Package ‘phoenix’

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Title  The Phoenix Pediatric Sepsis and Septic Shock Criteria

Version  1.1.0

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> (Drs. Sanchez-Pinto
and Bennett contributed equally to this manuscript; Dr. DeWitt and Mr.
Russell contributed equally to the manuscript) and “International Consensus
Criteria for Pediatric Sepsis and Septic Shock” by Schlapbach, Watson,
Sorce, Argent, et al. (2024) <doi:10.1001/jama.2024.0179> (Drs Schlapbach,
Watson, Sorce, and Argent contributed equally).

Depends  R (>= 3.5.0)

License  MIT + file LICENSE

Encoding  UTF-8

URL  https://github.com/CU-DBMI-Peds/phoenix/

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

Language  en-us

LazyData  true

Imports

LinkingTo

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

VignetteBuilder  knitr

RoxygenNote  7.3.1

NeedsCompilation  no

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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: \( \frac{DBP + (SBP - DBP)}{3} = \frac{2}{3} DBP + \frac{1}{3} SBP \)

Value

a numeric vector
Examples

```r
DF <- expand.grid(sbp = 40:130, dbp = 20:100)
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 Pressure"
)
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

```r
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

- **pf_ratio**: numeric vector for the PaO2/FiO2 ratio; PaO2 = arterial oxygen pressure; FiO2 = fraction of inspired oxygen; PaO2 is measured in mmHg and FiO2 is from 0.21 (room air) to 1.00.

- **sf_ratio**: numeric vector for the SpO2/FiO2 ratio; SpO2 = 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 Comma Score

- **fixed_pupils**: integer vector; 1 = bilaterally fixed pupil, 0 = otherwise

- **age**: numeric vector age in months

- **data**: a list, data.frame, or environment containing the input vectors

... 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)
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

```r
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 PaO2/FiO2 ratio; PaO2 = arterial oxygen pressure; FiO2 = fraction of inspired oxygen; PaO2 is measured in mmHg and FiO2 is from 0.21 (room air) to 1.00.
- **sf_ratio**: numeric vector for the SpO2/FiO2 ratio; SpO2 = 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)
Phoenix 8

- **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...

### Details

The Phoenix Sepsis Criteria is based on the score form respiratory, cardiovascular, coagulation, and neurologic. Phoenix 8 uses these four an 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,
phoenix_cardiovascular

# 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

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>vasoactives</td>
<td>an integer vector, the number of systemic vasoactive medications being admin-</td>
</tr>
<tr>
<td></td>
<td>istered to the patient. Six vasoactive medications are considered: dobutamine,</td>
</tr>
<tr>
<td></td>
<td>dopamine, epinephrine, milrinone, norepinephrine, vasopressin.</td>
</tr>
<tr>
<td>lactate</td>
<td>numeric vector with the lactate value in mmol/L</td>
</tr>
<tr>
<td>age</td>
<td>numeric vector age in months</td>
</tr>
<tr>
<td>map</td>
<td>numeric vector, mean arterial pressure in mmHg</td>
</tr>
</tbody>
</table>
data a list, data.frame, or environment containing the input vectors

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 systolic vasoactive medications, lactate, and MAP.

Systemic Vasoactive Medications

<table>
<thead>
<tr>
<th>Medications</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 medications</td>
<td>0 points</td>
</tr>
<tr>
<td>1 medication</td>
<td>1 point</td>
</tr>
<tr>
<td>2 or more medications</td>
<td>2 points</td>
</tr>
</tbody>
</table>

Lactate

<table>
<thead>
<tr>
<th>Lactate</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>[0, 5)</td>
<td>0 points</td>
</tr>
<tr>
<td>[5, 11)</td>
<td>1 point</td>
</tr>
<tr>
<td>[11, Inf)</td>
<td>2 points</td>
</tr>
</tbody>
</table>

MAP

<table>
<thead>
<tr>
<th>Age in [0, 1) months</th>
<th>[0, 17) mmHg</th>
<th>2 points</th>
</tr>
</thead>
<tbody>
<tr>
<td>[31, Inf) mmHg</td>
<td>0 points</td>
<td></td>
</tr>
<tr>
<td>[17, 31) mmHg</td>
<td>1 point</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age in [1, 12) months</th>
<th>[0, 25) mmHg</th>
<th>2 points</th>
</tr>
</thead>
<tbody>
<tr>
<td>[39, Inf) mmHg</td>
<td>0 points</td>
<td></td>
</tr>
<tr>
<td>[25, 39) mmHg</td>
<td>1 point</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age in [12, 24) months</th>
<th>[0, 31) mmHg</th>
<th>2 points</th>
</tr>
</thead>
<tbody>
<tr>
<td>[44, Inf) mmHg</td>
<td>0 points</td>
<td></td>
</tr>
<tr>
<td>[31, 44) mmHg</td>
<td>1 point</td>
<td></td>
</tr>
<tr>
<td>[0, 31) mmHg</td>
<td>2 points</td>
<td></td>
</tr>
</tbody>
</table>
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

```r
# 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),
              age = seq(24, 216, 12))
```
lactate = c(NA, 3.2, 5, 7.8, 11, 14),
age = c(NA, 0.4, 1, 3, 12, 18, 24, 45, 60, 61, 144, 145),
map = c(NA, 16:52))
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),
map = c(NA, 16:52))
DF2$card <- phoenix_cardiovascular(vasos, lactate = NA, age, map, DF2)

DF3 <- expand.grid(vasos = c(NA, 0:6),
lactate = NA,
age = c(NA, 0.4, 1, 3, 12, 18, 24, 45, 60, 61, 144, 145),
map = c(NA, 16:52))
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
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

```r
# using the example data set
phoenix_coagulation(
  platelets = platelets,
  inr = inr,
  d_dimer = d_dimer,
  fibrinogen = fibrinogen,
  data = sepsis
)

# build a data.frame with values for all possible combationations 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**

```r
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

```r
# using the example sepsis data set
data_set <- sepsis[c("pid", "glucose")]
data_set$score <- phoenix_endocrine(glucose, data = sepsis)
data_set
```

```r
# example data set to get all the possible endocrine scores
DF <- data.frame(glc = c(NA, 12, 50, 55, 100, 150, 178))
phoenix_endocrine(glucose = glc, data = DF)
```

---

**phoenix_hepatic**  
*Phoenix Hepatic Score*

**Description**

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

**Usage**

```r
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

```r
# using the example sepsis data set
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)
```
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 < 500 or ALC < 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,
```r
# using the example sepsis data set
immu_example <- sepsis[c("pid", "anc", "alc")]
immu_example$score <- phoenix_immunologic(anc, alc, sepsis)
immu_example

# using the example sepsis data set
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(anc = c(NA, 200, 500, 600), alc = c(NA, 500, 1000, 2000))
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**

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

**Arguments**

- `gcs`  
  integer vector; total Glasgow Comma Score

- `fixed_pupils`  
  integer vector; 1 = bilaterally fixed pupil, 0 = otherwise

- `data`  
  a list, data.frame, or environment containing the input vectors

- `...`  
  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 an 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

<table>
<thead>
<tr>
<th>Condition</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bilaterally fixed pupil</td>
<td>2</td>
</tr>
<tr>
<td>Glasgow Coma Score (total) less or equal 10</td>
<td>1</td>
</tr>
<tr>
<td>Reactive pupils and GCS &gt; 10</td>
<td>0</td>
</tr>
</tbody>
</table>

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

```r
# using the example sepsis data set
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

```r
phoenix_renal(
  creatinine = NA_real_,
  age = NA_real_,
  data = parent.frame(),
  ...
)
```
Phoenix Renal Scoring

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

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 Renal Scoring

<table>
<thead>
<tr>
<th>Age range</th>
<th>Creatinine range</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>[0, 1) months</td>
<td>[0, 0.8) mg/dL</td>
<td>0 points</td>
</tr>
<tr>
<td></td>
<td>[0.8, Inf) mg/dL</td>
<td>1 point</td>
</tr>
<tr>
<td>[1, 12) months</td>
<td>[0, 0.3) mg/dL</td>
<td>0 points</td>
</tr>
<tr>
<td></td>
<td>[0.3, Inf) mg/dL</td>
<td>1 point</td>
</tr>
<tr>
<td>[12, 24) months</td>
<td>[0, 0.4) mg/dL</td>
<td>0 points</td>
</tr>
<tr>
<td></td>
<td>[0.4, Inf) mg/dL</td>
<td>1 point</td>
</tr>
<tr>
<td>[24, 60) months</td>
<td>[0, 0.6) mg/dL</td>
<td>0 points</td>
</tr>
<tr>
<td></td>
<td>[0.6, Inf) mg/dL</td>
<td>1 point</td>
</tr>
<tr>
<td>[60, 144) months</td>
<td>[0, 0.7) mg/dL</td>
<td>0 points</td>
</tr>
<tr>
<td></td>
<td>[0.7, Inf) mg/dL</td>
<td>1 point</td>
</tr>
<tr>
<td>[144, 216] months</td>
<td>[0, 1.0) mg/dL</td>
<td>0 points</td>
</tr>
<tr>
<td></td>
<td>[1.0, Inf) mg/dL</td>
<td>1 point</td>
</tr>
</tbody>
</table>

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

```r
# using the example sepsis data set
renal_example <- sepsis[c("creatinine", "age")]
renal_example$score <- phoenix_renal(creatinine, age, sepsis)
renal_example

# build an example data set with all possible neurologic 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**

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

- **pf_ratio**: numeric vector for the PaO2/FiO2 ratio; PaO2 = arterial oxygen pressure; FiO2 = fraction of inspired oxygen; PaO2 is measured in mmHg and FiO2 is from 0.21 (room air) to 1.00.
- **sf_ratio**: numeric vector for the SpO2/FiO2 ratio; SpO2 = 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)
- **data**: a list, data.frame, or environment containing the input vectors

Details

- **pf_ratio** is the ratio of partial pressure of oxygen in arterial blood (PaO2) to the fraction of inspiratory oxygen concentration (FiO2).
- **sf_ratio** is a non-invasive surrogate for **pf_ratio** using pulse oximetry (SpO2) instead of invasive PaO2.

Important Note: when the Phoenix Sepsis criteria was developed there is a requirement that SpO2 < 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

- pf_ratio >= 400 and sf_ratio >= 292
- (pf_ratio < 400 or sf_ratio < 292) and any respiratory support
- (pf_ratio < 200 or sf_ratio < 220) and imv

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

```r
# Using the provided example data set:
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
)
```
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: diagnostic 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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