Package 'mmequiv'

July 23, 2025

Title Calculate Standardized Morphine Milligram Equivalent Doses

Version 1.0.0

Description Calculate morphine milligram equivalents (MME) for opioid dose comparison using standardized methods. Can directly call the 'NIH HEAL MME Online Calculator' <https://research-mme.wakehealth.edu/api> API or replicate API calculations on the user's local machine from the comfort of 'R'. Creation of the 'NIH HEAL MME Online Calculator' and the MME calculations implemented in this package are described in Adams MCB, Sward KA, Perkins ML, Hurley RW (2025) <doi:10.1097/j.pain.0000000000003529>.

License GPL (>= 3)

Imports cli, glue, httr2, lifecycle, rlang

Suggests dplyr, httptest2 (>= 1.1.0), spelling, testthat (>= 3.0.0), tibble, withr

Config/testthat/edition 3

Encoding UTF-8

RoxygenNote 7.3.2

URL https://kennethataylor.github.io/mmequiv/, https://github.com/KennethATaylor/mmequiv

Depends R (>= 4.1.0)

LazyData true

BugReports https://github.com/KennethATaylor/mmequiv/issues

Language en-US

Config/Needs/website rmarkdown

NeedsCompilation no

Author Kenneth A. Taylor [aut, cre, cph] (ORCID: <https://orcid.org/0000-0002-3205-9280>)

Maintainer Kenneth A. Taylor <kenneth.taylor.dpt@gmail.com>

Repository CRAN

Date/Publication 2025-05-19 23:50:03 UTC

Contents

`calculate_mme.data.frame`

Calculate morphine milligram equivalents (MME) with a `data.frame` *or tibble*

Description

Calculates the single-day MME and total MME for each individual prescription opioid medication submitted for calculation. Also calculates total MME, total days of supply, and four distinct Total MME/Day calculations from the NIH HEAL Online MME Calculator across all prescription medications for two different medication groupings: 1) opioids without buprenorphine and 2) opioids with buprenorphine.

Usage

```
## S3 method for class 'data.frame'
calculate_mme(
  x,
  id_col = "patient_id",
  medication_col = "medication_name",
  dose_col = "dose",
  doses_per_day_col = "doses_per_24_hours",
  days_col = "days_of_medication",
  therapy_days_col = "therapy_days",
  observation_days_col = "observation_window_days",
  therapy_days_without_col = NULL,
  observation_days_without_col = NULL,
  use_api = FALSE,
  ...
)

## S3 method for class 'tbl_df'
calculate_mme(
  x,
  id_col = "patient_id",
  medication_col = "medication_name",
  dose_col = "dose",
  doses_per_day_col = "doses_per_24_hours",
```

```
  days_col = "days_of_medication",
  therapy_days_col = "therapy_days",
  observation_days_col = "observation_window_days",
  therapy_days_without_col = NULL,
  observation_days_without_col = NULL,
  use_api = FALSE,
  ...
)
```

Arguments

x	(data.frame or tbl_df) Object with input data - either a data.frame or tibble with data in long format, with one row per medication per patient or participant (id_col) and including all necessary data for MME calculations (see opioid_trial data) and/or other function arguments
id_col	(charcter) Name of the column containing patient identifier; default is "patient_id"
medication_col	(charcter) Name of the column containing medication names; default is "medication_name"
dose_col	(charcter) Name of the column containing dose values; default is "dose"
doses_per_day_col	(charcter) Name of the column containing doses per 24 hours; default is "doses_per_24_hours"
days_col	(charcter) Name of the column containing days of medication; default is "days_of_medication"
therapy_days_col	(charcter) Name of the column containing therapy days with buprenorphine (up to one unique value per patient); default is "therapy_days"
observation_days_col	(charcter) Name of the column containing observation window days with buprenorphine (up to one unique value per patient); default is "observation_window_days"
therapy_days_without_col	(charcter) Name of the column containing therapy days without buprenorphine (up to one unique value per patient). If NULL (default), uses the value from therapy_days_col.
observation_days_without_col	(charcter) Name of the column containing observation window days without buprenorphine (up to one unique value per patient). If NULL (default), uses the value from observation_days_col.
use_api	(logical) Indicates whether to use the NIH HEAL Online MME Calculator API to perform

calculations or perform them locally instead. For `calculate_mme.data.frame()` and `calculate_mme.tbl_df()`, the default is `FALSE`, as the functions assume the user needs to perform the MME calculations without being restricted by the API rate limit of 50 patient-level calculations per 15 minutes. This also allows the user to perform the calculations without relying on internet access.

... These dots are for future extensions and must be empty.

Details

The function will provide the same results regardless of whether the user has specified they want calculation done using the API (`use_api`). Specifying `use_api == FALSE` helps overcome the online calculator API rate limit of 50 (patient-level) requests per 15 minutes. In addition to returning user-specified arguments, `calculate_mme()` also returns several other variables mentioned in the **Description** section. Output variable description details are below; see Adams, *et al.* (2025) for a comprehensive overview.

Value

A list containing three `data.frame` elements:

- `medications`: The original data with added prescription-level MME columns
- `patient_summary_with_buprenorphine`: Patient-level MME summary including buprenorphine
- `patient_summary_without_buprenorphine`: Patient-level MME summary excluding buprenorphine

Prescription-Level

Conversion Factor for <`medication_name`**>** (`factor`): the conversion factor used for calculating total MME/day.

MME for <`medication_name`**>** (`mme`): Morphine milligram equivalent for the whole prescription specified in `medication_name`, calculated as `(dose) * (doses_per_24_hours) * (factor) * (days_of_medication)`.

24h MME for <`medication_name`**>** (`single_day_mme`): Morphine milligram equivalent for the prescription specified in `medication_name` for a single day, calculated as `(dose) * (doses_per_24_hours) * (factor)`.

One day: Typically, the day with highest opioid exposure is entered, and the sum of 24-hour MME across the drugs that apply to this day is calculated. Highest MME in one day is definition 4.

Summary-Level:

On-therapy Days (`therapy_days`): The sum of prescription duration (`days_of_medication`) for each medication, but *with each calendar day counted only ONCE*. User-supplied; this is the denominator for MME/Day definition 2.

- If there is only one prescription, or if there is no calendar overlap (no days on which more than one prescription is active), this will be the same as the total days supply.
- If there are overlapping prescriptions, this is the number of unique calendar days.

Total MME (`total_mme`): The MME for each medication, summed across all prescriptions. This is the numerator for MME/Day definitions 1, 2, and 3.

Total Days Supply (`total_days`): The sum of the entered prescription duration (`days_of_medication`) for each of the `medications` (Med 1 duration + med 2 duration...). Automatically calculated. This is the denominator for MME/Day definition 1.

MME/Day:

MME/Day is an aggregate measure, calculating the total MME divided by a specified time window (a number of days). The MME/Day definitions specify the number of days:

MME/Day Definition 1 (`mme1`): Total Days Supply

MME Definition 1 = Total MME / Total Days Supply time window (sum of entered prescription durations).

```
mme1 = total_mme / total_days
```

- Note that the same calendar day may contribute multiple times, if overlapping prescriptions.
- Reason to select this definition: This is the least complicated calculation; appears best suited when immediate-release opioids are prescribed for short discrete times.
- Identified challenge with this definition: It consistently underestimated MME per day when overlapping prescriptions were present or when immediate-release and extended release opioids were prescribed concurrently.

MME/Day Definition 2 (`mme2`): On-therapy Days

MME Definition 2 = Total MME / On-therapy Days time window (sum of entered prescription durations except each calendar day is counted only ONCE).

```
mme2 = total_mme / therapy_days
```

- Note - On-therapy Days unique calendar days.
- Reason to select this definition: Provides a smoothed measure useful in studies of dose-dependent adverse effects, including opioid-induced constipation or overdose in patients with opioid tolerance or who have been stable on opioids.
- Identified challenge with this definition: The metric is time-varying and affords the greatest flexibility to define medication gap periods and leftover/unused medications to improve pharmacoepidemiologic studies.

MME/Day Definition 3 (`mme3`): Fixed Observation Window

Uses the Total MME study-specified fixed observation window. MME Definition 3 = Total MME / Number of days in observation window:

```
mme3 = total_mme / observation_window_days
```

- If this definition is selected, it is important to report on the duration of the fixed window.
- Reason to select this definition: Most suitable for studies with a known or suspected duration of risk during which adverse events are expected to occur, such as incidence of opioid use disorder. This definition may be useful when prescriptions are filled at irregular time intervals on a as needed basis (*pro re nata*, PRN).
- Identified challenge with this definition: The definition consistently had the lowest milligrams per day for immediate-release opioids. It is the most robust to misspecification, amenable to transformations, and has the least noise when constructing continuous functions. However, since it assumes uniform exposure/risk within a window, there is less scope for time-varying adjustment.

- This is the definition recommended by the Department of Health and Human Services Office of the Inspector General.

MME/Day Definition 4 (`mme4`): Maximum Daily Dose

Uses the sum of 24-hour MME for the day with highest opioid exposure.

MME Definition 4 = Drug 1 (dose (mg) x # of doses per day) x conversion factor + Drug 2 (dose (mg) x # of doses per day) x conversion factor + ...

```
mme4 = sum(dose * doses_per_24_hours * factor)
```

- Report the highest single-day exposure.
- Reason to select this definition: A toxicological perspective may be appropriate for patients with no opioid tolerance and in the presence of comorbidities for respiratory depression. It appears to be best suited for immediate dose-dependent toxic effects, such as respiratory depression.
- Identified challenged with this definition: This definition may have limited use if it includes opioids where fatal toxicity does not involve respiratory depression (e.g., tramadol) or have atypical *mu*-opioid receptor agonism (e.g., tapentadol, buprenorphine).
- The definition assumes uniform risk of adverse outcomes regardless of time on-therapy. More so than the others, this definition is prone to influence from early refills, unused medication, and how the 90 MME threshold is operationalized.
- This definition underlies the algorithm embedded in the CDC Opioid Guideline mobile app. There may be difficulty reconciling findings with studies using the other definitions because it returns a MME per day that is significantly higher.
- This calculator sums the 24-hour MME for every prescription, without considering calendar dates.

See Also

`calculate_mme.list()`

Examples

```
library(dplyr)
# Calculate MME using long-format data
# Subset of opioid_trial data used for speedier example
mme <- calculate_mme(
  x = opioid_trial |> dplyr::filter(patient_id %in% sprintf("P%03d", 1:100)),
  therapy_days_without_col = "therapy_days_without",
  observation_days_without_col = "observation_window_days_without"
  )

head(mme$medications)

head(mme$patient_summary_with_buprenorphine)

head(mme$patient_summary_without_buprenorphine)

# Cleanup
rm(mme)
```

`calculate_mme.list` *Calculate morphine milligram equivalents (MME) for a single study participant*

Description

Calculates the single-day MME and total MME for each individual prescription opioid medication submitted for calculation. Also calculates total MME, total days of supply, and four distinct Total MME/Day calculations from the NIH HEAL Online MME Calculator across all prescription medications for two different medication groupings: 1) opioids without buprenorphine and 2) opioids with buprenorphine.

Usage

```
## S3 method for class 'list'
calculate_mme(x, therapy_days, observation_window_days, use_api = TRUE, ...)
```

Arguments

`x` (`list`)
A `list` of medications. Each element must be a nested `list` containing each of the following fields:

- `medication_name`: a string matching an API-accepted medication name and its dosage units. To see a full list of API-accepted values, run `get_med_list()`.
- `dose`: a positive number indicating the dose of the associated opioid medication listed in the `medication_name` field. Units of `dose` should match the units listed in `medication_name`.
- `doses_per_24_hours`: a positive number indicating the number of doses in 24 hours.
- `days_of_medication`: a positive number indicating the duration of the opioid medication prescription listed in the associated `medication_name` in days.

`therapy_days` (`numeric`)
Either a single positive number or a vector of two positive numbers indicating the sum of prescription duration (days) for each medication, but *with each calendar day counted only ONCE*. When a single number is provided, it is used for the both the "with buprenorphine" and "without buprenorphine" MME calculations; when a vector of 2 numbers is provided (e.g., `c(10, 18)`) then the first and second numbers in the vector are used for the "with buprenorphine" and "without buprenorphine" MME calculations, respectively. This is the denominator for MME/Day definition 2.

- If there is only one prescription *or* if there is no calendar overlap (i.e., no days on which more than one prescription is active) this will be the same as the total days supply returned by the calculator API (`total_days`).
- If there are overlapping prescriptions, this is the number of *unique* calendar days.

`observation_window_days`
: (`numeric`)
Either a single positive number or a vector of two positive numbers indicating a study-defined fixed observation window of time. Typical choices are 7 day, 14 day, 30 day, 90 day. When a single number is provided, it is used for the both the "with buprenorphine" and "without buprenorphine" MME calculations; when a vector of 2 numbers is provided (e.g., `c(7, 30)`) then the first and second numbers in the vector are used for the "with buprenorphine" and "without buprenorphine" MME calculations, respectively. This is the denominator for MME/Day definition 3.

`use_api`
: (`logical`)
Indicates whether to use the NIH HEAL Online MME Calculator API (default) to perform calculations or perform them locally instead (`FALSE`). Setting to `FALSE` allows the user to perform the same calculations without being restricted by the Online MME Calculator API rate limit of 50 patient calculations per 15 minutes and also allows the user to perform the calculations without relying on internet access.

`...`
: These dots are for future extensions and must be empty.

Details

The function will provide the same results regardless of whether the user has specified they want calculation done using the API (`use_api`). Specifying `use_api == FALSE` helps overcome the online calculator API rate limit of 50 (patient-level) requests per 15 minutes. In addition to returning user-specified arguments, `calculate_mme()` also returns several other variables mentioned in the **Description** section. Output variable description details are below; see Adams, *et al.* (2025) for a comprehensive overview.

Value

A `list` of MME calculations. Will error if any medications are invalid or if any numeric parameters are not positive numbers.

Prescription-Level

Conversion Factor for <`medication_name`> (`factor`): the conversion factor used for calculating total MME/day.

MME for <`medication_name`> (`mme`): Morphine milligram equivalent for the whole prescription specified in `medication_name`, calculated as `(dose) * (doses_per_24_hours) * (factor) * (days_of_medication)`.

24h MME for <`medication_name`> (`single_day_mme`): Morphine milligram equivalent for the prescription specified in `medication_name` for a single day, calculated as `(dose) * (doses_per_24_hours) * (factor)`.

One day: Typically, the day with highest opioid exposure is entered, and the sum of 24-hour MME across the drugs that apply to this day is calculated. Highest MME in one day is definition 4.

Summary-Level:

On-therapy Days (`therapy_days`): The sum of prescription duration (`days_of_medication`) for each medication, but *with each calendar day counted only ONCE*. User-supplied; this is the denominator for MME/Day definition 2.

- If there is only one prescription, or if there is no calendar overlap (no days on which more than one prescription is active), this will be the same as the total days supply.
- If there are overlapping prescriptions, this is the number of unique calendar days.

Total MME (`total_mme`): The MME for each medication, summed across all prescriptions. This is the numerator for MME/Day definitions 1, 2, and 3.

Total Days Supply (`total_days`): The sum of the entered prescription duration (`days_of_medication`) for each of the `medications` (Med 1 duration + med 2 duration...). Automatically calculated. This is the denominator for MME/Day definition 1.

MME/Day:

MME/Day is an aggregate measure, calculating the total MME divided by a specified time window (a number of days). The MME/Day definitions specify the number of days:

MME/Day Definition 1 (`mme1`): Total Days Supply

MME Definition 1 = Total MME / Total Days Supply time window (sum of entered prescription durations).

```
mme1 = total_mme / total_days
```

- Note that the same calendar day may contribute multiple times, if overlapping prescriptions.
- Reason to select this definition: This is the least complicated calculation; appears best suited when immediate-release opioids are prescribed for short discrete times.
- Identified challenge with this definition: It consistently underestimated MME per day when overlapping prescriptions were present or when immediate-release and extended release opioids were prescribed concurrently.

MME/Day Definition 2 (`mme2`): On-therapy Days

MME Definition 2 = Total MME / On-therapy Days time window (sum of entered prescription durations except each calendar day is counted only ONCE).

```
mme2 = total_mme / therapy_days
```

- Note - On-therapy Days unique calendar days.
- Reason to select this definition: Provides a smoothed measure useful in studies of dose-dependent adverse effects, including opioid-induced constipation or overdose in patients with opioid tolerance or who have been stable on opioids.
- Identified challenge with this definition: The metric is time-varying and affords the greatest flexibility to define medication gap periods and leftover/unused medications to improve pharmacoepidemiologic studies.

MME/Day Definition 3 (`mme3`): Fixed Observation Window

Uses the Total MME study-specified fixed observation window. MME Definition 3 = Total MME / Number of days in observation window:

```
mme3 = total_mme / observation_window_days
```

- If this definition is selected, it is important to report on the duration of the fixed window.
- Reason to select this definition: Most suitable for studies with a known or suspected duration of risk during which adverse events are expected to occur, such as incidence of opioid use disorder. This definition may be useful when prescriptions are filled at irregular time intervals on a as needed basis (*pro re nata*, PRN).
- Identified challenge with this definition: The definition consistently had the lowest milligrams per day for immediate-release opioids. It is the most robust to misspecification, amenable to transformations, and has the least noise when constructing continuous functions. However, since it assumes uniform exposure/risk within a window, there is less scope for time-varying adjustment.
- This is the definition recommended by the Department of Health and Human Services Office of the Inspector General.

MME/Day Definition 4 (`mme4`): Maximum Daily Dose

Uses the sum of 24-hour MME for the day with highest opioid exposure.

MME Definition 4 = Drug 1 (dose (mg) x # of doses per day) x conversion factor + Drug 2 (dose (mg) x # of doses per day) x conversion factor + ...

```
mme4 = sum(dose * doses_per_24_hours * factor)
```

- Report the highest single-day exposure.
- Reason to select this definition: A toxicological perspective may be appropriate for patients with no opioid tolerance and in the presence of comorbidities for respiratory depression. It appears to be best suited for immediate dose-dependent toxic effects, such as respiratory depression.
- Identified challenged with this definition: This definition may have limited use if it includes opioids where fatal toxicity does not involve respiratory depression (e.g., tramadol) or have atypical *mu*-opioid receptor agonism (e.g., tapentadol, buprenorphine).
- The definition assumes uniform risk of adverse outcomes regardless of time on-therapy. More so than the others, this definition is prone to influence from early refills, unused medication, and how the 90 MME threshold is operationalized.
- This definition underlies the algorithm embedded in the CDC Opioid Guideline mobile app. There may be difficulty reconciling findings with studies using the other definitions because it returns a MME per day that is significantly higher.
- This calculator sums the 24-hour MME for every prescription, without considering calendar dates.

See Also

`calculate_mme.data.frame()`

Examples

```
# Recreating example from Adams MCB, et al. 2025 supplement
#     https://links.lww.com/PAIN/C213
meds_list <- list(
  list(
    medication_name = "Morphine (mg)",
    dose = 5,
    doses_per_24_hours = 4,
```

```
    days_of_medication = 7
    ),
  list(
    medication_name = "Morphine (mg) LA",
    dose = 10,
    doses_per_24_hours = 3,
    days_of_medication = 30
    )
)

# Using API
calculate_mme(meds_list, 30, 90)

# Not using API
calculate_mme(meds_list, 30, 90, use_api = FALSE)

# Clean up meds_list
rm(meds_list)
```

`get_med_list` *Retrieve full opioid medication list*

Description

Retrieve full opioid medication list

Usage

```
get_med_list()
```

Value

A `data.frame` with full list of opioid medication names (`med_name`) that are compatible with the MME calculator along with their conversion factors (`cf`).

See Also

`search_meds()`

Examples

```
get_med_list()
```

opioid_trial *Opioid Trial Data*

Description

Example (synthetic) data provided as an example of long format data to use with `calculate_mme_df()`.

Usage

```
opioid_trial
```

Format

`opioid_trial`**:**

A data frame with 2,371 rows and 9 columns:

patient_id Patient identifier; includes 1000 separate patients

medication_name Medication names of prescription opioids used by the patient

dose Dosage of the medication

doses_per_24_hours Number of daily doses for the medication

days_of_medication Duration of medication in days

therapy_days Sum of prescription duration (days) for across all of the patient's medications, but with each calendar day counted only ONCE

observation_window_days study-defined fixed observation window of time, applied to all of the patient's medications

therapy_days_without Sum of prescription duration (days) for across all of the patient's medications (excluding buprenorphine), but with each calendar day counted only ONCE

observation_window_days_without study-defined fixed observation window of time, applied to all of the patient's medications (excluding buprenorphine)

search_meds *Search opioid medication list*

Description

Search opioid medication list

Usage

```
search_meds(med_name = NULL)
```

Arguments

`med_name`	A single string specifying the medication name to search for.

Value

A `data.frame` containing medications matching the `med_name` argument and their associated conversion factor(s) (`cf`).

See Also

`get_med_list()`

Examples

```
search_meds("oxy")
```

Index