	Completely pink

Data from Apgar, V. *Anesth Analg* 32 (1953), 260.

Interpretation:

10: Best possible condition.

7–9: Adequate, no treatment.

4–6: Infant requires close observation and intervention such as suctioning.

<4: Infant requires immediate intervention such as intubation and further examination.

SILVERMAN SCORE

(See [Figure 1-1](#).)
















	Upper Chest	Lower Chest	Xiphoid Retraction	Chin Movement	Expiratory Grunt
Grade 0	 Synchronized	 No Retraction	 None	 No Movement of Chin	 None
Grade 1	 Lag on Insp.	 Just Visible	 Just Visible	 Chin Descends Lips Closed	 Stethos. Only
Grade 2	 See-Saw	 Marked	 Marked	 Lips Part	 Naked Ear

Figure 1-1 Silverman score. (Adapted from Silverman, W. A. and Andersen, D. H. *Pediatrics* 17 (1956), 1-10.)

Evaluates: Retractions, nasal flaring, and grunting.

Use: Evaluates respiratory distress in newborns.

Interpretation: Zero indicates no respiratory distress; 10 indicates severe respiratory distress; 7 or greater indicates impending respiratory failure.

■ NEWBORN RESPIRATORY DISTRESS SCORING (RDS) SYSTEM

(See Table 1–13.) The sum of all the individual scores. Clinical RDS = score ≥ 4 (overall mortality 25%); score ≥ 8 = severe respiratory distress with impending failure (65% mortality).

Table 1-13 Newborn Respiratory Distress Scoring (RDS) System*

RDS Score	0	1	2
Cyanosis	None	In-room air	In 40% FiO_2
Retractions	None	Mild	Severe
Grunting	None	Audible with stethoscope	Audible without stethoscope
Air Entry (crying)*	Clear	Delayed or decreased	Barely audible
Respiratory Rate (min)	60	60-80	>80 or apneic episodes

*Air entry represents the quality of the inspiratory breath sounds as heard in the midaxillary line.
Adapted from Downes, J. J. et al. *Clin Pediatr (Phila)* 9(6) (1970), 325-331.

■ SEPSIS DEFINITION

In an effort to standardize patients into categories of sepsis, a classification has been widely adopted. Although it has limitations, when revised 10 years later the same definitions stand with some new expansions. (From Bone, R. C. et al. *CHEST* 101 (1992), 1644–1655 and Levy, M. M. et al. *Critical Care Med* 31 (2003), 1250–1256.)

Systemic Inflammatory Response Syndrome

More than one of the following:

1. Body temperature greater than 38°C
2. Heart rate greater than 90 beats per minute

3. Tachypnea (respiratory rate >20 breaths per minute) or hyperventilation (PACO₂ <32 mmHg at sea level)
4. White blood cell count ≥ 12000 or ≤ 4000 /cu mm.

Infection

Pathologic process caused by the invasion of normally sterile tissue or fluid or body cavity by pathogenic or potentially pathogenic microorganism.

Sepsis

Clinical syndrome defined by the presence of both infection (suspected or confirmed) and systemic inflammatory response. ***Diagnostic criteria for sepsis in the pediatric population*** are signs and symptoms of inflammation plus infection with hyper- or hypothermia (rectal temperature >38.5 or $<35^{\circ}\text{C}$), tachycardia and one of the following indications of organ dysfunction: altered mental status, hypoxemia, increased serum lactate level, or bounding pulses.

Severe Sepsis

Sepsis complicated by organ dysfunction. May use the SOFA score or the MOD score (see above) to define organ dysfunction.

Septic Shock

Acute circulatory failure characterized by persistent arterial hypotension unexplained by other causes. ***Septic shock in pediatric patients*** is defined as tachycardia with signs of decreased organ perfusion (decreased peripheral pulses compared with central pulses, altered mental status, capillary refill >2 s, mottled or cool extremities, or decreased urine output).

Hypotension

Systolic blood pressure below 90 mmHg (in children <2 SD below normal for their age), a mean arterial pressure <60 mmHg, or a reduction in systolic blood pressure of >40 mmHg from baseline despite adequate volume resuscitation.

■ 2001 EXPANDED DIAGNOSTIC CRITERIA FOR SEPSIS

Infection (defined as a pathologic process induced by a microorganism), documented or suspected, and some of the following:

General Variables

Fever (core temperature $>38.3^{\circ}\text{C}$)

Hypothermia (core temperature $<36^{\circ}\text{C}$)

Heart rate >90 min or >2 SD above the normal value for age

Tachypnea

Altered mental status

Significant edema or positive fluid balance (>20 mL/kg over 24 h)

Hyperglycemia (plasma glucose >120 mg/dL) in the absence of diabetes

Inflammatory Variables

Leukocytosis (white blood cell count $>12,000$ μL)

Leukopenia (white blood cell count <4000 μL)

Normal white blood cell count with $>10\%$ immature forms

Plasma C-reactive protein >2 SD above the normal value

Plasma procalcitonin >2 SD above the normal value

Hemodynamic Variables

Arterial hypotension (systolic blood pressure <90 mm Hg, mean arterial pressure <70 , or a systolic blood pressure decrease >40 mm Hg in adults or <2 SD below normal for age)

Mixed venous oxygen saturation $>70\%$

Cardiac index >3.5 Lmin \cdot m²

Organ Dysfunction Variables

Arterial hypoxemia ($\text{PAO}_2/\text{FiO}_2 <300$)

Acute oliguria (urine output <0.5 mL/kg/h or 45 mmol/L for at least 2 h)

Creatinine increase >0.5 mg/dL

Coagulation abnormalities (INR >1.5 or aPTT >60 s)

Ileus (absent bowel sounds)

Thrombocytopenia (platelet count <100,000 μ L)

Hyperbilirubinemia (plasma total bilirubin >4 mg/dL)

Tissue Perfusion Variables

Hyperlactatemia (>1 mmol/L)

Decreased capillary refill or mottling

■ VASOPRESSOR SCORE (INOTROPIC SCORE, CATHECHOLAMINE INDEX)

Score used to describe the dose of vasopressors used.

$$\text{inotropic score} = (\text{dopamine dose} \times 1) + (\text{dobutamine dose} \times 1) + (\text{adrenaline dose} \times 100) + (\text{noradrenaline dose} \times 100) + (\text{phenylephrine dose} \times 100)$$

$$\text{vasopressor dependency index} = \text{inotropic score}/\text{MAP}$$

Data from Cruz, D. N. et al. *JAMA* 301(23) (2009), 2445–2452.

■ ACUTE RESPIRATORY DISTRESS SYNDROME DEFINITION

As defined by Bernard, et al. (*Am J Respir Crit Care Med* 149 (1994), 818–824), all of the following criteria must be present

- Acute onset
- $\text{PaO}_2/\text{FiO}_2 \leq 200$ mmHg (ARDS)
- $\text{PaO}_2/\text{FiO}_2 \leq 300$ mmHg (acute lung injury, ALI)
- Bilateral infiltrates on chest radiograph consistent with pulmonary edema
- Pulmonary artery occlusion pressure ≤ 18 mmHg or no clinical evidence of left atrial hypertension

■ LUNG INJURY SCORE (MURRAY SCORE)

(See [Table 1–14](#).) Designed to characterize the presence and extent of a pulmonary damage, the lung injury score was part of a three-component definition in the original paper. The lung injury score was used as the definition for ARDS (Score >2.5), but it is still used rather to characterize the severity of lung disease in clinical trials.

Table 1-14 Lung Injury Score (Murray Score)

	SCORE				
	0	1	2	3	4
Chest Radiograph Number of Quadrants with Alveolar Consolidation	None	1	2	3	4
Hypoxemia PaO₂/F_IO₂	≥300	225-299	175-224	100-174	<100
PEEP cmH₂O	≤5	6-8	9-11	12-14	≥15
Lung Compliance mL/cm H₂O	≥80	60-79	40-59	20-39	≤19

Add individual scores for each category and then divide by the number of components used. (i.e., not all patients have all measurements).

Adapted from Murray, et al. *Am Rev Respir Dis* 138 (1988), 720-723.

■ VENTILATOR-FREE DAYS

The number of ventilator-free days is used to evaluate the effects of therapies in critical care. This number combines the effects of mortality and the duration of mechanical ventilation in patients who survive. It assumes that any therapy that decreases duration of mechanical ventilation in patients who survive also increases the number of patients that survive. The number is calculated as

$$\text{ventilator-free days} = \text{number of days from day 1 to day 28 on which a patient breathed without assistance (if the period of unassisted breathing lasted at least 48 consecutive hours).}$$

If patient dies or requires more than 28 days of mechanical ventilation, the value is 0. (From Schoenfeld, D. A. et al. *Crit Care Med* 30 (2002), 1772–1777.)

■ PNEUMONIA DEFINITIONS

The following definitions are from the American Thoracic Society and Infectious Diseases Society of America in 2005 (*Am J Respir Crit Care Med* 171 (2005), 388–416).

Community-Acquired Pneumonia

Pneumonia occurring within 48 hours of admission in patients with no criteria for healthcare-associated pneumonia.

Ventilator-Associated Pneumonia

- Pneumonia occurring >48 hours after endotracheal intubation.
- Defined as a new lung infiltrate on chest radiography plus at least two of the following: fever, 38°C, leukocytosis or leukopenia, and purulent secretions.

Hospital-Acquired Pneumonia

Pneumonia occurring \geq 48 hours after hospital admission

Risk factors for multidrug resistant bacteria:

- Antibiotic therapy within 90 days of infection.
- Current hospitalization of \geq 5 days.
- High frequency of antibiotic resistance in community or specific hospital unit.
- Immunosuppressive disease or therapy.
- Presence of healthcare-associated pneumonia risk factors for multidrug resistant bacteria.

Healthcare-Associated Pneumonia

Pneumonia occurring \leq 48 hours of admission in patients with any risk factor for multidrug resistant bacteria as cause of infection:

- Hospitalization for \geq 2 days in an acute-care facility within 90 days of infection.
- Nursing home or long-term acute-care facility resident.
- Antibiotic therapy, chemotherapy, or wound care in last 30 days.
- Hemodialysis at a hospital or clinic.
- Home infusion therapy or wound care.
- Family member with infection due to a multidrug resistant bacteria.

■ CLINICAL PULMONARY INFECTION SCORE

(See Table 1–15.) Originally described by Pugin et al. (*Am Rev Resp Dis* 143 (1991), 1121–1129) and later modified by Singh et al. (*AJRCCM* 162 (2000), 505–511). A score developed to establish a numerical value of clinical, radiographic, and laboratory markers for pneumonia. Scores above 6 suggest pneumonia (specificity and sensitivity have been consistently less than in initial validation study). Singh et al. showed that some patients with a low clinical suspicion of ventilator-associated pneumonia (CPIS ≤ 6) can have antibiotics safely discontinued after 3 days, if the subsequent course suggests that the probability of pneumonia is still low. (See also Table 1–16.)

Table 1-15 Clinical Pulmonary Infection Score

Score	0	1	2
Temperature	≥ 36.5 and ≤ 38.4	≥ 38.5 and ≤ 38.9	≥ 39 or ≤ 36.4
Blood Leukocytes 10^3 mm^3	≥ 4 and ≤ 11	< 4 or > 12	
Tracheal Secretions	None	Nonpurulent	Purulent
Oxygenation $\text{Pao}_2/\text{Fio}_2$, mmHg	> 240 or ARDS*		≤ 240 and no ARDS
Chest Radiography	No opacity	Diffuse (patchy) opacities	Localized opacity
Progression of Radiographic Opacities	No progression		progression (after HF** and ARDS excluded)
Culture of Tracheal Aspirate	Pathogenic bacteria cultured in rare/few quantities or no growth	Pathogenic bacteria cultured in moderate or heavy quantity	

Add a point (+1) if: Bands are $> 50\%$ or same pathogenic bacteria seen on Gram stain.

*ARDS (Acute Respiratory Distress Syndrome) defined as $\text{Pao}_2/\text{Fio}_2$ 200, PAOP < 18 mmHg and acute bilateral infiltrates.

**HF: heart failure.

Adapted from Singh et al. *AJRCCM* 162 (2000), 505-511.

Table 1-16 Clinical Criteria for the Diagnosis of Pneumonia as Defined by the National Nosocomial Infection Surveillance System

Radiographic
<i>Two or more serial chest radiographs</i> with new or progressive and persistent infiltrate or cavitation or consolidation (one radiograph is sufficient in patients without underlying cardiopulmonary disease)
Clinical
<i>One of the following:</i> Fever $>38^{\circ}\text{C}$ (100.4°F) with no other recognized cause WBC count $<4,000/\mu\text{L}$ or $>12,000 \mu\text{L}$ For adults >70 yr old, altered mental status with no other recognized cause
And at least two of the following:
New-onset purulent sputum or change in character of sputum, or increase in respiratory secretions or suctioning requirements New-onset or worsening cough, dyspnea, or tachypnea Rales or bronchial breath sounds Worsening gas exchange, increased oxygen requirements, increased ventilatory support
Microbiology (optional)
Positive culture result (one): blood (unrelated to other source), pleural fluid, quantitative culture by BAL or PSB, $>5\%$ BAL-obtained cells contain intracellular bacteria

BAL: Bronchoalveolar lavage, PSB: Protected specimen brush

From CDC. *NNIS Criteria for Determining Nosocomial Pneumonia*. Atlanta, GA: U.S. Department of Health and Human Services, CDC, 2003. Prozcenskasi. *CHEST*, 2006; 130:597-604.

■ DEFINITIONS FOR WEANING AND LIBERATION OF MECHANICAL VENTILATION

Multiple terms and definitions are used indistinctly to describe the process of discontinuation of mechanical ventilation. The process of freeing a patient from ventilator assistance is often termed weaning (which for some includes the process of extubation). We favor the term liberation or discontinuation to describe the cessation of ventilator support. [Table 1-18](#) shows the latest multisociety attempt to define weaning/liberation of mechanical ventilation.

Table 1-17 Definitions for Weaning and Liberation of Mechanical Ventilation

Weaning success: is the extubation and the absence of ventilatory support for the following 48 h

Weaning failure: is one of the following: (1) failed spontaneous breathing trial; or (2) reintubation and/or resumption of ventilator support following successful extubation; or (3) death within 48 h following extubation

Simple weaning: Patients who proceed from initiation of weaning to successful extubation on the first attempt

Difficult weaning: Patients who fail initial weaning and require up to three spontaneous breathing trials, or as long as 7 days from the first attempt to achieve successful weaning

Prolonged weaning: Patients who fail at least three weaning attempts or require more than 7 days of weaning after the first spontaneous breathing trial

Failed spontaneous breathing trial:

Subjective criteria: Agitation, anxiety, depressed mental status, diaphoresis, cyanosis, increased accessory muscle activity, facial signs of distress and dyspnea

Objective criteria: $\text{PaO}_2 \leq 50\text{--}60$ mmHg on $\text{FiO}_2 \geq 0.5$ or $\text{SaO}_2 < 90\%$; $\text{Paco}_2 > 50$ mmHg or an increase in $\text{Paco}_2 > 8$ mmHg; $\text{pH} < 7.32$ or a decrease in $\text{pH} \geq 0.07$ pH units; shallow breathing index (respiratory rate/tidal volume) > 105 breaths/min/L; respiratory rate > 35 breaths/min or increased by $> 50\%$; heart rate > 140 beats/min or increased by $\geq 20\%$; systolic blood pressure > 180 mmHg or increased by $\geq 20\%$ or < 90 mmHg; or cardiac arrhythmias

Data from Boles, J. M. et al. *Eur Respir J* 29 (2007), 1033-1056.

■ INTUBATION DIFFICULTY SCALE

(See Table 1-18.) Quantitative score used to evaluate intubation difficulty, conditions, and techniques.

■ WELLS SCORE: PULMONARY EMBOLISM

The original interpretation of results of the Wells score for pulmonary embolism was modified for the Christopher study. Both are presented here.

Original Score

- Symptoms of deep venous thrombosis (DVT): Leg swelling, pain with palpation (3 points).
- No alternative diagnosis better explains the illness (3 points).

Table 1-18 Intubation Difficulty Scale

	Score		
	0	1	2
Number of Attempts	+1 for each attempt		3
Number of Operators	+1 for each operator		
Number of Alternative Techniques	+1 for each change (blade, position, equipment, approach, technique)		
Glottic Exposure*	Complete visualization of the vocal cords	Inferior portion of the glottis	Only the epiglottis Nonvisualized epiglottis
Lifting Force Required	Little effort	Increased effort	
Laryngeal Pressure	Not applied**	Applied	
Vocal Cord Mobility	Abduction	Adduction	

*Use Cormack's visual grade (*Anesthesiology* 39 (1984), 1105-1111).

**Sellick maneuver is used to prevent aspiration gastric contents and gives no points. Add all points to obtain total score. If unable to obtain total score, use total value previous to abandoning effort.

Adapted from Adnet, et al. *Anesthesiology* 87(6) (1997), 1290-1297.

- Tachycardia with pulse >100 (1.5 points).
- Immobilization (≥ 3 days) or surgery in the previous four weeks (1.5 points).
- Prior history of DVT or pulmonary embolism (1.5 points).
- Presence of hemoptysis (1 point).
- Presence of malignancy (1 point).

Results: 7–12 points: High probability
2–6 points: Moderate probability
0–1 points: Low Probability

Modified Score

Use original criteria.

Results: More than 4 points: Pulmonary embolism likely
Less than 4 points: Pulmonary embolism unlikely

Data from Wells, P. S. et al. *Thrombosis and Haemostasis* 83 (2000), 416–420; and van Belle, A. et al. *JAMA* 295 (2006), 172.

■ WELLS SCORE: DEEP VENOUS THROMBOSIS (DVT)

The original Wells score and its interpretation were modified in a later article. Both are presented here.

Original Score

- Paralysis, paresis, or recent orthopedic casting of lower extremity (1 point).
- Recently bedridden (≥ 3 days) or major surgery within past 4 weeks (1 point).
- Localized tenderness in deep vein system (1 point).
- Swelling of entire leg (1 point).
- Calf swelling 3 cm greater than other leg (measured 10 cm below the tibial tuberosity) (1 point).
- Pitting edema greater in the symptomatic leg (1 point).
- Collateral nonvaricose superficial veins (1 point).

- Active cancer or cancer treated within 6 months (1 point).
- Alternative diagnosis more likely than DVT (−2 points).

Results: 3–8 points: High probability of DVT

1–2 points: Moderate probability

−2–0 points : Low Probability

Modified Score

Add this criteria to the original.

- Previous documented DVT (1 point).

Results: 2 or > points: DVT likely

1 or less points: DVT unlikely

Data from Wells, P. S. et al. *Lancet* 350 (1997), 1795–1798; and Wells, P. S., Anderson, D. R., Rodger, M., et al. *N Engl J Med* 349 (2003), 179–1227.

