

Package ‘possum’

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Type Package

Title Surgical Risk Prediction with the POSSUM Score Family

Version 0.1.0

Description Computes the Physiological and Operative Severity Score for the enUmeration of Mortality and morbidity (POSSUM), its Portsmouth modification (P-POSSUM), and the colorectal (CR-POSSUM), vascular (V-POSSUM) and ruptured aortic aneurysm (RAAA-POSSUM) variants, risk-adjustment systems used in surgical audit. Functions map physiological and operative variables to their component scores and return the predicted probabilities of morbidity and mortality from the published logistic equations. The coefficients follow Copeland and others (1991) <[doi:10.1002/bjs.1800780327](https://doi.org/10.1002/bjs.1800780327)> for POSSUM, Prytherch and others (1998) <[doi:10.1046/j.1365-2168.1998.00840.x](https://doi.org/10.1046/j.1365-2168.1998.00840.x)> for P-POSSUM, Tekkis and others (2004) <[doi:10.1002/bjs.4430](https://doi.org/10.1002/bjs.4430)> for the colorectal variant (CR-POSSUM), and Neary and others (2003) <[doi:10.1002/bjs.4041](https://doi.org/10.1002/bjs.4041)> for the vascular variant (V-POSSUM). The package is intended for audit and research; it is not a validated medical device and must not be used as the sole basis for clinical decisions.

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Encoding UTF-8

URL <https://github.com/chrislongros/possum>

BugReports <https://github.com/chrislongros/possum/issues>

Imports stats

Suggests tinytest

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NeedsCompilation no

Author Christos Longros [aut, cre] (ORCID:
<<https://orcid.org/0009-0001-2717-0857>>),
Daniel Enrique Chourio Barboza [aut]

Maintainer Christos Longros <chris.longros@gmail.com>

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cr_possum	<i>CR-POSSUM predicted mortality</i>
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Description

Applies the colorectal POSSUM mortality equation (Tekkis and others, 2004):

$$\text{logit}(\text{mortality}) = -9.167 + 0.338 \times PS + 0.308 \times OS$$

Usage

```
cr_possum(physiological_score, operative_score)
```

Arguments

- physiological_score
CR-POSSUM physiological score (6-23), e.g. from [cr_possum_physiology](#).
- operative_score
CR-POSSUM operative score (4-22), e.g. from [cr_possum_operative](#).

Value

Predicted probability of mortality (0-1).

Examples

```
cr_possum(physiological_score = 12, operative_score = 8)
```

cr_possum_operative	<i>CR-POSSUM operative score</i>
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Description

Sums the four operative components of CR-POSSUM, all entered as their points. severity 1 (minor) / 3 (moderate) / 4 (major) / 8 (complex major); soiling 1 (none or serous) / 2 (local pus) / 3 (free pus, faeces or blood); cancer_staging 1 (none or Dukes A-B) / 2 (Dukes C) / 3 (Dukes D); urgency 1 (elective) / 3 (urgent) / 8 (emergency).

Usage

```
cr_possum_operative(severity, soiling, cancer_staging, urgency)
```

Arguments

severity	CR-POSSUM operative severity points (1, 3, 4 or 8).
soiling, cancer_staging	Points (1, 2 or 3).
urgency	Mode-of-surgery points (1, 3 or 8).

Value

Integer CR-POSSUM operative score (range 4-22).

Examples

```
cr_possum_operative(severity = 4, soiling = 1, cancer_staging = 2, urgency = 1)
```

cr_possum_physiology	<i>CR-POSSUM physiological score</i>
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Description

Sums the six physiological components of the colorectal POSSUM (CR-POSSUM) score. Age, systolic blood pressure, pulse, haemoglobin and urea are scored from raw clinical values; cardiac is entered as its points.

Usage

```
cr_possum_physiology(age, cardiac, systolic_bp, pulse, hb, urea)
```

Arguments

age, systolic_bp, pulse, hb, urea	Numeric raw clinical values, all non-negative.
cardiac	CR-POSSUM cardiac-failure points (1, 2 or 3).

Details

Cut-points and weights (Tekkis and others, 2004):

age (years)	$\leq 60=1$ / $61-80=3$ or 4 / $\geq 81=8$
systolic BP (mmHg)	$100-170=1$ / >170 or $90-99=2$ / $\leq 89=3$
pulse (/min)	$40-100=1$ / $101-120=2$ / >120 or $<40=3$
haemoglobin (g/dL)	$13-16=1$ / $10-12.9$ or $16.1-18=2$ / <10 or $>18=3$
urea (mmol/L)	$\leq 10=1$ / $10.1-15=2$ / $>15=3$
cardiac failure	none/mild=1 / moderate=2 / severe=3 (entered as points)

Value

Integer CR-POSSUM physiological score (range 6-23).

Examples

```
cr_possum_physiology(age = 72, cardiac = 1, systolic_bp = 140, pulse = 88,
  hb = 12, urea = 8)
```

possum	<i>POSSUM predicted morbidity and mortality</i>
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Description

Applies the original POSSUM logistic equations (Copeland and others, 1991) to a physiological and operative severity score:

$$\text{logit}(\text{morbidity}) = -5.91 + 0.16 \times PS + 0.19 \times OSS$$

$$\text{logit}(\text{mortality}) = -7.04 + 0.13 \times PS + 0.16 \times OSS$$

Usage

```
possum(physiological_score, operative_score)
```

Arguments

physiological_score

POSSUM physiological score (12-88), e.g. from [possum_physiology](#).

operative_score

POSSUM operative severity score (6-48), e.g. from [possum_operative](#).

Value

A list with elements morbidity and mortality, the predicted probabilities (0-1).

Examples

```
possum(physiological_score = 20, operative_score = 10)
```

possum_operative	<i>POSSUM operative severity score</i>
------------------	--

Description

Sums the six operative components. `n_procedures` and `blood_loss` are scored from their raw values; `severity`, `soiling`, `malignancy` and `urgency` are entered as their POSSUM points.

Usage

```
possum_operative(
  severity,
  n_procedures,
  blood_loss,
  soiling,
  malignancy,
  urgency
)
```

Arguments

<code>severity</code> , <code>soiling</code> , <code>malignancy</code>	POSSUM points (1, 2, 4 or 8).
<code>n_procedures</code>	Number of procedures at this operation (at least 1).
<code>blood_loss</code>	Total blood loss in mL (non-negative).
<code>urgency</code>	POSSUM points for the mode of surgery (1, 4 or 8).

Details

Raw cut-points (points 1 / 2 / 4 / 8): number of procedures 1 / - / 2 / >2; blood loss (mL) ≤ 100 / 101-500 / 501-999 / ≥ 1000 . Graded, as points: `severity` 1 (minor) / 2 (moderate) / 4 (major) / 8 (major+); `soiling` 1 (none) / 2 (serous) / 4 (local pus) / 8 (free bowel content, pus or blood); `malignancy` 1 (none) / 2 (primary only) / 4 (nodal metastases) / 8 (distant metastases); `urgency` 1 (elective) / 4 (emergency, within 24 h) / 8 (emergency, within 2 h).

Value

Integer operative severity score (minimum 6).

Examples

```
possum_operative(severity = 4, n_procedures = 1, blood_loss = 200,
  soiling = 1, malignancy = 2, urgency = 1)
```

possum_physiology	<i>POSSUM physiological score</i>
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Description

Sums the twelve physiological components of the POSSUM score. The nine objective variables are scored from their raw clinical values; the three graded variables (cardiac, respiratory, ecg) are entered directly as their POSSUM points.

Usage

```
possum_physiology(
  age,
  systolic_bp,
  pulse,
  gcs,
  hb,
  wbc,
  urea,
  sodium,
  potassium,
  cardiac,
  respiratory,
  ecg
)
```

Arguments

age, systolic_bp, pulse, gcs, hb, wbc, urea, sodium, potassium	Numeric raw clinical values in the units above. All must be non-negative, and gcs must be 3-15, the range of the scale.
cardiac, respiratory	POSSUM points (1, 2, 4 or 8) for the cardiac and respiratory signs.
ecg	POSSUM points for the ECG (1, 4 or 8).

Details

Cut-points (points 1 / 2 / 4 / 8):

age (years)	≤ 60 / 61-70 / ≥ 71 / -
systolic BP (mmHg)	110-130 / 100-109 or 131-170 / 90-99 or ≥ 171 / ≤ 89
pulse (/min)	50-80 / 40-49 or 81-100 / 101-120 / ≤ 39 or ≥ 121
GCS	15 / 12-14 / 9-11 / ≤ 8
haemoglobin (g/dL)	13-16 / 11.5-12.9 or 16.1-17 / 10-11.4 or 17.1-18 / <10 or >18
WCC ($10^9/L$)	4-10 / 3.1-3.9 or 10.1-20 / ≤ 3 or ≥ 20.1 / -
urea (mmol/L)	≤ 7.5 / 7.6-10 / 10.1-15 / ≥ 15.1
sodium (mmol/L)	≥ 136 / 131-135 / 126-130 / ≤ 125

potassium (mmol/L) 3.5-5 / 3.2-3.4 or 5.1-5.3 / 2.9-3.1 or 5.4-5.9 / ≤ 2.8 or ≥ 6

Graded variables, entered as points: cardiac and respiratory take 1, 2, 4 or 8; ecg takes 1 (normal), 4 (atrial fibrillation 60-90/min) or 8 (any other abnormality). Confirm the grading against the original tables before use.

Value

Integer physiological score (minimum 12).

Examples

```
possum_physiology(age = 65, systolic_bp = 120, pulse = 75, gcs = 15,
                  hb = 13.5, wbc = 8, urea = 6, sodium = 140, potassium = 4.2,
                  cardiac = 1, respiratory = 1, ecg = 1)
```

possum_risk

POSSUM and P-POSSUM risk for a table of patients

Description

Convenience wrapper that scores a whole cohort in one call, rather than invoking [possum_physiology](#), [possum_operative](#) and the risk functions separately. Each row of data is one patient.

Usage

```
possum_risk(data)
```

Arguments

data	A data frame (one row per patient) containing the columns required by possum_physiology and possum_operative : age, systolic_bp, pulse, gcs, hb, wbc, urea, sodium, potassium, cardiac, respiratory, ecg, severity, n_procedures, blood_loss, soiling, malignancy and urgency.
------	--

Details

Rows are scored independently. A row with a missing or out-of-range value cannot be scored, so its five output columns are returned as NA and the rest of the cohort is scored as normal; a single missing laboratory value no longer aborts the whole call. A warning reports how many rows were left unscored.

Value

data with five columns added: physiological_score, operative_score, possum_morbidity, possum_mortality and p_possum_mortality. Rows that could not be scored carry NA in all five.

Examples

```
df <- data.frame(
  age = c(45, 82), systolic_bp = c(120, 95), pulse = c(70, 115),
  gcs = c(15, 13), hb = c(14, 9.5), wbc = c(7, 22), urea = c(5, 18),
  sodium = c(140, 128), potassium = c(4.2, 6.1), cardiac = c(1, 4),
  respiratory = c(1, 4), ecg = c(1, 8), severity = c(1, 8),
  n_procedures = c(1, 1), blood_loss = c(50, 1200), soiling = c(1, 8),
  malignancy = c(1, 4), urgency = c(1, 8))
possum_risk(df)
```

p_possum	<i>P-POSSUM predicted mortality</i>
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Description

Applies the Portsmouth (P-POSSUM) mortality equation (Prytherch and others, 1998), which re-calibrates the POSSUM mortality prediction:

$$\text{logit}(\text{mortality}) = -9.065 + 0.1692 \times PS + 0.1550 \times OSS$$

Usage

```
p_possum(physiological_score, operative_score)
```

Arguments

- physiological_score
POSSUM physiological score (12-88).
- operative_score
POSSUM operative severity score (6-48).

Value

Predicted probability of mortality (0-1).

Examples

```
p_possum(physiological_score = 20, operative_score = 10)
```

raaa_possum	<i>RAAA-POSSUM predicted mortality (ruptured abdominal aortic aneurysm)</i>
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Description

Applies a POSSUM mortality equation specific to ruptured abdominal aortic aneurysm surgery, computed from the standard POSSUM physiological and operative severity scores. Two forms are provided:

$$\text{logit}(\text{mortality}) = -2.7569 + 0.0968 \times PS$$

$$\text{logit}(\text{mortality}) = -4.9795 + 0.0913 \times PS + 0.0958 \times OS$$

Usage

```
raaa_possum(
  physiological_score,
  operative_score = NULL,
  model = c("physiology", "full")
)
```

Arguments

physiological_score	Standard POSSUM physiological score (12-88), e.g. from possum_physiology .
operative_score	Standard POSSUM operative severity score (6-48), e.g. from possum_operative . Required when model = "full", and an error when model = "physiology", which cannot use it.
model	Which equation to use: "physiology" (default, physiology score only) or "full" (physiology plus operative score).

Details

RAAA-POSSUM (Prytherch and others, 2001) reuses the standard POSSUM scores. Both equations are as tabulated by Neary, Heather and Earnshaw (2003).

Value

Predicted probability of mortality (0-1).

Examples

```
raaa_possum(physiological_score = 30)
raaa_possum(physiological_score = 30, operative_score = 18, model = "full")
```

v_possum

*V-POSSUM predicted mortality (vascular)***Description**

Applies a vascular POSSUM (V-POSSUM) mortality equation, computed from the *standard* POSSUM physiological and operative severity scores (from [possum_physiology](#) and [possum_operative](#)). Two forms are provided:

$$\text{logit}(\text{mortality}) = -6.0386 + 0.1539 \times PS$$

$$\text{logit}(\text{mortality}) = -8.0616 + 0.1552 \times PS + 0.1238 \times OS$$

Usage

```
v_possum(
  physiological_score,
  operative_score = NULL,
  model = c("physiology", "full")
)
```

Arguments

physiological_score	Standard POSSUM physiological score (12-88), e.g. from possum_physiology .
operative_score	Standard POSSUM operative severity score (6-48), e.g. from possum_operative . Required when model = "full", and an error when model = "physiology", which cannot use it.
model	Which equation to use: "physiology" (default, physiology score only) or "full" (physiology plus operative score).

Details

V-POSSUM (Prytherch and others, 2001, for major arterial surgery) reuses the standard POSSUM scores. Both equations are as tabulated by Neary, Heather and Earnshaw (2003). No V-POSSUM morbidity equation has been published.

Value

Predicted probability of mortality (0-1).

Examples

```
v_possum(physiological_score = 25)
v_possum(physiological_score = 25, operative_score = 15, model = "full")
```

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