

# Package ‘phoenix’

October 22, 2025

**Title** The Phoenix Pediatric Sepsis and Septic Shock Criteria

**Version** 1.1.3

**Description** Implementation of the Phoenix and Phoenix-8 Sepsis Criteria as described in “Development and Validation of the Phoenix Criteria for Pediatric Sepsis and Septic Shock” by Sanchez-Pinto, Bennett, DeWitt, Russell et al. (2024) <[doi:10.1001/jama.2024.0196](https://doi.org/10.1001/jama.2024.0196)> (Drs. Sanchez-Pinto and Bennett contributed equally to this manuscript; Dr. DeWitt and Mr. Russell contributed equally to the manuscript), “International Consensus Criteria for Pediatric Sepsis and Septic Shock” by Schlapbach, Watson, Sorce, Argent, et al. (2024) <[doi:10.1001/jama.2024.0179](https://doi.org/10.1001/jama.2024.0179)> (Drs Schlapbach, Watson, Sorce, and Argent contributed equally) and the application note “phoenix: an R package and Python module for calculating the Phoenix pediatric sepsis score and criteria” by DeWitt, Russell, Rebull, Sanchez-Pinto, and Bennett (2024) <[doi:10.1093/jamiaopen/ooae066](https://doi.org/10.1093/jamiaopen/ooae066)>.

**Depends** R (>= 3.5.0)

**License** MIT + file LICENSE

**Encoding** UTF-8

**URL** <https://cu-dbmi-peds.github.io/phoenix/>,  
<https://github.com/CU-DBMI-Peds/phoenix/>

**BugReports** <https://github.com/CU-DBMI-Peds/phoenix/issues>

**Language** en-us

**LazyData** true

**Suggests** knitr, ggplot2, qwraps2 (>= 0.6.0), reticulate, rmarkdown

**VignetteBuilder** knitr

**RoxygenNote** 7.3.3

**Config/Needs/website** rmarkdown

**NeedsCompilation** no

**Author** Peter DeWitt [aut, cre] (ORCID:  
<<https://orcid.org/0000-0002-6391-0795>>),  
Seth Russell [ctb] (ORCID: <<https://orcid.org/0000-0002-2436-1367>>),

Meg Rebull [ctb] (ORCID: <<https://orcid.org/0000-0003-0334-4223>>),  
 Tell Bennett [ctb] (ORCID: <<https://orcid.org/0000-0003-1483-4236>>),  
 L. Nelson Sanchez-Pinto [ctb] (ORCID:  
 <<https://orcid.org/0000-0002-7434-6747>>)

**Maintainer** Peter DeWitt <[peter.dewitt@cuanschutz.edu](mailto:peter.dewitt@cuanschutz.edu)>

**Repository** CRAN

**Date/Publication** 2025-10-22 16:20:02 UTC

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map	<i>Mean Arterial Pressure</i>
-----	-------------------------------

---

## Description

Estimate mean arterial pressure from systolic and diastolic blood pressures.

## Usage

```
map(sbp, dbp)
```

## Arguments

sbp	numeric vector, systolic blood pressure measured in mmHg
dbp	numeric vector, diastolic blood pressure measured in mmHg

## Details

Mean Arterial Pressure is approximated by:  $(DBP + (SBP - DBP) / 3) = (2/3) DBP + (1/3) SBP$

**Value**

a numeric vector

**Examples**

```
DF <- expand.grid(
  sbp = 40:130, # expected units of mmHg
  dbp = 20:100 # expected units of mmHg
)

DF$map <- with(DF, map(sbp, dbp))
with(DF, plot(sbp, dbp, col = map))
DF$map[DF$sbp < DF$dbp] <- NA

z <- matrix(DF$map, nrow = length(unique(DF$sbp)), ncol = length(unique(DF$dbp)))

image(
  x = unique(DF$sbp),
  y = unique(DF$dbp),
  z = z,
  col = hcl.colors(100, palette = "RdBu"),
  xlab = "SBP (mmHg)",
  ylab = "DBP (mmHg)",
  main = "Estimated Mean Arterial Pressue"
)
contour(x = unique(DF$sbp), y = unique(DF$dbp), z = z, add = TRUE)
```

---

 phoenix

*The Phoenix Sepsis Score*


---

**Description**

The diagnostic Phoenix Sepsis Criteria based on four organ dysfunction scores, respiratory, cardiovascular, coagulation, and neurologic. A score of 2 or more indicates sepsis.

**Usage**

```
phoenix(
  pf_ratio,
  sf_ratio,
  imv,
  other_respiratory_support,
  vasoactives,
  lactate,
  map,
  platelets,
  inr,
```

```

    d_dimer,
    fibrinogen,
    gcs,
    fixed_pupils,
    age,
    data = parent.frame(),
    ...
  )

```

### Arguments

<code>pf_ratio</code>	numeric vector for the PaO <sub>2</sub> /FiO <sub>2</sub> ratio; PaO <sub>2</sub> = arterial oxygen pressure; FiO <sub>2</sub> = fraction of inspired oxygen; PaO <sub>2</sub> is measured in mmHg and FiO <sub>2</sub> is from 0.21 (room air) to 1.00.
<code>sf_ratio</code>	numeric vector for the SpO <sub>2</sub> /FiO <sub>2</sub> ratio; SpO <sub>2</sub> = oxygen saturation, measured in a percent; ratio for 92% oxygen saturation on room air is 92/0.21 = 438.0952.
<code>imv</code>	invasive mechanical ventilation; numeric or integer vector, (0 = not intubated; 1 = intubated)
<code>other_respiratory_support</code>	other respiratory support; numeric or integer vector, (0 = no support; 1 = support)
<code>vasoactives</code>	an integer vector, the number of systemic vasoactive medications being administered to the patient. Six vasoactive medications are considered: dobutamine, dopamine, epinephrine, milrinone, norepinephrine, vasopressin.
<code>lactate</code>	numeric vector with the lactate value in mmol/L
<code>map</code>	numeric vector, mean arterial pressure in mmHg
<code>platelets</code>	numeric vector for platelets counts in units of 1,000/uL (thousand per microliter)
<code>inr</code>	numeric vector for the international normalised ratio blood test
<code>d_dimer</code>	numeric vector for D-Dimer, units of mg/L FEU
<code>fibrinogen</code>	numeric vector units of mg/dL
<code>gcs</code>	integer vector; total Glasgow Coma Score
<code>fixed_pupils</code>	integer vector; 1 = bilaterally fixed pupil, 0 = otherwise
<code>age</code>	numeric vector age in months
<code>data</code>	a list, data.frame, or environment containing the input vectors
<code>...</code>	pass through

### Details

The details of each of the four component scores are found in their respective help files.

### Value

A data.frame with seven columns:

1. phoenix\_respiratory\_score

2. phoenix\_cardiovascular\_score
3. phoenix\_coagulation\_score
4. phoenix\_neurologic\_score
5. phoenix\_sepsis\_score
6. phoenix\_sepsis An integer vector, 0 = not septic, 1 = septic (score greater or equal to 2)
7. phoenix\_septic\_shock An integer vector, 0 = not septic shock, 1 = septic shock (score greater or equal 2 and cardiovascular dysfunction)

As with all other Phoenix organ system scores, missing values in the data set will map to a score of zero - this is consistent with the development of the criteria.

## References

See reference details in [phoenix-package](#) or by calling `citation('phoenix')`.

## See Also

- [phoenix](#) for generating the diagnostic Phoenix Sepsis score based on the four organ systems:
  - [phoenix\\_cardiovascular](#),
  - [phoenix\\_coagulation](#),
  - [phoenix\\_neurologic](#),
  - [phoenix\\_respiratory](#),
- [phoenix8](#) for generating the diagnostic Phoenix 8 Sepsis criteria based on the four organ systems noted above and
  - [phoenix\\_endocrine](#),
  - [phoenix\\_immunologic](#),
  - [phoenix\\_renal](#),
  - [phoenix\\_hepatic](#),

`vignette('phoenix')` for more details and examples.

## Examples

```
# Using the example sepsis data set, read more details in the vignette
```

```
phoenix_scores <-  
  phoenix(  
    # Respiratory  
    pf_ratio = pao2 / fio2,  
    sf_ratio = ifelse(spo2 <= 97, spo2 / fio2, NA_real_),  
    imv = vent,  
    other_respiratory_support = as.integer(fio2 > 0.21),  
    # Cardiovascular  
    vasoactives = dobutamine + dopamine + epinephrine + milrinone + norepinephrine + vasopressin,  
    lactate = lactate,  
    age = age,  
    map = dbp + (sbp - dbp)/3,  
    # Coagulation
```

```

    platelets = platelets,
    inr = inr,
    d_dimer = d_dimer,
    fibrinogen = fibrinogen,
    # Neurologic
    gcs = gcs_total,
    fixed_pupils = as.integer(pupil == "both-fixed"),
    data = sepsis
  )
)

str(phoenix_scores)

```

---

 phoenix8

*The Phoenix 8 Sepsis Score*


---

### Description

The extended Phoenix criteria using a total eight organ systems. This is intended mostly for research as an extension of the Phoenix Sepsis Criteria which is based on four organ systems.

### Usage

```

phoenix8(
  pf_ratio,
  sf_ratio,
  imv,
  other_respiratory_support,
  vasoactives,
  lactate,
  map,
  platelets,
  inr,
  d_dimer,
  fibrinogen,
  gcs,
  fixed_pupils,
  glucose,
  anc,
  alc,
  creatinine,
  bilirubin,
  alt,
  age,
  data = parent.frame(),
  ...
)

```

**Arguments**

pf_ratio	numeric vector for the PaO <sub>2</sub> /FiO <sub>2</sub> ratio; PaO <sub>2</sub> = arterial oxygen pressure; FiO <sub>2</sub> = fraction of inspired oxygen; PaO <sub>2</sub> is measured in mmHg and FiO <sub>2</sub> is from 0.21 (room air) to 1.00.
sf_ratio	numeric vector for the SpO <sub>2</sub> /FiO <sub>2</sub> ratio; SpO <sub>2</sub> = oxygen saturation, measured in a percent; ratio for 92% oxygen saturation on room air is 92/0.21 = 438.0952.
imv	invasive mechanical ventilation; numeric or integer vector, (0 = not intubated; 1 = intubated)
other_respiratory_support	other respiratory support; numeric or integer vector, (0 = no support; 1 = support)
vasoactives	an integer vector, the number of systemic vasoactive medications being administered to the patient. Six vasoactive medications are considered: dobutamine, dopamine, epinephrine, milrinone, norepinephrine, vasopressin.
lactate	numeric vector with the lactate value in mmol/L
map	numeric vector, mean arterial pressure in mmHg
platelets	numeric vector for platelets counts in units of 1,000/uL (thousand per microliter)
inr	numeric vector for the international normalised ratio blood test
d_dimer	numeric vector for D-Dimer, units of mg/L FEU
fibrinogen	numeric vector units of mg/dL
gcs	integer vector; total Glasgow Coma Score
fixed_pupils	integer vector; 1 = bilaterally fixed pupil, 0 = otherwise
glucose	numeric vector; blood glucose measured in mg/dL
anc	absolute neutrophil count; a numeric vector; units of 1,000 cells per cubic millimeter
alc	absolute lymphocyte count; a numeric vector; units of 1,000 cells per cubic millimeter
creatinine	numeric vector; units of mg/dL
bilirubin	numeric vector; units of mg/dL
alt	alanine aminotransferase; a numeric vector; units of IU/L
age	numeric vector age in months
data	a list, data.frame, or environment containing the input vectors
...	pass through

**Details**

The Phoenix Sepsis Criteria is based on the scores from respiratory, cardiovascular, coagulation, and neurologic systems. Phoenix 8 uses these four plus endocrine, immunologic, renal, and hepatic. Details on the scoring for each of the eight component organ systems are found in the respective manual files.

**Value**

a `data.frame` with 12 integer columns.

1. `phoenix_respiratory_score`
2. `phoenix_cardiovascular_score`
3. `phoenix_coagulation_score`
4. `phoenix_neurologic_score`
5. `phoenix_sepsis_score`
6. `phoenix_sepsis` 0 = not septic; 1 = septic (`phoenix_sepsis_score` greater or equal 2)
7. `phoenix_septic_shock` 0 = no septic shock; 1 = septic shock (sepsis with cardiovascular dysfunction)
8. `phoenix_endocrine_score`
9. `phoenix_immunologic_score`
10. `phoenix_renal_score`
11. `phoenix_hepatic_score`
12. `phoenix8_sepsis_score`

As with all other Phoenix organ system scores, missing values in the data set will map to a score of zero - this is consistent with the development of the criteria.

**References**

See reference details in [phoenix-package](#) or by calling `citation('phoenix')`.

**See Also**

- [phoenix](#) for generating the diagnostic Phoenix Sepsis score based on the four organ systems:
  - [phoenix\\_cardiovascular](#),
  - [phoenix\\_coagulation](#),
  - [phoenix\\_neurologic](#),
  - [phoenix\\_respiratory](#),
- [phoenix8](#) for generating the diagnostic Phoenix 8 Sepsis criteria based on the four organ systems noted above and
  - [phoenix\\_endocrine](#),
  - [phoenix\\_immunologic](#),
  - [phoenix\\_renal](#),
  - [phoenix\\_hepatic](#),

`vignette('phoenix')` for more details and examples.



**Examples**

```

# Using the example sepsis data set, read more details in the vignette

phoenix8_scores <-
  phoenix8(
    # Respiratory
    pf_ratio = pao2 / fio2,
    sf_ratio = ifelse(spo2 <= 97, spo2 / fio2, NA_real_),
    imv = vent,
    other_respiratory_support = as.integer(fio2 > 0.21),
    # Cardiovascular
    vasoactives = dobutamine + dopamine + epinephrine + milrinone + norepinephrine + vasopressin,
    lactate = lactate,
    age = age, # Also used in the renal assessment.
    map = dbp + (sbp - dbp)/3,
    # Coagulation
    platelets = platelets,
    inr = inr,
    d_dimer = d_dimer,
    fibrinogen = fibrinogen,
    # Neurologic
    gcs = gcs_total,
    fixed_pupils = as.integer(pupil == "both-fixed"),
    # Endocrine
    glucose = glucose,
    # Immunologic
    anc = anc,
    alc = alc,
    # Renal
    creatinine = creatinine,
    # no need to specify age again
    # Hepatic
    bilirubin = bilirubin,
    alt = alt,
    data = sepsis
  )

str(phoenix8_scores)

```

---

 phoenix\_cardiovascular

*Phoenix Cardiovascular Score*


---

**Description**

Generate the cardiovascular organ system dysfunction score as part of the diagnostic Phoenix Sepsis Criteria.

**Usage**

```

phoenix_cardiovascular(
  vasoactives = NA_integer_,
  lactate = NA_real_,
  age = NA_real_,
  map = NA_real_,
  data = parent.frame(),
  ...
)

```

**Arguments**

vasoactives	an integer vector, the number of systemic vasoactive medications being administered to the patient. Six vasoactive medications are considered: dobutamine, dopamine, epinephrine, milrinone, norepinephrine, vasopressin.
lactate	numeric vector with the lactate value in mmol/L
age	numeric vector age in months
map	numeric vector, mean arterial pressure in mmHg
data	a list, data.frame, or environment containing the input vectors
...	pass through

**Details**

There were six systemic vasoactive medications considered when the Phoenix criteria was developed: dobutamine, dopamine, epinephrine, milrinone, norepinephrine, and vasopressin.

During development, the values used for map were taken preferentially from arterial measurement, then cuff measures, and provided values before approximating the map from blood pressure values via  $DBP + 1/3 (SBP - DBP)$ , where DBP is the diastolic blood pressure and SBP is the systolic blood pressure.

**Value**

a integer vector with values 0, 1, 2, 3, 4, 5, or 6.

As with all other Phoenix organ system scores, missing values in the data set will map to a score of zero - this is consistent with the development of the criteria.

**Phoenix Cardiovascular Scoring**

The Phoenix Cardiovascular score ranges from 0 to 6 points; 0, 1, or 2 points for each of systemic vasoactive medications, lactate, and MAP.

*Systemic Vasoactive Medications*

0 medications	0 points
1 medication	1 point
2 or more medications	2 points

*Lactate*

[0, 5)	0 points
[5, 11)	1 point
[11, Inf)	2 points

*MAP*

Age in [0, 1) months	[31, Inf) mmHg	0 points
	[17, 31) mmHg	1 point
	[0, 17) mmHg	2 points
Age in [1, 12) months	[39, Inf) mmHg	0 points
	[25, 39) mmHg	1 point
	[0, 25) mmHg	2 points
Age in [12, 24) months	[44, Inf) mmHg	0 points
	[31, 44) mmHg	1 point
	[0, 31) mmHg	2 points
Age in [24, 60) months	[45, Inf) mmHg	0 points
	[32, 45) mmHg	1 point
	[0, 32) mmHg	2 points
Age in [60, 144) months	[49, Inf) mmHg	0 points
	[36, 49) mmHg	1 point
	[0, 36) mmHg	2 points
Age in [144, 216] months	[52, Inf) mmHg	0 points
	[38, 52) mmHg	1 point
	[0, 38) mmHg	2 points

**References**

See reference details in [phoenix-package](#) or by calling `citation('phoenix')`.

**See Also**

- [phoenix](#) for generating the diagnostic Phoenix Sepsis score based on the four organ systems:
  - [phoenix\\_cardiovascular](#),
  - [phoenix\\_coagulation](#),
  - [phoenix\\_neurologic](#),
  - [phoenix\\_respiratory](#),
- [phoenix8](#) for generating the diagnostic Phoenix 8 Sepsis criteria based on the four organ systems noted above and

- phoenix\_endocrine,
- phoenix\_immunologic,
- phoenix\_renal,
- phoenix\_hepatic,

vignette('phoenix') for more details and examples.

### Examples

```
# using the example sepsis data set
phoenix_cardiovascular(
  vasoactives = dobutamine + dopamine + epinephrine + milrinone + norepinephrine + vasopressin,
  lactate = lactate,
  age = age,
  map = dbp + (sbp - dbp)/3,
  data = sepsis
)

# example data set to get all the possible scores
DF <-
  expand.grid(vasos = c(NA, 0:6),
             lactate = c(NA, 3.2, 5, 7.8, 11, 14), # units of mmol/L
             age = c(NA, 0.4, 1, 3, 12, 18, 24, 45, 60, 61, 144, 145), # months
             map = c(NA, 16:52)) # mmHg
DF$card <- phoenix_cardiovascular(vasos, lactate, age, map, DF)
head(DF)

# what if lactate is unknown for all records? - set the value either in the
# data object or the argument value to NA
DF2 <-
  expand.grid(vasos = c(NA, 0:6),
             age = c(NA, 0.4, 1, 3, 12, 18, 24, 45, 60, 61, 144, 145), # months
             map = c(NA, 16:52)) # mmHg
DF2$card <- phoenix_cardiovascular(vasos, lactate = NA, age, map, DF2)

DF3 <-
  expand.grid(vasos = c(NA, 0:6),
             lactate = NA, # mmol/L
             age = c(NA, 0.4, 1, 3, 12, 18, 24, 45, 60, 61, 144, 145), # months
             map = c(NA, 16:52)) # mmHg
DF3$card <- phoenix_cardiovascular(vasos, lactate, age, map, DF3)

identical(DF2$card, DF3$card)
```

---

phoenix\_coagulation    *Phoenix Coagulation Score*

---

### Description

Applies the Phoenix coagulation organ dysfunction scoring to a set of inputs.

**Usage**

```
phoenix_coagulation(  
  platelets = NA_real_,  
  inr = NA_real_,  
  d_dimer = NA_real_,  
  fibrinogen = NA_real_,  
  data = parent.frame(),  
  ...  
)
```

**Arguments**

platelets	numeric vector for platelets counts in units of 1,000/uL (thousand per microliter)
inr	numeric vector for the international normalised ratio blood test
d_dimer	numeric vector for D-Dimer, units of mg/L FEU
fibrinogen	numeric vector units of mg/dL
data	a list, data.frame, or environment containing the input vectors
...	pass through

**Value**

a integer vector with values 0, 1, or 2

As with all other Phoenix organ system scores, missing values in the data set will map to a score of zero - this is consistent with the development of the criteria.

**Phoenix Coagulation Scoring**

1 point each for platelets < 100 K/micro liter, INR > 1.3, D-dimer > 2 mg/L FEU, and fibrinogen < 100 mg/dL, with a max total score of 2.

**References**

See reference details in [phoenix-package](#) or by calling `citation('phoenix')`.

**See Also**

- [phoenix](#) for generating the diagnostic Phoenix Sepsis score based on the four organ systems:
  - [phoenix\\_cardiovascular](#),
  - [phoenix\\_coagulation](#),
  - [phoenix\\_neurologic](#),
  - [phoenix\\_respiratory](#),
- [phoenix8](#) for generating the diagnostic Phoenix 8 Sepsis criteria based on the four organ systems noted above and
  - [phoenix\\_endocrine](#),
  - [phoenix\\_immunologic](#),

- phoenix\_renal,
- phoenix\_hepatic,

vignette('phoenix') for more details and examples.

## Examples

```
# using the example data set
phoenix_coagulation(
  platelets = platelets,    # 1000/uL (thousand per microliter)
  inr = inr,                # unitless
  d_dimer = d_dimer,       # mg/L FEU
  fibrinogen = fibrinogen, # mg/dL
  data = sepsis
)

# build a data.frame with values for all possible combinations of values
# leading to all possible coagulation scores.
DF <-
  expand.grid(plts = c(NA, 20, 100, 150),
             inr = c(NA, 0.2, 1.3, 1.8),
             ddmr = c(NA, 1.7, 2.0, 2.8),
             fib = c(NA, 88, 100, 120))

DF$coag <- phoenix_coagulation(plts, inr, ddmr, fib, DF)
DF
```

---

phoenix\_endocrine      *Phoenix Endocrine Score*

---

## Description

Assess the Phoenix endocrine organ dysfunction score. This score is not part of the Phoenix score, only part of the Phoenix-8 score.

## Usage

```
phoenix_endocrine(glucose = NA_real_, data = parent.frame(), ...)
```

## Arguments

glucose	numeric vector; blood glucose measured in mg/dL
data	a list, data.frame, or environment containing the input vectors
...	pass through

**Value**

a integer vector with values 0 or 1

As with all other Phoenix organ system scores, missing values in the data set will map to a score of zero - this is consistent with the development of the criteria.

**Phoenix Endocrine Scoring**

The endocrine dysfunction score is based on blood glucose with one point for levels < 50 mg/dL or > 150 mg/dL.

**References**

See reference details in [phoenix-package](#) or by calling `citation('phoenix')`.

**See Also**

- [phoenix](#) for generating the diagnostic Phoenix Sepsis score based on the four organ systems:
  - [phoenix\\_cardiovascular](#),
  - [phoenix\\_coagulation](#),
  - [phoenix\\_neurologic](#),
  - [phoenix\\_respiratory](#),
- [phoenix8](#) for generating the diagnostic Phoenix 8 Sepsis criteria based on the four organ systems noted above and
  - [phoenix\\_endocrine](#),
  - [phoenix\\_immunologic](#),
  - [phoenix\\_renal](#),
  - [phoenix\\_hepatic](#),

`vignette('phoenix')` for more details and examples.

**Examples**

```
# using the example sepsis data set
# recall glucose is expected to have units of mg/dL

endo_example      <- sepsis[c("pid", "glucose")]
endo_example$score <- phoenix_endocrine(glucose, data = sepsis)
endo_example

# example data set to get all the possible endocrine scores
# recall glucose is expected to have units of mg/dL

DF <- data.frame(glc = c(NA, 12, 50, 55, 100, 150, 178))
phoenix_endocrine(glucose = glc, data = DF)
```

---

phoenix_hepatic	<i>Phoenix Hepatic Score</i>
-----------------	------------------------------

---

**Description**

Apply the Phoenix Hepatic scoring based on total bilirubin and ALT.

**Usage**

```
phoenix_hepatic(  
  bilirubin = NA_real_,  
  alt = NA_real_,  
  data = parent.frame(),  
  ...  
)
```

**Arguments**

bilirubin	numeric vector; units of mg/dL
alt	alanine aminotransferase; a numeric vector; units of IU/L
data	a list, data.frame, or environment containing the input vectors
...	pass through

**Value**

a integer vector with values 0 or 1

As with all other Phoenix organ system scores, missing values in the data set will map to a score of zero - this is consistent with the development of the criteria.

**Phoenix Hepatic Scoring**

1 point for total bilirubin greater or equal to 4 mg/dL and/or ALT strictly greater than 102 IU/L.

**References**

See reference details in [phoenix-package](#) or by calling `citation('phoenix')`.

**See Also**

- [phoenix](#) for generating the diagnostic Phoenix Sepsis score based on the four organ systems:
  - [phoenix\\_cardiovascular](#),
  - [phoenix\\_coagulation](#),
  - [phoenix\\_neurologic](#),
  - [phoenix\\_respiratory](#),
- [phoenix8](#) for generating the diagnostic Phoenix 8 Sepsis criteria based on the four organ systems noted above and



- phoenix\_endocrine,
- phoenix\_immunologic,
- phoenix\_renal,
- phoenix\_hepatic,

vignette('phoenix') for more details and examples.

### Examples

```
# using the example sepsis data set
# recall expected units:
# (total) bilirubin: mg/dL
# alt: IU/L

hep_example      <- sepsis[c("pid", "bilirubin", "alt")]
hep_example$score <- phoenix_hepatic(bilirubin, alt, sepsis)
hep_example

# example data set with all possible hepatic scores
DF <- expand.grid(bil = c(NA, 3.2, 4.0, 4.3), alt = c(NA, 99, 102, 106))
phoenix_hepatic(bilirubin = bil, alt = alt, data = DF)
```

---

phoenix\_immunologic    *Phoenix Immunologic Score*

---

### Description

Apply the Phoenix immunologic scoring based on ANC and ALC. This is only part of Phoenix-8 and not Phoenix.

### Usage

```
phoenix_immunologic(anc = NA_real_, alc = NA_real_, data = parent.frame(), ...)
```

### Arguments

anc	absolute neutrophil count; a numeric vector; units of 1,000 cells per cubic millimeter
alc	absolute lymphocyte count; a numeric vector; units of 1,000 cells per cubic millimeter
data	a list, data.frame, or environment containing the input vectors
...	pass through

### Value

a integer vector with values 0 or 1

As with all other Phoenix organ system scores, missing values in the data set will map to a score of zero - this is consistent with the development of the criteria.

### Phoenix Immunologic Scoring

1 point if ANC < 0.500 or ALC < 1.000 (units are 1000 cells per cubic millimeter).

### References

See reference details in [phoenix-package](#) or by calling `citation('phoenix')`.

### See Also

- [phoenix](#) for generating the diagnostic Phoenix Sepsis score based on the four organ systems:
  - [phoenix\\_cardiovascular](#),
  - [phoenix\\_coagulation](#),
  - [phoenix\\_neurologic](#),
  - [phoenix\\_respiratory](#),
- [phoenix8](#) for generating the diagnostic Phoenix 8 Sepsis criteria based on the four organ systems noted above and
  - [phoenix\\_endocrine](#),
  - [phoenix\\_immunologic](#),
  - [phoenix\\_renal](#),
  - [phoenix\\_hepatic](#),

`vignette('phoenix')` for more details and examples.

### Examples

```
# using the example sepsis data set
# Expected units for ALC and ANC are 1000 cells per cubic millimeter

immu_example <- sepsis[c("pid", "anc", "alc")]
immu_example$score <- phoenix_immunologic(anc, alc, sepsis)
immu_example

# example data set with all possible immunologic scores
# Expected units for anc and alc are 1000 cells per cubic millimeter

DF <- expand.grid(anc = c(NA, 0.200, 0.500, 0.600),
                 alc = c(NA, 0.500, 1.000, 2.000))
phoenix_immunologic(anc = anc, alc = alc, data = DF)
```

---

phoenix\_neurologic      *Phoenix Sepsis Neurological Score*

---

### Description

Assessment of neurologic dysfunction based on Glasgow Coma Scale (GCS) and pupil reactivity. This score is part of the diagnostic Phoenix Sepsis criteria and Phoenix 8 Sepsis criteria.

**Usage**

```
phoenix_neurologic(  
  gcs = NA_integer_,  
  fixed_pupils = NA_real_,  
  data = parent.frame(),  
  ...  
)
```

**Arguments**

<code>gcs</code>	integer vector; total Glasgow Coma Score
<code>fixed_pupils</code>	integer vector; 1 = bilaterally fixed pupil, 0 = otherwise
<code>data</code>	a list, data.frame, or environment containing the input vectors
<code>...</code>	pass through

**Details**

Missing values will map to a value of 0 as was done when developing the Phoenix criteria. Note that this is done on a input by input basis. That is, if pupil reactivity is missing but GCS (total) is 9, then the neurologic dysfunction score is 1.

GCS total is the sum of a score based on eyes, motor control, and verbal responsiveness.

Eye response:

1. no eye opening,
2. eye opening to pain,
3. eye opening to sound,
4. eyes open spontaneously.

Verbal response:

1. no verbal response,
2. incomprehensible sounds,
3. inappropriate words,
4. confused,
5. orientated

Motor response:

1. no motor response,
2. abnormal extension to pain,
3. abnormal flexion to pain,
4. withdrawal from pain,
5. localized pain,
6. obeys commands

**Value**

an integer vector with values 0, 1, or 2. As with all Phoenix organ dysfunction scores, missing input values map to scores of zero.

**Phoenix Neurological Scoring**

Bilaterally fixed pupil	2 points
Glasgow Coma Score (total) less or equal 10	1 point
Reactive pupils and GCS > 10	0 point

**References**

See reference details in [phoenix-package](#) or by calling `citation('phoenix')`.

**See Also**

- [phoenix](#) for generating the diagnostic Phoenix Sepsis score based on the four organ systems:
  - [phoenix\\_cardiovascular](#),
  - [phoenix\\_coagulation](#),
  - [phoenix\\_neurologic](#),
  - [phoenix\\_respiratory](#),
- [phoenix8](#) for generating the diagnostic Phoenix 8 Sepsis criteria based on the four organ systems noted above and
  - [phoenix\\_endocrine](#),
  - [phoenix\\_immunologic](#),
  - [phoenix\\_renal](#),
  - [phoenix\\_hepatic](#),

`vignette('phoenix')` for more details and examples.

**Examples**

```
# using the example sepsis data set
# Expected units:
# GCS integer values from 3, 4, 5, ..., 15
# fixed_pupils: 1 if bilaterally fixed pupils, 0 otherwise

phoenix_neurologic(
  gcs = gcs_total,
  fixed_pupils = as.integer(pupil == "both-fixed"),
  data = sepsis
)

# build an example data set with all possible neurologic scores
DF <- expand.grid(gcs = c(3:15, NA), pupils = c(0, 1, NA))
DF$target <- 0L
```

```

DF$target[DF$gcs <= 10] <- 1L
DF$target[DF$pupils == 1] <- 2L
DF$current <- phoenix_neurologic(gcs, pupils, DF)
stopifnot(identical(DF$target, DF$current))
DF

```

---

phoenix\_renal

*Phoenix Renal Score*


---

### Description

Apply the Phoenix renal organ dysfunction score based on age adjusted creatinine levels.

### Usage

```

phoenix_renal(
  creatinine = NA_real_,
  age = NA_real_,
  data = parent.frame(),
  ...
)

```

### Arguments

creatinine	numeric vector; units of mg/dL
age	numeric vector age in months
data	a list, data.frame, or environment containing the input vectors
...	pass through

### Value

an integer vector with values 0 or 1

As with all other Phoenix organ system scores, missing values in the data set will map to a score of zero - this is consistent with the development of the criteria.

### Phoenix Renal Scoring

Age in [0, 1) months	creatinine [0, 0.8) mg/dL	0 points
	creatinine [0.8, Inf) mg/dL	1 point
Age in [1, 12) months	creatinine in [0, 0.3) mg/dL	0 points
	creatinine in [0.3, Inf) mg/dL	1 point
Age in [12, 24) months	creatinine in [0, 0.4) mg/dL	0 points

	creatinine in [0.4, Inf) mg/dL	1 point
Age in [24, 60) months	creatinine in [0, 0.6) mg/dL	0 points
	creatinine in [0.6, Inf) mg/dL	1 point
Age in [60, 144) months	creatinine in [0, 0.7) mg/dL	0 points
	creatinine in [0.7, Inf) mg/dL	1 point
Age in [144, 216] months	creatinine in [0, 1.0) mg/dL	0 points
	creatinine in [1.0, Inf) mg/dL	1 point

## References

See reference details in [phoenix-package](#) or by calling `citation('phoenix')`.

## See Also

- [phoenix](#) for generating the diagnostic Phoenix Sepsis score based on the four organ systems:
  - [phoenix\\_cardiovascular](#),
  - [phoenix\\_coagulation](#),
  - [phoenix\\_neurologic](#),
  - [phoenix\\_respiratory](#),
- [phoenix8](#) for generating the diagnostic Phoenix 8 Sepsis criteria based on the four organ systems noted above and
  - [phoenix\\_endocrine](#),
  - [phoenix\\_immunologic](#),
  - [phoenix\\_renal](#),
  - [phoenix\\_hepatic](#),

`vignette('phoenix')` for more details and examples.

## Examples

```
# using the example sepsis data set
# Expected units:
# age: months
# creatinine: mg/dL

renal_example <- sepsis[c("creatinine", "age")]
renal_example$score <- phoenix_renal(creatinine, age, sepsis)
renal_example

# build an example data set with representative renal scores
DF <- expand.grid(age = c(NA, 0.4, 1, 3, 12, 18, 24, 45, 60, 61, 144, 145),
                 creatinine = c(NA, seq(0.0, 1.1, by = 0.1)))
```

```
DF$card <- phoenix_renal(age = age, creatinine = creatinine, data = DF)

head(DF)
```

---

phoenix\_respiratory     *Phoenix Respiratory Score*

---

### Description

Apply the Phoenix Respiratory Scoring rubric to a data set. The respiratory score is part of the diagnostic Phoenix Sepsis criteria and the diagnostic Phoenix 8 Sepsis criteria.

### Usage

```
phoenix_respiratory(
  pf_ratio = NA_real_,
  sf_ratio = NA_real_,
  imv = NA_integer_,
  other_respiratory_support = NA_integer_,
  data = parent.frame(),
  ...
)
```

### Arguments

<code>pf_ratio</code>	numeric vector for the PaO <sub>2</sub> /FiO <sub>2</sub> ratio; PaO <sub>2</sub> = arterial oxygen pressure; FiO <sub>2</sub> = fraction of inspired oxygen; PaO <sub>2</sub> is measured in mmHg and FiO <sub>2</sub> is from 0.21 (room air) to 1.00.
<code>sf_ratio</code>	numeric vector for the SpO <sub>2</sub> /FiO <sub>2</sub> ratio; SpO <sub>2</sub> = oxygen saturation, measured in a percent; ratio for 92% oxygen saturation on room air is 92/0.21 = 438.0952.
<code>imv</code>	invasive mechanical ventilation; numeric or integer vector, (0 = not intubated; 1 = intubated)
<code>other_respiratory_support</code>	other respiratory support; numeric or integer vector, (0 = no support; 1 = support)
<code>data</code>	a list, data.frame, or environment containing the input vectors
<code>...</code>	pass through

### Details

`pf_ratio` is the ratio of partial pressure of oxygen in arterial blood (PaO<sub>2</sub>) to the fraction of inspiratory oxygen concentration (FiO<sub>2</sub>).

`sf_ratio` is a non-invasive surrogate for `pf_ratio` using pulse oximetry (SpO<sub>2</sub>) instead of invasive PaO<sub>2</sub>.

Important Note: when the Phoenix Sepsis criteria was developed there is a requirement that SpO2  $\leq 97$  in order for the `sf_ratio` to be valid. That assumption is not checked in this code and it is left to the end user to account for this when building the `sf_ratio` vector.

`imv` Invasive mechanical ventilation - integer vector where 0 = not intubated and 1 = intubated.

`other_respiratory_support` other respiratory support such as receiving oxygen, high-flow, non-invasive positive pressure, or imv.

### Value

a integer vector with values 0, 1, 2, or 3.

As with all other Phoenix organ system scores, missing values in the data set will map to a score of zero - this is consistent with the development of the criteria.

### Phoenix Respiratory Scoring

0 points	1 point	2 points
<code>pf_ratio</code> $\geq 400$ and <code>sf_ratio</code> $\geq 292$	( <code>pf_ratio</code> $< 400$ or <code>sf_ratio</code> $< 292$ ) and any respiratory support	( <code>pf_ratio</code> $< 200$ or <code>sf_ratio</code> $< 292$ )

### References

See reference details in [phoenix-package](#) or by calling `citation('phoenix')`.

### See Also

- [phoenix](#) for generating the diagnostic Phoenix Sepsis score based on the four organ systems:
  - [phoenix\\_cardiovascular](#),
  - [phoenix\\_coagulation](#),
  - [phoenix\\_neurologic](#),
  - [phoenix\\_respiratory](#),
- [phoenix8](#) for generating the diagnostic Phoenix 8 Sepsis criteria based on the four organ systems noted above and
  - [phoenix\\_endocrine](#),
  - [phoenix\\_immunologic](#),
  - [phoenix\\_renal](#),
  - [phoenix\\_hepatic](#),

`vignette('phoenix')` for more details and examples.



**Examples**

```

# Using the provided example data set:
# Expected units:
#   pf_ratio: PaO2 / FiO2
#   PaO2: mmHg
#   FiO2: decimal between 0.21 (room air) to 1.00 (pure oxygen)
#   sf_ratio: SpO2 / FiO2
#   SpO2: percentage, 0 to 100
#   FiO2: decimal between 0.21 (room air) to 1.00 (pure oxygen)
#   imv: (invasive mechanical ventilation) 1 for yes, 0 for no
#   other_respiratory_support: 1 for yes, 0 for no

phoenix_respiratory(
  pf_ratio = pao2 / fio2,
  sf_ratio = spo2 / fio2,
  imv      = vent,
  other_respiratory_support = as.integer(fio2 > 0.21),
  data = sepsis
)

# A set of values that will get all possible respiratory scores:
DF <- expand.grid(
  pfr = c(NA, 500, 400, 350, 200, 187, 100, 56),
  sfr = c(NA, 300, 292, 254, 220, 177, 148, 76),
  vent = c(NA, 0, 1),
  o2   = c(NA, 0, 1)
)

phoenix_respiratory(
  pf_ratio = pfr,
  sf_ratio = sfr,
  imv      = vent,
  other_respiratory_support = o2,
  data = DF
)

```

---

sepsis

*sepsis*


---

**Description**

A fully synthetic data set with variables needed for examples and documentation of the Phoenix Sepsis Criteria.

**Usage**

```
sepsis
```

**Format**

a data.frame with 20 rows and 27 columns

[, 1]	pid	patient identification number
[, 2]	age	age in months
[, 3]	fio2	fraction of inspired oxygen
[, 4]	pao2	partial pressure of oxygen in arterial blood (mmHg)
[, 5]	spo2	pulse oximetry
[, 6]	vent	indicator for invasive mechanical ventilation
[, 7]	gcs_total	total Glasgow Coma Scale
[, 8]	pupil	character vector reporting if pupils are reactive or fixed.
[, 9]	platelets	platelets measured in 1,000 / microliter
[, 10]	inr	international normalized ratio
[, 11]	d_dimer	D-dimer; units of mg/L FEU
[, 12]	fibrinogen	units of mg/dL
[, 13]	dbp	diastolic blood pressure (mmHg)
[, 14]	sbp	systolic blood pressure (mmHg)
[, 15]	lactate	units of mmol/L
[, 16]	dobutamine	indicator for receiving systemic dobutamine
[, 17]	dopamine	indicator for receiving systemic dopamine
[, 18]	epinephrine	indicator for receiving systemic epinephrine
[, 19]	milrinone	indicator for receiving systemic milrinone
[, 20]	norepinephrine	indicator for receiving systemic norepinephrine
[, 21]	vasopressin	indicator for receiving systemic vasopressin
[, 22]	glucose	units of mg/dL
[, 23]	anc	units of 1,000 cells per cubic millimeter
[, 24]	alc	units of 1,000 cells per cubic millimeter
[, 25]	creatinine	units of mg/dL
[, 26]	bilirubin	units of mg/dL
[, 27]	alt	units of IU/L

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