

# Package ‘tidycmprsk’

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**Title** Competing Risks Estimation

**Version** 1.1.2

**Description** Provides an intuitive interface for working with the competing risk endpoints. The package wraps the 'cmprsk' package, and exports functions for univariate cumulative incidence estimates and competing risk regression. Methods follow those introduced in Fine and Gray (1999) <[doi:10.1002/sim.7501](https://doi.org/10.1002/sim.7501)>.

**License** AGPL (>= 3)

**URL** <https://mskcc-epi-bio.github.io/tidycmprsk/>,  
<https://github.com/MSKCC-Epi-Bio/tidycmprsk>

**BugReports** <https://github.com/MSKCC-Epi-Bio/tidycmprsk/issues>

**Depends** R (>= 4.2)

**Imports** broom (>= 1.0.1), cli, cmprsk (>= 2.2.10), dplyr, ggplot2 (>= 3.3.5), gtsummary (>= 2.0.0), hardhat (>= 1.3.0), purrr (>= 0.3.4), rlang, stringr (>= 1.4.0), survival, tibble (>= 3.1.6), tidy

**Suggests** aod, broom.helpers (>= 1.15.0), cardx (>= 0.2.0), covr (>= 3.5.1), ggsurvfit, knitr (>= 1.36), spelling, testthat (>= 3.2.0)

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## Contents

add_cuminc . . . . .	2
base_methods_crr . . . . .	4
base_methods_cuminc . . . . .	5
broom_methods_crr . . . . .	5
broom_methods_cuminc . . . . .	7
crr . . . . .	8
cuminc . . . . .	9
gtsummary_s3_methods . . . . .	11
predict.tidycrr . . . . .	12
tbl_cuminc . . . . .	12
trial . . . . .	14

<b>Index</b>	<b>15</b>
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add_cuminc	<i>Additional Functions for tbl_cuminc()</i>
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## Description

- `add_p()` Add column with p-value comparing incidence across stratum
- `add_n()` Add column with the total N, or N within stratum
- `add_nevent()` Add column with the total number of events, or number of events within stratum
- `inline_text()` Report statistics from a `tbl_cuminc()` table inline

## Usage

```
## S3 method for class 'tbl_cuminc'
add_p(x, pvalue_fun = gtsummary::style_pvalue, ...)

## S3 method for class 'tbl_cuminc'
add_n(x, location = NULL, ...)

## S3 method for class 'tbl_cuminc'
add_nevent(x, location = NULL, ...)

## S3 method for class 'tbl_cuminc'
inline_text(x, time = NULL, column = NULL, outcome = NULL, level = NULL, ...)
```

## Arguments

<code>x</code>	object of class 'tbl_cuminc'
<code>pvalue_fun</code>	function to style/format p-values. Default is <code>gtsummary::style_pvalue</code>
<code>...</code>	These dots are for future extensions and must be empty.

location	location to place Ns. When "label" total Ns are placed on each variable's label row. When "level" level counts are placed on the variable level for categorical variables, and total N on the variable's label row for continuous.
time	time of statistic to report
column	column name of the statistic to report
outcome	string indicating the outcome to select from. If NULL, the first outcome is used.
level	if estimates are stratified, level of the stratum to report

### p-values

The p-values reported in `cuminc()`, `glance.tidycuminc()` and `add_p.tbl_cuminc()` are Gray's test as described in Gray RJ (1988) *A class of K-sample tests for comparing the cumulative incidence of a competing risk*, Annals of Statistics, 16:1141-1154.

### See Also

Other `tbl_cuminc` tools: [tbl\\_cuminc\(\)](#)

### Examples

```
# Example 1 -----
add_cuminc_ex1 <-
  cuminc(Surv(ttdeath, death_cr) ~ 1, trial) |>
  tbl_cuminc(times = c(12, 24), label_header = "**Month {time}**") |>
  add_nevent() |>
  add_n()
add_cuminc_ex1

# Example 2 -----
add_cuminc_ex2 <-
  cuminc(Surv(ttdeath, death_cr) ~ trt, trial) |>
  tbl_cuminc(times = c(12, 24),
             outcomes = c("death from cancer", "death other causes"),
             label_header = "**Month {time}**") |>
  add_p() |>
  add_nevent(location = c("label", "level")) |>
  add_n(location = c("label", "level"))
add_cuminc_ex2

# inline_text() -----
inline_text(add_cuminc_ex2, time = 12, level = "Drug A")
inline_text(add_cuminc_ex2, column = p.value)
```

---

base\_methods\_crr      *Functions for tidycrr objects*

---

## Description

Functions for tidycrr objects

## Usage

```
## S3 method for class 'tidycrr'  
coef(object, ...)
```

```
## S3 method for class 'tidycrr'  
vcov(object, ...)
```

```
## S3 method for class 'tidycrr'  
model.matrix(object, ...)
```

```
## S3 method for class 'tidycrr'  
model.frame(formula, ...)
```

```
## S3 method for class 'tidycrr'  
terms(x, ...)
```

## Arguments

...	not used
formula	a formula
x, object	a tidycrr object

## Value

coef vector, model matrix, model frame, terms object

## Examples

```
mod <- crr(Surv(ttdeath, death_cr) ~ age + grade, trial)  
  
coef(mod)  
  
model.matrix(mod) %>% head()  
  
model.frame(mod) %>% head()  
  
terms(mod)
```

---

base\_methods\_cuminc    *Functions for tidycuminc objects*

---

### Description

Functions for tidycuminc objects

### Usage

```
## S3 method for class 'tidycuminc'  
model.frame(formula, ...)
```

```
## S3 method for class 'tidycuminc'  
model.matrix(object, ...)
```

### Arguments

formula	a formula
...	not used
object	a tidycuminc object

### Value

a model frame, or model matrix

### Examples

```
fit <- cuminc(Surv(ttdeath, death_cr) ~ trt, trial)  
  
model.matrix(fit) %>% head()  
  
model.frame(fit) %>% head()
```

---

broom\_methods\_crr    *Broom methods for tidycrr objects*

---

### Description

Broom methods for tidycrr objects

**Usage**

```
## S3 method for class 'tidycrr'
tidy(x, exponentiate = FALSE, conf.int = FALSE, conf.level = x$conf.level, ...)

## S3 method for class 'tidycrr'
glance(x, ...)

## S3 method for class 'tidycrr'
augment(x, times = NULL, probs = NULL, newdata = NULL, ...)
```

**Arguments**

<code>x</code>	a <code>tidycrr</code> object
<code>exponentiate</code>	Logical indicating whether or not to exponentiate the coefficient estimates. Defaults to <code>FALSE</code> .
<code>conf.int</code>	Logical indicating whether or not to include a confidence interval in the tidied output. Defaults to <code>FALSE</code> .
<code>conf.level</code>	Level of the confidence interval. Default matches that in <code>crr(conf.level=)</code> (typically, 0.95)
<code>...</code>	not used
<code>times</code>	Numeric vector of times to obtain risk estimates at
<code>probs</code>	Numeric vector of quantiles to obtain estimates at
<code>newdata</code>	A <code>base::data.frame()</code> or <code>tibble::tibble()</code> containing all the original predictors used to create <code>x</code> . Defaults to <code>NULL</code> .

**Value**

a tibble

**See Also**

Other `crr()` functions: [crr\(\)](#), [predict.tidycrr\(\)](#)

**Examples**

```
crr <- crr(Surv(ttdeath, death_cr) ~ age + grade, trial)

tidy(crr)

glance(crr)

augment(crr, times = 12)
```

---

 broom\_methods\_cuminc *Broom methods for tidy cuminc objects*


---

**Description**

Broom methods for tidy cuminc objects

**Usage**

```
## S3 method for class 'tidycuminc'
tidy(x, times = NULL, conf.int = TRUE, conf.level = x$conf.level, ...)

## S3 method for class 'tidycuminc'
glance(x, ...)
```

**Arguments**

x	object of class 'tidycuminc'
times	Numeric vector of times to obtain risk estimates at
conf.int	Logical indicating whether or not to include a confidence interval in the tidied output. Defaults to FALSE.
conf.level	Level of the confidence interval. Default matches that in cuminc(conf.level=) (typically, 0.95)
...	not used

**Value**

a tibble

**tidy() data frame**

The returned tidy() data frame returns the following columns:

Column Name	Description
outcome	Competing Event Outcome
time	Numeric follow-up time
estimate	Risk estimate
std.error	Standard Error
n.risk	Number at risk at the specified time
n.event	If the times= argument is missing, then the number of events that occurred at time t. Otherwise, it is the cumulative number of events that occurred at time t.
n.censor	If the times= argument is missing, then the number of censored obs at time t. Otherwise, it is the cumulative number of censored observations at time t.
cum.event	Cumulative number of events at specified time
cum.censor	Cumulative number of censored observations at specified time

If tidy(time=) is specified, then n.event and n.censor are the cumulative number of events/censored in the interval. For example, if tidy(time = c(0, 12, 18)) is passed, n.event and n.censor at time = 18 are the cumulative number of events/censored in the interval (12, 18].

**p-values**

The p-values reported in `cuminc()`, `glance.tidycuminc()` and `add_p.tbl_cuminc()` are Gray's test as described in Gray RJ (1988) *A class of K-sample tests for comparing the cumulative incidence of a competing risk*, *Annals of Statistics*, 16:1141-1154.

**Confidence intervals**

The confidence intervals for cumulative incidence estimates use the recommended method in *Competing Risks: A Practical Perspective* by Melania Pintilie.

$$x \exp(z * se / (x * \log(x)))$$

where  $x$  is the cumulative incidence estimate,  $se$  is the standard error estimate, and  $z$  is the z-score associated with the confidence level of the interval, e.g.  $z = 1.96$  for a 95% CI.

**See Also**

Other `cuminc()` functions: [cuminc\(\)](#)

**Examples**

```
cuminc <- cuminc(Surv(ttdeath, death_cr) ~ trt, trial)

tidy(cuminc)

glance(cuminc)

# restructure glance to one line per outcome
glance(cuminc) %>%
  tidyr::pivot_longer(
    everything(),
    names_to = c(".value", "outcome_id"),
    names_pattern = "(.*)_(.*)"
  )
```

**Description**

Competing Risks Regression

**Usage**

```
## S3 method for class 'formula'
crr(formula, data, failcode = NULL, conf.level = 0.95, ...)

crr(x, ...)

## Default S3 method:
crr(x, ...)
```

**Arguments**

formula	formula with <code>Surv()</code> on LHS and covariates on RHS. The event status variable must be a factor, with the first level indicating 'censor' and subsequent levels the competing risks. The <code>Surv(time2=)</code> argument cannot be used.
data	data frame
failcode	Indicates event of interest. If <code>failcode=</code> is NULL, the first competing event will be used as the event of interest. Default is NULL.
conf.level	confidence level. Default is 0.95.
...	passed to methods
x	input object

**Value**

tidycrr object

**See Also**

Other `crr()` functions: [broom\\_methods\\_crr](#), [predict.tidycrr\(\)](#)

**Examples**

```
crr(Surv(ttdeath, death_cr) ~ age + grade, trial)
```

---

cuminc

*Competing Risks Cumulative Incidence*

---

**Description**

Competing Risks Cumulative Incidence

**Usage**

```
## S3 method for class 'formula'
cuminc(formula, data, strata, rho = 0, conf.level = 0.95, ...)

cuminc(x, ...)

## Default S3 method:
cuminc(x, ...)
```

**Arguments**

formula	formula with Surv() on LHS and covariates on RHS. The event status variable must be a factor, with the first level indicating 'censor' and subsequent levels the competing risks. The Surv(time2=) argument cannot be used.
data	data frame
strata	stratification variable. Has no effect on estimates. Tests will be stratified on this variable. (all data in 1 stratum, if missing)
rho	Power of the weight function used in the tests.
conf.level	confidence level. Default is 0.95.
...	passed to methods
x	input object

**Value**

tidycuminc object

**Confidence intervals**

The confidence intervals for cumulative incidence estimates use the recommended method in *Competing Risks: A Practical Perspective* by Melania Pintilie.

$$x^{\exp(z*se/(x*\log(x)))}$$

where  $x$  is the cumulative incidence estimate,  $se$  is the standard error estimate, and  $z$  is the z-score associated with the confidence level of the interval, e.g.  $z = 1.96$  for a 95% CI.

**p-values**

The p-values reported in cuminc(), glance.tidycuminc() and add\_p.tbl\_cuminc() are Gray's test as described in Gray RJ (1988) *A class of K-sample tests for comparing the cumulative incidence of a competing risk*, Annals of Statistics, 16:1141-1154.

**See Also**

Other cuminc() functions: [broom\\_methods\\_cuminc](#)

**Examples**

```
# calculate risk for entire cohort -----
cuminc(Surv(ttdeath, death_cr) ~ 1, trial)

# calculate risk by treatment group -----
cuminc(Surv(ttdeath, death_cr) ~ trt, trial)
```

---

gtsummary\_s3\_methods *gtsummary methods*

---

**Description**

These functions are S3 methods for working with `crr()` model results.

- `tbl_regression.tidycrr()`: This function sets the `tidycmprsk` tidier for `crr()` models.
- `global_pvalue_fun.tidycrr()`: This function ensures that `gtsummary::add_global_p(anova_fun)` uses the Wald test by default (instead of `car::Anova()`, which does not support this model type). The Wald test is executed with `cardx::ard_aod_wald_test()`, which wraps `aod::wald.test()`.

**Usage**

```
## S3 method for class 'tidycrr'
tbl_regression(x, tidy_fun = tidycmprsk::tidy, ...)

## S3 method for class 'tidycrr'
global_pvalue_fun(x, type, ...)
```

**Arguments**

<code>x</code>	( <code>tidycrr</code> ) <code>tidycmprsk::crr()</code> regression object
<code>tidy_fun</code>	(function) Tidier function for the model. Default is <code>tidycmprsk::tidy()</code> .
<code>...</code>	Additional arguments passed to <code>broom.helpers::tidy_plus_plus()</code> .
<code>type</code>	not used

**Value**

gtsummary table or data frame of results

**Examples**

```
crr(Surv(ttdeath, death_cr) ~ age + grade, trial) |>
  gtsummary::tbl_regression() |>
  gtsummary::add_global_p() |>
  gtsummary::as_gt()
```

---

predict.tidycrr      *Estimate subdistribution functions for crr objects*

---

### Description

Estimate subdistribution functions for crr objects

### Usage

```
## S3 method for class 'tidycrr'
predict(object, times = NULL, probs = NULL, newdata = NULL, ...)
```

### Arguments

object	a tidycrr object
times	Numeric vector of times to obtain risk estimates at
probs	Numeric vector of quantiles to obtain estimates at
newdata	A base::data.frame() or tibble::tibble() containing all the original predictors used to create x. Defaults to NULL.
...	not used

### Value

named list of prediction estimates

### See Also

Other crr() functions: [broom\\_methods\\_crr](#), [crr\(\)](#)

### Examples

```
crr(Surv(ttdeath, death_cr) ~ age, trial) %>%
  predict(times = 12, newdata = trial[1:10, ])
```

---

tbl\_cuminc      *Tabular Summary of Cumulative Incidence*

---

### Description

Tabular Summary of Cumulative Incidence

**Usage**

```
## S3 method for class 'tidycuminc'
tbl_cuminc(
  x,
  times = NULL,
  outcomes = NULL,
  statistic = "{estimate}% ({conf.low}%, {conf.high}%)",
  label = NULL,
  label_header = "**Time {time}**",
  estimate_fun = NULL,
  conf.level = x$conf.level,
  missing = NULL,
  ...
)

tbl_cuminc(x, ...)
```

**Arguments**

x	a 'tidycuminc' object created with cuminc()
times	Numeric vector of times to obtain risk estimates at
outcomes	character vector of outcomes to include. Default is to include the first outcome.
statistic	string of statistic to report. Default is "{estimate}% ({conf.low}%, {conf.high}%)"
label	string indicating the variable label
label_header	string for the header labels; uses glue syntax. Default is "**Time {time}**"
estimate_fun	function that styles and formats the statistics. Default is <code>~gtsummary::style_sigfig(.x, scale = 100)</code>
conf.level	Level of the confidence interval. Default matches that in <code>cuminc(conf.level=)</code> (typically, 0.95)
missing	string to replace missing values with. Default is an em-dash, "\U2014"
...	not used

**See Also**

Other `tbl_cuminc` tools: [add\\_cuminc](#)

**Examples**

```
# Example 1 -----
cuminc(Surv(ttdeath, death_cr) ~ 1, trial) |>
  tbl_cuminc(times = c(12, 24), label_header = "**Month {time}**")

# Example 2 -----
cuminc(Surv(ttdeath, death_cr) ~ trt, trial) |>
  tbl_cuminc(times = c(12, 24),
             outcomes = c("death from cancer", "death other causes"),
             label_header = "**Month {time}**")
```

---

trial

*Results from a simulated study of two chemotherapy agents*

---

**Description**

A dataset containing the baseline characteristics of 200 patients who received Drug A or Drug B. Dataset also contains the outcome of tumor response to the treatment.

**Usage**

trial

**Format**

A data frame with 200 rows—one row per patient

**trt** Chemotherapy Treatment

**age** Age

**marker** Marker Level (ng/mL)

**stage** T Stage

**grade** Grade

**response** Tumor Response

**death** Patient Died

**death\_cr** Death Status

**ttdeath** Months to Death/Censor

# Index

- \* **crr() functions**
  - broom\_methods\_crr, 5
  - crr, 8
  - predict.tidycrr, 12
- \* **cuminc tidiers**
  - broom\_methods\_cuminc, 7
- \* **cuminc() functions**
  - broom\_methods\_cuminc, 7
  - cuminc, 9
- \* **datasets**
  - trial, 14
- \* **tbl\_cuminc tools**
  - add\_cuminc, 2
  - tbl\_cuminc, 12
- \* **tidycrr tidiers**
  - broom\_methods\_crr, 5
- \* **tidycuminc tidiers**
  - broom\_methods\_cuminc, 7
- add\_cuminc, 2, 13
- add\_n.tbl\_cuminc (add\_cuminc), 2
- add\_nevent.tbl\_cuminc (add\_cuminc), 2
- add\_p.tbl\_cuminc (add\_cuminc), 2
- augment.tidycrr (broom\_methods\_crr), 5
  
- base\_methods\_crr, 4
- base\_methods\_cuminc, 5
- broom.helpers::tidy\_plus\_plus(), 11
- broom\_methods\_crr, 5, 9, 12
- broom\_methods\_cuminc, 7, 10
  
- coef.tidycrr (base\_methods\_crr), 4
- crr, 6, 8, 12
- crr(), 11
- cuminc, 8, 9
  
- glance.tidycrr (broom\_methods\_crr), 5
- glance.tidycuminc
  - (broom\_methods\_cuminc), 7
- global\_pvalue\_fun.tidycrr
  - (gtsummary\_s3\_methods), 11
  
- gtsummary\_s3\_methods, 11
  
- inline\_text.tbl\_cuminc (add\_cuminc), 2
  
- model.frame.tidycrr (base\_methods\_crr), 4
- model.frame.tidycuminc
  - (base\_methods\_cuminc), 5
- model.matrix.tidycrr
  - (base\_methods\_crr), 4
- model.matrix.tidycuminc
  - (base\_methods\_cuminc), 5
  
- predict.tidycrr, 6, 9, 12
  
- tbl\_cuminc, 3, 12
- tbl\_regression.tidycrr
  - (gtsummary\_s3\_methods), 11
- terms.tidycrr (base\_methods\_crr), 4
- tidy.tidycrr (broom\_methods\_crr), 5
- tidy.tidycuminc (broom\_methods\_cuminc), 7
- trial, 14
  
- vcov.tidycrr (base\_methods\_crr), 4